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SAPTHAGIRI
College of Engineering
Creating Tomorrow

In Association With

International Conference on

"Global Convergence in Technology, Entrepreneurship, Computing and Value Engineering: Principles and Practices"

(ICGCP—2021)

16th - 17th July, 2021

Conference Proceedings

Jointly Organized by
Department of
Mechanical Engineering, Civil Engineering, Physics & Mathematics

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Preface

Sapthagiri College of Engineering, Bengaluru was established in the year 2001 by Srinivasa Education and Charitable Trust with a vision to transform its students into competent, inspired and responsible professionals. It is one of the best Engineering Colleges in India.

It is our great honour and pleasure to publish the Proceedings of the International Conference on Global Convergence in Technology and Entrepreneurship, Computing and Value Engineering, Principles and Practices - 2021 (ICGCP – 2021). The conference was held on 16th and 17th July, 2021 in virtual mode. The conference was organized to encourage the young research minds and also to bring all researchers, academics, scientists, industry experts, on a common platform.

Present global scenario demands unprecedented actions and efforts to converge social, economic and environment issues. Science, Technology and Innovations in the area of Internet of Things, Artificial Intelligence, Bio-Technology, Nano Materials and Renewable Energy must play a key role in achieving these goals. The call for Make in India products by the central and state governments has given impetus to start-ups and entrepreneurships. The conference covered all emerging areas of Science, Engineering and Technology towards fulfilling the objectives.

The response to call for papers was excellent. More than 500 papers were received from across the country, out of which 320 papers were selected for presentation and publication in the proceedings. These papers provided a wide spectrum of research covering all the areas for which the conference was intended.

We wish to express our deepest thanks and gratitude to speakers B.R. Indushekar Head, Operations Development Volvo Construction Equipment, Bangalore and Dr.Yared Abera Ergu Dean, School of Technology Ambo University, Ethiopia for delivering keynote addresses. We would like to express our gratitude and appreciation to the authors for their contributions. Many thanks go as well to all of the reviewers who helped us maintain the quality of the research papers included in the Proceedings. Our sincere thanks go to the Management for their encouragement and support for conducting the conference. We also express our sincere thanks to the members of the organizing team for their dedication and hard work.

Conference Chair of ICGCP – 2021

Dr. Ramakrishna H

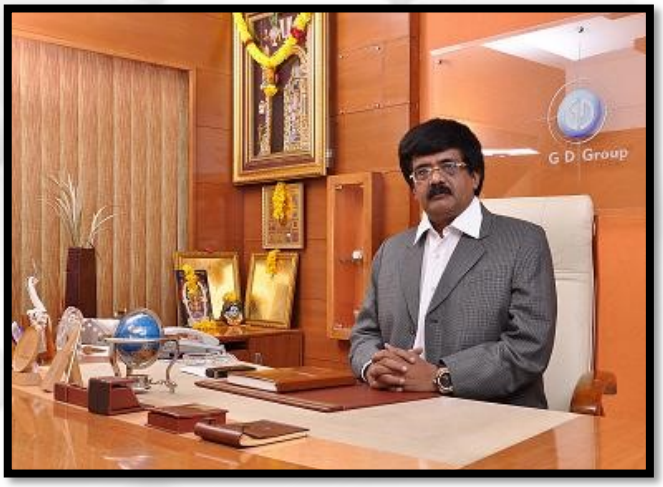
Principal.

Conference Co-Chair

Dr. Shripad Markande

Prof. & Head, Department of Mathematics.

On behalf of the ICGCP – 2021 Organizing Committee



Sri. G Dayananda
Chairman

Message from The Chairman

It gives me immense pleasure in congratulating the Chairman and team members of ICGCP- 2021, on successfully hosting the two days international conference at Sapthagiri college of Engineering. We are overwhelmed by the kind of response received by the research scholars across the country and I wish all of them a bright future and successful career. Also I would like to appreciate the contributions from the Principal, Heads of Departments, faculty and staff of the college for joining their hands in successful conduct of the international conference.

Sri. G.D Manoj
Executive Director

Message from Executive Director

On this occasion, I express my heartiest congratulations to all the participants of ICGCP-2021 for presenting and publishing their research findings in the international conference. I hope that, the two-day international conference has motivated faculty, research scholars and students to continue their research. Also on behalf of the Management, I would like to extend my appreciation to the sincere efforts of Principal, Heads of Departments, and Staff members of Sapthagiri College Engineering.

Message from Principal

Dr. H Ramakrishna
Principal

At the outset I would like to congratulate the entire team of ICGCP-2021 for successfully organizing "Global Convergence in Technology, Entrepreneurship, Computing and Value Engineering: Principles and Practices – 2021" which witnessed active participation of more than 320 research scholars from across the Karnataka and outside. On this occasion, I would like to thank our Chairman, Shri. G. Dayananda and Executive Director, Shri. G. D. Manoj for the magnanimous support extended in organizing the conference. I would also like to congratulate all the faculty, research scholars and undergraduate students for publishing their research works in the conference and I hope that the two-day interaction has motivated them to further pursue their research work and contribute to society. Also I would like to appreciate the efforts of session chairs / reviewers / heads of departments / technical support team for their contributions in adding value to all the sessions. Finally, I would like to congratulate the team ICGCP-2021 for bringing out the proceedings of the conference in a precise manner and for making it available for the researchers' community.

CONTENTS

DESIGN OPTIMIZATION AND PROOF OF CONCEPT FOR A FLAT SOLE AND ITS MOULD

K. Saketh [1]

Dr. K.Lokesha [2]

G. Mohan Pradeep [3]

[1]*MTech, Mechanical engineering department/MS Ramaiah Institute of Technology, Bangalore, 560054.India*

[2] *Assistant Professor, Mechanical engineering department/ MS Ramaiah Institute of Technology, Bangalore, 560054.India*

[3] *Manager, leather and mould technologist Hua Yao Mould , Ranipet, 632509*

Abstract

Sole of the shoe or any footwear is the outer bottom section of the shoe which comes in contact with the ground or surface of the floor. The purpose of the sole is to protect the feet of the wearer from environmental factors. Shoe industry has large number of companies which are constantly competing with each other and each of them introduce new and improved designs in order to meet the customer demands. The objective of present work is to model and fabricate a Flat sole mould by changing the pattern of the on the bottom section. The new design must be obtained from comparing an already existing sole with a varying height and one which has heel. Three existing sample sole and a sample in the form of an image for designing the new mould for the sole are used to carry out the present work. The mould must be designed to undergo compression moulding process. Computer Aided Design (CAD) and Computer Aided Manufacturing (CAM) commercial software's are used to design and fabricate the mould in order to deliver the product quickly and with high accuracy.

***Keywords**: Design optimization, flat sole and mould.*

Introduction

Shoe soles, also most commonly referred to as out soles, that are located at the bottom of the shoes which actually come in contact with the ground. This section of the sole needs to be sturdy enough to withstand the weight of the person wearing the shoes, they need to be flexible enough to bend to provide a fluid motion during walking. Soles are very complex in shape and have changing profile pattern.

There are several companies in the market that make their own shoes. The public have a wide range of designs to choose from. In order to satisfy the public. Companies introduce need designs to appeal to the public. In some cases, certain variety of designs have a higher demand. Hence while launching a new pattern, the companies modify an older more successful designs by combining two or more existing designs.

The customer takes a life size replica pattern of the foot and uses it to design the sole. Shape of the sole changes for men and female shoes. It also depends on the type of shoe that needs to be manufactured. In order to keep up the demand and to attract the public, aesthetics play an

important role in the design of the sole. Intricate and complicated shaped may be involved that are incorporated into the design of the sole. And some shapes are very unsymmetric in their shape which helps in providing grip to the wearer. All these aspects and considered and the customer places the order. But due to rapid rise in demand and computation in the market, new methods need to be implemented in order to produce the product quickly. By implementing Computer aided drawing and Computer aided manufacturing the time for manufacturing can be reduced drastically. Introduction of computer into the manufacturing field has drastically reduced the machining time, drawing time and increased quality and accuracy of the product. High quality products and complicated designs can be produced in short time.

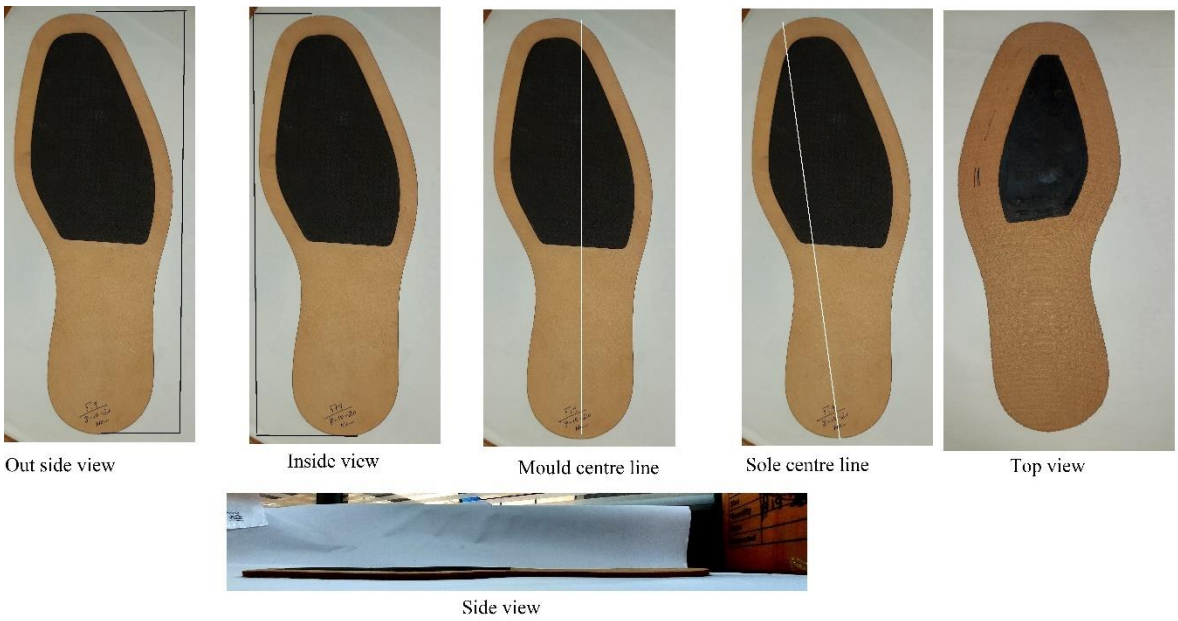


Fig: A typical Sole.

Methodology involved in fabricating the mould:

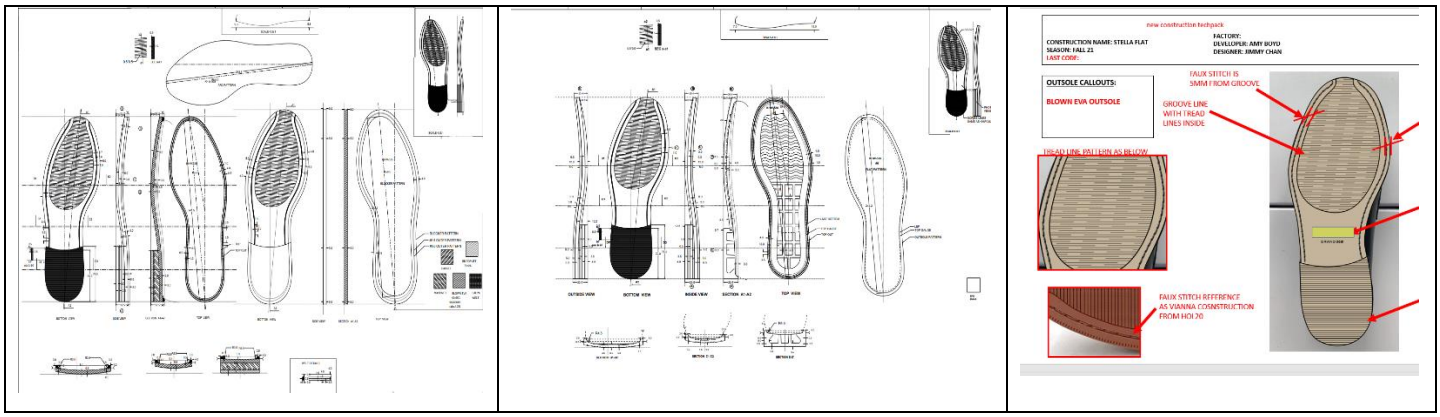
In order to manufacture a mould for a new sole. The process starts by making the sole design first. And then the mould is reverse engineered from the 2D drawing. The steps involved to fabricate a flat sole mould are as follows:

1. 2D drawing: A 2D drawing of the sole is designed. This was is done according customer design parameters.
2. Conversation of 2D to 3D model: the 2D drawing was used to create a 3D model of the sole.
3. Resin board core machining: A life size replica of the sole was created. This is used as prototype which will be used for customer approval before mould fabrication and also as core which will be used for silicon casting.
4. Silicon and POP cast: the resin board is used for making a silicon rubber cast and this silicon rubber cast is later used for POP casting.
5. Mild steal casting: the POP cast is used as a mould for casting mild steal of the final mould.

6. 3D scanning and 3dmould modeling: the casted mild steal is 3D scanned; this scanned data is used to create a 3D virtual model in the computer software.
7. CNC codes generation for mild steal. The 3D mould model is used for virtually simulating the tool motion and then to generate CNC codes.

2D design.

The customer had sent 3 pre-existing designs for reference. The new design, the existing designs which were sent were designed for sole which had heel. But the new design was designed for a flat sole without heel.



Design 1 heel with plane top surface

Design 2 heel with plane sturdy structure on top surface

Design 3 heel with plane for stitches

The final sole drawing was designed by combining the 3 reference designs. The new design was designed to a be flat sole. The benefit of a flat sole over sole with heel is that multiple sizes of the sole could be obtained form a single mould.

The final design was obtained using rhinoceros software:

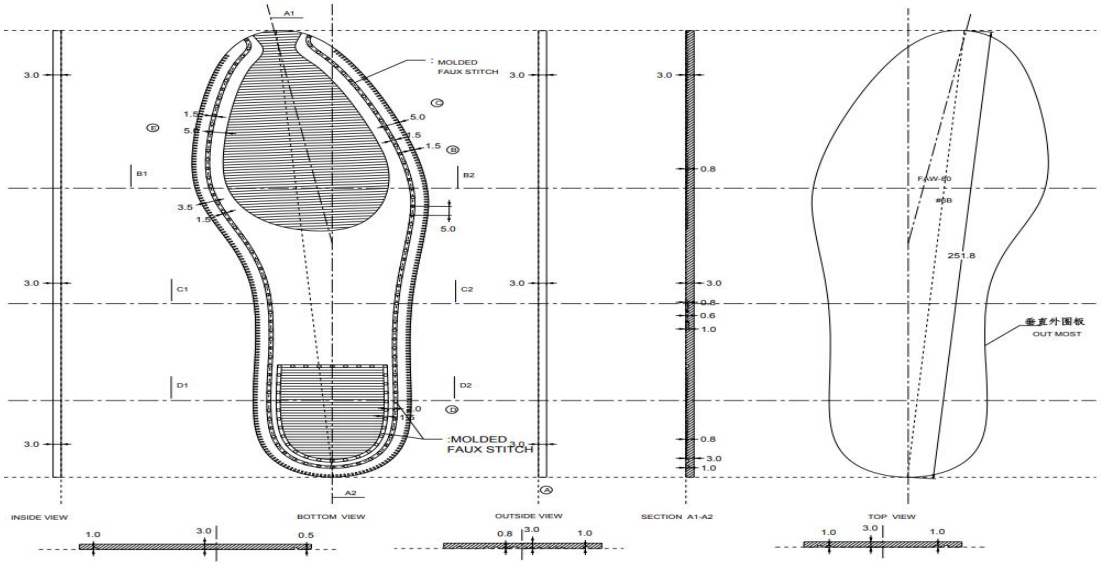


Fig: New deign

2D to 3D conversation

3D modeling helps in visualizing the actual shape of the sole that requires the mould for. The model which needs to be converted from 2D to 3D will be directly be utilized in fabricating the wooden model of the sole. Various textures are added during the 3D modeling process. The basic principle of 2D drawing to 3D model is to extending or protrude the surface from the 2D sections. Since the resin board model was used as cast. The shrinkage of both rubber and mild steal is calculated and to obtain the optimal dimensions of the sole during production. The shrinkage value is considered and added in the 3D model during conversation to increase the dimensions.

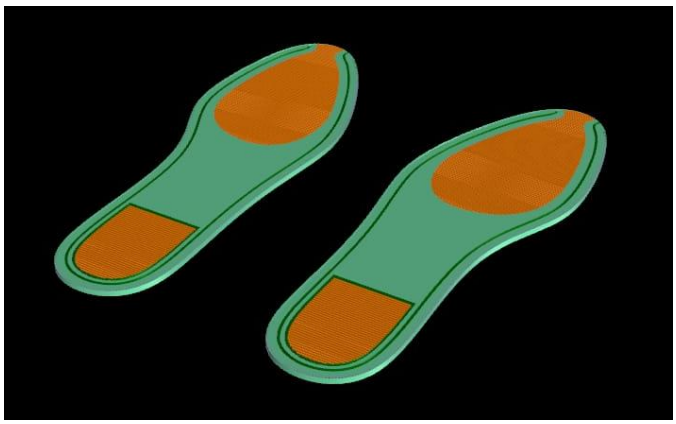


Fig: 3D deign model in **rhinoceros** software

Shrinkage of mild steel: 2.3%

Shrinkage of rubber: 2.2%

Total shrinkage = shrinkage or mild steel + shrinkage of rubber

= 2.3%+2.2%

=4.5%

This obtained total shrinkage must be scaled to the existing geometric parameters to obtain an optimal mould than produces the product that is in accordance with customer specifications.

100/4.5= 0.045

Considering a unit square length 1 as reference, the obtained shrinkage is added to the value reference unit square length which will be used as scaling value to increase the geometry of the mould equally.

1+0.045

= 1.045mm

This value is used in the software to scale the dimensions automatically.

NC codes generation for resin board:

The raw block as shown before is cut from a large raw block of length 700mm, width 400mm and thickness of 50mm is used to obtain the resin board model. The CimatronE7.0 software was used for generating the NC codes.

The different tools and machining parameters used for machining are as follows:

Tool name	Step over value (mm)	Step down value(mm)	Spindle speed (rpm)	Feed /moment (mm/minute)
E6	3	2.5	4500	6500
E6	3	2.5	4500	6500
B6	3	2	4500	6500
B6	2.5	0	4500	6500
B3	0.2	0	3500	6500
B0.5	0.1	0	1200	6500
E0.3	0.06	0	1000	6500
E1.5	0.25	0	2500	6500
E0.3	0.12	0.166	1000	6500

Silicon rubber casting:

Mallet is used for taking a die cast using silicon rubber resin. First a frame of 310mm*420mm *50mm is marked on a steel frame around the mallet. Additional 10mm was provided on the length and width of the mould and 30mm extra marital on the height. which was later machined to remove surface defects and also to obtain a smooth surface finish from the casted block. Then the liquid silicon is poured in the open end of the frame. The liquid silicon was allowed to cure for 2 hours in room temperature.

Plaster of Paris Casting

Liquid Plaster of Paris which a combination of limestone and water is poured into the rubber cast to take the impression of the cavity. A mixture of lime stone and water used was 1:1 ratio. A rectangular steal frame is used to hold the mould in shape in order to be used to fill the POP mixture. The frame dimension used was same as that of the silicon rubber cast. Which was between of 310mm*420mm*80mm. And this POP cast was placed in an oven whose temperature was maintained at 480C° for a period of 8 hours.

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3D SCANNING

After the casting, the mould is covered with defects like, pores, blow holes, cracks and excess material. The mould is to surface finished before delivering it to the customer. Before sending the mould for finishing. The casted mould is 3D scanned. The scanned model is than converted to STL format so that the 3D modeling and finishing can be simulated virtually.

3D Mould Modeling

To reduce machining time and also to improve quality of the mould. Computer Numerical Controller machine was used to reduce the time for machining. A 3D model needs to be created in order for the tool to move in the software. In order to make a model. STL file obtained from the scanning department of the mould was used to create a smooth 3D life size replica of the mould in **rhinoceros'** software. The runner and Pillars and bushes were also created using the STL file. The bush and pin structure are a standard that remains common in every mould.

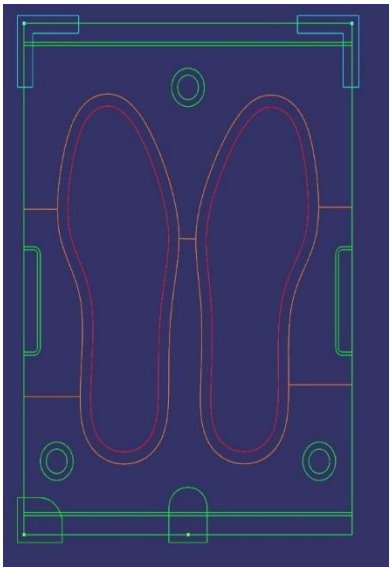

Fig: 3D design of the mould in **rhinoceros'** software

NC CODES GENERATION FOR MILD STEAL MOULD STEEL

Two sets of CNC codes need to be generated. One for the bottom plate which has the mould cavity and also this was obtained from the casting mild steal. The 3D mould's STL file is imported into CimatronE7.0 software. The code tools available for the process is selected based on the 2D drawing. The NC codes for the top plate were simulated from a raw block of 300mm*400mm*50mm.

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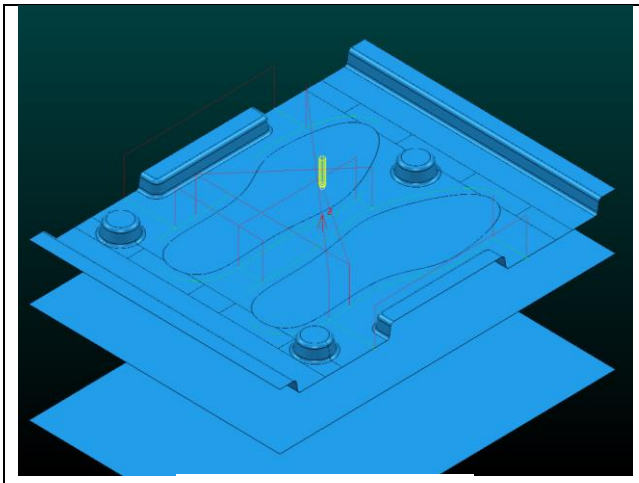
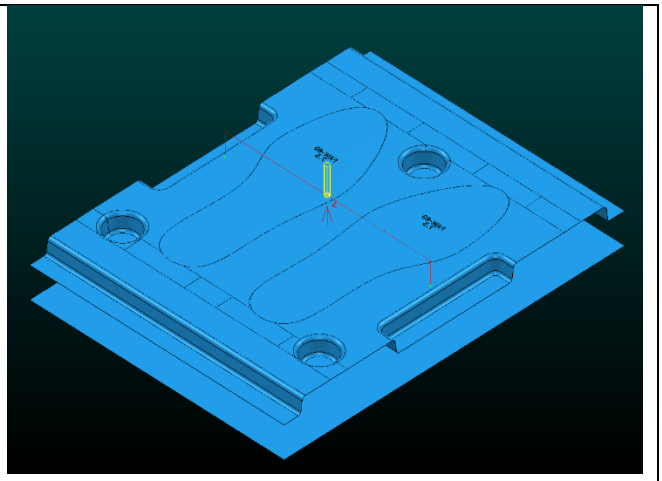
The different tools and machining parameters used for machining are as follows:

Tool name	Step over value (mm)	Step down value(mm)	Spindle speed (rpm)	Feed /moment (mm/minute)
25R5	15.0	1.1	8000	4500
E-12	6.0	0.35	8500	4500
E-6	3.0	0.15	12500	5000
B-10	0.33	0.15	10000	5000
B-6	0.235	0.12	12500	5000
B-3	0.135	0.1	14500	5000
E-3	0.135	0.13	14500	5000



Bottom plate



Top plate

Conclusion

The new design was designed using the 3 existing designs. The outer pattern was altered by considering the first and second reference designs. The stitch pater was obtained from the third reference design. A combination of the 3 designs of the once with heel was used to make a new design for the flat sole. Using the said using 3 model of the sole was created and a resign board and model of the sole was machined with the help of a 3 axis CNC machine. Using the resin board model mild steal cast was obtained and the further machining of the flat sole was carried out. The obtained mould was approved by the customer.

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References

1. Rawi, I.I.M., Karuppannan, G. and Abd, K., 2020. 2D CAD Engineering Drawing for Industrial Design: Furniture and Products Designed by Students. *INTERNATIONAL JOURNAL OF ACADEMIC RESEARCH IN BUSINESS AND SOCIAL SCIENCES*, *10*(2).
2. Mamilla, V.R., Srinivasulu, M. and Mani, P.N., 2016. Study on computer numerical control (CNC) machines. *International Journal of Advanced Scientific Research*, *1*(1), pp.21-25.
3. Boër, C.R., Dulio, S. and Jovane, F., 2004. Shoe design and manufacturing.
4. Lord, M., Foulston, J. and Smith, P.J., 1991. Technical evaluation of a CAD system for orthopaedic shoe-upper design. *Proceedings of the Institution of Mechanical Engineers, Part H: Journal of Engineering in Medicine*, *205*(2), pp.109-115.
5. Telfer, S. and Woodburn, J., 2010. The use of 3D surface scanning for the measurement and assessment of the human foot. *Journal of foot and ankle research*, *3*(1), pp.1-9.
6. Xiong, S., Zhao, J., Jiang, Z. and Dong, M., 2010. A computer-aided design system for foot-feature-based shoe last customization. *The International Journal of Advanced Manufacturing Technology*, *46*(1), pp.11-19.
7. Smith, G. and Claustre, T., 2006. A case study on concept design and CAD modelling in the footwear industry. In *DS 36: Proceedings DESIGN 2006, the 9th International Design Conference, Dubrovnik, Croatia*.
8. Krar, S.F., Gill, A. and Smid, P., 2001. *Computer numerical control simplified*. Industrial Press Inc..
9. Eryilmaz, M.S., 2012. Analysis of shoe manufacturing factory by simulation of production processes. *Southeast Europe Journal of Soft Computing*, *1*(1).
10. Usman, M.M., Ahmad, A.S., Sulaiman, N.A. and Ibrahim, M.A., 2016. Application of CAD/CAM tools in the production of investment casting part. *IOSR Journal of Mechanical and Civil Engineering*, *13*(1), pp.1684-2278.
11. Zhang, Y., Luximon, A., Pattanayak, A.K. and Zhang, M., 2012. Shoe-last design exploration and customization. *Journal of The Textile Institute*, *103*(5), pp.541-548.
12. https://m.made-in-china.com/product/Chemical-Wood-702969521.html
13. https://www.alibaba.com/product-detail/Better-surface-structure-ZS-TOOL-Epoxy_60710031091.html
14. https://explorecomposites.com/articles/tooling/machinable-tooling-boards/
15. https://www.futurefootwear.in/making-sole-moulds-5-mould-design-by-casting-process/
16. https://en.tempo.co/read/916026/4-advantages-of-wearing-flat-shoes
17. https://www.inescop.es/en/software-for-footwear/2d-footwear-design

A REVIEW ON METAL INJECTION MOLDING PROCESS

Prathibha D S[1], Dr. Jaya Christiyan K G[2]

[1] *M Tech, Mechanical engineering department/MS Ramaiah Institute of Technology, Bangalore, 560054.India*
[2] *Assistant Professor, Mechanical engineering department/ MS Ramaiah Institute of Technology, Bangalore, 560054.India*

Abstract

Metal injection molding (MIM) is a method for producing metal parts by using plastic injection molding technique. In Metal Injection Molding process small metal parts can be manufactured with precision shape forming ability. MIM method produces metal parts with complicated shapes and small tolerances, with use of the injection molding machine. The aim of this Paper is to cover the whole metal injection molding process and all the stages involved. Metal injection molding (MIM) is a process where metal powder is mixed with binder material in order to create feedstock which is then fed into injection molding machine. Complex and high volume parts can be produced. After molding, the part undergoes debinding and sintering operations

Introduction

Metal Injection Molding (MIM) is a technology to form metals and alloys into desired shape. Metal Injection Molding process is a blend of plastic injection molding and powder metallurgy technique. Producing cost-effective, complex shaped parts in both large and small volumes metals and inter metallic compound are the advantage of Metal Injection Molding Process. MIM is a process that is developed from the combination of plastic injection molding and traditional powder metallurgy technique. MIM is similar to plastic injection molding as the material is fed into a heated barrel, mixed and pushed into a mould cavity where it cools and then hardens to the mould cavity shape. Moreover, MIM is similar to traditional powder metallurgy in that procedure is able to compact a lubricated powder mix in a rigid die by uni-axial pressure, eject the compact from the die and sinter it. MIM is also a branch of powder injection molding (PIM), which is a subject that covers both metallic and non-metallic powder used in the manufacturing of small-to-medium-complex shaped parts in large numbers [1]-[2]

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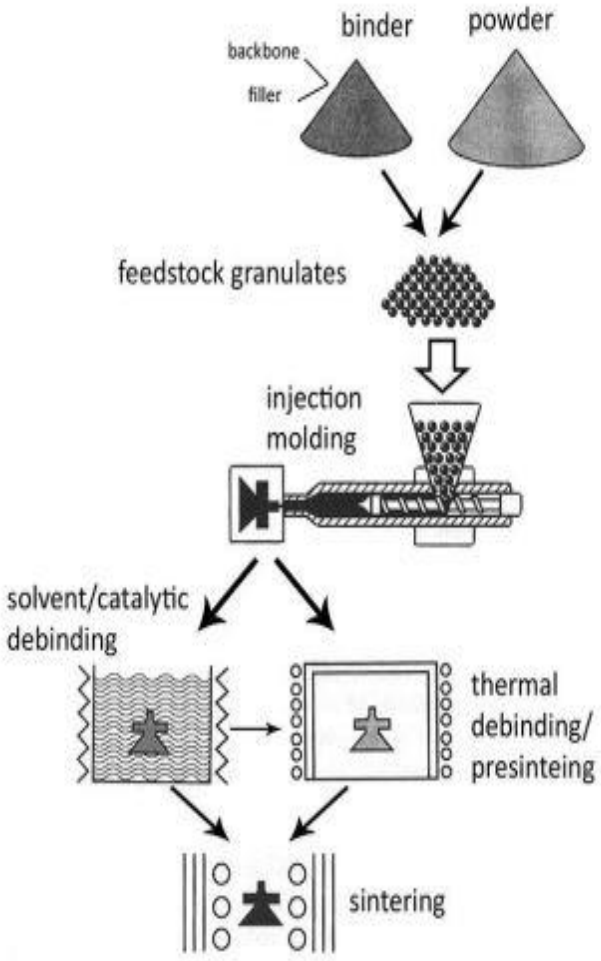

Figure 1: Flow Diagram of MIM Process

Preparing the feedstock

Metal powders and thermoplastic binders are the primary raw materials for Metal Injection Molding process .The binder is only an intermediate processing aid and must be removed from the products after injection molding. The property of Metal Injection Molded product is determined by the property of the powder. There are two different ways that materials are typically mixed, a planetary mixer or a tubular mixer. The mixture is then heated at desired temperature which causes the binders to melt. The obtained product is called feedstock [3]

Powders for Metal Injection Molding

Figure 2: Metal Powder

The metal powder provides the mechanical properties to the finished product. A produced MIM-part displays similar properties as the metal that the powder is made from. The metal powder can be used in MIM production as long as it satisfies the following criteria, Particle size of 0.1-20µm sizes are recommended, Mean particle size of 2-8µm are recommended, should have Clean particle surface. Most commonly used alloys consist of stainless steel, tool steel, copper, cemented carbides, titanium and other refractory metals. [4]

Binders for Metal Injection Molding

The most important part of the entire process is binders. The binder must be able to incorporate a high volume of fine metal or ceramic powders, typically 60% by volume, provide enough strength after debinding by means of the 'backbone binder', and should have uniform properties. The binder may be of at least two different materials. The binder constituents influence injection flow and operation temperature. The binder characteristics are also affected from different binder components. Some ready-made feedstock contain additional additives in the binder to help with mold release and injection process [5]

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Injection Molding

In this step compounded mixture (feedstock) is fed into a machine where it is heated and injected into a mould cavity under high pressure. The part (now termed as green part) is allowed to cool and then ejected from the mould so the process can repeat. The entire process happens at desired temperature so that only the binders can melt. There can be multiple tooling cavities to achieve high production rates. The mould cavity will be larger in order to compensate for shrinkage that takes place during sintering [6]

Figure 3: A typical injection molding Process

Binder Removal (Debinding)

De-binding is a process of removing binders from the molded component. Majority of the binders are removed in this step. De-binding can be accomplished by multiple methods such as thermal binding, catalytic de-binding, solvent de-binding. The most popular method used is Solvent Extraction. Acetone or Heptane is used as a solvent. The temperature maintained throughout the process is about 80deg Celsius. The pressure is about 40Kpa. The time required for the removal of binders during this process is about 8hours. After de-binding the part is now semi-porous this allows the remaining binder to easily escape during sintering [7]

Figure 4: Debinding Furnace

Sintering

In this step de-binded parts are placed on ceramic setters which are loaded into a high temperature, atmosphere controlled furnace. The parts are heated in order to remove remaining binders. When the binders are vaporized, the part is then heated at high temperature so that the space between the particles gets eliminated. The part shrinks iso-tropically to its design dimensions and transforms into a dense solid. The sintered density is typically greater than 97% of theoretical for most materials. The temperature required for sintering process may vary depending upon the material. The time required for the completion of sintering process is about 24hours [8]

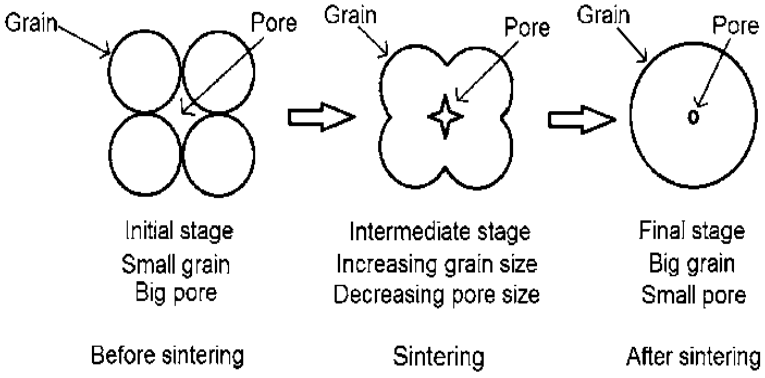

Figure 5: Sintering Process

Batch Type Furnace

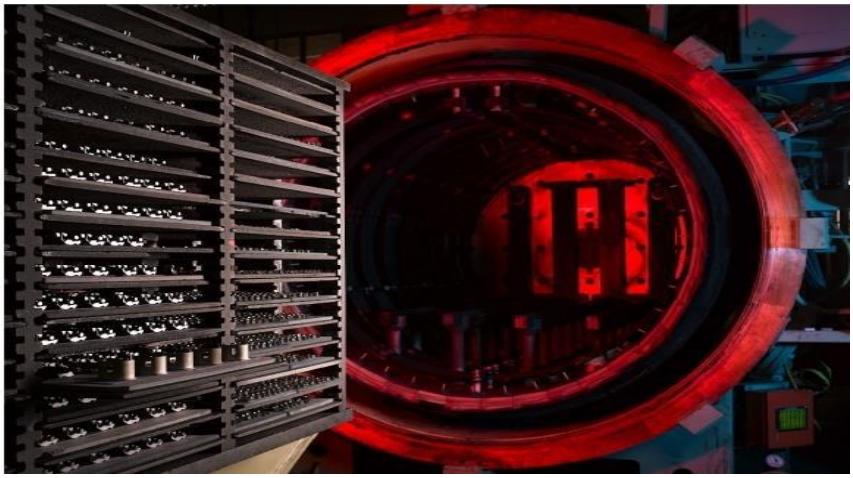

Figure 6: Batch type furnace

The batch type furnace is a type of chamber furnace. The products which are to be heated are positioned above one another in the furnace with the help of vertical conveyor system. Extremely uniform temperature distribution in the furnace interior is achieved by means of a vertical and horizontal airflow with the air that has been heated beforehand to the exact temperature required. This permits products that are to be heat-treated to be homogeneously. Heating and cooling ramps can be adjusted with the precision, inline with process complexity and customer-or product specific requirements.

Continuous Type Furnace

Figure 7: Continuous Type Furnace

Continuous type furnace is a type of furnace in which the charge introduced in one end moves continuously through the furnace and discharged at other end. In such furnaces the billets are arranged crosswise and in moved the opposite direction to the products of combustion of the fuel. This type of motion provides high efficiency of use of the heat supplied to the furnace the billets passed consecutively through three heat treatment zones: preheating, heating and soaking the furnace are heated by gaseous or liquid fuel using burners or atomizers located mainly on the back walls of heating and soaking zones. The temperature in continuous furnace is constant over time and variable over the length of furnace. In the heating and soaking zones the temperature is almost constant; in the holding zone it decreases towards the front of the furnace. Continuous furnace are heated by many relatively small heat sources located mainly on the side walls; in some cases heat source are located on the roof and in the hearth. When gas is used to heat items above 700deg Celsius or mazut is used to heat items above 1000deg Celsius, the fuel is burned directly in the working chamber.

Results and Discussion

Metal injection molding process can be useful where costly machining operations can be avoided. Producing cost-effective, complex shaped parts in both large and small volumes metals and inter metallic compound are the advantages of Metal Injection Molding Process. If the numbers of parts required is high then metal injection molding process may be helpful in saving the cost of the mould. MIM is a process that is developed from the combination of plastic injection molding and traditional powder metallurgy technique. The optimization of a metal injection molding process is labour intense and a long process.

Conclusion

Metal injection molding (MIM) is a method for producing metal parts by using plastic injection molding technique. In Metal Injection Molding process small metal parts can be manufactured with precision shape forming ability. MIM is a technology that continues to grow in size and capability every year. Markets that have embraced this process continue to find applications, while material development and process control improvements allow new end-users to benefit from this innovative manufacturing technology.

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References

[1] Prathabrao, M., Sri Yulis M. Amin, and M. H. I. Ibrahim. "Review on Sintering Process of WC-Co Cemented Carbide in Metal Injection Molding Technology." IOP Conference Series: Materials Science and Engineering, Vol.16, Issue.1, 2017

[2] Todd, I., and A. T. Sidambe. "Developments in metal injection moulding (MIM)" Woodhead Publishing Limited, Vol.3, Issue.3, 2013

[3] M Prathabrao, M H I Ibrahim, Sri Yulis M Amin, M H Othman, "Parameter Optimization of Metal Injection Moulding: A Review" Journal of Mechanical Engineering, Vol.5, Issue.6, 2018

[4] Liu, Z. Y, et al. "Micro-powder injection molding," Journal of Materials Processing Technology, Vol.2, Issue.7, PP.165-168, 2002

[5] Vervoort, P. J, R. Vetter, J. Duszczyk. "Overview of powder injection molding," Advanced Performance Materials, Vol.5, Issue.5, PP.121-151, 1996

[6] Ibrahim, M. H. I., et al. "Optimization of Micro Metal Injection Molding for Highest Green Strength by Using Taguchi Method" International Journal of Mechanical and Materials Engineering, Vol.4, PP.282-289, 2010

[7] Chuankrerkkul, Nutthita, Peter F. Messer, Hywel A. Davies. "Application of polyethylene glycol and polymethyl methacrylate as a binder for powder injection moulding of hard metals" IOP Conference Series: Materials Science and Engineering, Vol.165, Issue.5, PP.188-195, 2008

[8] R. Zauner, D.F Heaney, J.C.Piemme, C.Binet, R.M.German, "The Effect of Powder Type and Powder Size on Dimensional Variability in PIM", Advances in Powder Metallurgy and Particulate Materials, Vol.45, Issue.10, PP.192 -198, 2002.

[9] Jamaludina, K. R., et al. "Injection molding parameter optimization using the Taguchi method for highest green strength for bimodal powder mixture with SS316L in PEG and PMMA", International Journal of Mechanical and Materials Engineering, Vol.15, Issue.1, 2008

[10] Alexandre Royer, Thierry Barrière, Jean-Claude Gelin, "Development and Characterization of a Metal Injection Molding Bio Sourced Inconel 718 Feedstock Based on Polyhydroxyalkanoates", Department of Applied Mechanics, FEMTO-ST Institute, Vol.10, Issue.4, 2008

[11] Huang, Ming-Chih, and Ching-Chih Tai. "The effective factors in the warpage problem of an injection-molded part with a thin shell feature." Journal of Materials Processing Technology, Vol.5, Issue.1.PP.1-9, 2001

Advance Vehicle Security System

Prashanth K P[1], Sanjay G M[2], Yuvraj L[3], Sanman S[4], Jayanth Varma K[5]

[1,2,3,5]Department of Automobile Engineering, Acharya Institute of Technology, Bengaluru, India
[4]Department of Mechanical Engineering, Acharya Institute of Technology, Bengaluru, India

[1]prashanthkp@acharya.ac.in,[2]sanjaym.17.beau@acharya.ac.in

Abstract **- Car locks that are usually available will not provide sufficient protection to vehicle owners. Furthermore, protection choices are available to the bike, which are unique and distinct from the conventional key lock. A bio-metric tool could be used as a popular and effective moderate security options. Since the fingerprint of every individual is special, multiple security alternatives can also be used. In this task, we emphasize on using biometric scanners to start or turn off the vehicle against using conventional key locking processes.**

Keywords **- Biometrics, RFID, Alcohol Sensor**

I. INTRODUCTION

A. Vehicle Security

Due to the growing number of cars, the safety level of automobiles needs to be improved. The thieves are also well known for the traditional and usually used key locks in cars and trucks and therefore car thieves may easily unlock it. It is very quick to open the bikes by the robbery with the help of the master key. Vehicle safety is simply avoiding vehicle theft. Few of the existing systems are face recognition, retinal scanning, voice recognition, signature recognition iris recognition, iris recognition.

B. Biometrics in Vehicle Security

Biometric software is an automatic, behaviourally or physiologically dependent access monitoring system used to validate Several variants of the biometric security system are available on the market, such as fingerprints for speech authentication.

We are dealing here with the use of these biometric features in the safety and security of vehicle access. Fingerprint reader, voice recognition, retinal / iris scanning, face recognition, hand recognition, etc. Typically, the integrated access system for hi-tech vehicles has four access lists to ensure highly secure and approved controls. This code matches the one saved in a local server. The biometric access control system allows users to start the car's engine after passing all these checks. The holder has several ways to address this sensitive violation by "remote control" immobilizing the car, allowing use on a case-by-case notified to the police by means of notification.

Algorithms: for example, a vehicle that feels the driver has a high body temperature and a significant increase in breathing rate that automatically open windows or increase the interior.

C. Fingerprint Based Vehicle Starting System

Fingerprint sensor is the most popular of these various methods for bio metric authentication as fingerprinting is universally accessible and can be used for everybody on world. When the car key in the ignition system is turned once, two wires coming from the kick starter to the key system are bridged. This causes the engine and some other parts of the vehicle to be put in a ready or on state [1]. The fingerprints lock system also offers greater durability than traditional locks and also less expensively and easily implementing RFID locking system apart from the other fingerprint. Therefore, the concept of biometric authentication is proposed as a model. A fingerprint in its specific sense resides in the traction ribs of Human fingerprints are reliable, almost identical, hard to change and trustful in a person's life, making them ideal in terms of long-term human identity.

D. RFID Based Vehicle Unlock and Starting System

The tension rips of the human finger create a mark in its own context. Human fingerprints are accurate almost identical, difficult to change and consistent in a person's life, makes them ideal for long-term identification for humans. It provides improved vehicle security and at the same time makes unlocking fun and convenient to use. It consists of an RFID card and a scanner which act as an active and passive device to help in identifying the person. This card can be incorporated with a driving license thus ensuring vehicle security and at the same time the driving license is carried at all times.

E. Highly Sensitive Alcohol Sensor

Ethanol is assessed by ethanol receptors in the driver's skin. The low-cost sensor of semiconductors will measure ethanol gas quantities from 0.05 mg / L to 10 mg / L. Like your widely known breathalyser, this alcohol detection system is ideal for the detection of your breathing alcohol level. The sensor detects the breath during operation and the sensor directs the microcontroller to shut the motor off and thus stop the vehicle when any alcohol content is detected.

II . MATERIAL AND METHODS

It involves increasing vehicle safety through the addition of various types of locks and warning systems to the car's warning holder in the event of a threat. The systems that the project concentrates on when brought together make a strong and secure once by avoiding maximum threat, making sure the driving license is carried and doesn't allow a drunken individual to drive the vehicle.

The friction ridges of the human finger are a thin representation of fingerprint. Human fingerprints are precise, almost special, hard to change and stable to individual lives, rendering them suitable as long-term markers of human identity. They are a very long term. Is construction involving a fingerprint sensor which is connected to the ignition system through microcontroller.

The RFID based vehicle unlock and starting system consists of an RFID card and a scanner which act as an active and passive device to help in identifying the person. This card can be incorporated with a driving license thus ensuring vehicle security and at the same time the driving license is come at all times alcohol sensors can be used to detect the presence of alcohol in the driver's body.

Design And Fabrication of Components

1) Arduino Microcontroller: It is a computer, but one that doesn't yet have the means to interact with it. You will create digital loops and interfaces and ask the microcontroller how to communicate with other parts. The Microcontroller development board is at the heart of your projects. Arduino is open-source electronics prototyping platform based on flexible, easy-to-use hardware and software [2].

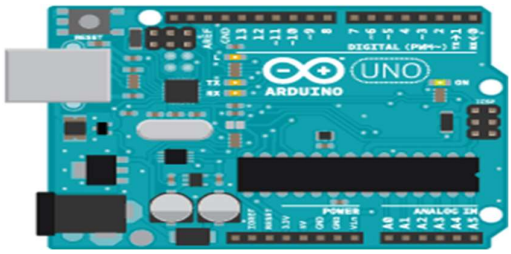

Fig.1 Arduino uno microcontroller

2) Breadboard: A board where electronic circuits can be created. It's like a board with gap lines, enabling the cables and components to be linked. The versions required for soldering and the solder less type used here are available.

3) DC Motor: As voltage is added to its conduits converts electrical energy into mechanic energy, when the current flows through the coils of the wire inside the engine. These magnetic champs attract and repel magnets, which spin the shaft. The motor will turn the opposite direction if the direction of the electricity is reversed.

4) Light Emitting Diodes (LEDs): A form of diode emitting electricity. Like all diodes, only electricity travels through these components in one direction. You probably know this on a number of electronic devices as markers. Typically, the anode that binds usually to electricity is the long leg and the cathode the shorter leg.

A. Fingerprint Vehicle Unlock and Starting System

1) Fingerprint Module: There are two principal ways to catch a fingerprints picture: inked and live. Usually, an ink-picture of an inked fingerprint is produced in this way: A trained practitioner gets a strong impression of an ink-picking finger on a sheet. The live fingerprint recognition scan is a team concept for an image that is collected actually directly from the finger again without being exerted on a document also at the interim level. In the sense of the process of identification verification, it is both inappropriate and morally reprehensible that inked fingerprints are obtained. When a body of a finger is positioned on either side of a glass surface (prism), crests of the finger touch the plate when regions of the finger may not be in contact with the surface, the remainder of the imager effectively contains an arrangement of LEDs. The most common design is optically irritated with completely intermediate reflections (FTIr) into a certain direction, the laser beam source illumines the glass as well as the Lens The luminous incident at the exterior of the glass of the crests is spontaneously spread while the light incident is reflected internally by the surface of the valleys.

2) Fingerprint Representation: There are two forms of fingerprints recognition: regional and worldwide. Most of regional fingerprint data is focused on the full picture, finger-corners, pores on the ridges, or external details of the ridges. Representations focused largely on ridge ends or bifurcations are the commonest, mainly due to the following reasons: (i) thoroughness of the collection of a large proportion of the individual info; (ii) thorough processing capacity on the basis of characterizations; and (iii) thorough identification of numerous fingers printed deterioration sources. In general, detailed interpretation depends on the location of the specifics and the orientation of ridges at the thorny spot. Some worldwide analysis includes data on crucial spots in a biometric (e.g., core and delta). These include patterns, which are aggregate characteristics of ridges, and minutia points, which are unique features found within the patterns. It is also necessary to know the structure and properties of human skin in order to successfully employ some of the imaging technologies [5].

3) Fingerprint Matching: Two types are possible for fingerprint matching methods: minutiae based and comparison based. Minutiae derived procedures locate precise points first and then trace their relative position on the finger However, the application of this approach provides some difficulties. When the fingerprint is of bad quality, the details are difficult to remove accurately. However, this approach results in a larger template size because the associated ridges for each minutia must be saved [4]. The correlation-based model will solve some of the problems of the comprehensive approach. But it has some weaknesses of its own. Co-relational strategies include the exact location of a data point and are influenced by the image. It is inherently more reliable and more capable than

knowledge-based and token-based techniques in differentiating between an authorized person and a fraudulent impostor, because the physiological or behavioral characteristics are unique to every person [3].

B. RFID Based Driving License Vehicle Unlock and Starting System:

1) Starting System: RFID devices consist of three elements – a RFID label or an Intelligent Tag, a RFID scanner, and an analogue (KD)– software that unfavorably recognizes the subject of electromagnetic or electrostatic coupling in a radio frequency (RF) potion of an electro-magnetic continuum to distinguish the particular object, item or human RFID methods. RFIDs have 860-960MHz and ultra-hydro frequency ranges (A passive RFID standard reading has reading length of 1 meter or 3 feet), but the newest IC plus antenna technology now brings the gap up to 15meters.

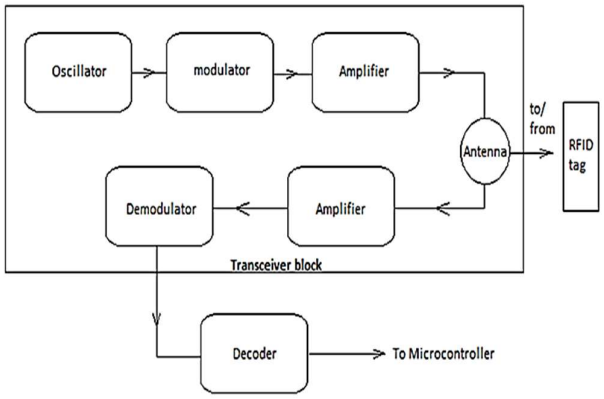

Fig.2 RFID Working block diagram

2) RFID Transceiver: The RF is used to trigger the RF control and to operate sensitive RFID labels. It can be loaded into the same container or another tool as a scanner. When produced as a separate kit, the signal generator is commonly referred to as the RF sensor. The RF detection system tracks propagation and receives radio frequencies from directional antennas and recreates them. A sensitive RFID label is activated and enhanced by the transmitter.

3) RFID Tag: RFID tags are a tracking system type that utilizes intelligent bar-codes to define items. RFID is based for "the detection of radio frequencies," so that RFID labels utilize radio frequency engineering. Such radio waves transmit data from the mark to an RFID computer program, which is then sent to the user. In its simplest implementation, the transponder listens for a radio beacon, and sends a beacon of its own as a reply[6]. RFID tags are commonly used to track carriages, animals and even Alzheimer's disease patients but also can be used to track them. The RFID label can also be referred to as the RFID button.

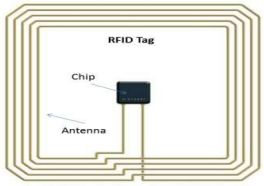

Fig.3 RFID tag

C. Alcohol Sensor: It uses the Alcohol Gas Sensor MQ3 to create this module. It is a low-cost semiconductor detector capable of detecting the existence of alcohol gasses at levels varying from 0.05 mg / L to 10 mg / L For this device the sensitive material is SnO2, with a less clean-air conductivity. It tends to become more conductive than alcohol gasses increase in concentration. The module of the alcohol sensor MQ3 can be interacted easily with microcontrollers, boards Arduino and Raspberry Pi, etc. An alcohol detector is appropriate as your typical breathing air for the measurement of alcohol levels in your blood [7]. The detector generates an alcohol-based analogue resistive output, the drive track is very simple and one resistor is all that it requires.

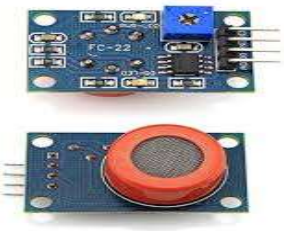

Fig.4 Alcohol Gas Sensor MQ3

Block Diagram Of Vehicle Security System

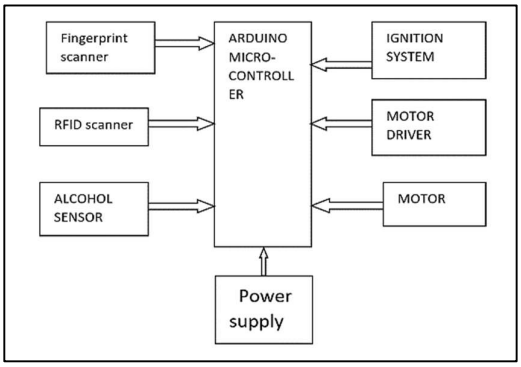

Fig.5 Block diagram of vehicle security system

The system is made up of a fingerprint reader, an Alcohol sensor and RFID scanner. The three devices carry out specific safety checks and activate the ignition system as soon as the examination is finished.

III. WORKING

A. Fingerprint Based Vehicle Ignition System

- User will be asked to keep the finger on the fingerprint scanner to verification.
- System will go through scan the finger & it will verify with already stored-enrolled data within it.
- User can enroll as many numbers, of fingers impressions as he/she wants.
- Once verified the vehicles ignition system will be activated automatically, thus providing keyless ignition system.

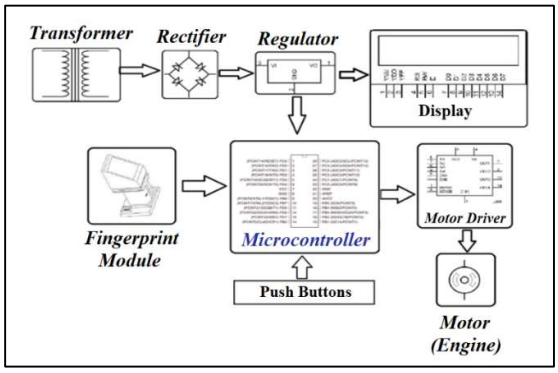

Fig .6 Block diagram of biometric working

B. RFID Based Vehicle Lock and Ignition System

RFID-based authentication program for driving licenses reveals how you can lock and unlock your car with a radio-frequency ID.

The order of operations of the system includes:

- Moving into the vehicle and scan the driving license incorporate RFID tag.
- The RFID reads serially submit the data tags for correction to the micro-controller
- The microcontroller then verifies data that the tag has the correct code that matches data and unlocks the automobile.
- If the code is invalid the vehicle doesn't unlock from the data rectification
- Now the RFID tag is scanned again and once verified the vehicle starts to on the ignition system.

C. Alcohol Sensor Based Security System

- An ethanol detector is connected to the steering wheel at the front of the vehicle.
- The device also senses ethanol in the breath of drivers to most minutes.
- The car can stop if the driver is affected by alcohol.

IV. RESULT

The practical execution of a model has to do with research, choice of the material and process evaluation. The plan was applied and reviewed to ensure its proper execution in compliance with the guidance stated.

The different components were checked and the findings obtained were good. Because the used parts fall within the sensitivity reliability of the elements, the system will function properly. From the figure above, the value computed is incorporated by the designed system.

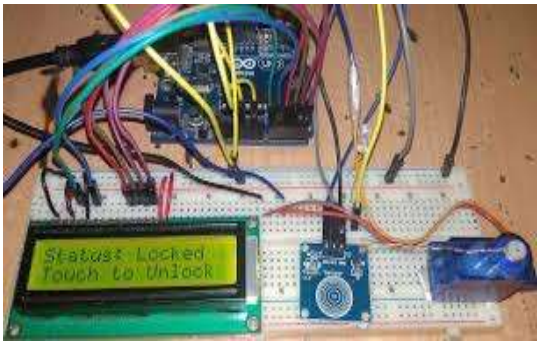

Fig.7 prototype working of biometric sensor

The chain includes a liquor sensor. The alcohol content in the atmosphere was detected by the sensor in the breathing of intoxicated individuals. The detector produces a current with a statistically significant correlation to the ethanol molecules between null to a very higher concentration. The sensor output is immediately commensurate with the alcohol price [8]. If the ethanol molecules in the atmosphere contact the detector electrode between alumina and tin dioxide, ethanol is hardened into acetic acid, resulting in more heat. The more ethanol molecules are made, the more existing molecules get various sensor preferences for this current change. In contrast, the sensor output is then fed to the comparator.

Fig.8 prototype working of alcohol sensor

PPM	Rs/Ro
200	1.6
500	1.1
800	0.85
1000	0.8
2000	0.6
3000	0.5
5000	0.38
10000	0.26

Table. I Alcohol sensor graphs result

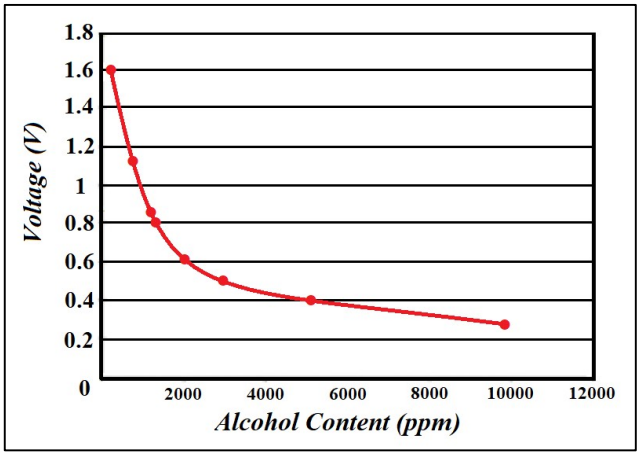

Fig. 9 PPM of MQ3 alcohol sensor graph

Limitations Of Vehicle Security Systems

- Distortion of the fingertip by dirt / dust.
- Bursts or fingertips may contribute to the unread ability or even removal of a person's fingerprint.
- For some people it is very intrusive as there is still a relationship to the criminal verification.
- It can make errors with the finger's skin dry or dirty and the skin of the finger.
- It is not suitable for children because the fingerprint size changes fast.
- 500 points per centime (dpi) image seized: 8 bits per pixel resolution.
- A 500 dpi 8-bit fingerprint picture requires a big capacity, compression of about 240 kbytes is sufficient.

Applications

- For opening and booting vehicles a fingerprint-based safety system can thus be used to take safety to the next point.
- A special key is required for each RFID tag which helps you to build a common safety system for cars that use the RFID tags to open and begin the vehicle.
- In different vehicles, an alcohol detector may be used to determine if the driver has taken or not alcohol.

Future Development

- An incomplete fingerprint could be easily interpreted as an attempt to enter in unlawfully after such an ungratified case, an external siren warning could be activated to expose potential theft.
- Several fingerprint scanning can be used for applications requiring further security.
- GSM software can be introduced with an alcoholic tracker.
- In order to inform families and the operator of a car of alcohol consumption through liquor identification and traffic monitoring via text SMS.
- The RFID can be included together with the driver's license so that an individual still holds his driving license and at the same time safety improvements were introduced.
- The use of RFID with the GSM system can be used, so that the car position can be identified in the case of theft.

Programming of Board:

```
String inputString = '';  // a string to hold incoming data
boolean string Complete = false;  //  whether the string
is complete
String Driver-String ("90824687\n");
Int motorola=8;
int motorpinlb-9;
int motorpin2a=10;
int motorpin2b=11;
int Switch=7;
int enable=12;
intsensorValue;
void setup() {
// initialize serial:
Serial.begin(9600);
// reserve 200 bytes for the inputString:
inputString.reserve(200);
pinMode (motorpinla OUTPUT);
pinMode (motorpinlb,OUTPUT);
pinMode (motorpin2a,OUTPUT);
pinMode (motorpin2b,OUTPUT);
pinMode (enable,OUTPUT);
digitalWrite (enable, HIGH);}
void loop() {
// print the string when a newline arrives:
int sensor Value = digitalRead(6);
if (string Complete) {
Serial.println("1");
// so the main loop can do something about it:
Serial.println(inputString);
if(inputString =Driver)
{Serial.println("2");}
else if(sensor Value = false)}
{{Serial.println(sensorValue);
digitalWrite (motorpinla, HIGH);
digital Write (motorpinlb,LOW);
digital Write (motorpin2a,HIGH);
digitalWrite (motorpin2b, LOW);
Serial.println(inputString);}
{inputString ='''';
string Complete = false;
if  digitalRead(Switch)=LOW  sensorValue  true  )
{
  Serial.println(sensor Value);
digitalWrite (motorpinla,LOW);
digitalWrite (motorpinlb,LOW);
```

```
digital Write (motorpin2a,LOW);
digitalWrite (motorpin2b,LOW);}}
void serialEvent() {
while (Serial.available() {
W get the new byte:
char inChar (char)Serial.read();
// add it to the inputString:
inputString + inChar;
// if the incoming character is a newline, set a flag
if (inChar="n') {  string Complete = true;}}}
```

V. CONCLUSION

The identity of fingerprints improves the safety of a car, allowing only certain selected persons to start a car. Therefore, the implementation of this comparatively easily and cheaply accessible car system allows for much more safety and exclusiveness than that provided by traditional lock and key. A variety of factors damage the right location of the minutes. In this project we merged many different methods for making a minute applicator with a minute match. Low image quality is the significant one.

The productivity and existence that can be accomplished through the progression of the functionality to capture images or through the enhancement of imaging technology are further improved. In terms of improving the input picture to the thinning point, on the other side, RFID is becoming an extremely popular application and can now be implemented in a car. It improves the safety of a vehicle and allows only chosen individuals to start a vehicle. It is easy to realize that the components of the RFID tag can increase, prices are expected to decrease and their performance, health and so on significantly improve and accuracy. To order for this software to be applied effectively, main concerns need to be resolved so that it affects the personal lives of us and thereby strengthens and enhances the safety system.

REFERENCES

[1]. Omidiora E. O.(2011) "*A Prototype of a Fingerprint Based Ignition Systems in Vehicles*" Published in European Journal of Scientific Research ISSN 1450216 X Vol.62 No.2 (2011), pp. 164-171 O EuroJournals

[2]. TAN ANGELL *"Two Wheeler Vehicle Security System*" Published in International Journal of Engineering Sciences & Emerging Technologies, Dec. 2013. ISSN: 22316604 Volume 6, Issue 3, pp: 324-334 IJESET

[3]. Lin Hong. "*Automatic Personal Identification Using Fingerprints*", Ph.D. Thesis, 1998.

[4]. Yang S. and Verbauwhede I. (2003) *"A Secure Fingerprint Matching Technique*"

[5]. *"Biometric security using fingerprint recognition"* by MAZUMDAR SUBHRA

[6]. THORNTON JOHN by *"RFID setting standards in comparison and identification"*

[7]. Prashanth, K.P., Padiyar, K., Naveen, K.P.H. and Kumar, K.S., 2014. *"Road accident avoiding system using drunken sensing technique"*. International Journal of Engineering Research and Technology, 3(10), pp.818-823.

[8]. Prashanth, K.P., Prajwal M and Deepak J., 2020. *"Motorcycle headlight design for clear visibility & comfort riding"*. Our Heritage Journal, 3(22), pp.240-248 (9).

Analysis of Machining Parameters of Materials using forged & heat treated D type cutting tool

H S SHIVASHANKAR[1], T S SIDDALINGAPRASAD*[1],T M CHANDRASHEKHARAIAH[2],BASAVARAJ GANIGER*[3]
[1] R & D Centre, Department of Mechanical Engineering, Siddhaganga Institute of Technology Tumkur
hssmed@sit.ac.in, siddu48@gmail.com
[2] R & D Centre, Department of Mechanical Engineering, Kalpataru Institute of Technology Tiptur
siddu48@gmail.com, chandrtm@gmail.com
[3] R & D Centre, Department of Mechanical Engineering, Sapthagiri College of Engineering Bangalore
ganiger2011@sgmail.com

***Abstract*—Aluminum, brass and aluminum based metal matrix composite are considered as work piece materials, Forged & heat treated D2 and D3 having better hardness value are selected as Cutting tool material. This paper is focused on the study of chip formation during turning of aluminum, brass and composite along with study the influence of machining conditions, surface roughness. The cutting tool used in the present study is forged & heat treated D2 and D3 tool steel,surface roughness was measured and the results were observed for different machining conditions. Based on the surface roughness value, chips were classified as favorable and unfavorable chips.**

***Keywords*— D1 & D2 tool, machining, surface roughness, chip formation**

I. INTRODUCTION

Aluminum as a base metal, brass as an alloy and composite materials are used as work pieces. Among three different materials composite machining is difficult to achieve good surface finish. Aluminum is very light metal and which can be easily machined under various parameters. It gives a good surface finish and responds to tool steel while machining. Brass alloy is a brittle material which is considered as difficult to machine using tool steel at more depth of cut. Particulate reinforced aluminum metal matrix composites are considered to be one of the 'difficult to machine' materials. Due to the addition of reinforcements like Silicon Carbide (SiC), alumina which are normally harder and stiffer than the matrix, machining become significantly more difficult when compared to normal conventional materials. Many authors have derived their excellent mechanical properties from the combination of reinforcement like SiC and a ductile matrix material such as Magnesium. The properties of Metal Matrix Composites (MMCs) are influenced by their matrix, reinforcement, and interface properties. Matrix materials are usually lightweight materials, and especially ceramic reinforcements are added to get high specific strength (Joshi et al., 1999; Caroline et al., 2000). Reinforcements have been used in the form of particulates, whiskers, or continuous fibers. Currently, most of the processes employed in the synthesis of MMCs involve the incorporation of ceramic particles such as carbides and borides into the matrices (Lin et al., 1997). Reinforcements like alumina have high yield strength and high modulus of elasticity. It also improves the hardness of the composite. The addition of graphite makes it act like a self- lubricant preventing the need of supplying separate lubricants while machining.

Variation of the cutting speed: type of chip breakage and chip segmentation In general, chip breakage can be divided into three different types [2]. Firstly, the chip may break into single segments just during the chip formation process due to low ductility (primary chip breakage). Secondly, spontaneous chip breakage may occur due to low strength, as consequence of rising chip weight or oscillation of the free chip end (secondary chip breakage). Thirdly, the chip may break due to collision with the workpiece, tool, or any other element of the periphery (tertiary chip breakage). In a very first step, it was analyzed whether any chip breakage occurred depending on the work piece material and cutting speed (Christophe Nobel et al).

The importance of chip formation has been well recognized and studied by other researchers. Problems with surface finish, work piece accuracy and tool life can be caused even by minor changes in the chip-formation process. Hence, it is necessary to understand the chip forming mechanism for this material through further investigation. This will render the material more suitable for advanced applications and more efficient chip control in machining can also be achieved. The theory of metal cutting regards the study of chip formation as the cheapest and most effective way of understanding the machining characteristics of a material (Joshi et al., 1999).Based on the available literature, it is clear that various factors like cutting speed, feed rate, rake angle and volume of reinforcement greatly influences on the chip formation mechanism. Joshi et al. (1999) observed that the chips produced while machining the composite showed a systematic breaking pattern depending on the volume of reinforcement in the composite material and found that the chip breaking can be related to mechanical properties by a chip breaking criterion. They also observed that at negative rake angles, the length of contact of chip on the tool face is higher; hence the chips could be flatter and hence comparatively larger in diameter. Besides that they also found that, if the cutting speed is low, the shear strength of a work hardening material is high resulting in an early breakage of chips. Thus, the phenomenon also decreased the number of circles (or the length of chip) through which a chip curls. According to Ravi raj et al.(2008),chips of discontinuously reinforced aluminum composites curl through circles of wider and larger diameter as the cutting speed increases; this may be due to adhering of work piece material on the tool face. The initial radius decreases with decrease in cutting speed. This could be due to changes in the length of contact on to tool face. Further studies reveal that the chip formation mechanism, during the machining of composites is mainly influenced by cutting speed. Increase in cutting speed results in the decrease in saw toothed chip.

Studies by Uday and Suhas (2009) also have concluded that feed rate is also a major factor in chip formation mechanism. At higher feed rates, the number of chip curls found is more than for a lower feed. This may be attributed to the increased

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deformation volume and tool-chip contact length. It increases the machining temperature and thereby the ductility and increases the number of chip curls. However, at lower feed rate, the chip cross-sectional area is very small due to which flake, needle type segmented and small radii curled chips are generated. The aim of the paper is to present the mechanism of the chip formation while machining aluminum, brass and aluminum base metal matrix composites. The tool used was forged and heat treated self-prepared D2 & D3 single point cutting lathe tool. The mechanism of the chip formation was studied for various values of cutting parameters and tool conditions.

II.EXPERIMENTAL DETAILS

The main objective of the paper is to present the mechanism of the chip formation and study the effects of various cutting conditions on chip formation while machining aluminum, brass and aluminum metal matrix composites. The tools used for cutting are HSS, forged and heat treated D (D2& D3) type tool steels. Accordingly experiments were conducted under varying machining conditions (speed, federate, and depth of cut).

Table 1. Process parameters and its levels

Process parameters		**Level**	
	1	2	3
Cutting speed(m/min)	300	540	720
Feed rate(mm/rev)	0.1	0.15	0.15
Depth of cut(mm)	0.3	0.5	1

Three independent variables such as speed, feed rate and depth of cut are used in this work. Based on the preliminary set of experiments performed on the machining of aluminum composite three levels of each independent variables has been selected (Table1). A total of 27 experiments were carried out on aluminum, brass and composite materials. Cutting tool life is one of the most important considerations in metal cutting. The major parameters which affect the tool life are the rake angle, hardness, cutting speed and the feed rates .The use of very low speed and feed to give maximum tool life is uneconomical because of the low production rates. Tool rake angles can be positive or negative, the latter increases the number of usable cutting edges by allowing the insert to be inverted to utilize the edges on the lower insert face; but on the other hand produces thicker chips resulting in higher cutting forces. An increase in the rake generally tends to improve the cutting conditions leading to longer tool life. However it is evident that the usage of larger rake angles makes the cutting edges mechanically weak; this results in higher wear rates and shorter tool life. Forged heat treated D2 & D3 type tool steels are used with rake angle of 120 and nose radius of 0.4mm was chosen for the present work.

The type of tools used in this work are D2 ,D3 and HSS materials, chemical composition of D2 tool steel is mentioned below in table 2. Chemical composition of D3 tool steel is mentioned in table3 similarly chemical composition of HSS tool is mentioned in table 4. The turning operations on aluminum, brass and MMCs of length 180 mm and 32mm diameter using an industry standard gear lathe under dry machining conditions D2 and D3 tool steels which are forged and heat treated at different levels are used as cutting tools. HSS tool is used to make a comparison between D2, D3 tool steels. Large numbers of chips were collected from various experiments. The surface roughness of work pieces were taken after each experiment using Mitytoyo surf tester with sample length 8mm. The surface roughness of the work piece after each experiment was recorded. The images of the chips were captured using a digital camera and inspected. The observations made on them were used to classify according to their physical structure and appearance.

Table 2. Chemical composition of D2 tool steel material

Element	C	Mn	Si	Co	Cr	Mo	V	P	Ni	Cu	S
%	1.4-1.6	0.6	0.6	1	11.2-13	0.7-1.2	1.1	0.03	0.3	0.25	0.03

Table 3. Chemical composition of D3 tool steel material

Element	C	Si	Mn	Cr	Ni	V	W	P	S	Cu
%	2-2.35	0.6	0.6	11-13.5	0.3	1	1	0.03	0.03	0.25

Table 4. Chemical composition of HSS tool steel material

Element	C	Si	Mn	P	S	Cr	Mo	V	W	Co
%	1.05-1.15	0.15-0.65	0.15-0.4	0.35	0.35	3.5-4.25	9	0.95-1.35	1.15-1.85	8

Microhardness

Vickers micro hardness value measured by Omnitech micro hardness tester, hardness values for all tool steel specimens was taken as shown in the table no 5. Indentation on the specimen at 1 kg load and dwell time considered for 10 seconds. Hardness value was calculated by semi-automatic method in the software provided by omnitech hardness tester. Among 9 specimens one from D2, D3 and HSS 3 specimens having highest hardness value are selected for cutting tools to machine the said work piece materials. From the table.5 D2 20% forged heat treated, D3 20% forged heat treated and HSS material are having highest hardness value. After conducting microhardness test, hardness values obtained are entered in table 5. Each specimen is undergone for 3 trials of hardness test, Among 3 trials average hardness value is taken and tabulated in tabular column. Among 9 specimens they are classified in to 3 types HSS, D2 and D3 tools, selecting one tool from each classified tools which is having highest hardness number. The tool having highest hardness number is selected as cutting tool in lathe machine for machining operations on aluminum, brass and composite materials.

Figure 1 Micro hardness Tester.

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III. RESULTS AND DISCUSSIONS

3.1 Effect of cutting speed and Feed rate on Chip formation

At high cutting speeds (300m/min and 0.1mm/rev with 1mm depth of cut) the chips formed were very long, formed in curls (Figure1a). The diameter of the curl was found to increase with the feed rate (Figure 3). As the cutting edge of the tool approaches the work piece material, it gets compressed because of the relative motion of the tool and work piece and reaches a plastic state. This initiates the chip formation along the rake face of the tool. Thus a finite thickness of the work piece gets sheared across the shear plane in a continuous manner resulting in the formation of lengthy chips [4 & 8]. The change in form of chips as the cutting speed increases is due to increased ductility of the work material because of the high machining temperature at higher cutting speeds (Figure1 a).

For lower cutting speeds segmented chips were obtained (Figure1 b). When the cutting edge of the tool approaches the work piece, the work piece material gets severely compressed resulting in high strain. Because of this strain hardening and the fact that the material deforms plastically beyond a critical stated is continuous alumina particles) which is the main reason for the segmented chips were formed [7]. The material behaves like a brittle material when machining at lower cutting speeds. More over brittle type of failure was more predominant (because of very less displacement of formation of segmented chips. At higher feed rates (Figure 2 a) the number of curls in the chips formed was more when compared to those formed at lower feed rates (Figure 2 b)

This increases the machining temperature which increases the ductility in the case of reinforcements like alumina. At lower feed rates the chip cross-sectional area is comparatively low .This is the main reason for the formation of segmented chips with low curl radii (Figure 2 b).When the cutting speed is lowered (Figure 2b), for [6]. During machining, the material undergoes shear by the movement of the cutting tool. These initiates the cracks from the outer free surface of the chip .Voids were formed due to the separation of the reinforcement and the parent matrix [6]. Further shearing of the material the low feed condition almost powder like chips were causes the coalescence of the voids leading to crack formed and the length of the chips begins to increase as the feed rate is gradually increased from 0.1mm/rev to 0.2mm/rev (Figure 2a).This can be attributed to very low chip cross sectional area and increase in the number of brittle failures, leading to the formation of segmented or almost powder like chips at lower feed rates. propagation and growth in a zigzag manner along the shear plane. As a consequence of this fracture and sliding of materials saw toothed chips were formed. In the case of worn out tool, the movement of the cutting tool over the material was not uniform because of the wear (tool damage) present in the cutting edges. Hence saw tooth shape was not found in these chips.

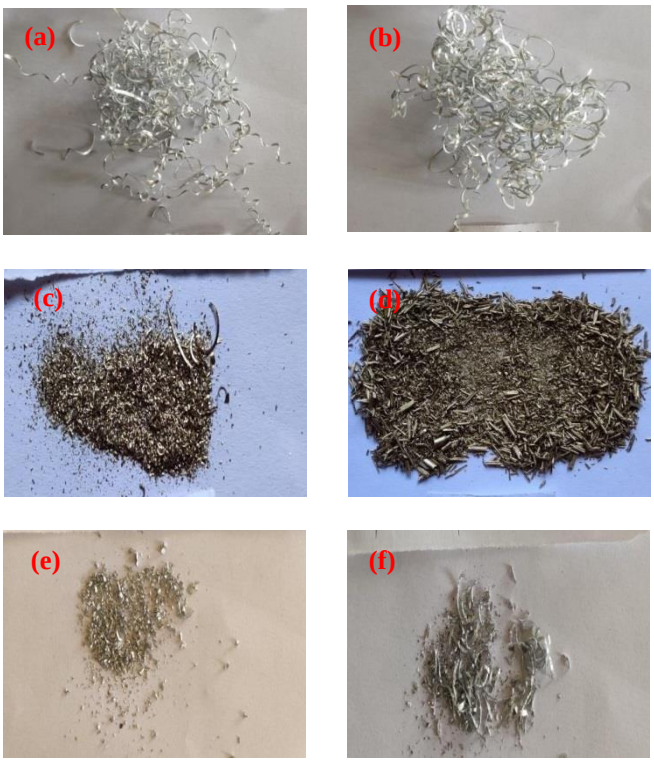

Figure 1.(a)-(f) Materials chips with D2 20%forged and heat treated tool; (a) Aluminum chips at low speed (b). Aluminum chips at high speed (c) Brass chips at low speed. (d) brass chips at high speed (e). Composite chips at low speed and (f) Composite chips at high speed

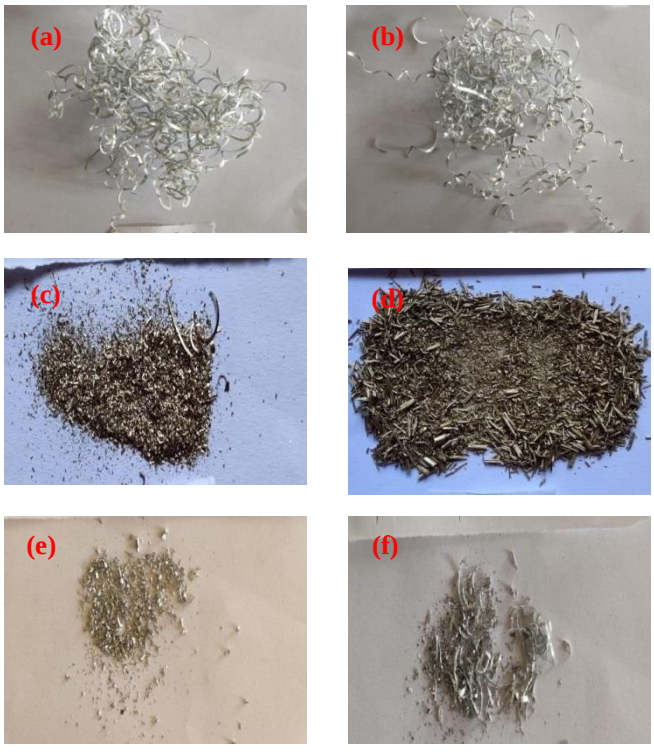

Figure 2.(a)-(f) Materials chips with D 3 20%forged and heat treated tool; (a) Aluminum chips at low speed (b). Aluminum chips at high speed (c) Brass chips at low speed. (d) Brass chips at high speed (e). Composite chips at low speed and (f) Composite chips at high speed

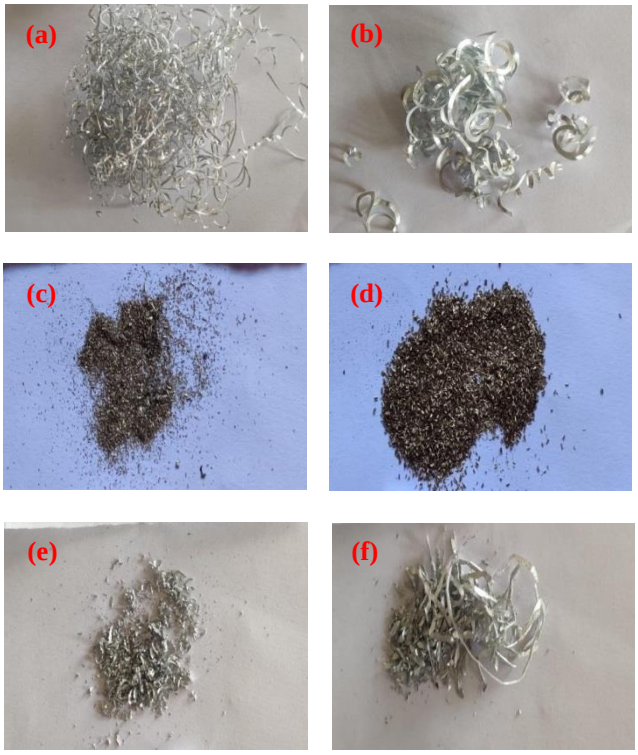

Figure 3 (a)-(f) Materials chips with HSS tool; Aluminum chips at low speed (b). Aluminum chips at high speed (c) Brass chips at low speed. (d) Brass chips at high speed (e). Composite chips at low speed and (f) Composite chips at high speed

3.2 Effect of Surface roughness on Chip formation

The aluminum composite is then machined the surface roughness machining process may obtained during a practical be considered as sum of two using this tool and large numbers of chips collected were analyzed. The chips formed for this condition (speed=300 Independent effects, one resulting from the geometry of the tool, feed or cutting speed and the other being natural m/min, feed rate = 0.1mm/rev, depth of cut= 0.5mm) surface roughness which being a result of irregularities in were very long and continuous with curls of small radii. The cutting operation [8]. It was The saw tooth shape was not found in these chips observed that for optimum surface finish (condition of Figure4).The addition of alumina particles reinforcement into the aluminum matrix reduces the minimum surface roughness, , saw-toothed chips were obtained as shown in Figure 1 (f).

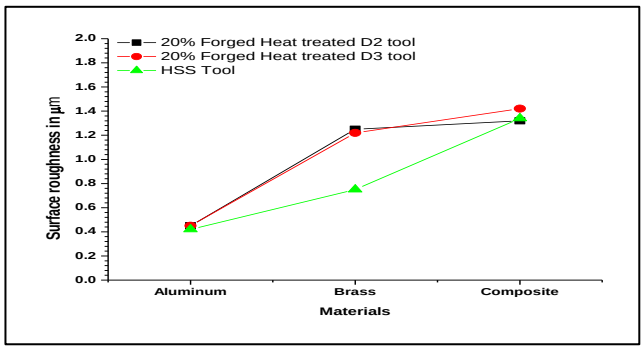

Figure 4 Variation of surface roughness in materials with different tools at 300rpm speed, 0.15 mm feed and 0,5mm depth of cut.

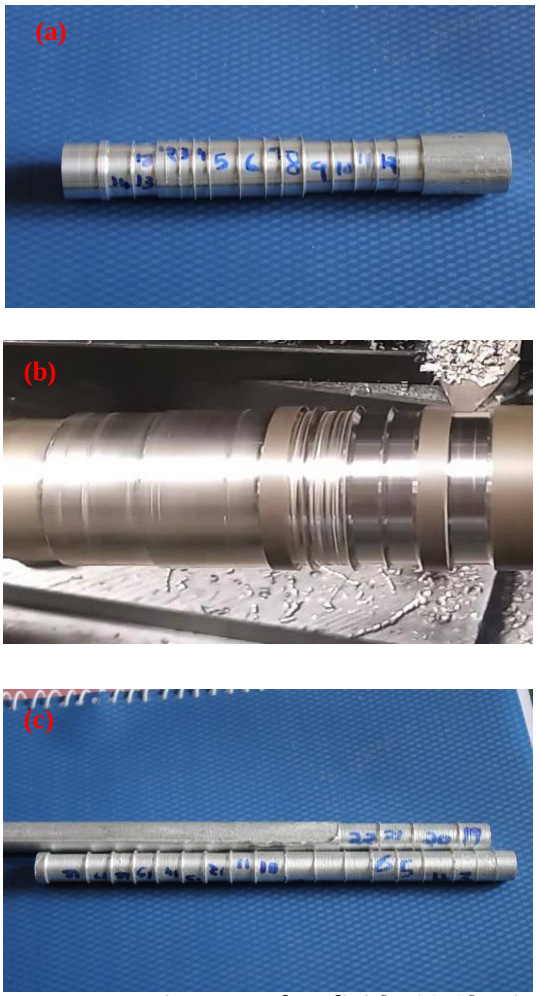

Figure 5.(a)-(f) **Optimum Surface finish; (a) Aluminum, (b) Brass and (c) Composite**

3.3 Micro hardness Study

Among 9 specimens one from D2, D3 and HSS 3 specimens having highest hardness value are selected for cutting tools to machine the said work piece materials. From the table.5 D2 20% forged heat treated, D3 20% forged heat treated and HSS material are having highest hardness value. After conducting microhardness test, hardness values obtained are entered in table 5. Each specimen is undergone for 3 trials of hardness test, Among 3 trials average hardness value is taken and tabulated in tabular column. Among 9 specimens they are classified in to 3 types HSS, D2 and D3 tools, selecting one tool from each classified tools which is having highest hardness number. The tool having highest hardness number is selected as cutting tool in lathe machine for machining operations on aluminum, brass and composite materials.

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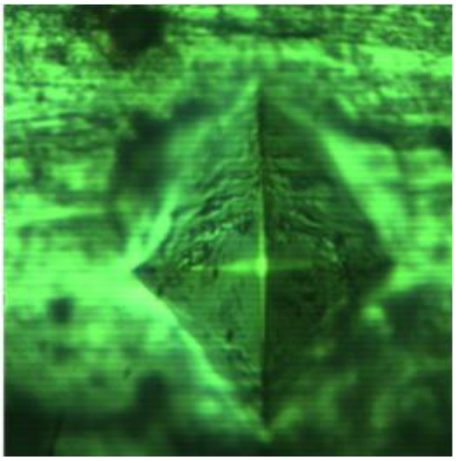

Figure 6 Indentor mark on the specimen surface

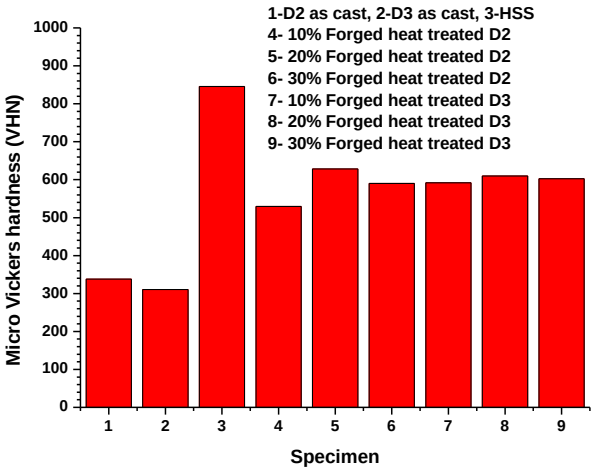

Figure 7 Variation in Micro hardness of specimen.

IV. CONCLUSIONS

At lower cutting speed the chips formed were discontinuous and segmented. At higher cutting speeds chips were semi continuous with saw toothed tip found in the inner surface of the chip. As the feed rate is increased, keeping the other two parameters constant, the length of the chips increased. The number of curls was also found to increase. The surface roughness value (Ra value) in table5 was found minimum for semi continuous segmented chips. At lower cutting speeds and high feed rates the chips formed (discontinuous segmented chips) were found to be unfavorable as the surface roughness values were found to be larger. Saw toothed tip was not found in the chips classified under "unfavorable chips "indicating tool wear. The fact that different kinds of chip formation can be observed for machining same material under different cutting conditions makes the analytical model of machining difficult because individual approaches tend to be aimed at one type of chip formation .Thus the prediction of when each type of chip formation will occur is a difficult complication to overcome. It is observed from experiments and machining aluminum and brass with D2 tool at lower speed will yield favorable chips along with good surface finish. Chips will be continuous and semi continuous. Machining aluminum with all the tools yields a good surface finish at lower speed with variable feed and depth of cut. Machining composite with D2 tool will not get good surface finish but choosing better among various parameters at high speeds it yields an average surface finish and chip conditions will be saw toothed chips

REFERENCES

[1] Caroline J E, et al. Machining of an aluminum/SiC composite using diamond inserts, Journal of Materials Processing Technology, 2000,Vol. 10, pp.25-29.

[2] Joshi S S et al. Analysis of chip breaking during orthogonal machining of Al/SiC composites, Journal of Materials Processing Technology 1999, Vol. 88, pp. 90-96.

[3] Kannan S, et al. On the role of reinforcements on tool performance during cutting of Metal Matrix Composites, Journal of Manufacturing Processes, 2006, Vol. 8(2), pp.67-75.

[4] Kilickap E, et al. Study of tool wear and surface roughness in machining of homogenized SiC reinforced aluminum metal matrix composite", Journal of Materials Processing Technology, 2005, Vol. 164, pp.862-867.

[5] Lin J T, et al. Chip Formation in the Machining of Sic-Particle Reinforced Aluminum Matrix Composite", Composites Science. Technology 1997, Vol.58, pp.285-291.

[6] Manna A, et al. A Study of Machinability of Al/SiC MMC, Journal of Materials Processing Technology 2003, Vol.140(1), pp.711-.716

[7] Raviraj S, et al. Experimental and Analytical Study on Chip Formation Mechanism in Machining of DRACs, Journal of Engineering Applications Science, 2008, Vol. 3(5), pp.27-32.

[8] Uday AD, et al. Analysis of chip formation mechanism in machining of Al/SiCp metal matrix composites", Journal of Materials. Processing Technology, Vol. 209.

[9] Radhika N et al. Analysis of chip formation in machining aluminium, brass and composite material using forged & heat treated D type cutting tool, Journal of Scientific Research.2014, Vol. 2(1). pp. 009-015,

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Analysis of Skin-Stringer Attachment of an Aircraft Wing

Ganesh Pateel D G
Research Scholar, Dept. of Mechanical Engg.
BMS Institute of Technology and Management
Bangalore-560064, India
ganipateel79@gmail.com

Dr. Suresh N
Retd. Professor, Dept. of Mechanical Engg.
BMS Institute of Technology and Management
Bangalore-560064, India
sureshnmech@gmail.com

***Abstract* — In the present study, skin to stringer attachment analysis of an aircraft wing has been performed. The skin-stringer attachment provides longitudinal stability to the wing. The function of the stringers is to support skin against buckling and transfer the bending loads onto the ribs and spars. The take-off weight of an aircraft and the primary loading of the wing; lift, drag and pitching moments are estimated. The skin-stringer attachment analysis is carried-out using finite element method. A methodology has been introduced to calculate fastener loads without simulating the fasteners in the finite element model. Skin buckling and inter-rivet buckling calculations are performed as the attachment is subjected to compressive stresses. The analysis also includes net strength, lug and bearing strength calculations. The software tools used are Hypermesh as a pre and post processor and Nastran as a solver. The finite element analysis and hand calculation results show that the skin-stringer attachment is safe for the estimated primary wing loads.**

Keywords- Weight estimation, Lug strength, Skin buckling, Inter-rivet buckling, Hypermesh, Nastran

I. INTRODUCTION

A wing is one of the primary components of an aircraft, which provides lift, accommodates fuel and carry aircraft control surfaces. An aircraft has two wings: left hand and right hand wings. These wings are symmetrical and they are subjected to same loads.

The structural components of an aircraft wing are shown in Figure 1. An aircraft wing mainly consists of three components namely; wing box, leading edge and trailing edge. The wing box refers to the primary load carrying structure of the wing, which forms the structural center of the wings and also an attachment point for leading edge and trailing edge components. The main components of wing box are;

- Top skin and bottom skin panels
- Top and bottom stringers
- Ribs and spars

The skin consists of number of panels which fit together to form the outer wing profile. Skin panels carry shear stresses and provide torsional rigidity. Stringers are attached to the top and bottom skin panels and run through the span-wise direction of the wing. Stringers stabilize the skin against buckling by means of providing longitudinal stability and carry bending stresses. An aircraft has at least two spars, front and rear spars, which run through the span of the wing and from top to bottom. Spar acts as an end member for the wing box and carries wing bending loads. The ribs form the aerodynamic profile of the wing, supports skin and stringer against buckling.

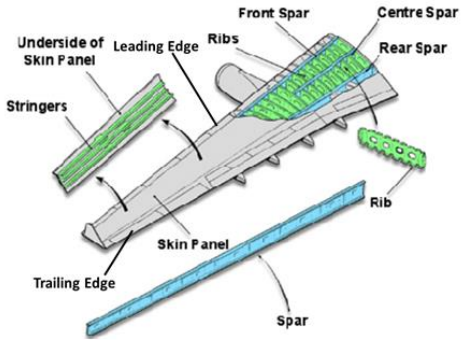

Figure 1. Main Components of an Aircraft Wing

II. WING PRIMARY LOADS CALCULATION

The calculation of Maximum Take-Off Weight (MTOW) of an aircraft is based on the type of flight mission requirements. A simple cruise flight mission profile consists of five segments namely, take-off, climb, cruise, loiter and landing as shown in Figure 2. Each mission segments are defined in terms of weight fractions expressed as (W_i / W_{i-1}) where 'W_i' is the weight of an aircraft at the end of the mission segment and 'W_{i-1}' is the weight of an aircraft at the beginning of the mission segment.

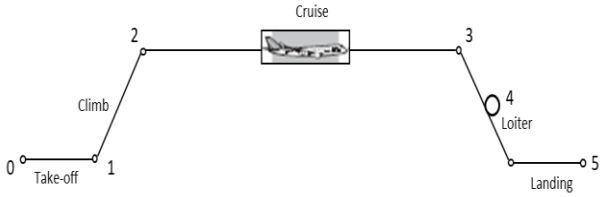

Figure 2. Typical Simple Cruise Flight Mission Profile

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The method followed for the estimation of the take-off weight is according to [1]. The MTOW considers 4 weight elements of an aircraft namely; Crew weight (W_C), Payload weight, (W_{PL}), Fuel weight (W_F) and Empty weight (W_E).

The MTOW or W_{TO} is calculated by

$$W_{TO}=W_C+ W_{PL}+W_F+W_E$$

The take-off weight W_{TO} is expressed in terms of weight fractions are calculated by

$$W_{TO}=\frac{W_C+ W_{PL}}{1-\left(\frac{W_F}{W_{TO}}\right)-\left(\frac{W_E}{W_{TO}}\right)}$$

The take-off weight fraction (W_1/W_0), climb weight fraction (W_2/W_1) and landing weight fraction (W_5/W_4) are estimated based on the average historical values of different types of aircrafts [1].

The cruise mission segment weight fraction (W_3/W_2) is calculated using Breguet Range equation,

$$R=\left(\frac{550\ \eta_p}{C_{bhp}}\right)\left(\frac{L}{D}\right)\ \ln\left(\frac{W_i}{W_{i-1}}\right)$$

where;
R = Range of an aircraft
C_{bhp} = Specific Fuel Consumption of propeller
V = Velocity of air
L/D = Lift to Drag ratio

The loiter weight fraction (W_4/W_3) is calculated using Endurance 'E' equation by

$$E=\left(\frac{550\ \eta_p}{C_{bhp}\,V}\right)\left(\frac{L}{D}\right)\ \ln\left(\frac{W_4}{W_3}\right)$$

The fuel weight fraction (W_F/W_{TO}) is obtained by

$$\frac{W_F}{W_{TO}}=1.05\left(1-\frac{W_5}{W_0}\right)$$

The landing to take-off weight fraction (W_5/W_0) is determined by

$$\frac{W_5}{W_0}=\frac{W_1}{W_0}\ \frac{W_2}{W_1}\ \frac{W_3}{W_2}\ \frac{W_4}{W_3}\ \frac{W_5}{W_4}$$

The empty weight fraction (W_E/W_{TO}) is calculated by

$$\frac{W_E}{W_{TO}}=A{W_{TO}}^C\,K_{vs}$$

The values of 'A', 'C' and variable sweep constant 'K_{vs}' are taken from [1]. The weight fractions for various mission segments and summary of weight estimation is presented in Table 1.

Table 1. Weight Fractions and Weight Estimation

Mission Segment and Weight Fractions		**Design Weight [kg]**	
Take-off, (W_1/W_0)	0.970	Crew weight, W_C	186
Climb, (W_2/W_1)	0.985	Payload, W_{PL}	544
Cruise, (W_3/W_2)	0.910	Fuel weight, W_F	686
Loiter, (W_4/W_3)	0.966	Empty weight, W_E	2537
Landing, (W_5/W_4)	0.995	Take-off weight, W_{TO}	3953

The initial sizing of the wing is performed according to [1] and [2]. Some of the important parameters considered in the wing design are presented in Table 2.

Table 2. Wing Design Parameters

Design Parameters		
Engine Type	Single Engine-Turboprop	
Mach number, M	0.50	
Range, R	1300	km
Maximum Speed, V_{max}	172	m/s
Cruise Speed, V_c	155	m/s
Stall Speed, V_s	39	m/s
Take-off Speed, V_{TO}	47	m/s
Lift / Drag Ratio, (L/D)	14	
Wing Span, b	10.0	m
Root Chord, C_r	2.0	m
Wing Area, S	16.3	m^2
Aspect Ratio, AR	6.2	
Thickness / Chord Ratio, (t/c)	0.15	
Taper Ratio, λ	0.50	
Wing Loading, W/S	243	kg/m^2

An airfoil section is responsible for the generation of the optimum pressure distribution on the top and bottom surfaces of the wing such that the required lift is created with the lowest drag and pitching moment. An airfoil is selected based on National Advisory Committee for Aeronautics (NACA) airfoil profiles [3]. NACA 6-series airfoils offer highest lift to drag ratio and optimized for high speed aircrafts.

In general, the following are the criteria to select an airfoil for a wing:

- The airfoil with highest maximum lift coefficient (C_{lmax}) and design lift coefficient (C_{Li}).
- The airfoil with lowest minimum drag coefficient (C_{dmin}) and pitching moment coefficient (C_M)
- The airfoil with highest lift-to-drag ratio and lift curve slope ($C_{l\alpha max}$)
- The airfoil with proper stall quality, etc.

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The required thickness to chord ratio (t/c) is calculated as per [1] based on the design Mach number. The design lift co-efficient (C_{Li}) as per [2] is calculated by

$$C_{Li}=0.85\times\frac{2\,W_{TO}}{\rho\,V_c^{\,2}\,S}=0.34$$

The wing is primarily subjected to 3 types of loads namely; lift, drag and pitching moment. Reference [2] is used for the calculation of wing primary loads. For the calculated C_{Li} and t/c = 15%, NACA 6-series airfoil $64_{(2)}$-415 has been selected which has higher C_{Lmax} and L/D ratio, minimum C_{dmin} and C_M and docile stall quality.

The lift co-efficient during take-off, C_{LTo} is calculated by

$$C_{L_{TO}}=\frac{2\,W_{TO}}{\rho_0\,V_{TO}^{\,2}\,S}=1.78$$

where 'ρ_o' is the air density at sea level

The drag co-efficient (C_D) is calculated by

$$C_D=C_{D_0}+C_{D_i}=C_{D_0}+K\,C_L^{\,2}$$

where 'C_{D0}' is zero-lift drag co-efficient and an average value that can be considered in the initial design is 0.02. 'C_{Di}' is induced drag co-efficient and 'C_L' is the lift co-efficient. 'K' is referred as the induced drag factor and is determined by

$$K=\frac{1}{\pi\,e\,AR}$$

where 'e' is Oswald span efficiency factor and typical values are between 0.7 and 0.95.

The co-efficient of pitching moment (C_M) for $64_{(2)}$-415 is found to be -0.068 [3]. The lift force, drag force and pitching moment of the wing are calculated by

$$\text{Lift Force, } L=C_L\frac{\rho\,V^2\,S}{2}$$

$$\text{Drag Force, } D=C_D\frac{\rho\,V^2\,S}{2}$$

$$\text{Pitching Moment, } M=C_M\frac{\rho\,V^2\,S\,C}{2}$$

where;
V = Velocity of air
C = Chord length

The span-wise lift distribution for the wing is calculated according to [5]. The lift distribution of the wing is elliptical as shown in Figure 3.

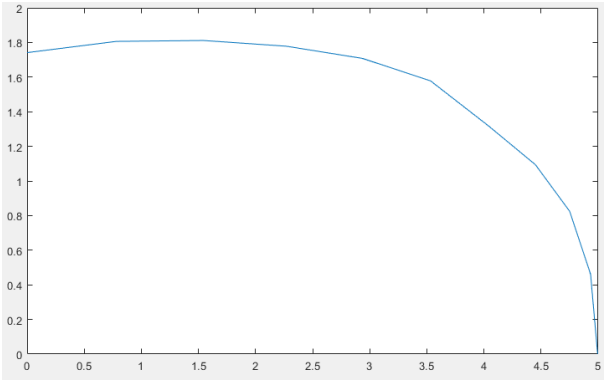

Figure 3. Lift Distribution over the Semi Span Wing

III. SKIN-STRINGER ATTACHMENT ANALYSIS

The complete wing is not used, only a portion of it is considered for the analysis and finite element model (FEM) of the wing is shown in Figure 4. The wing portion between rib 6 and rib 12 is considered for the finite element (FE) analysis and the FE modeling is carried-out in Hypermesh.

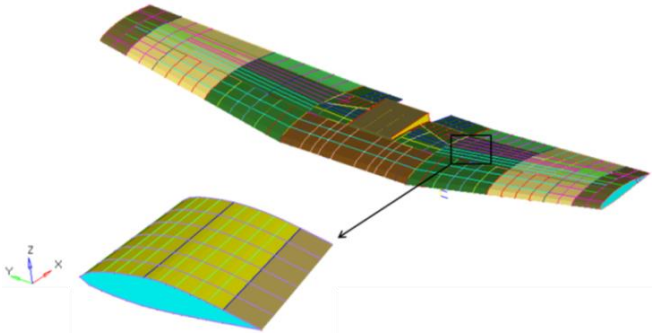

Figure 4. Finite Element Model of the Wing

The individual components of the wing are modeled using 1-dimension and 2-dimension finite elements as shown in Figure 5. The skin and stringers are modeled as Quad and Bar elements respectively.

The top and bottom skin panel thicknesses are 1.8 mm and 2.0 mm respectively, obtained based on the initial static analysis results. Since the present study emphasizes on skin-stringer attachment, the geometry and results of spars/ribs are not presented; however it is confirmed that the stresses on these components are within the allowable limits.

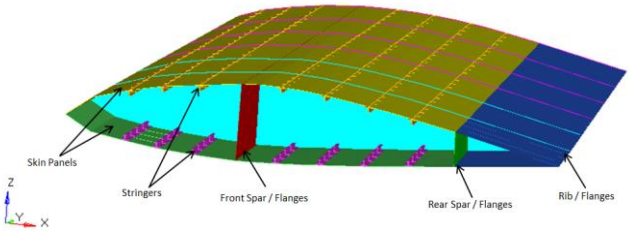

Figure 5. Finite Element Modeling of the Wing Components

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Stringer Geometry

The typical skin-stringer attachment and geometry of the stringer considered in the analysis is shown in Figure 6. I-section stringers are easy to form and provide better attachment. The minimum edge distance (ED) requirement of '2D' is maintained on the stringer attached flange, where 'D' is fastener diameter. Since the skin-stringer attachment fasteners are exposed to air, countersunk (CSK) head fasteners are recommended.

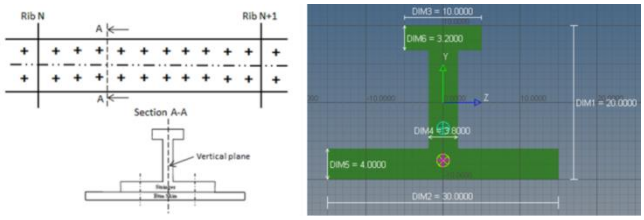

Figure 6. Typical Skin-Stringer Attachment and Stringer Geometry

Material Properties

Skin and stringer material properties are presented in Figure 7. The material properties are obtained from [4].

Component	Material Spec.	Billet Size [mm]	F_{tu} [MPa]	F_{t2} [MPa]	F_{cy} [MPa]	F_{su} [MPa]	E [MPa]	E_c [MPa]	F_{bru} [MPa]	e [%]	υ
Top Skin	7010-T7651	25-40	525	455	448	290	70326	73080	730	0.06	0.33
Top Stringer	7010-T7651	80-100	500	440	427	303	70326	73080	723	0.06	0.33
Bottom Skin	2024-T351	33-40	427	290	262	255	73700	75000	648	0.06	0.33
Bottom Stringer	2024-T351	57-82	393	262	240	234	73700	75000	592	0.04	0.33

Figure 7. Material Properties of Skin and Stringer

Where; E = Young's modulus of elasticity
E_c = Young's modulus of elasticity in compression
F_{tu} = Ultimate tensile strength
F_{cy} = Yield strength in compression
F_{su} = Ultimate shear strength
F_{bru} = Ultimate bearing strength
e = Elongation in percentage
υ = Poisson's Ratio

Loads and Boundary Conditions

The lift/drag forces and pitching moments calculated for the wing during the take-off condition are presented in Table 3.

Table 3. Primary Loads on the Wing

Rib Location	Lift [N]	Drag [N]	Moment, M [N-m]
Rib 7	19383	2314	-1.48e6
Rib 8			-1.41e6
Rib 9			-1.37e6
Rib 10			-1.33e6
Rib 11			-1.29e6
Rib 12			-1.25e6

The loads are applied at the aerodynamic center of the airfoil using rigid elements (RBE3) created at each rib locations. The lift, drag forces pitching moment are applied in z-direction, x directions and y direction of the aircraft co-ordinate system respectively.

One end of the wing is simply supported, constrained in all 3 translational directions and the other end is free. The loads and boundary conditions applied on the wing are shown in Figure 8.

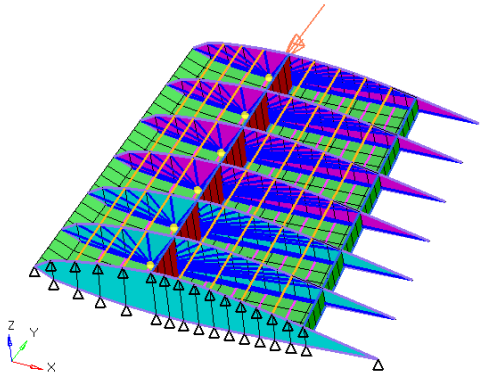

Figure 8. Loads and Boundary Conditions

The static analysis of the wing is performed in Nastran. The maximum displacement and Von-Mises stress plots are shown in Figure 9 and Figure 10 respectively, the values are found to be 15.3 mm and 198.0 MPa.

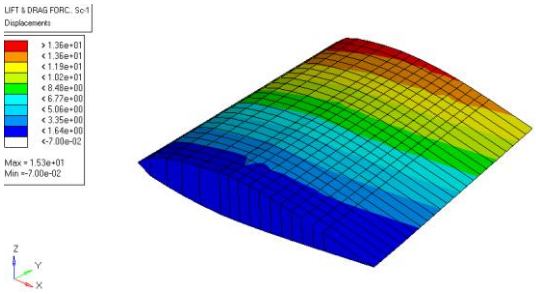

Figure 9. Displacement Plot

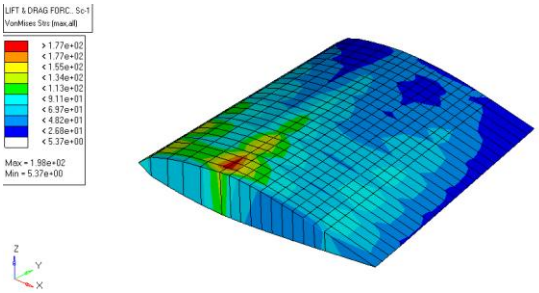

Figure 10. Von-Mises Stress Plot

Net Strength Calculation

The bottom and top covers are predominantly in tension and compression respectively during wing up-bending load

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case. Hence bottom covers are designed for net strength and top covers for buckling.

Since fastener holes are not simulated, the stresses from FEM are gross stresses. The net tensile and shear stresses are calculated using gross to net area factor.

The gross to net area factor (G/N) is determined by

$$\text{Gross to Net Area Factor (G/N)} = \frac{A_{gross}}{A_{net}} = \frac{A_{gross}}{(A_{gross} - 2\,d\,t)}$$

The net tension and shear Reserve Factor (RF) for bottom skin/stringer is calculated by

$$\text{Net Tension RF} = \frac{F_{tu}}{\sigma_{net}}$$

$$\text{Net Shear RF} = \frac{F_{su}}{\tau_{net}}$$

The bottom skin and stringer net strength RF summary is presented in Table 4.

Table 4. Skin-Stringer Net Strength RF Summary

Component	σ_{net} [MPa]	Tension RF	τ_{net} [MPa]	Shear RF
Bottom Skin	134.4	3.18	79.3	3.22
Bottom Stringer	120.8	3.25	-	-

Fastener Load Calculation

The fastener loads on the attachment are calculated using skin and stringer loads extracted from FEM. The total load on an attachment is the combined loading from the change in the stringer end-load along the rib bay and the shear load generated from the bending of the stringer between the ribs. The loads on the skin-stringer attachment are shown in Figure 11.

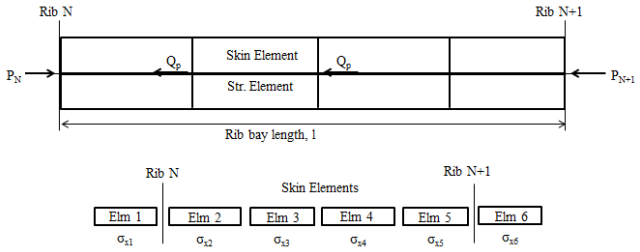

Figure 11. Skin-Stringer Attachment Loads

Change in the stringer end loads along the rib bay produces shear flow in the attachment. The stringer end loads at the rib datum 'Rib N' and 'Rib N+1' are calculated by

$$P_N = \frac{(\sigma_{x1} \times A_r \times A_{str}) + (\sigma_{x2} \times A_r \times A_{str})}{2}$$

$$P_{N+1} = \frac{(\sigma_{x5} \times A_r \times A_{str}) + (\sigma_{x6} \times A_r \times A_{str})}{2}$$

where 'P_N' and 'P_{N+1}' are the stringer end load at 'Rib N' and 'Rib N+1' respectively
σ_{xi} = Stringer span-wise stresses
A_{str} =Stringer Area
A_r = Area reduction factor

The local bending of combined skin-stringer w.r.t overall wing bending is measured by the term 'Ar' as shown in Figure 12 and it can be determined by

$$A_r = \frac{\text{Stringer Area at OSL}}{\text{True Stringer Area}} = \frac{Y_{STR\ NA}}{Y_{WingBox}}$$

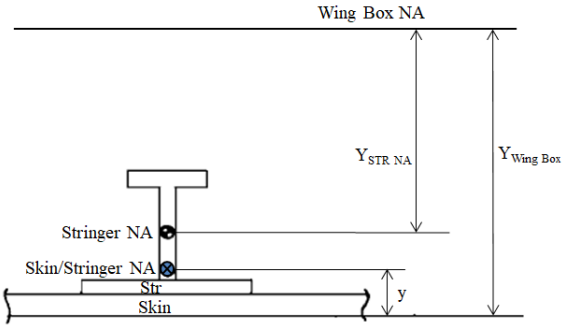

Figure 12. Skin - Stringer Geometry and Combined Neutral Axis

Shear Flow 'Q_p' due to change in the stringer end loads along the rib bay length 'l' is calculated by

$$q_p = \frac{(P_N - P_{N+1})}{l}$$

Shear flow due to stringer bending 'Qs' in the attachment is calculated by

$$q_s = \frac{(F \times A_{skin\text{-}str} \times y)}{I}$$

where 'F' is maximum shear force at the skin-stringer interface, '$A_{skin\text{-}str}$' is combined skin-stringer area, 'I' is area moment of inertia of the combined skin-stringer, and 'y' is distance between combined skin-stringer NA and OSL.
The total applied load on an attachment 'Q' is given by

$$q = \frac{(q_p + q_s)}{n} \times p$$

where 'p' is maximum bay pitch of an attachment and 'n' is the number of fastener rows.

The bolt shear RF is calculated by

$$\text{Bolt Shear RF} = \frac{\text{Shear Allowable}}{FF \times \text{Applied Shear}}$$

Fitting Factor (FF) of 1.15 is considered in the bolting RF calculation. Bolt shear-tension (S+T) interaction RF is calculated by

$$\text{Bolt (S+T) Interaction RF} = \frac{1}{\sqrt{R_s^2 + R_t^2}}$$

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where 'R_s' and 'R_t' are shear and tension stress ratios and are calculated by

$$\text{Shear stress ratio, } R_s = \frac{\text{FF} \times \text{Applied Shear}}{\text{Shear Allowable}}$$

$$\text{Tension stress ratio, } R_t = \frac{\text{FF} \times \text{Applied Tension}}{\text{Tension Allowable}}$$

Skin and stringer are fastened by 4.76 mm (3/16") diameter CSK bolts: Hi-lok (HL-11VA6) 100^0 flush shear head titanium bolts. The bolt shear and tension allowable are 11964 N and 8895 N respectively.

Skin to stringer joint bolting RF summary is presented in Table 5.

Table 5. Skin-Stringer Bolting RF Summary

Location	Shear Allowable [N]	Applied Shear Load [N]	Shear RF	S+T Interaction RF
Top cover	11964	2766	4.32	4.31
Bottom cover	11964	2347	5.09	5.09

Lug and Bearing Strength Calculation

Skin-stringer attachment forms a straight lug configuration. The design requirement for any fastener joint is to maintain land to diameter ratio (L/D) > 2.0, if the required L/D for an attachment is not met due to manufacturing errors and damages, then a lug strength calculation must be performed. Straight lug failures are burst out and shear out as shown in Figure 13.

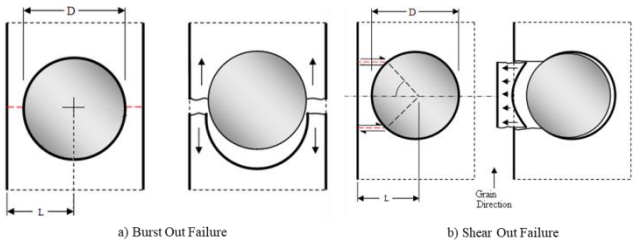

Figure 13. Skin-Stringer Stright Lug Failure Modes

Lug and bearing strength allowable calculation is performed according to [6] and [7]. The burst out and shear out allowable for the straight lug is calculated by

$$\text{Burst-Out Allowable, } P_{\text{All-Burst}} = 1.45\, t\, F_{tu}(L-r)$$

$$\text{Shear-Out Allowable, } P_{\text{All-Shear}} = 1.5\, t\, F_{tu}(L^2-r^2)$$

The minimum allowable of the burst-out and shear-out failures is considered in the lug strength RF calculation.

The allowable bearing strength is calculated by

$$\text{Allowable Bearing Strength, } P_{brg} = 1.5\, F_{bru} D\, t$$

The lug strength and bearing RF summary for the skin-stringer attachment (minimum RF of skin/stringer) is presented in Table 6.

Table 6. Lug and Bearing Strength RF Summary

Location	Lug Allowable [N]	Applied Load [N]	Lug Strength RF	P_{brg} [N]	Bearing RF
Top cover	7278	2405	3.02	9461	3.93
Bottom cover	7111	2041	3.48	9331	4.57

Skin Buckling Analysis

When a skin-stringer panel is subjected to axial compressive loads, skin may buckle. The skin buckling failure mode is shown in Figure 14.

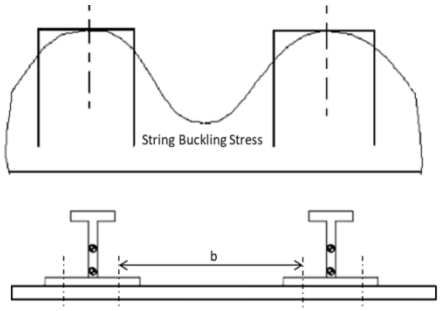

Figure 14. Skin-Stringer Panels in Compression

The general buckling stress (F_{cr}) equation for flat and curved plates in compression [6] is calculated by

$$F_{cr} = \frac{\pi^2 K_{cc} E_t}{12(1-\upsilon^2)} \left(\frac{t}{b}\right)^2$$

where;

K_{cc}=Buckling co-efficient which depends on the edge conditions

E_t=Tangent Modulus

t=Thickness of the skin panel

b=Distance between the two stringers

Buckling allowable stress is calculated using Ramberg-Osgood equation [8]; it simulates the stress-strain relationship up to yield strength of the material. The Ramberg-Osgood general equation is,

$$e_{total} = \frac{\sigma}{E} + e_{ref}\left(\frac{\sigma}{\sigma_y}\right)^{\frac{1}{n}}$$

where;

e_{ref} = % offset of the yield stress which is assumed to be 0.002 (0.2% proof stress)

σ = Reference value of stress

n = Ramberg-Osgood exponent

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The Ramberg-Osgood exponent 'n' for compressive stress is determined by

$$n = \frac{\log\left(\frac{F_{tu}}{F_{cy}}\right)}{\log\left(\frac{e_f}{e_p}\right)}$$

where;

e_p = Plastic strain

e_f = Plastic strain at failure = $e_u - \frac{F_{tu}}{E_c}$

e_u = Ultimate strain

The tangent modulus 'E_t' [9] can be determined by

$$E_t = \frac{E_c}{1 + \left(\frac{F_{cr}}{\sigma_{ref}}\right)^{n-1}}$$

'σ_{ref}' is the stress value at the reference point.

Since the buckling allowable stress 'F_{cr}' is incorporated within the value of 'E_t', the equation has to be solved iteratively.

Inter-Rivet Buckling (IR Buckling)

The Inter-Rivet (IR) Buckling occurs when the pitch of the fasteners attaching the skin to the stringer is sufficiently large to allow the skin to fail as a strut between each fastener.

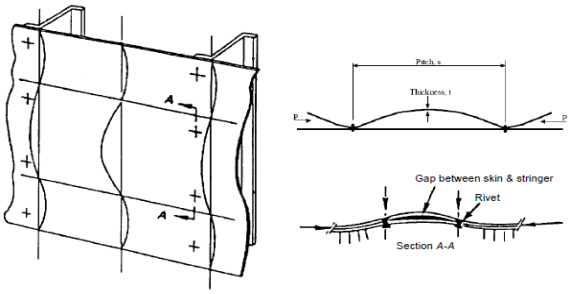

Figure 15. Typical Skin-Stringer IR Buckling

The inter-rivet buckling stress 'F_{ir}' [10] is calculated by

$$\left(\frac{F_{ir}}{E_t}\right) = \frac{\pi^2 K_R}{12}\left(\frac{t}{p}\right)^2$$

where;

K_R = Fixity co-efficient depends on the type of fasteners used

p = Fastener pitch

t = Sheet thickness

The skin buckling and IR buckling RF summary is presented in Table 7.

Table 7. Skin Buckling RF Summary

Location	F_{cr} [MPa]	σ_{app} [MPa]	Skin Buckling RF	F_{ir} [MPa]	IR Buckling RF
Top Skin	126.2	117.7	1.07	428.0	3.63
Bottom Skin	144.9	96.7	1.49	262.0	2.70

IV. CONCLUSIONS

During preliminary sizing of the aircraft components, the fasteners were not simulated in the finite element model; hence a methodology is introduced to calculate fastener loads at the skin-stringer attachment. Based on analysis results, the following conclusions can be drawn:

- The weight and wing primary loads estimation helps to carry-out the initial sizing of the wing components.
- The skin-stringer attachment loads extracted from the finite element model are used for bolt strength, lug and bearing strength calculations.
- Skin-stringer attachment subjected to compressive stresses, skin buckling and inter-rivet buckling calculations were carried-out.
- The finite element analysis and hand calculation results ensure that the sizing of skin and stringer is safe for the primary wing loads.

V. REFERENCES

[1] Daniel P. Raymer, 'Aircraft Design-A Conceptual Approach', 2nd Edition, AIAA Education Series, Washington D C, 1992

[2] Mohammad H. Sadraey, 'Aircraft Design – A Systems Engineering Approach', 1st Edition, John Wiley & Sons, Ltd, 2013

[3] Ira H. Abbott, Albert E, von Doenhoff and Louis S. Stivers, Jr., 'Summary of Airfoil Data, Report No. 824, National Advisory Committee for Aeronautics, 1945

[4] MIL-HDBK-5J', Metallic Materials And Elements For Aerospace Vehicle Structures, Department of Defence Handbook, 31 Jan 2003

[5] Houghton, E.L. and Carpenter, P.W. 'Aerodynamics for Engineering Students', 5th Edition, Butterworth Heinemann, 2003

[6] Michael C. Y. Niu, 'Airframe Stress Analysis and Sizing', 2nd Edition. Hong Kong Conmilt Press Ltd. 1989

[7] ESDU 91008, 06021, 'Strength of Lugs under Axial Load and Transverse Load' London, December 1991.

[8] Ramberg, W. & Osgood, W. R., "Description of stress-strain curves by three parameters." Technical Note No. 902, National Advisory Committee For Aeronautics, Washington DC, 1943

[9] ESDU 76016, 'Generalisation of smooth continuous stress-strain curves for metallic materials', 2013 Edition, February, 2013

[10] E. F. Bruhn, 'Analysis and Design of Flight Vehicle Structures', Jacobs Publishing Inc. June, 1973

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CHARACTERIZATION OF ALUMINIUM REINFORCED WITH SILICON CARBIDE PARTICULATE COMPOSITE SYNTHESISED BY STIR CASTING METHOD

Mr. Saleem, Mr. Sumanth A, Mr. Rakshith Gowda P N, Mr. Alen Mathew, Mr. Dinesh Kumar S, Dr. Harishanand KS, Dr. Raghu S*
Department of Mechanical Engineering, East Point College of Engineering and Technology
*Industrial Production Engineering Department, PES College of Engineering, Mandya
dineshkumars.mech@eastpoint.ac.in

Abstract **-MMCs represent a new generation of engineering materials in which a strong ceramic reinforcement is incorporated into a metal matrix to improve its properties including specific strength, specific stiffness, wear resistance, corrosion resistance and elastic modulus. Thus, they have significant scientific, technological and commercial importance. During the last decade, because of their improved properties, MMCs are being used extensively for high performance applications such as in aircraft engines and more recently in the automotive industries. Aluminium oxide and silicon carbide powders in the form of fibers and particulates are commonly used as reinforcements in MMCs and the addition of these reinforcements to aluminium alloys has been the subject of a considerable amount of research work. Aluminium oxide and silicon carbide reinforced aluminium alloy matrix composites are applied in the automotive and aircraft industries as engine pistons and cylinder heads, where the tribological properties of these materials are considered important. Therefore, the development of aluminium matrix composites is receiving considerable emphasis in meeting the requirements of various industries. Incorporation of hard second phase particles in the alloy matrices to produce MMCs has also been reported to be more beneficial and economical due to its high specific strength and corrosion resistance properties. In the present work Al-2014 is used as Matrix Material and the SiC is used as reinforcement with Wt. % of 0,4, 8 &12 and is synthesized by using Bottom Pouring Stir casting Furnace.**

Keywords – MMC, Al-2014, SiC, Tensile Properties and Hardness.

I. INTRODUCTION

Aluminium is used as a matrix material because of its attractive characteristics and second most available material. Aluminum alloy alone shows poor mechanical and tribological properties. This leads for the development of new composite material the term Composite broadly refers to a material system which is a mixture of a discrete constituent (the reinforcement) distributed in a continuous phase (the matrix) and which derives its distinguishing character from the properties of its constituents, from the geometry and architecture of the constituents and from the properties of the boundaries (interfaces) between different constituents. Composite materials are ideal for structural applications where high strength-to-weight ratios are required. Aircraft and spacecraft are typical weight sensitive structures in which composite materials are cost-effective.

The main advantage of a composite material over conventional material is the combination of different properties which are not often found in the conventional materials. The extraordinary combination properties include high strength to weight ratio, higher stiffness to weight ratio, improved fatigue resistance, improved corrosion resistance, higher resistance to thermal expansion, higher wear resistance and fracture toughness etc. There are a number of situations in service that demand an unusual combination of properties. Further, the present-day trend is to go in for light weight constructions for easy handling and reduced space, aesthetic appearance and high resistance to weathering attack. These factors have propelled the modern designers to develop newer composite materials up to the stage of large-scale production with exacting requirements.

The property of composite materials depends on the properties of constituents, geometry and distribution of phases. One of the most

important parameters is the volume (or weight) fraction of the reinforcement or fiber volume ratio. The distribution of the reinforcement determines the homogeneity or uniformity of the material system. The more non-uniform is the reinforcement distribution more heterogeneous is the material and higher is the probability of failure in weakest areas. The geometry and orientation of the reinforcement affect the anisotropy of the system.

In recent years, the potential of metal-matrix composite (MMC) materials for significant improvement in performance over conventional alloys has been recognized widely. However, their manufacturing costs are still relatively high. There are several fabrication techniques available to manufacture the MMC materials: there is no unique route in this respect. Due to the choice of material and reinforcement and of the types of reinforcement, the fabrication techniques can vary considerably. The processing methods used to manufacture particulate reinforced MMCs can be grouped as follows.

- Solid-phase fabrication methods: diffusion bonding, hot rolling, extrusion, drawing, explosive welding, PM route, pneumatic impaction, etc.
- Liquid-phase fabrication methods: liquid-metal infiltration, squeeze casting, compo casting, pressure casting, spray code position, stir casting etc.
- Two phase (solid/liquid) processes: Which include Rheocasting and Spray atomization.

Normally the liquid-phase fabrication method is more efficient than the solid-phase fabrication method because solid-phase processing requires a longer time. The matrix metal is used in various forms in different fabrication methods. Generally, powder is used in pneumatic impaction and the powder metallurgy technique, and a liquid matrix is used in liquid-metal infiltration, plasma spray, spray casting, squeeze casting, pressure casting, gravity casting, stir casting, investment casting, etc. A molecular form of the matrix is used in electroforming; vapour deposition and metal foils are used in diffusion bonding, rolling, extrusion, etc. There are certain main manufacturing processes which are used presently in laboratories as well as in industries are diffusion bonding, the powder metallurgy route, liquid-metal infiltration, squeeze casting, spray co-deposition, stir casting and compo casting. Brief Description of these processes is given below.

II. LITERATURE SURVEY

S Raghu et al [1], in his research work showed that as the particle size decreases the clustering and agglomeration is observed, but the overall mechanical properties increases expect the ductility.

R. S. Rana et al [2] compared the effects of composite with micro and nanoparticles of SiC prepared by ultrasonic assisted stir casting. The composites were synthesized using different wt% of SiC of 35 micron (3.5, 8, 10 wt. %) and SiC size of 40 nanometers (1, 2, 3 and 4). % in weight. The results show that the porosity increases thru the increase of the weight % of SiC. The modulus of elasticity, tensile strength and compressive strength is more for Al nano SiC than Al micron SiC composites. The hardness of the composite upsurges with increasing percent by weight of SiC.

H M Nanjundaswamy et al [3] exhibited the effect of forged and un-forged magnesium based composites by using bottom pouring stir casting technique by In-Situ method and showed how the BHN and Tensile properties will vary in the forged and un-forged composites. The reinforcements used are SiC and TiO_2 Particles. The BHN and Tensile values showed more for the forged composites when compared with un-forged composites because of decreased porosity and inter-metallic particle.

Yang et al. [4] have prepared nano-SiC based bulk aluminum nanocomposites by ultrasonic cavitation casting. They confirmed that the nanoscale SiC particles are equally dispersed in the matrix, that the YS of the alloy A356 is increased by above 50% and that the nanoscale SiC particles only represent 2.0 % in weight. An improvement of the hardness of about 20% was obtained in the nanoparticle composite developed using 2.0% by weight of SiC nanoparticles.

Satinder Singhet al [173] related the wear behavior of pure aluminum composites, Al-SiC (nano and micro) and Al-Al2O3 (nano and micro) under 3 kg load at a constant speed of 500 rpm. The test was carried out in ambient air with a relative humidity of 40-75% and an ambient temperature of 30-32° C. By adding a

reinforcing material to the aluminum, it was found that the resistance to abrasion was remarkably increased. Al-SiC (nano) proved to have the highest wear resistance, while pure aluminum had the lowest wear resistance. The wear resistance of Al, Al- SiC (nano and micro) and Al-Al2O3 (nano and micro) composites follows the following trends under normal loads of 3 kg and 500 rpm: - Al-SiC (nano)> Al - SiC (Micro)> Al - Al2O3 (nano)> Al - Al2O3 (micro)> Al pure.

III. MATERIALS & METHODS

2014 aluminiumalloy is an aluminium-based alloy often used in the aerospace industry. It is easily machined in certain tempers, and among the strongest available aluminium alloys, as well as having high hardness. However, it is difficult to weld, as it is subject to cracking. It is commonly extruded and forged. The corrosion resistance of this alloy is particularly poor. To combat this, it is often clad with pure aluminium. If unclad 2014 aluminium is to be exposed to the elements, it should be painted as a corrosion protection measure.

Silicon carbide (SiC), also known as carborundum, is a compound of silicon and carbon with chemical formula SiC. It occurs in nature as the extremely rare mineral moissanite. Silicon carbide powder has been mass-produced since 1893 for use as an abrasive. Grains of silicon carbide can be bonded together by sintering to form very hard ceramics which are widely used in applications requiring high endurance, such as car brakes, car clutches and ceramic plates in bulletproof vests. Electronic applications of silicon carbide as light emitting diodes and detectors in early radios were first demonstrated around 1907, and nowadays SiC is widely used in high-temperature/high-voltage semiconductor electronics. Large single crystals of silicon carbide can be grown by the Lely method; they can be cut into gems known as "synthetic moissanite". Silicon carbide with high surface area can be produced from SiO2 contained in plant material.

A batch type stir-casting furnace cum pouring set-up has been used for solidification processing of Al 2014 based composites. The photograph of the experimental set-up is as shown in Fig.1

The experimental set-up mainly consists of the following parts:

a. Melting unit.
b. Stirring arrangement.

The melting unit consists of an electrical resistance heating vertical furnace designed for a temperature of 1000°C. One end of the muffle was kept open and the other end was closed with a hole at its centre. A suitable steel structure was fabricated to assemble the furnace, leaving sufficient clearance from the floor for placing a mould conveniently right below the furnace.

Melting of the Al 2014 was carried out in a graphite crucible that has been cleaned to avoid contamination. The graphite crucible (No-3) has a cylindrical tapered shape with an average inner diameter of 80 mm and a hole of 12 mm in diameter at the centre of its bottom. The graphite crucible is placed inside the furnace and the bottom hole of the crucible is plugged tightly by inserting a graphite stopper in it through the bottom of the furnace.

A stirring arrangement was made for stirring the melt in the crucible. A ½ HP electric motor, having a maximum rated speed of 300 rpm was used to drive the stirrer. The motor was mounted above the furnace by a fixture arrangement as shown in Fig.3.2. The stirrer was fixed to the shaft of the motor by a screw coupling arrangement. A provision was also made for the stirrer height adjustment. A power supply unit was connected to supply voltage of 240V. A calibrated thermocouple was used to measure the temperature of the furnace by placing it close to the crucible wall.

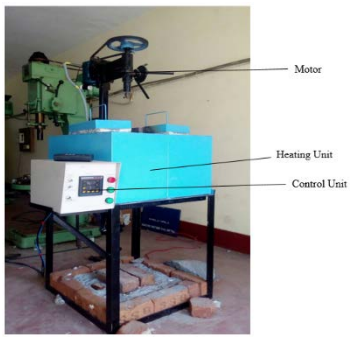


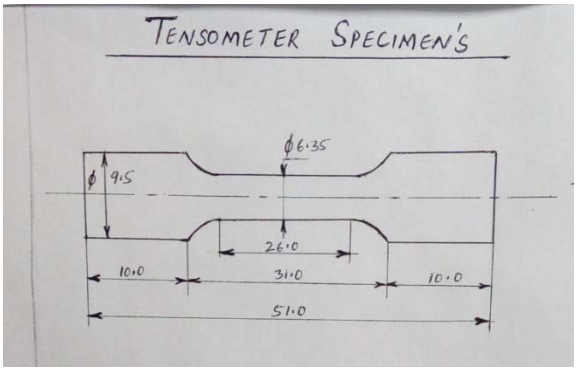
Fig 1: Photograph showing experimental set-up for stir casting used for solidification processing of different cast composites and cast unreinforced base alloy.

The Brinell hardness test is a simple indentation test for determining the hardness of a wide variety of materials and it is particularly preferred for particle reinforced composites as it

could provide a better average hardness over a larger area containing several fine particles in the matrix. The Brinell hardness of the cast composites and cast unreinforced alloys were studied on the samples prepared according to ASTM–E8 standards. The testing was carried out at a load of 500 Kg by using a steel ball indentor of diameter 10 mm. The load was applied for about 180 seconds on a sample and then the diameter of indentation was measured with the help of travelling microscope. For each indentation, an average of two diameters measured perpendicular to each other was used to find the corresponding hardness. On each sample, at least thirty indentations for hardness measurement were made at different locations and the average of these readings is reported as the hardness value of the material.

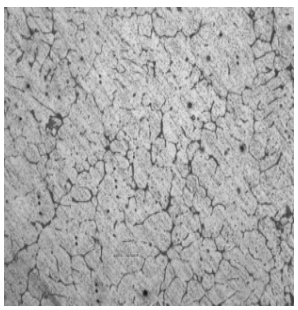
The tensile tests were conducted using a standard computerized Tensometer (KIPL-PC2000 made in Pune). The specimens were machined from each cast composites. The shape and dimension of the tensile specimens, conforming to ASTM–E8 specification, is shown schematically in Fig.2.

Fig 2: Schematic representation oftensile specimen ASTME 8 standard, round test piece**.**

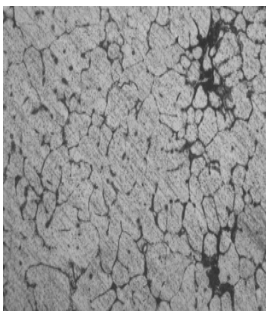


IV. RESULTS& DISCUSSIONS

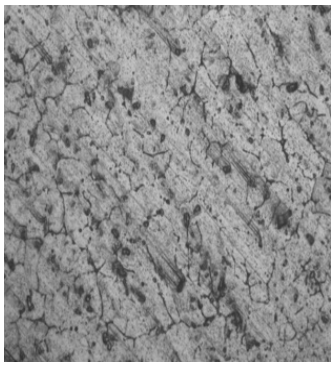
Microstructure Analysis



(a)



(b)



(c)

Fig 3: SEM Image of 4, 8 and 12 Wt. %.

The result shows the uniform distribution of SiC particles in the developed composites, but for 12 wt. % little bit agglomeration and clustering have been observed. The porosity was less in the developed composites because of good wettability between the matrix and reinforcement particles which are observed from the SEM images. The clustering and agglomeration will be minimize by continuous stirring and preheating the particles before adding to the Al alloy at the time of castings.

Hardness.

The hardness of the cast composites increases with increasing addition of SiC particles. However, the aluminium 2014 without any SiC powder added has the lowest hardness. As the reinforcement contents increased in the matrix material, the hardness of the composites also increased as observed in Table 1

Table 1: Average Hardness of alloy and cast composites.

Designation of alloy/ composite	**Brinell hardness number**
Al	89
Al-4%SiC	94
Al-8%SiC	100
Al-12%SiC	109

Tensile Properties.

In cast composites, the yield stress increases from 64.1 MPa in Al-0 % SiC alloy to 86.4, 96 and 103.5 MPa in composite containing about 4, 8 &12 wt.%. UTS also increase with increasing SiC Particles in the composites from 87.97 MPa in Al-0 % SiC to 107.1, 118.8 and 127.8 MPa correspondingly. The Ductility decreases with increase in the reinforcement SiC particles.

V. CONCLUSIONS

The results of the study of microscopic structure and mechanicalproperties of the Al2014 with 0, 4, 8 and 12 wt.% of SiC composites materials producedby stir casting are remarked as below:

The liquid metallurgy technique was successfully adopted in the preparation of Al2014 with wt. %of 0, 4, 8 and 12 SiC composites.
The microstructural studies revealed the uniform distributionof the SiC particulates in the Al2014 alloy matrix.
Hardness, Tensile Strength and Yield Strength increases as the SiC Wt. % increases in the composites.
It was observed that the percentage elongation decreases as the SiC Wt. % increases as compared to base Al2014 alloy matrix.

VI. ACKNOWLEDGMENT

We would like to express our sincere gratitude to the Management, Principal East Point College of Engineering Bengaluru for the facilities provided and their support. Also we would like to thank the Head of department Mechanical Engineering and faculties for their encouragement and support.

REFERENCES

[1] Raghu. S, H. M. Nanjundaswamy, Savitha. M & M. Sreenivasa: Synthesis andCharacterization of Mechanical Properties ofNano TiO2 Particle Reinforced Al-MMC. International Journal of Mechanical and ProductionEngineering Research and Development (IJMPERD) ISSN (P): 2249-6890; ISSN (E): 2249-8001 Vol. 8, Issue 2, Apr 2018, 981-988 © TJPRC Pvt. Ltd

[2] R S Rana, Rajesh Purohit, Sanjay Soni and S. Das: Comparison of Mechanical Properties and Microstructure of Aluminum Alloy Micron and Nano SiC Composites Fabricated by Ultrasonic Vibration. International Journal of Advance Engineering and Research Development, Year 2014, Volume 1, Issue 12.

[3] H M Nanjundaswamy, S K Nath and S Ray: Tensile and Fracture Properties of Cast and Forged Composite Synthesized by Addition of In-Situ Generated Al3Ti-Al2O3 particles to Magnesium. International Conference of Chemical, Molecular, Nuclear, Metallurgical Engineering, Year 2016, Volume 10, Issue No 6.

[4] Y Yang, J Lan and X Li: Study on Bulk Aluminum Matrix Nano-Composite Fabricated by Ultrasonic Dispersion Of Nano-Sized SiC Particles in Molten Aluminum Alloy. Materials Science and Engineering, Year 2004, Volume 380, pp. 378–383.

[5] Satinder Singh and NirajBala: Fabrication and Wear Testing of Nano and Micro Carbides/Oxides Reinforced Aluminium Based Metal Matrix. International Journal of Engineering Research & Technology (IJERT), Year 2015, Volume 4, Issue 08,ISSN: 2278-0181 IJERTV4IS080707.

[6] Raghu S, H M Nanjundaswamy, M Sreenivasa “Effect of Nano-Sized TiO2 particles on the Wear Behaviour of Aluminium Composites Synthesized by Stir Casting Method”. International Journal of Mechanical and Production Engineering, ISSN (p): 2320-2092, ISSN (e): 2321-2071 Volume- 7, Issue-9, Sep.-2019, pp: 53-58.

Exoskeleton for knee replacement

Architha N[1]

Dr. R Kumar[2]

[1]*MTech, Mechanical engineering department/MS Ramaiah Institute of Technology, Bangalore, 560054.India*

[2] *Assistant Professor, Mechanical engineering department/ MS Ramaiah Institute of Technology, Bangalore, 560054.India*

Abstract

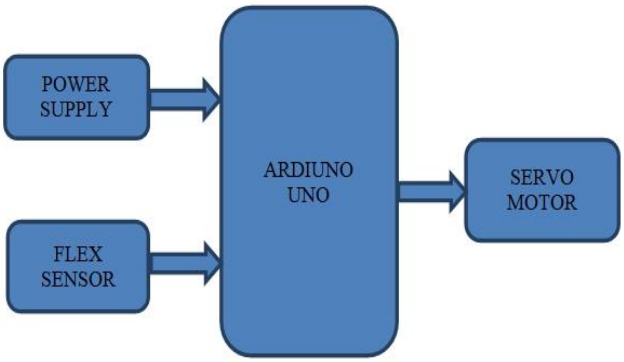
People face difficulty in walking due to old age or due to accident or stroke. An external wearable device can be used to provide strength and also moment in their joints. These devices are called exoskeletons. exoskeleton aims to empower the physically weak individuals by helping them harness the power of exoskeleton to amplify the strength of their legs. An exoskeleton is an add-on that is provided to the amputees, helps to provide the movement of the leg. This helps the patient to walk. This requires a lot of upper body strength to travel. An automated exoskeleton leg helps patients to move around with dysfunctional leg even with the other leg being amputated by flex sensor. With the use of electromechanical devices and sensors, the movement the patient is controlled based on the motion of the functional leg. The objective is to design a robotic exoskeleton that is basically sensors with high degrees of repeatability, precision, and reliability. This designed work is a concept as robotic control is an exciting and high challenge research work in recent year..

Keywords*: exoskeleton, mechatronics, sensors*

Introduction

The term “Exoskeleton” refers to an external wearable robot that is worn by the user to extend muscle strength and enhance body stability. It is designed in a skeletal manner i.e., the joints of the exoskeleton line up correspondingly with the joints of the human limb on which it is worn. The force exerted by the exoskeleton is thus exerted on the joints of the human to create power-augmented motion. In recent years, there has been an increasing interest in the development of different kinds of exoskeletons. This is made possible now by many technological advancements some including reduction in weight such, improvements in reduction of size of power supplies and longer lifetime, better control techniques, etc. The exoskeleton is a classification under wearable robots that describes a robotic field which studies the interaction between the human body and robotics.

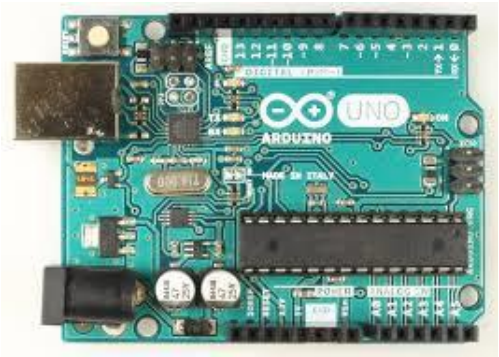
In these systems, a mechatronics structure is attached to different parts of the human body, and while the wearer commands the mechanical system using physical signals (like electronic sensors, controllers and motors) the mechanical system does the hard work, like carrying heavier objects or helping the movement of handicapped parts of the body. Since its conception in the sixties, the bibliography written by Crawshaw speaks about two models of wearable robots - the prosthetics and the orthotics. The first group replaces the lost body members, while the second one assists the body movements or enhances the body capabilities.



The electronics consists of two 5A relays, microcontroller, the motion of the femur is sensed by a flex sensor, placed at the pelvic joint. The resistance of the flex sensor changes with the angle bent by the femur. The flex sensor resistance increases with increase in the bending angle thereby decreasing the output voltage. The change in the output voltage of the flex sensor is detected by the microcontroller.
The DC motor of the linear actuator is controlled by the microcontroller through a pair relays based on the voltage output of the flex sensor. When the voltage ranges from 0 to 1.85V, the microcontroller produces clockwise direction of the motor thereby retracting the leg front movement. If the voltage is above 1.85V, the direction of the motor is reversed hence, the leg moves in opposite direction.

Main components used

Ardino uno:

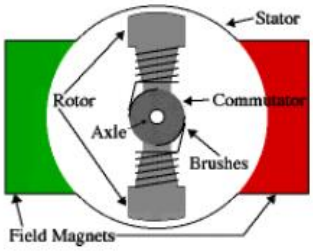


Arduino Uno is a microcontroller board based on 8-bit ATmega328P microcontroller. Along with ATmega328P, it consists other components such as crystal oscillator, serial communication, voltage regulator, etc. to support the microcontroller. Arduino Uno has 14 digital input/output pins (out of which 6 can be used as PWM outputs), 6 analog input pins, a USB connection, A Power barrel jack, an ICSP header and a reset button.

Flex sensor:
Flex sensor is also called as bend sensor. That is capable of sensing any kind of minute bend in its structure. Flex sensor is designed in a thin plastic strip type material. This flex sensor is a variable resistor, the resistance of the flex sensor increases as the body of the component bends

Dc motor:

A DC motor is a mechanically commutated electric motor powered from direct current (DC). The stator is stationary in space by definition and therefore so is its current. In any electric motor, operation is based on simple electromagnetism



Battery

Battery is the main power source for the exoskeleton to run. Therefore more voltage gives longer run

Knee Joint:

The knee joint is the movable joint which is connected to the connector by three links. One end of the knee joint is connected to the connected and the other end hinged to the links.

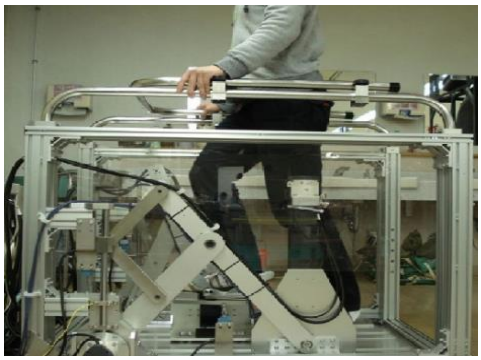
TESTING

SI no	Angle (degrees)	' X' coordinate	'Y' coordinate	Displacement (degrees)
1	90	25	-20	30
2	20	25	-20	18
3	30	25	-20	25
4	40	25	-20	20
5	50	25	-20	20
6	90	20	-25	18
7	20	20	-25	20
8	30	20	-25	18
9	40	20	-25	17
10	50	20	-25	15

Table 9.1 upper and lower gripper position

The position angle plays an important role , help in achieving maximum displacement and improve in ergonomics of the prosthetic. The optimum angle and maximum displacement achieved is tabulated.

A few examples,



Haptic walker for rehabilitation

exoskeleton for walking purposes

The HapticWalker is a haptic locomotion interface able to simulate not only slow and smooth trajectories (like walking on an even floor and up/down staircases), but also foot motions like walking on rough ground or even stumbling or sliding, which require high-order system

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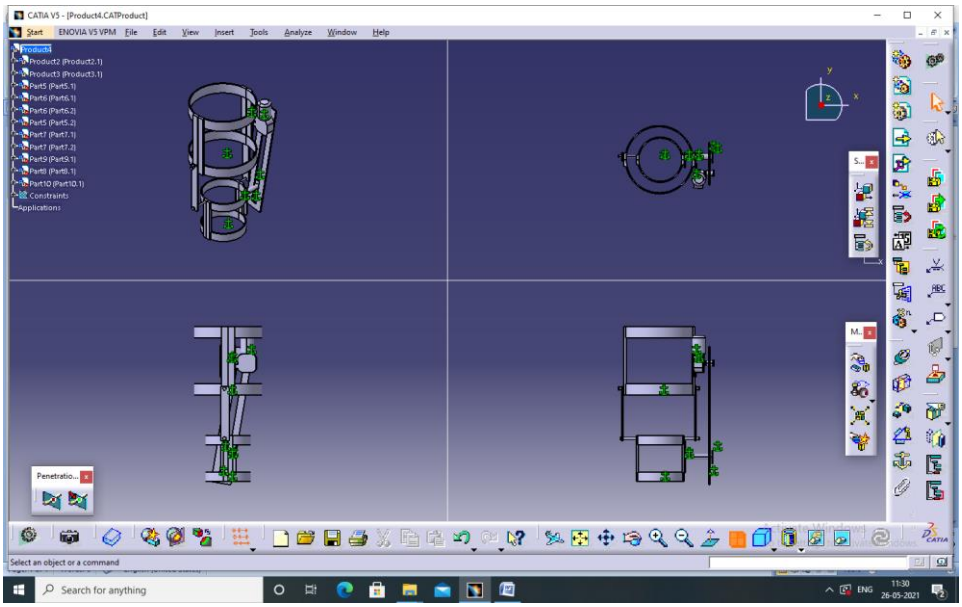
dynamics. It is a major redesign of GT I with foot plate trajectories fully programmable, and it is currently being clinically evaluated in several trials with stroke patients and spinal cord injury patients

CAD model



Conclusion

The exoskeleton leg proves to be an excellent assist tool for the people who have difficulty in walking. The exoskeleton limb is just the beginning of a potential power enhancing exoskeleton suit which is the technology of the future. The results highlighted the importance of principles of legged mechanics for understanding human motor control, as well as of neuromuscular controllers for improving the functionality of powered leg exoskeleton. Eventually, these results might change how we understood human locomotion and engineered artificial legs, improving the quality of life of people who face difficulty.
Automated exoskeleton has a greater advantage, adaptability, reduction in complexity is achieved. Thus,

Automation of this system can be achieved without tapping neural signal Automated exoskeleton is more cost efficient

The frames were designed keeping in mind the average dimensions obtained from a survey of various human leg sizes

Scope for future work

The exoskeleton can be improved by working on some parameters,
Duty cycle: stepper motor to operate for a longer period thereby helping the patient to walk for a longer time.
Battery: The battery should be more durable, by equipping the prosthetic with higher voltage battery higher speed can be obtained, use of different type of batteries which are lighter enables reduction in weight and net power consumption
Adaptability: The exoskeleton can be made adaptable by having variable dimension adjustable, by doing so, the requirements of different cases are satisfied.
Stair climbing and sitting condition: The step angle needs to be increased and with the suitable addition of electronics stair climbing and sitting process can be achieved.
Sensor: The delay in the response can reduce by introducing new sensor like myoware, Gyroscope etc. A myoware sensor which is sensitive compared to other sensor and is more reliable.

References

[1] Abdulla Almomani, Faisal Miqdadi, Mustafa Hassanin, Mustafa Samy, and Mohammed Awadallah, “The 1st Pneumatic Fluidic Muscles Based Exoskeleton Suit in The U.A.E,” IEEE, 2014.

[2] Kwok-Hong Chay, Jer-Vui Lee, Yea-Dat Chuah and Yu-Zheng Chong, “Upper Extremity Robotics Exoskeleton: Application Structure and Actuation,” International Journal of Biomedical Engineering and Science (IJBES), Vol. 1, Issue No. 1, pp 35-45, April 2014.

[3] Joel C. Perry, Jacob Rosen and Stephen Burns, “Upper-Limb Powered Exoskeleton Design,” IEEE/ASME Transactions on Mechatronics, Vol. 12, Issue No. 4, pp 408-417, August 2007, Publisher: IEEE.

[4] Boris Jobbágy, Dušan Šimšík, Jiří Marek, Ján Karchňák and Daniela Onofrejová, “Robotic Exoskeleton for Rehabilitation of the Upper Limb,” American Journal of Mechanical Engineering, Vol. 2, Issue No. 7, pp 299-302, 2014, Publisher: Science and Education Publishing.

[5] Gregory Clark Henderson and Jun Ueda, “Pneumatically-Powered Robotic Exoskeleton to Exercise Specific Lower Extremity Muscle Groups in Humans,” Biomedical Robotics and Biomechatronics (BioRob), 4th IEEE RAS & EMBS International Conference on IEEE, pp 1506-1511, 2012, Publisher: IEEE.

[6] Younkoo Jeong, Yongseon Lee, Kyunghwan Kim, Yeh-Sun Hong and Jong-Oh Park, “A 7 DOF Wearable Robotic Arm Using Pneumatic Actuators,” Proceedings of the 32nd ISR (International Symposium on Robotics), Vol. 19, pp 21, April 2001.

[7] Zhichuan Tang, Kejun Zhang, Shouqian Sun, Zenggui Gao, Lekai Zhang and Zhongliang Yang, “An Upper-Limb Power-Assist Exoskeleton Using Proportional Myoelectric Control,” Sensors, Vol. 14, Issue No. 4, pp 6677-6694; DOI: 10.3390/s140406677, Publisher: Multidisciplinary Digital Publishing Institute, 2014.

[8] Hugh Herr, “Exoskeletons and orthoses: classification, design challenges and future directions,” Journal of Neuroengineering and Rehabilitation, Vol. 6, Issue No. 1, pp 21, DOI: 10.1186/1743-0003-6-21, Publisher: BioMed Central, 2009.

[9] Evangelos Papadopoulos and Georgios Patsianis, “Design of an Exoskeleton Mechanism for the Shoulder Joint,” 12th IFToMM World Congress, Besançon (France), pp 18-21, 2007.

[10] Md. Sadiur Rahman, Md. Tanjil Rashid Avi, “Exoskeleton Arm - The First Step of Real Life Iron Suit,” School of Engineering and Computer Science BRAC University, Publisher: BRAC University, 2015.

[11] Arjun Kurunji and Team, “Project Report on Design and Fabrication of Exoskeleton Arm,” St. Joseph Engineering College, Mangalore, Karnataka, 2014.

Design of fogger system for cattle farming to control mites

Anil K C[1], Anusha A S *[2], Thrupthi G S [2], Manoj M[2]

[1]*Assistant Professor,* [2] *UG student*
Department of Industrial Engineering & Management,
Siddaganga Institute of Technology, Tumkur.
[*]*anushaas2004 @gmail.com*

Abstract **– In the agricultural field, cattle rearing and cattle farming, which is allied sector of agriculture is one of the important activities. Most of the cattle die due to diseases and most of the diseases are due to parasitic bite on cattle. controlling parasitic attack is one of the major responsibilities. Existing methods use manually operated system. It includes, burning coconut jute and spreading smoke inside the cattle shelter and manually spraying mites controlling oils around the cattle. There is no automatically operated system for this operation.**

Keywords- ***cattle farming, mites controlling, fogger machine.***

I. INTRODUCTION

India is an agricultural country. In India, 70% of rural households still depend primarily on agriculture for livelihood. As per 2016, Agriculture and allied sectors contributes 17% to 18% for country's GDP with about 41.49% of work force. It's allied sectors include Horticulture, Sericulture, Fisheries, Animal husbandry and livestock. Out of all other sectors, livestock contributes 4.11% GDP and 25.6% of total agricultural GDP. Along with feeding and sheltering, disease management of cattle is one of the major responsibilities in livestock or cattle farming. Disease usually occurs due to less nutrition value, biting of tick mites, communicable diseases.

Most common cattle diseases and symptoms are:

1. Parasitic diseases : external and internal parasites like tick mites, lice , worms etc.
2. Communicable diseases : pathogens like bacteria and viruses.
3. Non-communicable diseases: deficiency of nutrients or malfunctioning of body organs.

<u>Symptoms :</u>

- Animal become inactive and stops eating food.
- It gets away from other animals and may have shiver and fever.
- The dung may be loose.
- Color of urine may change.

It was through case study that we found disease management, which is one of the major responsibilities, has traditional techniques though technology has improved a lot. It involves manually operated technique which is, burning coconut jute and spreading smoke inside the cattle shelter and manually spraying mites controlling oils around the cattle. There is no automatically operated system for this operation.

II. MATERIALS AND METHODS

The fogger machine (which is usually used for creating virtual fog in functions) which is having speed controller both manual and remote control, with pressure is connected to a pipeline which runs inside the cattle shelter. At the compartment of each cattle, provide a nozzle to control the flow of fog. Use eco friendly oils such as eucalyptus oil or neem oil in fogger machine. Use two walls to control input of fog. Automated Arduino switch is used to turn off and on the flow after every 4 or 5 minutes. Once the mains are turned on, switch works until the required time.

III CONCEPTUAL DESIGN AND WORKING

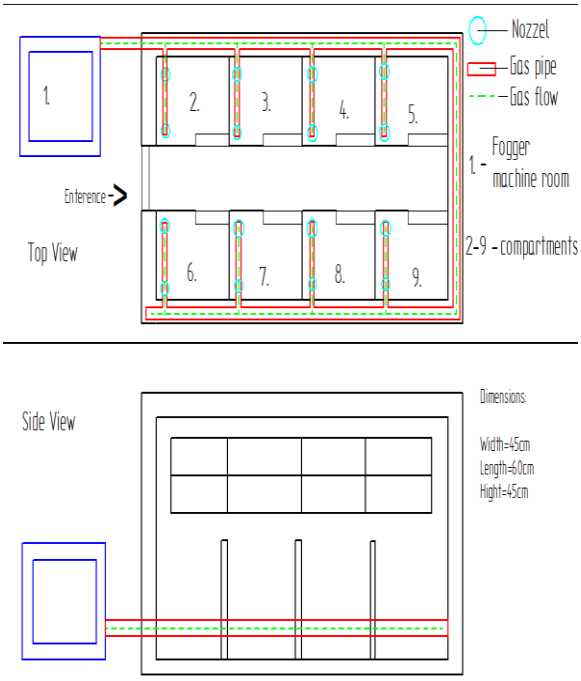


Figure1: Layout plan of fogger system

When machine is turned on with eco friendly oil filled in it, fog is produced and flows inside the pipeline. When nozzle is opened, oil is sprayed inside cattle shelter and hence mites are controlled. pressure of spray and area up to which sprayed oil will reach depends on area of cattle shelter and selected accordingly. The Arduino switch is programmed in such a way that it should turn on and off automatically after every 4 or 5 minutes, once the mains is on. This makes the system to work automatically.

IV CONCLUSIONS

One of the greatest challenges in cattle farming is controlling disease. For enhancing the production, use of hazardous chemicals leads to severe damage to the health of cattle, soil and environment. By using available technique automatically operated fogger machine can be design which has following advantage mentioned below.

By this technique communicable and parasitic diseases can be controlled.

ADVANTAGES

- Automatically operated system
- Use of eco friendly oils
- Use of timer for automatic operation
- More effective than manual techniques
- Easy maintenance
- One time investment

V CONCLUSIOS

A performance test was carried on the cattle shelter and got expected results. Farmers can use eco-friendly oil in order to produce fog. Different capacity and frequency fogger machine can be used in accordance with shelter area. Mainly it is one time investment and can be operate automatically. Duration of fog spray is altering. Using this spray disease causing parasites, mites, ticks and mosquito can be control and productivity can be improved.

REFERENCES

[1] Narladkar BW (2018) Projected economic losses due to vector and vector-borne parasitic diseases in livestock of India and its significance in

implementing the concept of integrated practices for vector management, Veterinary World, 11(2): 151-160.

[2] Arunkumar, S. and Nagarajan, K. (2013) A study on prevalence status of infection among cattle population of Kancheepuram and in and around Chennai districts of Tamil Nadu. Int. J. Food Agric. Vet. Sci., 3: 155-157

[3] Ghosh, S., Azhahianambi, P. and Yadav, M.P. (2007) Upcoming and future strategies of tick control: A review. J. Vector Dis., 44: 79-89

[4] Chhillar, S., Chhilar, J.S. and Harpreet, K. (2014) Investigations on some hard ticks (Acari: Ixodidae) Infesting domestic buffalo and cattle from Haryana, India. J. Entomol. Zool. Stud., 2: 99-104

[5] Annual Report. (2013-14) Department of Animal Husbandry, Dairying and fisheries. Ministry of Agriculture, Government of India, New Delhi. Available from: http:// www.dahd.nic.in. Accessed on 19-10-2017

[6] 19th Livestock Census. (2012) All India Report, Ministry of Agriculture, Department of Animal Husbandary, Dairying and Fisheries, Krishi Bhavan New Delhi, Government of India

[7] Bandeira, M.D.C.A, Brito, G.A., da Penha, A. and Rebêlo, J.M.M. (2017) The influence of environmental management and animal shelters in vector control of Culicoides (Diptera, Ceratopogonidae) in northeastern Brazil. J. Vector Ecol., 42: 113-119.

[8] Muhammad, G., Naureen, S., Firyali, S. and Saqib, M. (2008) Tick control strategies in dairy production medicine. Pak. Vet. J., 28: 43-50.

IMPLEMENTING VALUE ANALYSIS FOR DESIGNING A MULTIFUNCTIONAL WARDROBE

Aishwarya Pandiyan, *Pre-final Year Engineering student. Bangalore Institute of Technology, KR Road, V.V Puram, Bangalore, India*
Email ID: aishwaryapandiyan25@gmail.com

Aishwarya H M, *Pre-final Year Engineering student. Bangalore Institute of Technology, KR Road, V.V Puram, Bangalore, India*
Email ID: hmaishwaryagowda05@gmail.com

AmruthaLakshmi G L, *Pre-final Year Engineering student. Bangalore Institute of Technology, KR Road, V.V Puram, Bangalore, India*
Email ID: amruthalakshmigl14@gmail.com

Sandhya M, *Pre-final Year Engineering student. Bangalore Institute of Technology, KR Road, V.V Puram, Bangalore, India*
Email ID: sandysandhyammsk@gmail.com

Prof. V.S. Giri, *Associate Professor. Bangalore Institute of Technology, KR Road, V.V Puram, Bangalore, India*
Email ID: vsgiri.bit@gmail.com

ABSTRACT- Wardrobe, in furniture, a large cupboard, usually equipped with drawers, a mirror, and other devices, used for storing clothes. This technical paper aims to elicit how to use the Value Analysis methods to analyze the existing design and come out with an improved design.
The above objectives are achieved by the implementation of systematic approach, Value Analysis Methodology encompassing techniques such as Functional Analysis, Decision Matrix, Evaluation Matrix.
Wardrobe is redesigned through its functions in order to meet customer requirements of having higher value furniture, by increasing functions while there is slight increase in the cost without sacrificing the quality, durability and maintainability.

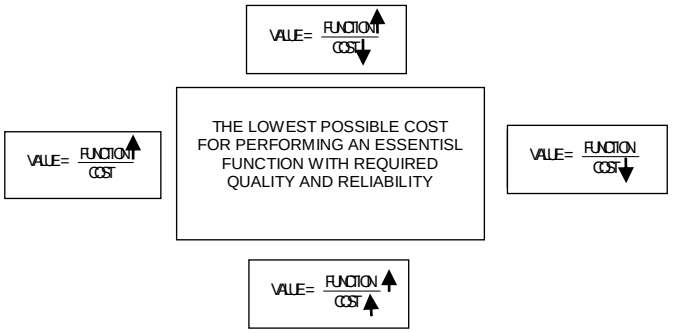
KEYWORDS- Multifunctional Wardrobe, Value Analysis, Functional Analysis, Decision Matrix, Evaluation Matrix

I. INTRODUCTION

Value Engineering is a proven management technique that can make valuable contributions to value enhancement and cost reduction in furniture industry. Wardrobe is an integral part of home decor and majorly used for storage. Plywood is the preferred choice for the manufacturing of the Wardrobe. With the current environmental concerns or threats prevailing around the globe, there arises a need for alternatives for this conventional use. A material such as OSB can be used in view of cost reduction with ensured functional enhancement, assured quality and environmentally friendly.

II. CONCEPT OF VALUE

Value is defined as "the conceivable possible cost for performing an essential function with required quality and reliability". It can be increased by either reducing the cost or increasing the function while maintaining performance, quality and reliability.



A. *Types of Value:*

a. Use value: The properties, features and qualities which accomplish the use, the work or service-causing the item to perform or serve an end.

b. Cost value: The total of material, labor and other costs that have to be incurred to produce an item.

c. Esteem value: The properties, features or attractiveness which cause us to yearn to possess it-causing the item to sell

d. Exchange value: The properties, or qualities which enable us to exchange an item for something else we want.

Category of 'value'	Examples
Use value	Nail
Cost value	Bus fare
Esteem value	Gold watch
Exchange value	Antique furniture

III. DEFINITION OF VALUE ANALYSIS:

It can be defined as an organized approach to the identification and elimination of unnecessary cost. Unnecessary cost is cost which provides neither use, nor life, nor quality, nor appearance, nor customer features. Value analysis is an organized procedure for efficient identification of unnecessary cost. It is a study of the relationship of design, function and cost of any project, material or manufactured by more efficient process, change in source of supply, or possible elimination or incorporation in a related item.

A. *Objectives and Scope of Value Engineering:*

- Improve project quality
- Reduce project cost
- Foster innovation
- Eliminate unnecessary and costly design elements
- Ensure efficient investments
- Develop implementation procedures

B. Advent of Value Analysis:

Value engineering began at General Electric Co. during World War II. Because of the war, there were shortages of skilled labour, raw materials, and component parts. Lawrence Miles and Harry Erlicher at G.E. looked for acceptable substitutes. They noticed that these substitutions often reduced costs, improved the product, or both. What started out as an accident of necessity was turned into a systematic process. They called their technique "value analysis".

C. *VAVE Methodology:*

The Value methodology (VA/VE), also called Value Engineering (VE), Value Analysis (VA) or Value Management (VM), is a powerful problem-solving tool that can reduce costs while maintaining or improving performance and quality requirements. VE is a technique directed towards analyzing the functions of an item or process to determine "best value," or the best relationship between worth and cost.

D. *Benefits of Value Analysis:*

- With population growing and non-renewable energy resources dwindling it because as much a moral as an economic issue that we become cost conscious.
- Generates new concepts and ideas for R and D work
- Determines appropriate cost for reliable performance of essential functions
- Motivates employee in better understanding of their jobs and its importance
- Widespread tendency to think function rather than think hardware
- To attain cost effectiveness
- To improve in house manufacturing facility and can affect improvement of technological process
- Increases the mental output of any person or productivity in a more valuable way at minimum cost

E. Phases of Value Analysis:

- Information phase
- Functional phase
- Creative phase
- Evaluation phase
- Development phase
- Recommendation phase
- Presentation phase

IV. CASE STUDY:

Case study is on a Wardrobe. Value Analysis is performed in the following steps on the design of Wardrobe.

a) Collecting information about Wardrobe.
b) Function Analysis worksheet- Different parts of Wardrobe.
c) Preparation of Numerical Evaluation sheet.
d) Creative Worksheet is formulated.
e) Alternatives are selected through decision matrix.
f) Recommendations are given.
g) Conclusions.

V. INFORMATION PHASE

Wardrobe, in furniture, a large cupboard, usually equipped with drawers, a mirror, and other devices, used for storing clothes. Wardrobe plays a vital role to ascertain the user profile from the fashion preferences. The wardrobe planning is to select clothes that are so basic in style and good in design that they are appropriate for the present set up as well as suitable for a few years to come. Durability, quality of clothing items, price, appearance and ease of care.

A. Origin of a Wardrobe:

The word wardrobe appeared in the English language in the early 14th century. It originated from Old French words warderobe, wardereube and garderobe, in which "warder" meant "to keep, to guard" and "robe" meant "garment".

In the United States, the wardrobe in its moveable form as an oak "hanging cupboard" dates back to the early 17th century. At that time, it was an early export product from America to England, because English woodlands were over-harvested or reserved for the Navy. Consequently, the item was sometimes referred to as an Oakley. For probably a hundred years, such pieces, massive and cumbrous in form, but often with well-carved fronts, were produced in moderate numbers; then the gradual diminution in the use of oak for cabinet-making produced a change of fashion in favor of the more plentiful American walnut. Walnut succeeded oak as the favorite material for furniture, but hanging wardrobes in walnut appear to have been made very rarely, although clothes presses, with drawers and sliding trays, were frequent.

Existing Wardrobe

B. *Function of Wardrobe:*

A wardrobe is not an enlarged closet. It's a small room. Its function is to systematize storing clothes, domestic things and other.

Helps to avoid mess: The main function of a wardrobe is to help to get rid of the mess. This is perfect accessory for storing a variety of items. All in all, this is a compact and fully functional substitution for common shelfs and chests.

Available in many designs: Some of the most affordable wardrobe models will be made of durable material. However, if wardrobe has a lot of space left, it can easily go with a set of MDF drawers.

Carefully optimizes your storage space: A wardrobe is not only a great little accessory to get rid of the mess – it is also a fantastic solution to optimize your available storage space and carefully subdivide it into distinct categories. So, things will no longer be left in a tangle, which is another obvious advantage.

Easily available in stores: A wardrobe practically is sold in any online store that sells household accessories – there is no need to actually go anywhere.

The bottom line, a wardrobe is one of those things that make our lives easier.

VI. FUNCTIONAL ANALYSIS

Functional analysis is concerned with improving profits by attempting to reduce costs and/or by
improving products by adding new features in a cost effective way that are so attractive to customers that profits actually increase. The functions are classified as Basic or Secondary. A function is Basic if it is the prime or specific purpose for which the assembly or components were designed. A function is Secondary if it does not directly contribute to the basic function or it is only required to support the achievement of the basic function.

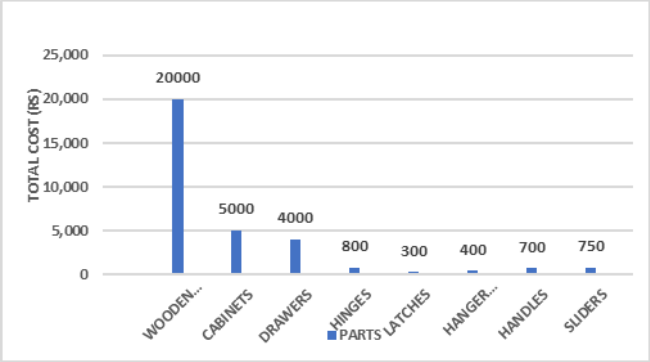
Sl no.	**Part Name**	**Quality**	**Function**		**Category**	
			Verb	Noun	Basic	Secondary
1.	Wooden frame (complete)	1	Hold	Assembly	X	
			Hold	Parts		X
			Provide	Strength		X
			Provide	Storage		X
2.	Cabinets	8	Provide	Storage	X	
			Improve	Appearance		X
			Provide	Support		X
3.	Drawers	3	Provide	Storage	X	
			Improve	Appearance		X
4.	Hinges	8	Hold	Assembly		X
			Provide	Flexibility	X	
			Provide	Strength		X
5.	Latches	2	Provide	Safety	X	
			Improve	Appearance		X
6.	Hanger rods	2	Provide	Storage	X	
			Improve	Appearance		X
7.	Handles	4	Improve	Appearance		X
			Provide	Grip	X	
8.	Sliders	6	Hold	Material		X
			Move	Parts	X	

Table 1: Functional Analysis-Identification of functions

A. *Costing of different parts of wardrobe as shown in the table below:*

SL NO.	**Parts**	**Quantity**	**Cost**
1.	Wooden frame	1	20,000
2.	Cabinets	8	5,000
3.	Drawers	3	3,000
4.	Hinges	8	800
5.	Latches	2	300
6.	Hanger rods	2	400
7.	Handles	4	700
8.	Sliders	6	750
		Total : 31,950	

Table 2: Total Costing of wardrobe parts



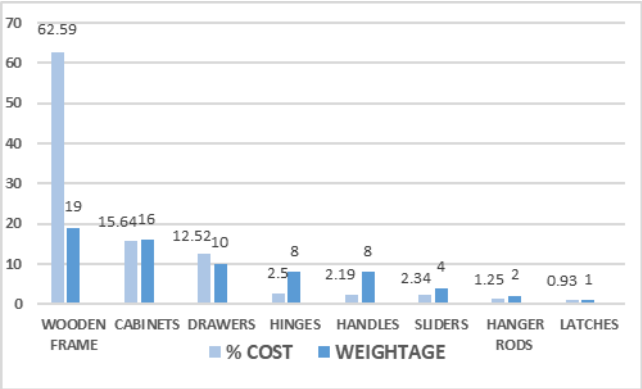
Graph 1: Cost of each part of wardrobe (in Rs) Functional

B. *Functional Evaluation:*

Detailed Functional Evaluation Of different parts of wardrobe with weight and percentage cost in the product as shown in the table

Key letter	Parts	Function	Weightage	% cost
A	Wooder frame	Hold Assembly	19	62.59
B	Cabinets	Provide Storage	16	15.64
C	Drawers	Provide Storage	10	12.52
D	Hinges	Provide Flexibility	8	2.50
E	Handles	Provide Grip	8	2.19
F	Sliders	Move Parts	4	2.34
G	Hanger Rods	Provide Storage	2	1.25
H	Latches	Provide Safety	1	0.93

Table 3: Function Evaluation



Graph 2: Component's Weight and % Cost

C. *Numeric Evaluation Sheet:*

	B	C	D	E	F	G	H	
A	A3	A3	A2	A2	A3	A3	A3	19
	B	B3	B2	B2	B3	B3	B3	16
		C	C2	C2	C1	C2	C3	10
			D	D1	D2	D2	D3	8
				E	E3	E2	E3	8
					F	F2	F2	4
						G	G2	2
							H	1

Major Performance-3
Medium Performance- 2
Minor Performance- 1

VII. CREATIVE PHASE

This is the creative phase concerned with the generation of new alternatives to replace or removing the existing ones. Accordingly, a brainstorming session is held to generate alternative ideas by thinking creatively and positively. The below listed are some of the optimum alternatives:

1. Wardrobe
2. Sofa cum bed
3. Space saving multipurpose table
4. Smart furniture
5. Multifunctional Wardrobe

Ideas → No. of Parameters↓	1	2	3	4	5
Durability	1	0	0	0	1
Ease of use	1	1	1	1	1
Compactness	0	1	1	1	1
Maintenance	0	0	1	0	0
Cost	0	1	0	0	1
Appearance	1	1	1	1	1
Total	3	4	4	3	5
%	30	40	40	30	50

1: Yes 0: No

Table 4: Evaluation of alternative with respect to desirable feature

VIII. EVALUATION PHASE

In Evaluation phase, each and every alternative is analyzed and the most promising alternatives are selected. These alternatives are further examined for economic and technical feasibility.

The creative ideas generated during the brainstorming session are critically examined, each idea is ranked from a scale of 1 to 10 and few of the proposals are finalized.

Sl. no	Ideas	State of art 10: off the shelf 1: new technology	Probability of implementation 10: excellent chance 1: low chance	Cost to develop 10: no cost 1: high cost	Time to implement 10: extremely short 1: extremely long	Features 10: with additional features 1: without additional features	Total
1.	**Wardrobe**	10	8	8	6	3	35(II)
2.	**Sofa cum Bed**	7	6	6	8	6	33(IV)
3.	**Space saving multipurpose table**	7	7	5	8	7	34(III)
4.	**Smart furniture**	4	3	2	5	8	22(V)
5.	**Multifunctional wardrobe**	9	9	8	7	10	43(I)

Table 5: Evaluation of ideas found from Creative Phase

IX. DEVELOPMENT PHASE

This phase allows the manufacturers to determine the most preferred alternatives amongst the various proposed alternatives. Advantages and Disadvantages are listed and ranked to determine which alternative should be implemented.

Sl. No	Ideas	Ranking	Advantages	Disadvantages
1	Wardrobe	2	Sufficient storage	no additional features
2	Space saving multipurpose table	3	Compact few additional features	less durable heavy weight
3	Multifunctional wardrobe	1	Multi-functions compact cost saving sufficient storage	Heavy weight

Table 6: Ranking of preferred ideas

Parameter ⇨ / **Weightage** ⇨ / **Alternatives** ⇩	**Durability** 9	**Cost** 8	**Appearance** 7	**Total**
Existing Product (Wardrobe)	2 / 18	3 / 24	3 / 21	63
Space saving multipurpose table	2 / 18	3 / 24	2 / 14	56
Multifunctional wardrobe	3 / 27	4 / 32	3 / 21	80

4: Excellent 3: Good 2: Fair 1: Poor

Table 7: Decision Matrix

X. RECOMMENDATION PHASE

The Evaluation Matrix indicated that alternative of Multi-functional Wardrobe is preferred to the existing product and to the space saving multipurpose table. The function benefit analysis is done for the preferred alternative and the existing one as shown below:

Situation before existing product	Situation after multifunctional wardrobe
Less efficient	More efficient
Used only for storage	Contains features such as, study/computer table, dining table, dressing table, sofa, bed, TV cabinet
Not cost saving	Cost saving

Table 8: Comparison Table

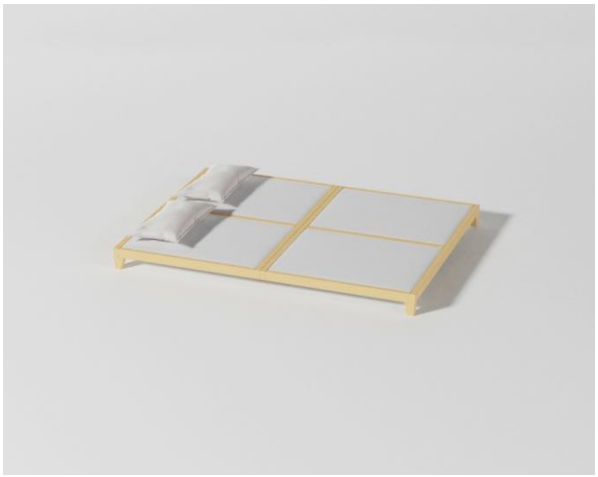
XI. PRESENTATION PHASE

Illustrations of Proposed Alternative

Front view of the Multifunctional Wardrobe
[Wardrobe and Study Table]

Right view of the Multifunctional Wardrobe
[TV Cabinet, foldable chairs and Sofa cum Bed]

Left view of the Multifunctional Wardrobe
[Dressing Table and Dining Table]



Sofa cum Bed

XII. KEY POINTS ON IMPLEMENTATION

- Improved Space Usage
- Higher Return-on-Investment
- Increased functionality
- Better Ergonomics
- Higher Customer Satisfaction

XIII. CONCLUSION

Value Analysis Methodology is a well-defined systematic process that is employed by a versatile team consisting of Value Engineers and Field Specialists to improve the Value of a project, product, process or service. It is a function-oriented team approach where the critical assessment of the product, system or service is performed to achieve their essential functions at the lowest cost without compromising its performance, reliability, quality and safety.

In this Case Study, we have discussed above how the Value analysis is used for increasing the function with change in the product design & its value. We have tried to implement these potential ways to improve the function of the product. The results of our study show that the traditional wardrobe serving the purpose of storage can be evidently improved by

adding functions of Computer table or Study table, Dining table, TV cabinet, Dressing table, Sofa cum bed and Foldable chairs. A proper decision matrix is prepared for choosing the appropriate alternative from the feasible choices available. The introduction of OSB material has also eased the machining process which leads to reduction in labour costs and also use of OSB material benefits the environment. With the proposed modifications in the design stages, the value of the product is thus enhanced leading to greater benefit.

REFERENCES

[1] Lawrence D. Miles, "Techniques of Value Analysis and Engineering", A reference Book

[2]https://www.researchgate.net/publication/283008783_Application_of_Value_Engineering_for_Cost_Reduction_of_Household_Furniture_Product_-A_Case_Study

[3]https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&cad=rja&uact=8&ved=2ahUKEwjU0r7ni73xAhV163MBHabRCPkQFjAXegQIEhAD&url=http%3A%2F%2Fwww.ijsrd.com%2Farticles%2FIJSRDV8I10104.pdf&usg=AOvVaw1p2EMRQqUvJplyu_-78gM8

[4]Anil Kumar Mukopadhyaya "Indian Value Engineering Society (1977-2017) Survey of Forty Years and Selected Essays"

IOT Based Multispecialty Farm System

Dr. K V Manjunath[#1], Ananth Jain D[#2], Sagar S N[#3], Sujan D M[#4]

Industrial Engineering and Management,
Siddaganga Institute of Technology, Tumakuru– 572102, Karnataka, India

[1]kvmanju@sit.ac.in

[2]ananthjain8@gmail.com

[3]sagarnataraj2000@gmail.com

[4]sujandmallesh@gmail.com

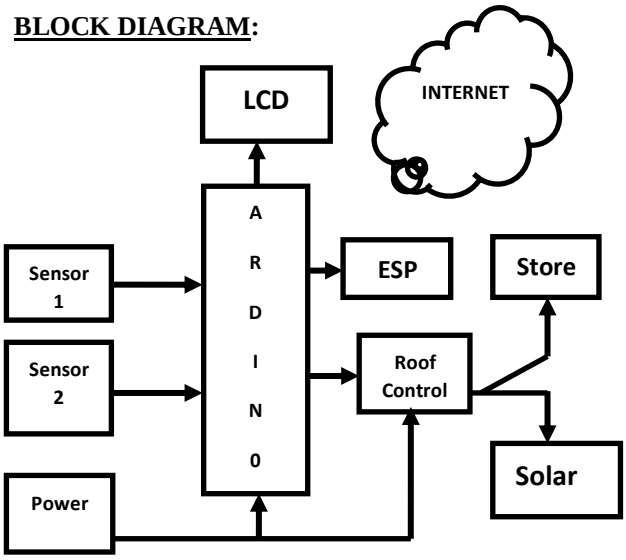
Abstract **- Agriculture sector in India is diminishing day by day which affects the production capacity of ecosystem. There is an exigent need to solve the problem in the domain to restore vibrancy and put it back on higher growth. The Concepts of Internet of Things (IOT) are applied to a number of applications ranging from home automation to IOT, where connecting physical things, from anywhere critical parameters is enhanced with email and short messaging system for alert system. Greenhouse is controlled environment to grow plants. The main aim of this paper is to design a simple, low cost, Arduino based system to monitor the values of environmental parameters and that are continuously uploaded and controlled in order to achieve optimum plant growth and yield. A GSM (Global System for Mobile communication) modem is used to send SMS which displays the present status of the environmental parameter. We also use prediction for automatically direction and resolution of any problem in the devices. Controlling these parameters are through any remote device or internet services and the operations are performed by interfacing sensors, Wi- Fi, camera with microcontroller. IOT is a shared Network of objects where these objects interact through Internet. Fluctuations in rainfall or market prices can cause profits to quickly rise or plummet. Obtaining accurate, ongoing data on operations has historically also been a challenge. Unlike cars or microprocessors, you cannot mass produce identical tomatoes. Companies like Clean Grow and Slum have begun to bring Big Data to the field with tools that can dynamically calibrate moisture and other metrics. Between efforts to eat more food grown locally, a younger generation of farmers and cheaper component-farming is getting an infusion of data and technology. As the concept of the Internet of Things becomes increasingly prevalent, many systems are being devised to allow all manner of data to be gathered analyzed and devices controlled via wireless data networks.**

Keywords– IoT, Smart Agriculture, Humidity, Temperature, Soil Moisture, Arduino

I. INTRODUCTION

As the world is trending into new technologies and implementations it is a necessary goal to trend up in agriculture also. Many researches are done in the field of agriculture. Each paper signifies the use of technology to collect data from different sensors sent it through the wireless protocol. The collected data provide the information about the various environmental factors. Monitoring the environmental factors is not the complete solution to increase the yield of crops. There are number of other factors that decrease the productivity to a greater extent. Hence automation must be implemented in agriculture to overcome these problems. So, in order to provide solution to all such problems, it is necessary to develop an integrated system which will take care of all factors affecting the productivity in every stage. But complete automation in agriculture is not achieved due to various issues. Though it is implemented in the research level it is not given to the farmers as a product to get benefitted from the resources. Hence this paper deals about developing smart agriculture using IoT and given to the farmers.

BLOCK DIAGRAM:



Working place: As shown in above block the heart of the project is Controller were it sense the input data and based on it take decision of controlling the output. As mention in objective the motive of this concept is to get proper growth of the crop. Basically controller is connected with two sensors, Motor driver and Wi-Fi Module

. Since it has two sensors i.e. Rain sensor and Temperature sensor were both sensors are used to sense Rain and temperature respectively. When controller detects any abnormality at the input end, immediately it will take decision of controlling the motor. Due to low output current from controller a driver is used to drive the motor by which mechanism of roof will be controlled.

When the situation comes to normal i.e. no rain or normal temperature again controller gives command to motor driver to take roof back to its normal condition.

And ate another side an Wi-Fi module (ESP 8266 12E) has been used to keep update to the farmer through cloud about status of the field. Sensed values by controller from the field will send to the Wi-Fi and Wi-Fi will extract all the data and it will update to the Thingspeak network. Where Thing Speak cloud is an part of server were sensor data will be stored. Finally by end farmer can have fruitful growth of the crops.

Roof control:

The output of MCU is roofing. Here MCU controls the opening and closing of roof depending upon the input from sensors compared with database stored. The roof used is "solar panels".

What is IoT?

Internet of Things (IoT) describes an emerging trend where a large number of embedded devices (things) are connected to the Internet. These connected devices communicate with people and other things and often provide sensor data to cloud storage and cloud computing resources where the data is processed and analyzed to gain important insights. Cheap cloud computing power and increased device connectivity is enabling this trend. IoT solutions are built for many vertical applications such as environmental monitoring and control, health monitoring, vehicle fleet monitoring, industrial monitoring and control, and home automation.

Solar Cell Type	Efficiency-Rate	Advantages	Disadvantages
Monocrystalline Solar Panels (Mono-SI)	~20%	High efficiency rate; optimised for commercial use; high life-time value	Expensive
Polycrystalline Solar Panels (p-Si)	~15%	Lower price	Sensitive to high temperatures; lower lifespan & slightly less space efficiency
Thin-Film: Amorphous Silicon Solar Panels (A-SI)	~7-10%	Relatively low costs; easy to produce & flexible	shorter warranties & lifespan
Concentrated PV Cell (CVP)	~41%	Very high performance & efficiency rate	Solar tracker & cooling system needed (to reach high efficiency rate)

Table 1: Types of Solar panels:

II. OBJECTIVES

1. Field protection is the main aim of our project.
2. To develop an integrated system, this will take care of all factors affecting the productivity in every stage.
3. Below listed things are the main objectives of our project which are used for protection of the field
    - Over Temperature monitoring
    - Rain Detection
    - Rain harvesting
    - Solar power generation

III. CONCLUSIONS

Present day requirements of the farmers have not been met by modern technology. Through this paper we intend to help farmers to manage their water resources effectively and also to prevent damage to the crop. This project will also help people who are interested in setting up a mobile farming area in their respective apartment or home. In this modern era, people find it difficult to manage their gardens and terrace farm. This project can make their gardens and terrace farms almost self-sufficient and it will only require a Small amount of the user's attention.

In this paper we have integrated the concepts of smart irrigation, water conservation, and prevention of damage to crops due excessive rainfall, hailstorms and extreme temperatures. In conclusion, we have made an attempt to bring agriculture and technology further. The goal is to provide the farmers with a solution to effectively harvest their crops and make use of water conservation to their advantage.

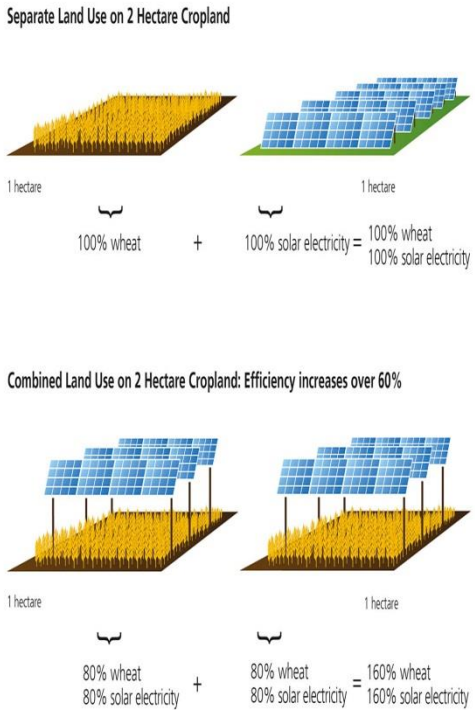


Figure 1: Estimated Productivity increase

REFERENCES

[1] Jaideep Nuvvula, Srivatsa Adiraju, Shaik Mubin, Shahana Bano, VenkataSubba Rao Valisetty1 Environmental smart agriculture monitoring system using internet of things K L University, Department of Computer Science and Engineering, Guntur, Andhra Pradesh, India. International Journal of Pure and Applied Mathematics Volume 115 No. 6 2017, 313-320.

[2] K. Jyostsna Vanaja, Aala Suresh, S. Srilatha, K. Vijay Kumar, M. Bharath IOT based Agriculture System Using Node MCU. International Research Journal of Engineering and Technology(IRJET). Volume: 05 Issue: 03 | Mar-2018, e-ISSN: 2395-0056.

[3] Wang N, Zhang N P, Wang M H. Wireless sensors in agriculture and food industry- Recent development and future perspective[J]. Computers and Electronics in Agriculture, 2006.

[4] Chan M Campo, Esteve D Fourniols J.Y., "Smart homes-current features and future perspectives" Maturitas, vol. 64, issue 2, pp. 90-97, 2009.

[5] A.D. Adage, J. D. Gawade (2009) 'Wireless Control System for Agriculture Motor', IEEE Computer Science: 722-25, pp.722-725.

[6] Wireless Sensor Based Crop Monitoring System for Agriculture Using Wi-Fi Network Dissertation', IEEE Computer Science, pp.280-285.

[7] Junyan Ma, Xingshe Zhou, Shining Li, Zhigang Li (2011) 'Connecting Agriculture to the Internet of Things through Sensor Networks2011 IEEE International Conferences on Internet of Things, and Cyber, Physical and Social Computing',978-0-7695-4580-6/11©2011IE

Segregation of Waste using Smart Dustbin

GAGANDEEP T S*[1], VISHWANATHA P C[2], ANUSHKA MOHAN[3], RAJAKRISHNA R A[4], R SHADAKSHARI[5]

Department of Manufacturing science and Engineering, Acharya Institute of Technology

Acharya Doctor Sarvepalli Radhakrishnan Rd, Soladevanahalli, Karnataka -560107

[1]gagandeepts.17.bems@acharya.ac.in

[2]vishwanatha.bems.16@acharya.ac.in

[3]anushka.bems.16@acharya.ac.in

[4]rajakrishnara.17.bems@acharya.ac.in

[5]shadaksharir@acharya.ac.in

Abstract - Waste is a significant global issue. Increasing volumes of waste as the global population and living standards rise. The environmental impact is significant, with massive volumes of waste generated annually with only basic or little treatment to minimise its impact. People are increasingly concerned about the production of waste and its effect, and are seeking ways to deal with the problem. The Global Waste Management Market reported that the annual amount of waste generated worldwide is 2.02 billion tones. The innovative method we created is an easy and simple solution to India's problem, the segregation of three types of wastes: dry, metal and wet.

It is designed to sort the trash into wet waste and dry waste which is ready to be processed separately for the next stage of waste management by using embedded technology to continuously monitor the dustbin

Keywords - Waste segregation, Recycling, Environmental impact, Dustbin

I. INTRODUCTION

The massive increase in population has led to improper garbage disposal. Managing waste is time consuming and labour intensive. In the last few years, garbage disposal has become a huge undertaking. The most common waste disposal method is unplanned. Pieces of waste dumped in landfills. This method will have adverse effects on all living things, this can also lead to produce leachate and other fungi, contaminating surface and groundwater are also accelerate the emergence of harmful diseases, which will cause a decrease in the value of environmental aesthetics. In India, the recycling of solid waste done by wipes that play an important role in this process.

Wipes are affect by many health problems, such as skin infections. Automatic waste separation can eliminate lot of problems at its root. The waste divided into the basic mainstream, such as metal, dry and wet, and these wastes have great potential for recycling and reuse. Even if there are multiple industrial waste separators, it is best to separate the waste at the source itself. The advantage of doing this sorting is that rag collectors are not needed to sort the trash. In addition, the separated waste can be sent directly to the recycling plant instead of sending the waste to the separation plant and then to the recycling plant. Currently, does not have a system that can automatically divide waste into dry, wet and metal waste. The main objective of the project is to provide a compact, low-cost and easy-to-use waste sorting system for cities to simplify their waste management processes. The economic value of the waste generated is not realised unless it is recycled completely.

Several advancements in technology has also allowed the refuse to be processed into useful entities such as Waste to Energy, where the waste can be used to generate synthetic gas (syngas) made up of carbon monoxide and hydrogen. The gas is then burnt to produce electricity and steam, Waste to Fuel, where the waste can be utilize to generate bio-fuels. When the waste are segregated into basic streams such as wet, dry and metallic, the waste has a higher potential of recovery, and consequently, recycled and reused. The wet waste fraction are often converted either into compost or methane-gas or both. Compost can replace demand for chemical fertilizers, and biogas can use as a source of energy. The metallic waste can be reuse or recycle. Even though there are large scale industrial waste segregators present, it is always much better to segregate the waste at the source itself.

The benefits of doing so are that a higher quality of the material is retained for recycling which means that more value could be recovered from the waste. The occupational hazard for waste workers is reduced. Also, the segregated waste could be directly sent to the recycling and processing plant instead of sending it to the segregation plant then to the recycling plant. Currently there is no system of segregation of dry, wet and metallic wastes at a household level. J.S. Bajaj has recommended that a least cost, most appropriate technological option for safe management should be developed. The purpose of this project is the realization of a compact, low cost and user friendly segregation system for urban households to streamline the waste management

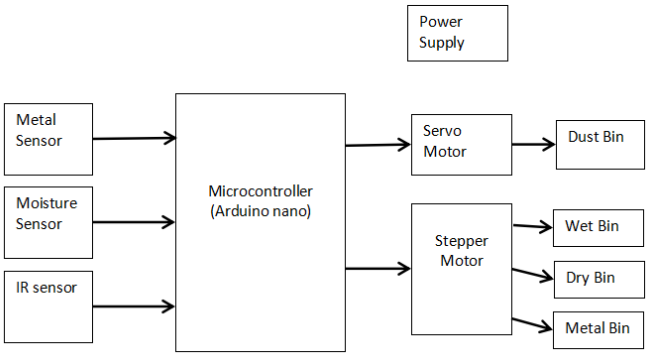
process. We are implementing a smart dustbin, which is a cheap, easy to use solution for a segregation system at households, so that it can be sent directly for processing.

II. MATERIALS & METHODS

The Smart Dustbin is design to be compact, simple and modular. The mechanism has three steps. First is the opening of the dustbin consist of vibrating mechanism. Which is tilted to an angle and roll to the internal opening tube, when different type of waste are put together, the vibrating mechanism helps to roll down the lighter material first then the heavier one, Second part is, the Tube which has another opening in the bottom with open and closing mechanism consist of all the sensors which will be explained further below, when the waste is rolled down to the tube, sensors help detect the waste and the micro-controller decides which bin it should go to , then the Tube bottom cover opens , Next is the third and final step which has the Bins labelled according to the waste such as Wet, Dry ,Metal , these bins are on the rotating platform, When the waste is recognized , the labelled Dustbin will place itself under the Tube to capture the waste .

Methodology:

- As soon as the waste material comes in contact with the IR sensor, it gets detected and is categorized as dry waste and is dumped into the dedicated bin for dry waste
- If the waste material also triggers the moisture sensor along with the IR sensor, the detected waste are categorized as wet waste and is dumped into the dedicated bin for wet waste.



- Similarly, if the waste material triggers the metal detector along with the IR sensor, the detected waste is categorized as metallic waste and is dumped into the bin dedicated for metallic waste.
- Once the process runs continuously, the bins start to fill up over time
- In future, these bins can be connect to ultrasonic sensors to detect if the bin is fill or not.

Components used:

- **Infrared Sensor** - An infrared sensor is an electronic device that emits in order to sense some aspects of the surroundings. An IR sensor can measure the heat of an object as well as detects the motion. The types of sensors measures only infrared radiation, rather than emitting it that is called as a passive IR sensor. Usually in the infrared spectrum, all the objects radiate some form of thermal radiations. These types of radiations are invisible to our eyes, that can be detected by an infrared Sowndharya V et al. / International Research Journal of Multidisciplinary Tec novation /2019, 1(2), 1-10 sensor. The emitter is simply an IR LED (Light Emitting Diode) and the detector is simply an IR photodiode which is sensitive to IR light of the same wavelength as that emitted by the IR LED. When IR light falls on the photodiode, The resistances and these output voltages, change in proportion to the magnitude of the IR light received

- **Moisture Sensor** - The Moisture sensor is used to measure the water content (moisture) of soil when the soil is having water shortage, the module output is at high level, else, the output is at low level. This sensor reminds the user to water their plants and monitors the moisture content of soil. It has been widely used in agriculture, land irrigation and botanical gardening. The Soil Moisture Sensor uses capacitance to measure dielectric permittivity of the surrounding medium. The dielectric permittivity is a function of the water content. The sensor creates a voltage proportional to the dielectric permittivity, and therefore the water content of the soil. The sensor averages the water content over the entire length of the sensor. There is a 2 cm zone of influence with respect to the flat surface of the sensor, but it has little or no sensitivity at the extreme edges. The Moisture Sensor are used to measure the loss of moisture over time due to evaporation and plant uptake, evaluate optimum moisture contents for various species of plants, monitor soil moisture content to control irrigation in greenhouses and enhance bottle biology experiments.

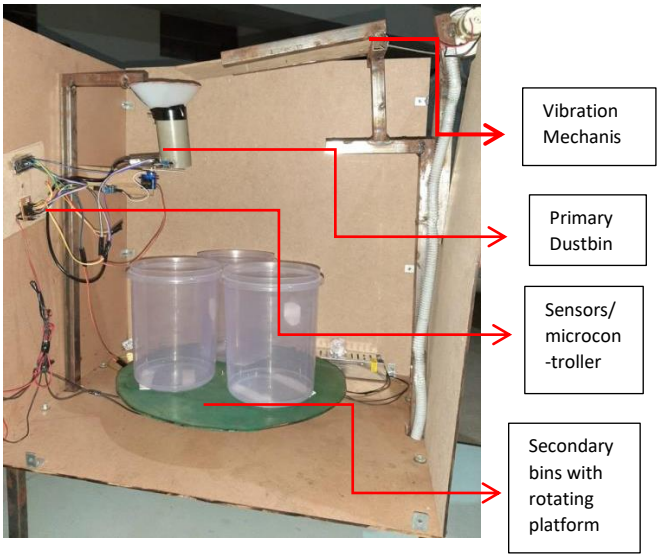
- **Metal Detector** - A metal detector is an electronic instrument, which detects the presence of metal nearby. Metal detectors are useful for finding metal inclusions hidden within objects, or metal objects buried underground. They often consist of a hand-held unit with a sensor probe, which can be swept over the ground or other objects. If the sensor comes near a piece of metal this is indicate by a changing tone in earphones, or a needle moving on an indicator. Usually

the device gives some indication of distance; the closer the metal is, the higher the tone in the earphone or the higher the needle goes. Another common type are stationary "walk through" metal detectors used for security screening at access points in prisons, courthouses, and airports to detect concealed metal weapons on a person's body.

- **Servo Motor-** Servomotor is a rotary actuator or linear actuator. It allows for precise control of angular or linear position, velocity, and acceleration. It consists of a suitable motor coupled to a sensor for position feedback.
- **Stepper Motor-** A stepper motor is an electric motor whose main feature is that its shaft rotates by performing steps, that is, by moving by a fixed amount of degrees. This feature is obtained thanks to the internal structure of the motor, and allows knowing the exact angular position of the shaft by simply counting how may steps have been performed, with no need for a sensor. This feature also makes it fit for a wide range of applications.
- **Arduino Nano -** or ATmega328, The Arduino Nano can be powered via the Mini-B USB connection, 6-20V unregulated external power supply (pin 30), or 5V regulated external power supply (pin 27). The power source is automatically selected to the highest voltage source

Design and Body Fabrication:

- A Basic sketch has to be draw to render on software.
- Material selection and procurement done.
- Fabrication of the body according to the final design and final dimensions.
- Electronics are placed on the side, which is shielded from impact or environmental factors.
- The body is assembled and tested.
- It is covered by MDF board, which can be easily removed.



III. RESULTS & DISCUSSIONS

Waste segregation done at the Grass root level. Since industrial waste is of larger quantities mixed in different proportions, immediate segregation can done. Since hand-picking has several disadvantages, it's eradicated and the work is done by the machine. Hence the segregation is immediate and all time available. Valuable materials in scrap can identified before disposal. About 5 litres of waste can collect in each bin. Due to the vibrator used, the waste are separated for easy segregation. Since waste segregation is done at the root level it saves a lot of time and labour. Handling of waste becomes easier as well as less complicated using smart dustbins. Several trials were done for various types of wastes, however further modifications can be done for better accuracy and according to the need. Including more sensors, installing IOT, display screens, alarms can be upgraded for sophisticated industrial purpose . The project of 'Waste segregation using Smart dustbin is successful in making the environment less polluted

IV. CONCLUSIONS

It is possible to develop an affordable, safe, and self-operating waste segregator which is also compact and affordable to place in Public places, Offices ,School/University and so on , in future this machine can be integrated with IoT for real time updates and to control remotely . Thus this device can effectively segregate waste at the source of the problem without any human intervention..

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REFERENCES

[1] D. Eason, B. Noble, and I.N. Sneddon, "On certain integrals of Daniel Hoornweg et al., "what a waste- A Global Review of Solid Waste Management", Urban Development & Local Government Unit World Bank, Washington, DC., No.15, Mar. 2012

[2] Nishigandha Kothari , "Waste to Wealth", NSWAI, New Delhi, Jul. 2013

[3] Claudine Capel, "Innovations in Waste", Waste management-world, Volume 11, Issue 2, Mar 2010

[4] Claudine Capel, "Waste Sorting - A Look at the Separation and Sorting Techniques in Today's European Market", Waste-management world, Volume 9, Issue 4, Jul 2008

[5] "Review of Environmental and Health Effects of Waste Management: Municipal Solid Waste and Similar Wastes", Written by Enviros Consulting Ltd and University of Birmingham with Risk and Policy Analysts Ltd, Open University and Maggie Thurgoo

[6] Manisha Jayson(2018),Lakshmi H R ,"Smart Bin-automatic waste segregation and collection". Second International Conference on Advances in Electronics, Computer and Communication (ICAE CC-2018).

BANGALORE INSTITUE OF TECHONOLOGY

Profit Optimization by Menu Engineering

Author Profile

Prajwal Hathwar,
Final year student, Industrial Engineering and Management,
Bangalore Institute of Technology, K R Road, V V Puram,
Bangalore, Karnataka, India.

Pradyoth Prakash,
Final year student, Industrial Engineering and Management,
Bangalore Institute of Technology, K R Road, V V Puram,
Bangalore, Karnataka, India.

Shomik Ghosh,
Final year student, Industrial Engineering and Management,
Bangalore Institute of Technology, K R Road, V V Puram,
Bangalore, Karnataka, India.

Dr. A.P Partha,
Associate Professor, Industrial Engineering and Management,
Bangalore Institute of Technology, K R Road, V V Puram,
Bangalore, Karnataka, India.

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ABSTRACT

Menu Engineering can be described as a devised method for scientifically analyzing and segregating/bucketing different menu items to understand its impact on different factors which include – gross sales revenue, net profit realized, revenue due to increased popularity etcetera for different menu items in a restaurant firm. The main goal that menu engineering strives to achieve is to bring about optimization is cost, presentation, service and the overall functioning of the restaurant firm. The goal of this paper is to implement menu engineering methodology devised by Kasavana and Smith matrix model [1] on a multi-cuisine vegetarian restaurant named “MINT MASALA” located in Sadashivnagar, Bengaluru.Outcome is to design and present an optimized menu based on the findings of employing menu engineering methodology.

KEYWORDS: Menu Engineering, optimization, Kasavana and Smith model, Gregg Rapp Stars, Dogs, Puzzles, Challenges, Workhorse, Plowhorse, Menu Engineering Matrix, Menu Engineering Metrics.

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INTRODUCTION

Restaurants, a public venue for catering various cuisines, dates back to nearly 1700's. The first modern concept of a 'Restaurant' originated in Paris, France by Antoine Beauvillierswhich consisted of a well-designed room, a set of people hired to cater to the needs of the guests and various cuisines to entertain and satisfy the guests. Even though the concept of serving guests with food was practiced from a much older time, the concept of fine dine began here and this flourished across the times to come. Currently, the restaurant industry is projected to reach 889 billion dollars around the world and the Indian market when narrowed down, has a industry valuation of approx. 75000 crores growing at 7% annually.[6]

TOPIC IN FOCUS: The RestaurantIndustry

The food & beverage sector has seen leaps and bounds in trends and popularity around the world. Focusing on INDIA, the annual growth rate for the restaurant industry is placed at an average of 15 – 20 % [3].The sheer size of the demography, the cultural diversities across India and the immense depth in the ethnicities are the sole reasons for the rise of multiple Indian cuisines across India.

With such tremendous growth in this sector lead to a set of challenges as well which pose as a blocker to this trend. Majority of the organized restaurants would be investing effort, time and money to face and eliminate majority of these challenges but for the unorganized restaurants they just learn to live with this. Some major challenges include-

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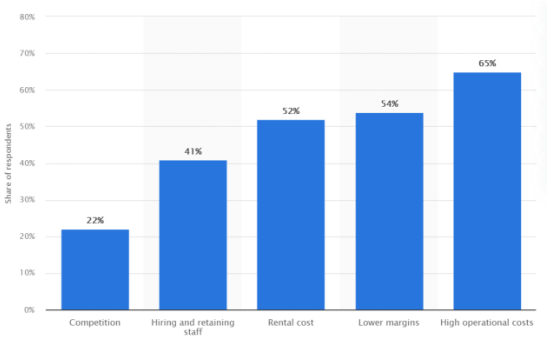
1. FOOD COST INFLATION - The unfavorable seasonality changes, the change in world trade relations affecting the import/export, the unpredictable demand-to-supply ratio are the key points leading to instability in the food cost prices. With the advent of the pandemic, situation turned for the worse and impacted every sector of the society greatly with the food sector taking some massive blows. .[4]
2. DISTORTED MARKET – The Food service industry is highly fragmented into various sectors mainly due the popularity and the prevalent cultures across India. Each sectors have multiple competitors offering more or less the same assortment to the masses atcompetitive pricings and service. This creates a highly competitive environment and a business to succeed in this, it must outperform the others in multiple ways..[4]
3. OPERATIONAL INCONSISTENCIES – The majority constraints here include the lack of availability of skilled labors, instable logistics and cold-chain, outdated methods of operations, lack of implementation of various optimizations tools and services which helps with data analytics for problem solving.[4]
4. MENU – A menu is a crucial component for a restaurant. A menu needs to be crisp and must create an impression on the guests when they read them. The restaurant must take utmost care to devise its menu so as to leverage it for its advantage. It's a common practice in India to have a lot of items on the menu without inventing time and methods to understand what sells and what's profitable.



The above statistics displays the affect of onset on the pandemic on the restaurant sector and what are the key contributing factors to the overall cost factor for a restaurant in India on an average note.[7]

We notice that out of all the factors, high operational costing adds up to be the major factor contributing to cost. It becomes crucial to address the operational cost and minimize it to the greatest extent possible. A major component accounting to the high operational cost includes the complexity of menus. AMenu's basic purpose is to represent

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what the restaurant has to offer to the guests. A menu needs to stand out, appeal to the guests and a smooth flow of information must be the primary goal of a menu. Hence, utilizing ME (Menu Engineering) to redesign the entire menu with the goal of cost optimization is the foremost step that needs to be implemented and practiced across both the unorganized and organized sectors of the food industry.

The affect of the COVID Pandemic

The onset of the COVID-19 pandemic immensely affected the restaurant industry. The multiple curfews, lockdowns, severe social distancing norms etcetera severely impacted both, the organized and unorganized sector of the restaurant industry. Nearly 40% of the total restaurants all over India have permanently closed shop due to the mounting losses. For the existing restaurants which managed to survive, its critical that they improvise and adapt to the new standards for catering to guests which includes increased importance to **safety/ hygiene** and **social distancing practices** as a standard practice that needs to be integrated into every operation. Hence, in order to bounce back from the current scenarios, its important for the restaurant to utilize menu analysis methods as a tool to increase the overall revenue turnovers so as to stabilize their foothold in the industry.

MENU ANALYSIS MODELS

Menu analysis has long been practiced in our society. Basic approach of menu engineering model includes the use of historic data to understand the trend of the subject in focus. In Some models include-

- Minimum cost analysis – A simple and the oldest for of analysis, it involves finding the direct cost of each plate.
- Cost/Margin analysis – With direct food cost, the selling margin should also be considered. The items are categorized under those which have the maximum contribution with lower direct costs.
- Menu engineering is by far the most recent/advanced method of studying menus. The items are fragmented into different bucket based one 4 criterions. This method of analysis goes in depth with a thorough analysis. This analysis model gives us a detailed categorization of products giving us insights on popularity, performance, profit margins etcetera.[8]

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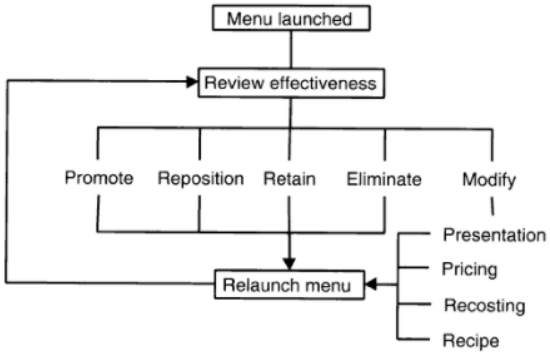
MENU ENGINEERING

The credit of formulating menu engineering is given to Michael Kasavana and Donald Smith. The whole basic idea behind menu engineering includes finding out the popularity and profit realized factors for each menu item and the dividing factor for the segregation into categories would be 8% of the aggregate, which is represented as –

$$80\% * 1/n$$

Where n=number of competing items

Menu Engineering as a process can be described based on the below process –



[9]

Menu engineering methodology first begins with analyzing the current menu. *What is the number of items in each category? What are the competitors offering that we do not? How appealing is the menu to the guests?* Are some of the questions that need to answered in this face? This boils down to one main reason, which items are sold in high volume with the best profit margins, and which don't. These can plotted along and X axis (profit margins) to Y axis (volume sold). Based on this the items are bucketed into –

- STARS – Items which sold the most and the profit margins were significantly greater than the rest. There are the outperformers.

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- WORKHORSES/PLOWHORSES – These items have high volumes of sales, but the profit margins made on these are comparatively low. These need to be worked on to make them your 'star' players.
- CHALLENGES/PUZZLES– These items are hard to sell. They have good profits but not popular among the common masses. The main goal is to somehow improve their popularity so that profits automatically start flowing in.
- DOGS/DUDS – These items need to be eliminated as they neither are popular nor do they bring in any profits to the business. Ideal strike these out of the menu or second case scenario, rework these items so that it proves to be a performer.

Based on which bucket these items fall into, those respective conclusions can be drawn and respective actionable must be performed for the category. These include-

1. STAR – These are your outperformers. They are the main attractions and are the 'popular cuisines' of your restaurant. Profit realized and the volume of sales recorded is very high. No actionable required for these dishes.
2. WORKHORSES/PLOWHORSES – These dishes have great sales, i.e., the volume of sales recorded is high, but the profit margins realized on these are low. Actionable for the dishes falling into these categories are mainly to increase the profit from these items. This can be done by increase reducing the overall food cost price and expanding the profits gained.
3. CHALLENGES/PUZZLES – The dishes in this category have potential but aren't popular. The profits made from these are great, but these dishes don't sell in good volumes. The main goal here is to increase popularity and recognition for these food items so that the guests are subconsciously influenced to purchase these dishes.
4. DOGS/DUDS – These are the underperformers in your list. They neither are popular not do they bring in any profits. Action that needs to be taken against them – re-engineering the dishes to make them fall into the star category or eliminate them.

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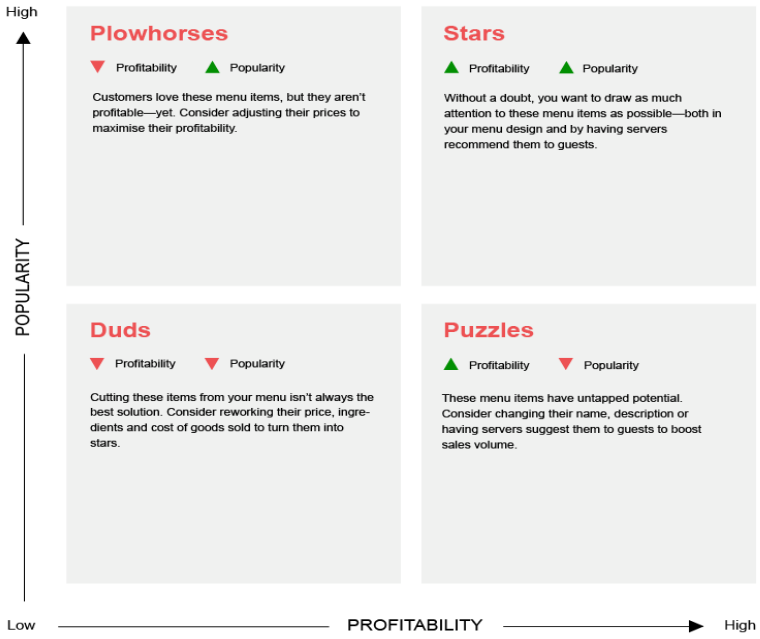

This is the basic principles and methodology of menu engineering. The entire menu can now be redesigned based on the analysis received.

IMPLEMENTATION of ME leading to value addition

The core values being delivered by Menu Engineering includes the addition of value in the form of service. **Gregg Rapp**, a pioneer in the field of menu engineering, founded the site menuengineers.com which carried out many value based services to the leading restaurant industry clients.

As an operational example, they successfully applied menu engineering on a local chain and increased profitability per guest by 4% on a quarterly basis and managed to increase 25 cents per item on the menu resulting annually profit increase by nearly $7500 roughly.[10]

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-- Our Implementation ofMENU ENGINEERING --

As we realized how vital menu engineering can be in transforming the restaurant's sales and in boosting profitability, we found it necessary to deep dive into this discipline and experiment by ourselves to see how Indian menus can be transformed using menu engineering.

We approached the Mint Masala Restaurant (Sadashivanagar, Bangalore, Karnataka, India) and pitched in our idea of menu engineering. They were in line with the whole concept and were ready to co-ordinate and support us on our requirements to carry out the same. Bills of sample size of 10 days were collected to carry out the project. This provided us all the historic data needed to implement menu engineering methodology.

MINT MASALA
384/1, Bashyam Circle,
Sadashivanagar, Bangalore
Tel : 080-23610668
GSTIN : 29ABLFM6071D1Z2

COPY Dine In

Bill No DU440 Table No 101
Date & Time 12/04/2021 22:12

Item Name	Rate	Qty	Amount
CARRY BAG	5.00	1	5.00
CONTAINER(RI)	10.00	1	10.00
PANEER DUM BIRY	260.00	1	260.00
Total:		3	275.00
CGST @ 2.5%			6.87
SGST @ 2.5%			6.87
Roundoff			0.26

Tot Amount: 289.00

** Thank You Visit Again **
** Free Home Delivery **

KOT No.
2056

MINT MASALA
384/1, Bashyam Circle,
Sadashivanagar, Bangalore
Tel : 080-23610668
GSTIN : 29ABLFM6071D1Z2

Dine In

Bill No DU630 Table No 100
Date & Time 19/04/2021 20:01

Item Name	Rate	Qty	Amount
CARRY BAG	5.00	1	5.00
CONTAINER	5.00	1	5.00
PANEER PALAKWAL	290.00	1	290.00
TANDOORI ROTI	55.00	3	165.00
Total		6	485.00
CGST @ 2.5%			11.61
SGST @ 2.5%			11.61
Roundoff			-0.22

Tot Amount: 488.00

** Thank You Visit Again **
** Free Home Delivery **

KOT No.
2035

Tools and Techniques -

After the bills were collected from the restaurant it was time to harness the data collected and build a model to draw out insights. Once the aggregate data was ready and complied, the model was built on a Google spreadsheet where the standard metrics of menu engineering was used to categorize the items into stars, dogs, workhorses and challenges. Below is example of one of the category for reference -

A	B	C	D	E	F	G	H	L	P	R	S
Menu Item Name APPETIZERS	Number Sold	Popularity %	Item Food Cost	Item Sell Price	Item Profit *(E-D)*	Total Cost *(D*B)*	Total Revenue *(E*B)*	Total Profit *(H-G)*	Profit Category	Popularity Category	Menu Item Class
VALKANICK MUSHROOM	4	1.9%	₹234.00	₹285.00	₹51.00	₹936.00	₹1,140.00	₹204.00	High	Low	Challenge
PANEER TIKKA	20	9.6%	₹234.00	₹285.00	₹51.00	₹4,680.00	₹5,700.00	₹1,020.00	High	High	Star
PANEER HARIYALI TIKKA	21	10.1%	₹226.00	₹275.00	₹49.00	₹4,746.00	₹5,775.00	₹1,029.00	Low	High	Workhorse
TANDOORI BABYCORN	21	10.1%	₹218.00	₹265.00	₹47.00	₹4,578.00	₹5,565.00	₹987.00	Low	High	Workhorse
THIL BABYCORN	19	9.1%	₹230.00	₹280.00	₹50.00	₹4,370.00	₹5,320.00	₹950.00	High	High	Star
PAPDI PANEER	4	1.9%	₹234.00	₹285.00	₹51.00	₹936.00	₹1,140.00	₹204.00	High	Low	Challenge
TANDOORI KUMBH LAJABDAR	4	1.9%	₹238.00	₹290.00	₹52.00	₹952.00	₹1,160.00	₹208.00	High	Low	Challenge
TIRANGA PANEER TIKKA	86	41.3%	₹230.00	₹280.00	₹50.00	₹19,780.00	₹24,080.00	₹4,300.00	High	High	Star
HARA BHARA KABAB	29	13.9%	₹218.00	₹265.00	₹47.00	₹6,322.00	₹7,685.00	₹1,363.00	Low	High	Workhorse

After classification and bucketing items, insights were drawn based on number of stars, dogs, workhorses and challenges in each category of cuisine. Sales along different weekdays, Category wise sales contribution using the weighted average technique where the weights for amount and quantity sold was 2 & 1 respectively.

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-- INSIGHTS FROM THE DATA—

Based on the methodologies of ME, Various insights could be developed regarding the aggregate data. The data post compilation could be seen from various angles thereby giving rise to multiple insights. Below includes some of the insights that we managed to populate based on our project implementation.

- Category split of each quadrant

Category	Star	Challenge	Dog	Workhorse	Total Items
Soups & Salads	1	5	1	1	8
Quick bites	1	2	1	1	5
Tandoor Starter	3	3	0	3	9
Chinese Starter	2	4	4	1	11
Indian Main course	9	3	4	8	24
Indian Breads	3	6	1	4	14
Rice Delicacies	4	6	0	3	13
Beverages & Desserts	1	6	2	3	12
TOTAL	24	35	13	24	96

- Revenue generated per day as recorded during experimental period

DATE	Order items	Amount	Weekday
4/10/2021	172	₹52,225	Sat
4/11/2021	200	₹62,430	Sun
4/12/2021	100	₹32,035	Mon
4/13/2021	101	₹32,150	Tue
4/14/2021	143	₹43,425	Wed
4/15/2021	114	₹37,710	Thu
4/16/2021	156	₹46,045	Fri
4/17/2021	180	₹48,830	Sat
4/18/2021	219	₹64,850	Sun
4/19/2021	98	₹23,105	Mon

- Quadrant wise sales generated– quantities sold under each category

Category wise Sales			
	# of items	Amount delivered by each category	Qty sold in each category
STAR	29	₹121,745.00	1061
WORKHORSE	20	₹68,555.00	936
CHALLENGE	33	₹52,480.00	463
DOG	14	₹22,165.00	148

- Weighted contributions to sales per quadrant wise

	Weights		Contribution to sales
	2	1	
STAR	0.46	0.41	44%
WORKHORSE	0.26	0.36	29%
CHALLENGE	0.20	0.18	19%
DOG	0.08	0.06	7%

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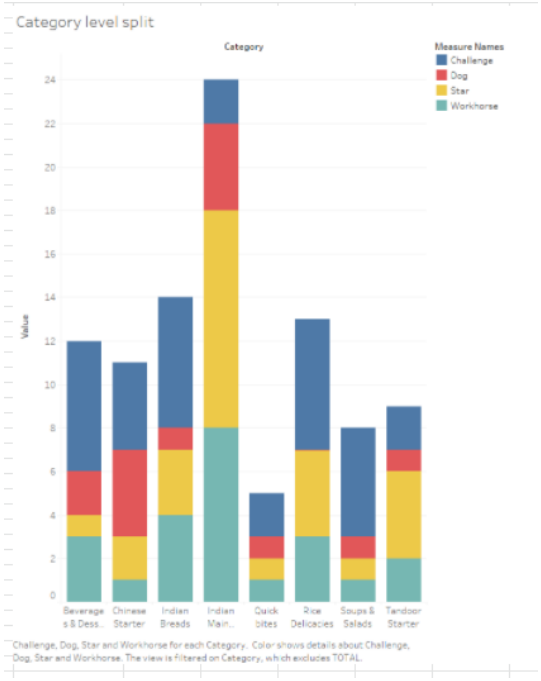
- A bar char for the category split



--ACTIONABLES BASED ON INSIGHTS—

The insights gave us a clear picture as to what is the contribution of each category to the menu's sales & profits. Few actionable that we took after a detailed analysis are as follows:

Stars:

•We kept the stars unchanged as they satisfied both our constraints that are popularity and profitability. Not many changes or update were required for this cluster of items as their performance would be better irrespective of any changes.

Dogs:

•These are the redundant items that were removed from our final proposed menu as they did not contribute much in terms of profitability and were not popular among the customers.

•These items can be reintroduced in the future with a complete makeover in terms of look, taste and feel.

Workhorses:

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•Workhorse being those set of items which are fast moving and highly popular will need no tweak to boost its popularity but requires some focus on increasing the profit margin.

•The portion size can be altered which will help cutting down the cost, at the same time not affecting the guest's psychology by using different cutlery than the regular big ones. Eg: Presentation of items play a critical role here. Using unique, attractive crookery to present dishes would divert the minds of the guest away from the slightly decreased portion sized.

•Affecting guest's psychology by making the price look low though the margin has been increased.

Eg: Changing the selling price of an item to Rs.299 instead of Rs.300.

Challenges:

•These set of items are hard to sell as the popularity is low but the profitability is high. The key actionable here is to boost the popularity of the item.

•The recipes might require a bit of tweaking making it look more attractive and appealing to the guests.

•Upselling the items by educating the waiters to recommend the items in this category to increase the familiarity of these items.

•Wisely promoting these items thereby indirectly influencing the buying decisions of the majority of guests walking into the premise.

•Run exclusive campaigns and offers until the items gain popularity.

•Make these items salient by tagging it with symbols as best sellers.

FINAL OUTCOME FROM THE EXPERIMENTATION

The multi-panel menu was redesigned based on the insights obtained from the experimentation by right promoting items, giving a brief description about the item, tagging challenges as best sellers and placing it wisely according to human psychology of reading the menu.

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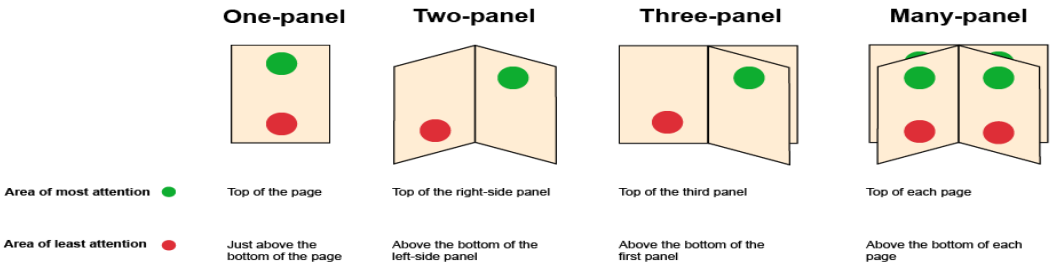
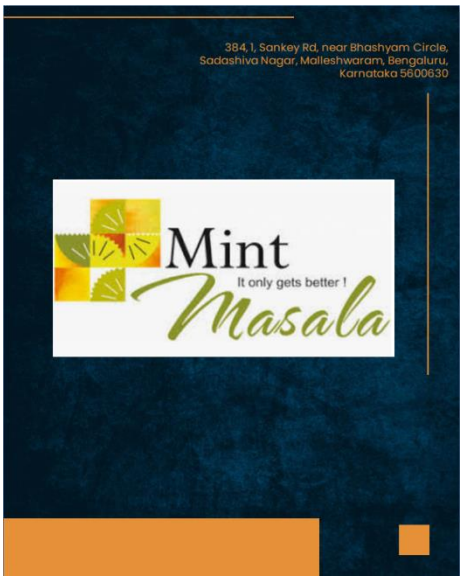
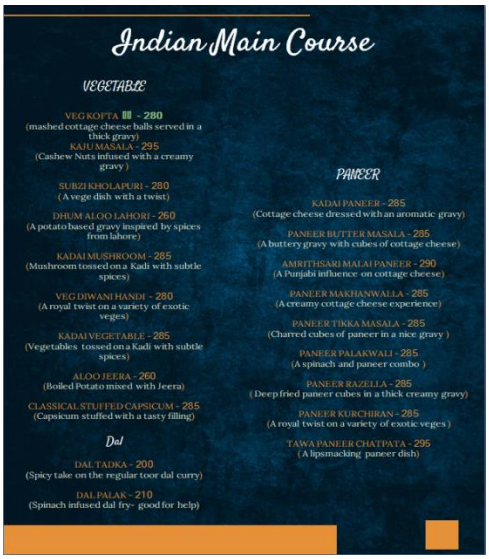


Revised Menu sample





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Conclusion

By reading this paper the reader will gain knowledge on Menu Engineering and its principles on how Menu Engineering can transform the restaurant industry by making their business more profitable. Considering the current pandemic situation where many restaurants are being impacted badly, menu engineering can be a game changer and save restaurants from losses.

Future scope for this project would be to automate the billing ERP system with the model to obtain real time data so that the restaurants can monitor their menu health performance and make necessary changes.

Monitoring the menu health at the finger tips to increase profitability per guest at a very cheap investment is the ultimate goal of this project.

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REFERENCES

- [1]"Application of Kasavana& smith Menu Engineering Model to Menu of a ...." http://www.i-scholar.in/index.php/jhar/article/view/38659.
- [2] *Prosper Montagné Prosper Montagné. "The New Larousse Gastronomique". Éditions Larousse. p. 97. Retrieved February 22, 2019.*
- [3] *https://theaims.ac.in/resources/rise-of-the-restaurant-industry-in-india.html*
- [4]*Issues and Challenges by Restaurant Industry*-NOVEMBER 19, 2013 - https://www.restaurantindia.in/article/Issues-and-Challenges-by-Restaurant-Industry.6121
- [5]Menu Engineering: How to Increase Profits by 20%,Apr 15, 2019 - https://restaurant.eatapp.co/blog/food-cost/menu-engineering
- [6] Indian Restaurant Industry - https://www.smergers.com/industry-watch/indian-restaurant-industry/
- [7] Statista-https://www.statista.com/statistics/1226932/india-challenges-due-to-covid-19-for-restaurants/
- [8] Menu Analysis-https://www.hospitalityupgrade.com/Hospitalityupgrade.com-0093-2016Redesign/media/hospitalityupgrade.com-0093/File_Articles/Sum02-BenchmarkingMenu-Kasavana.
- [9]Menu development and analysis in UK restaurant chain- https://www.jstor.org/stable/23743850?read-now=1&seq=8
- [10] Menu Engineering-https://www.menuengineers.com/

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Semi Automated Roller Painting Machine

Akash N[1], Mohammed Zohaib[2], Ravi Ranjan Kumar[3], Srichethan A S[4]
Department of Mechanical Engineering,
East Point College of Engineering and Technology. Bengaluru, Karnataka, India
[1]akashnarendranath83@gmail.com
[2]mdzohaib78@gmail.com
[3]ravikumar9504930@gmail.com
[4]chethans87269@gmail.com

***Abstract* - Building and construction is one of the major industries around the world. In this fast moving life construction industry is also growing rapidly. But the labours in the construction industry are not sufficient. This insufficient labour in the construction industry is because of the difficulty in the work. In construction industry, during the work in the sites where there is more risky situation like interior area in the city. There are some other reasons for the insufficient labour which may be because of the improvement the education level which cause the people to think that these types of work is not as prestigious as the other jobs.**

I. INTRODUCTION

The advances in the machine and automation in the construction industry has grown rapidly. Despite the advances in the machine and its wide spreading applications, painting is also considered to be the difficult process as it also has to paint the whole building. To make this work easier and safer and also to reduce the number of labours automation in painting was introduced. The automation for painting the exterior wall in buildings has been proposed.

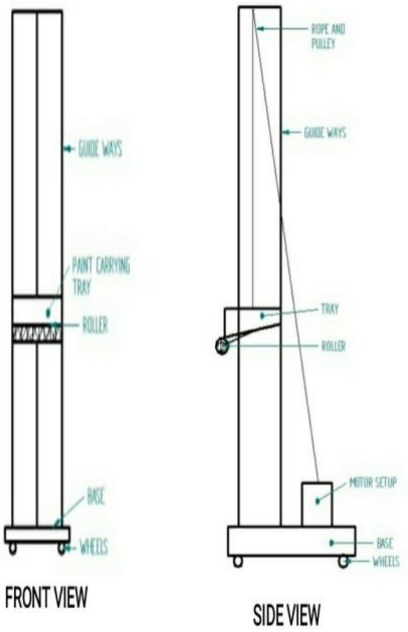
II. MATERIALS USED

- DC motor
- Ropes and Pulley Castor wheels
- Roller brush
- Sheet metal
- Hollow pipes and seamless pipes
- L angle rod
- Switches
- Circuit board

III. METHODOLOGY

- Observation and analysis of the conventional methods used to paint walls.
- Market survey about any existing tools equipment and machineries.
- Analysis about the existing methodology to improve existing methods.
- Methods to tackle the disadvantages in the current Methods
- Fabrication of the designed model.

IV. DESIGN OF SEMI AUTOMATED ROLLER PAINTING MACHINE



V. RESULTS

By using the semiautomatic roller painting machine it is clear that the human efforts are reduces as well as the cost of labour also reduces. Semi-automatic roller Painting machine can also paint the huge building easily and safely without any hazards to human being and labours.

VI. CONCLUSION

A method has been developed for semi-automatic roller painting of unknown parts. This machine is very useful for painting of interior and exterior walls with very less time period. Accuracy of this machine is more as compared to manually painting .It also saves the labour cost and the total cost of painting. The methods of painting and intends to enlighten readers and artists alike with knowledge of modern art techniques as well as forgotten techniques of the painting technology. By using the semiautomatic roller painting machine it is clear that the human efforts are reduces as well as the cost of labour also reduces. Semi-automatic roller Painting machine can also paint the huge building easily and safely without any hazards to human being and labours.

VII. ACKNOWLEDGMENT

We would like to express our sincere gratitude to the Management. Principal of East Point College of Engineering and Technology Bengaluru for the facilities provided and their support. Also we would like to thank the Head of Department of Mechanical Engineering and faculties for their encouragement and support.

VIII. REFERENCE

[1]. Mohamed Abdellatif “Design of an Autonomous Wall Painting Machine” Mechatronic. Egypt Japan University of Science and Technology, Alexandria, Egypt, 7 February 2016.

[2]. Takuya Gokyu, Masayuki Takasu, Sumio Fukuda “Development of Wall Painting Machine” Tokyu Construction Co. Ltd. 1-16-14 Shibuya-ku , Tokyo, Japan.

[3]. DhavalThakar, Chetan P. Vora “A Review on Development of SemiAutomatic Painting Machine““ Int. Journal of Engineering Research and Applications, ISSN : 2248-9622, Vol. 4, Issue 4(Version 7), April 2014

Smart Automated Braking System

Prashanth K P[1], Amruth K U[2], Sanman S[3], Yuvraj L[4], Sanjay G M[5]

[1,2,4,5]*Department of Automobile Engineering, Acharya Institute of Technology, Bengaluru, India*
[3]*Department of Mechanical Engineering, Acharya Institute of Technology, Bengaluru, India*

[1]prashanthkp@acharya.ac.in, [2]amruth.17.beau@acharya.ac.in

Abstract **- Overcrowding of parking spots is one of today's most prevalent issues. Vehicles are outnumbering available parking spots, thus obstructing the roads. There exist few objects which we concern a lot about on the roads which might not be visible from the vehicle's cabin. It could be kids playing around or pets relaxing behind the vehicle. If the driver is unaware of these obstructions, both the external obstructions and the vehicle will suffer significant damage. It is essential to have a smart system that automatically engage the brakes to limit the amount of damage caused during an unexpected situation. This task presents an electronically controlled car slowing mechanism called "Smart Automated Braking System". A sensor operated pneumatic braking system accommodates the ultrasonic trigger and receiver circuit, control unit and a pneumatic slowing mechanism. The ultrasonic sensor is utilized to detect the obstacle and if there is any obstacle in the way, the ultrasonic sensor sends signal to the control unit activate the slowing mechanism and the pneumatic slowing mechanism is utilized for the safety of the vehicle. In essence, the vehicle brakes without the assistance of the driver by determining the best path away from the object. The pit gaps are detected by infrared sensors placed immediately next to the wheels on the backside of the vehicle, which provides the necessary signal to the control unit to engage the braking mechanism.**

Keywords – Ultrasonic trigger, infrared sensor, Smart automated braking system, Obstacle.

I.INTRODUCTION

A Smart Automated Braking System is incorporated with Ultron and Infrared course circuit which operates a pneumatic slowing mechanism. The primary goal of this task is for the vehicle to be able to turn around and perform programmed braking in an event when an obstruction is being detected by the system as well as for the vehicle to disengage the system when appropriate space is detected. The braking circuit's role is to brake the vehicle appropriately after receiving a signal from the sensor. These concepts address the use of mechanical brakes to replace human intervention [1]. While traveling at a speed of fifty kilometers per hour, the regal slowing system can stop the vehicle in 2 to 3 seconds, within a distance of 1 meter. The intelligent braking system is completely automated, allowing the driver to let the vehicle stop once the obstacle is detected. It also includes a normal mode for basic conventional operation. The range reduced to 40cm in this mode. In addition, the framework contains a late catch that, when held, supersedes the slowing mechanism. The preset stopping mechanism is activated when the release button is depressed. This mode is activated when the night time factor is greater than the day time threshold for the sensors to detect the area ahead.

II.METHODOLOGY

The project started with a field research, in which numerous articles and papers relevant to the concept were reviewed and observed. This leads us into the next step, which was problem facing. The study explored various and common challenges/difficulties such as to overcome the limitations of the previously studied experiments that were recorded in the field study stage. Following this, auto-electronic sensors and the problems faced in their applications were studied. Finally, our ideas were transformed into a physical project and the last phase, testing was carried out to evaluate the working of our project. Fig. 1 represents the method of project execution.

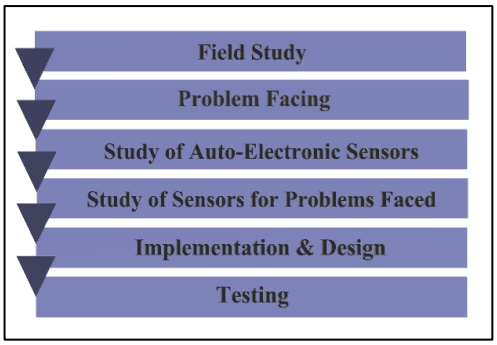


Fig. 1 Method of Project Execution

Ultrasonic moving and spotting systems use high-recurrence sound waves to determine the distance and range of an object. An ultrasonic sensor often employs a transducer that generates an electrical yield signal when ultrasonic energy is applied.

The Fig. 2 shows the primary segments canny switch stopping mechanism. An Arduino is used to detect the pulses and apply brakes to the vehicle [2]. There are two types of energy supply required, ie. the electric supply for the functioning of the ultrasonic sensor control unit, and the air supply for the pneumatic brake to work. Different surfaces exhibit different responses. Some surfaces scatter, reflect, and absorb infrared energy which will not work properly to interpret the sensor output as distance measure [3]. Ultrasonic STNT is made up of an ultrasonic transmitter and a receiver. An ultrasonic transmitter sends a constant stream of graded

class waves. Ultrasonic waves are created when the vehicle gets too close to a deterrent, which are then picked up by the Ultrasonic receiver. The control unit is powered after receiving the reflected signal. This controls whether or not the solenoid valve is to be switched on. These tactics are entirely electronic, necessitating the use of computerized inventory.

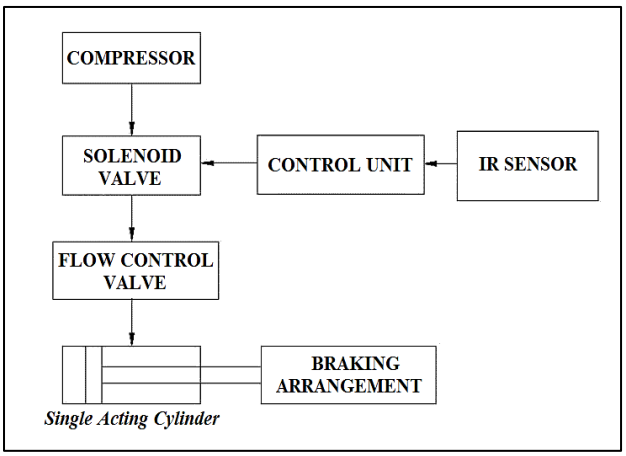


Fig. 2 Circuit Diagram

A. *Components of the System*

The pneumatic bearing press consists of the following components and requirements for the complete operation of the machine:

1) Power supply & control unit

2) Pneumatic double acting cylinder

3) Solenoid valve

4) Flow control valve

5) Ultrasonic sensor

6) Infrared sensor

7) Control unit

8) Pu connector, reducer, hose collar

9) Gear motor

10) Speed Control box

The specifications and application of the above components are as follows:

1) Control Unit: The main parts of the control unit are:

i. Arduino Uno: The Arduino Uno is a microcontroller board that features the ATmega328 microprocessor (datasheet). It features 14 digital input/output pins (six of which may be used as PWM yields), six analogue inputs and a 16 MHz ceramic resonator. It also consists of an USB port, a power jack, an ICSP header, and a reset switch. It comes packed with everything that user need to get started with the microcontroller. It is only required to simply plug it into a computer with an USB cable or power it with an AC-to-DC adapter or a battery.

Fig. 3 Arduino Unit

ii. Relay: Relays are switches that are used to close and open circuits both electronically and electromechanically. It regulates the opening and closure of an electronic circuit's connections. A group of input terminals for a single or several control signals, as well as a set of operational contact terminals make up the device. The switch can have a number of contacts in any contact form; ie. they comprising of ‘make contacts’, ‘break contacts’, and combinations of the two [4]. The relay’s switch connections are commonly categorized as ‘COM’, ‘NC’ and ‘NO’:

- COM = Common Terminal, always is connected to a terminal based on the application required.
- NC = Normally closed, COM is connected into NC when the relay coil is off.
- NO = Normally open, COM is connected into NO when the relay coil is on.

2) Sensor Unit: Ultrasonic transmitter for generating ultrasonic beams and ultrasonic collector for receiving ultrasonic beams when they are reflected back from obstacle make up the sensor unit. When Ultrasonic receiver receives waves reflected from the obstacle, it communicates the data to the control unit. The control unit then determines the distance between the deterrent and the vehicle, and if the distance is within a specific range, it sends a signal to the solenoid valve, which therefore engages the brake.

3) Ultrasonic sensor: The ultrasonic sensor detects an obstruction in the path of movement and sends the signal to the microcontroller. It serves as the control unit's eyes. The HC-SR04 Ultrasonic Sensor is a low-cost proximity or distance sensor that has mostly been utilized in robotics applications for object detection. It simply acts as a pair of eyes for the Arduino. It comprises of connecting terminals T and R, where T denotes wave transmission and R denotes wave reception.

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Fig. 4 Ultrasonic Sensor Unit

4) Infrared sensor: An IR sensor is a type of electronic sensor which detects and analyzes infrared radiation in its surroundings. The infrared system can have long-distance detection and accuracy outshining that of ultrasonic [5]. It accomplishes this by generating and detecting infrared radiation in numerous ways. Infrared sensors can also detect movement and measure the heat generated by an object.

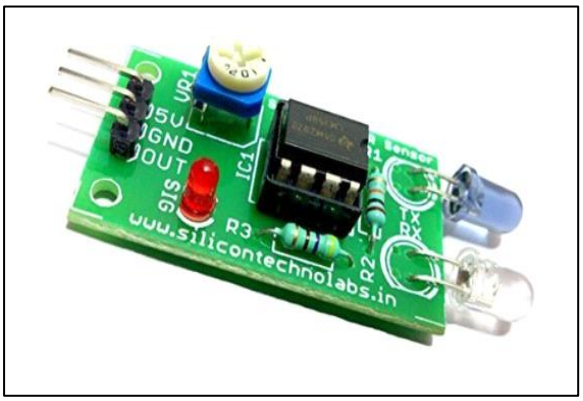

Fig. 5 An IR Sensor

5) Pneumatic cylinder: The pneumatic cylinder is used to perform the role of the compressor. A compressor is a Mechanical Device that increases pressure of a gas by reducing its volume [6]. Double acting cylinders are a helpful use when the operation demands more than one movement and seeks for a device to transfer load in both directions. Unlike single-acting air cylinders, double-acting cylinders do not require a spring to expand and retract. Instead of delivering pressurized air through a single port, double acting cylinders feature two ports through which air may flow in and out. Few advantages of using an double acting cylinders are that they offer more control over movement since pressurized air moves both ways, they are both fast and strong and also use less energy. Double acting cylinders also feature design variations, ie. stroke and bore sizes which can be chose according to the design requirements.

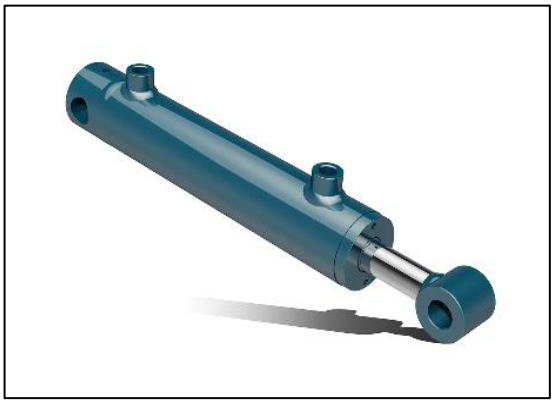

Fig. 6 Double Acting Cylinder

6) Solenoid valve: To regulate the fluid flow automatically, solenoid valves are employed. A solenoid valve is a valve which is controlled electrically. A solenoid, which is an electric coil with a moveable ferromagnetic core (plunger) at the center, is used in the valve. The plunger covers a small orifice in the rest position. When a magnetic field is created by passing an electric current through the coil, the plunger is pushed higher by the magnetic field, which in turn opens the aperture. This is the basic principle which is employed to open and close the solenoid valves.

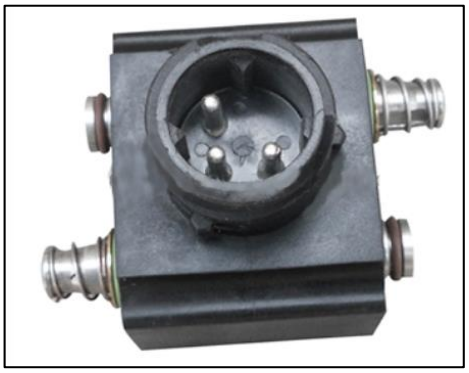

Fig. 7 Solenoid Valve

7) Flow Control valve: A flow control valve is used to control the amount of flow of air in one direction only. This valve is used to avoid any disturbances to the compressor. A flow control valve is formed by a non-return valve and a variable throttle. A flow control valve is connected in between the solenoid valve and the compressor. But most of the time the flow control valve is connected to the cylinder. By using this valve, the time consumption is decreased because of the quicker motion of the piston.

Technical Data:

Size: $1/_4{}^{th}$ *inch.*

Pressure: 0 to10 kg/cm^2.

Media: Air.

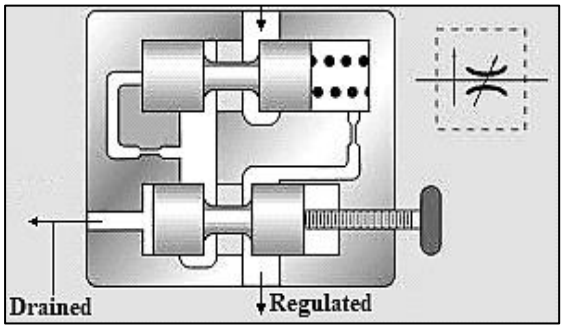

Fig. 8 Flow Control Valve

8) Motor: A three-phase squirrel cage induction motor is a type of three phase induction motor that works on the electromagnetic principle. The ability to alter the speed-torque characteristics of a squirrel cage motor is a significant benefit. This may be accomplished by simply altering the shape of the rotor's bars. In industry, squirrel cage induction motors are widely used because they are reliable, self-starting, and are simple to tune.

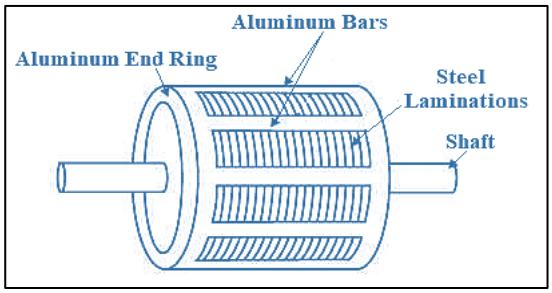

Fig. 9 Squirrel Cage Induction Motor

III.EXPERIMENTATION

The smart automatic braking system consists of an ultrasonic sensor which when detects an obstruction ahead, engages the pneumatic brakes automatically. The goal of this project is to slow down the automobile when an obstacle or a barricade is sensed with the sensors which are placed both at the front and the rear of the vehicle. Furthermore, the usage of a button to apply the brakes is preferred by the vehicle's motive force.

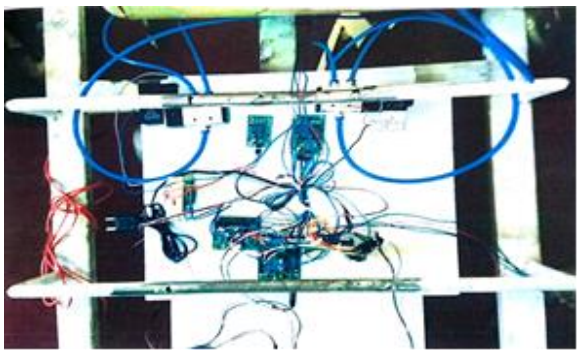

Fig. 10 The circuit in application

The system includes an air storage tank, an ultrasonic sensor, double acting pneumatic cylinder, solenoid valve and a control unit. The air storage tank is embedded with a flow control valve which regulates the float of air pressure through the air storage tank. High pressurized air is passed to the solenoid valve.

A solenoid valve is an electromechanically operated valve which is controlled by a solenoid and serves as an interface between the control unit and the pneumatic cylinder, with the operation being guided by the control unit.

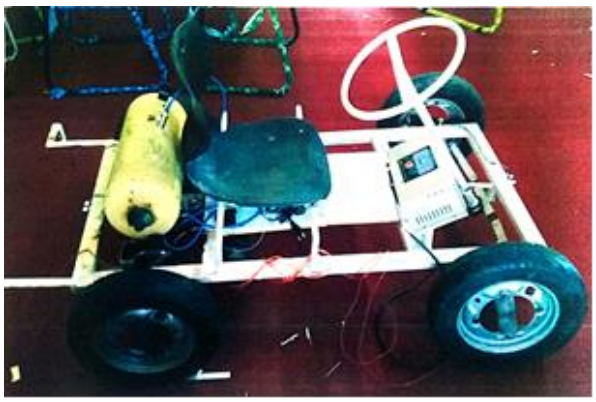

Fig. 11 Side View of the test vehicle

The solenoid valve operates the double acting pneumatic cylinder, which uses compressed air energy to produce a force in a reciprocating linear motion. The control unit is said to be the heart of the entire system and is supplied with an external power supply and also accepts signal from the ultrasonic sensors. The ultrasonic sensor is made up of a trigger and a receiver, with the trigger emitting ultrasonic waves and the receiver absorbing them when the waves are blocked by an obstacle. Within the sensors range, if the ultrasonic wave is redeemed, a response is sent to the control unit, and the control unit, in turn, activates the solenoid valve, which ejects high pressure air into the pneumatic cylinders. Now, the shaft projecting out from cylinder traverses perpendicularly with the shaft connected to each of the rear wheels [ie. Brakes]. Thus, the vehicle is automatically brought into a standstill.

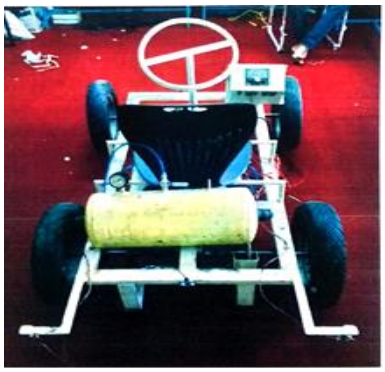

Fig. 12 Rear View of the test vehicle

The control unit of the smart automatic braking system consists of a rectifier which converts AC to DC. The speed controller in this system converts 250 V AC to 188 V DC, which powers an 1hp motor. When the pothole or an obstacle is detected by the two infrared sensors at the rear of the vehicle, it transmits the signal to activate the pneumatic braking system. The infrared detection range can be adjusted manually by loosening or tightening the screw on the sensor circuit board. Both the forward and reverse motion of the vehicle is accomplished by pressing the appropriate switches on the velocity controller. The adjustment screw found at each of the pneumatic cylinders can be used to adjust the intensity of the brakes to be applied. The ultrasonic sensors mounted both at the front and the rear end of the vehicle's chassis have a detection range of up to 50cms. With the assistance of a ball joint, the power transmission takes place through the differential, thus resolves the problem of meshing which may occurs when gears are being used.

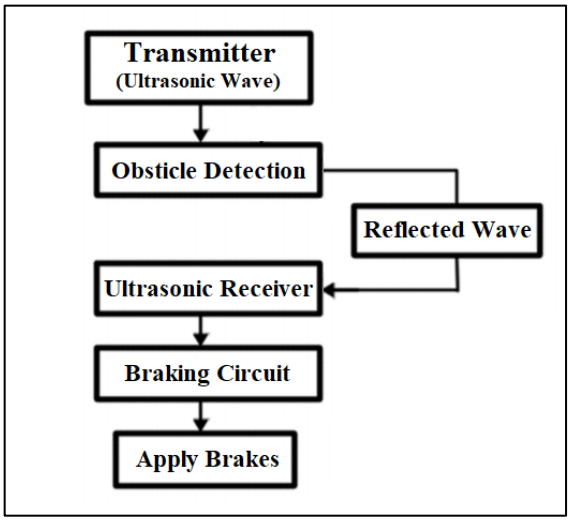

Fig. 13 Sensor - Brake block diagram

Also, the driver is provided with a button which can be pressed at any occasion anticipated by the driver, and when the button is pressed, a signal is sent to the control unit, which directs the solenoid valve for the application of brakes through the pneumatic cylinder, permitting for regular braking of the vehicle.

IV.RESULT

Consider a vehicle driving through a crowded parking space at a speed of 10 Kmph. If there is an obstruction caused to the vehicles path, such as a random pedestrian getting into the path, pets moving around or a random object which is out of sight of the driver, the smart automated braking system detects these random objects present within the sensors range ie. up to 50cms and automatically applies the brakes to reduce the damage caused both for the obstructing object and for the vehicle itself.

The Fig. 14(a) and Fig. 14(b) represent the effectiveness of the smart automated braking system. When the obstruction at point 'b' is identified within the sensors range (50cms) at point 'a', the autonomous brakes engage, as shown by the green line between points 'a' and 'b', thus slowing the vehicle to a standstill without colliding with the obstacle. The blue line indicates the absence of the automatic braking system and hence leads to a collision with the obstacle which is out of sight from the driver's cabin.

The pneumatic cylinder in Fig.14(a) is set to a low intensity, so the vehicle moves 40 to 45cms with the brakes applied before coming to a complete stop. When the pneumatic cylinder is set to its full potential, the vehicle can reach a compete standstill within 20cms post the object detection, and this is represented in the Fig. 14(b).

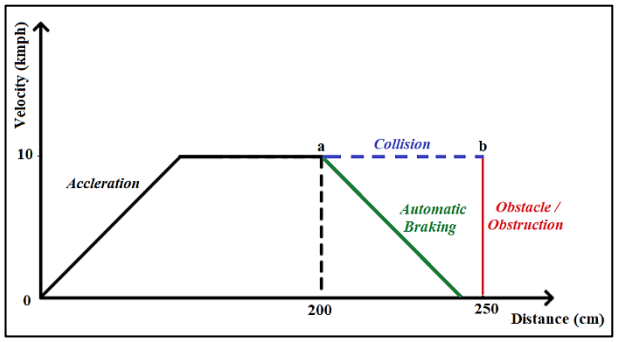

Fig. 14(a) Automatic braking in action

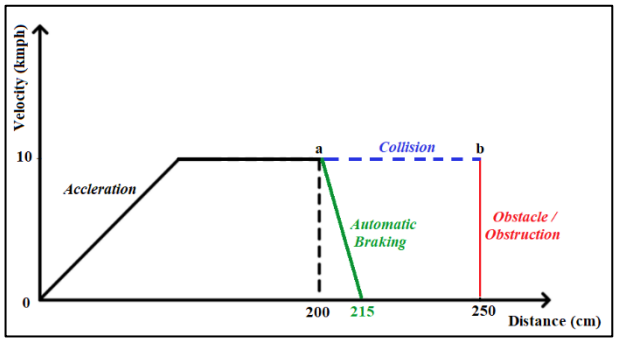

Fig. 15(b) Automatic braking in action

V.CONCLUSION

Every feature of each component present in the prototype test vehicle functions effectively and the whole system together reflects successful results. Once the obstruction or the obstacle is detected, the vehicle moves till the safe distance and is braked until the path of travel is free from any kinds of obstructions. The prototype's ultrasonic sensor has a range accuracy of around 2cm to 1m and operates perfectly within the prescribed range.

The functioning of the system was analyzed by plugging in the system into the battery, and by controlling the braking

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system with a DC motor and a servo motor's assistance. This is an immature approach, and this effort is towards to reduce the damages which may occur due to poor vision or during critical driving scenarios.

REFERENCES

[1] Prashanth, K.P., Padiyar, K., Naveen, K.P.H. and Kumar, K.S., 2014. *Road accident avoiding system using drunken sensing technique*. International Journal of Engineering Research and Technology, 3(10), pp.818-823.

[2] Gajanan Koli, Akshay Patil, Prasad Patil, Shubham Sokashe, "*Intelligent Braking System using the IR Sensor*", International Journal of Advances in Scientific Research and Engineering (IJASRE) ISSN: 2454-8006 [Vol.03, Issue 2, March -2017]

[3] Niveditha, P. and Gowri, S., 2014. *Collision warning system using ultrasonic sensors and automatic brake system.* In Proceedings of the 5th International Conference on Recent Trends in Information, Telecommunication and Computing (pp. 419-424).

[4] Prashanth, K.P., Prajwal M and Deepak J., 2020. *Motorcycle headlight design for clear visibility & comfort riding*. Our Heritage Journal, 3(22), pp.240-248 (90.

[5] Hai Wang & Ronghong Xiao, "*Automatic Car Braking System --Based on original reverse warning system*" [March 2012]

[6] Tembhurkar, C., Jatav, V., Pande, A., Udapurkar, S., Sinha, N., Borkar, P., Thakre, A., Madankar, V. and Runghe, K., 2018. *Design of Intelligence Braking System.*

Smart Vehicle Mileage and Emission Detection System

Prashanth K P[1], Jayanth Varma K[2], Sanman S[3], Yuvraj L[4], Amruth K U[5]

[1,2,4,5]*Department of Automobile Engineering, Acharya Institute of Technology, Bengaluru, India*
[3]*Department of Automobile Engineering, Acharya Institute of Technology, Bengaluru, India*
[1]*prashanthkp@acharya.ac.in,* [2]*jayanthv.17.beau@acharya.ac.in,*

***Abstract*—For quite a long time, our vehicles have been connected in ways that seem to be natural at this point: they flawlessly link to our cell phones, report genuine traffic cautions, stream our spotify playlists, and offer help on the roadway for a grab. The automotive business has a more drawn-out and extravagant reputation in terms of merging drivers and innovation than any other division.**

We conducted tests to link the analog the data sensed by various sensors for fuel and emissions to be converted to digital form and show how quick the data can be transmitted with accuracy to the user. These tests help show the connectivity in the automotive industry and how various parts of the vehicle can be monitored real-time to help drivers be alert all the time while driving and provide them with information if there are any problems that might occur.

***Index Terms*—Cell phones, Gadgets, Sensors.**

I. Introduction

A. Internet Of Things

The Internet of Things involves the arrangement of physical items or ”things” embedded in equipment, scheduling, sensors and accessibility for exchanging information with the manufacturer or chairman. Use of IOT systems for monitoring and working structures will probably enhance the event of officials and coordination of the emergency response and the nature of the organization.

B. Python Language

Python is decrypted higher level programming language for extensively valuable programming. Made by Guido van Rossum and first released in 1991, Python has an arrangement thinking that underlines code clarity, prominently using colossal whitespace. It gives builds up that engage clear programming on both little and colossal scales. Python incorporates a ground-breaking sort structure and customized memory the board. It supports diverse programming perfect models, including object-arranged, essential, valuable and procedural, and has a tremendous and intensive standard library.

C. Sensors

Over the last 20 years advances in inserted frameworks, remote management systems and identification prowess, amplified by federal interest, have changed the way we accumulate and react to physical work data. In a certain way, the car shows a world where estimates appear’ undetectable;’ detect and input control frameworks for camera operation, though simply returning sufficient information to the human person is the only way to express this world.

D. Microprocessors

The microchip comprises a few co-ordinated logic circuits on a solitary chip. It is typically made using Large Scale Integration (LSI) or VLSI innovation. This is the most common characteristic of this product. This can be measured and determined by mathematics. Arithmetic logic unit (ALU), registers and control unit develop the important components of a chip. Below is the square contour of a microchip. The accompanying data affirms its capabilities.

a) Arithmetic Logic Unit (ALU): Numerous juggling tasks are carried out by the ALU, such as expansion, subtraction, and rationalization, like AND, OR and Exclusive OR.

b) Registers: The registers are utilized for impermanent stockpiling of an information, during the execution of the program. Certain registers have unique capacities: for instance, holding the location of the following guidance to be executed.

c) Control Unit: The control unit gives the planning and control sign to complete various activities with in just as outside the CPU.

d) Input: The motive behind the field of information is to acknowledge and shift projects to CPUs and memories. A console Microprocessor based frameworks use largely hexadecimal consoles as a regularly enrolled information gadget. These consoles are equipped with 16 0 to F information keys. Again, frameworks based on microchips can get information from gadgets such as ADC and also switches.

e) Output: The calculation / preparation effects in the CPU are reflected in the outer world via the yield gadgets. The usually utilized yield gadget is a 7-part gadget progression. Singular Light Emitting Diode (LED) and transfers can be used as a output gadgets

E. Programming Languages

A language of programming is a conventional language that puts some guidelines that can be used to create different kinds of returns. Dialects of programming can be used to develop specifically computed programs. Rather than just the general programming dialects of current PCs, there are programmable machines that will use a restricted set of explicit directions.

Many dialects for programming expect the calculation to be constructed in a fundamental structure (i.e. as the arrangement of activities to be practiced), while different dialects are using different types of program in particular, such as the describing structure.

II. Background Study

It is expected to build a leisure gadget that displays the fuel fuel mileage efficiently of a motorbike, and will show this progressively on a presentation that is added / set alongside other driver information management on the vehicle's dashboard [1]. The Lowest possible Effort Intelligent Real Time Fuel Mileage Dataset is also optimized. A one size fits all strategy and trying to set was evolved to gradually provide a momentary mileage through both conditions of driving and sitting connected to the measurement of fuel absorbed and separation via engines.

- The drawback is that the data gathered will be one or two days after this procedure.
- It is tedious.

Due to the continuously rigorous natural controllers, the power makers are compelled to generate electricity at any rate cost and with the lowest degree of release. The age of petroleum power discharges several polluting influences into the air, that become excrescences when the production unit is filled with Multiple Fuel Sources (MFS) [2]. This is an encouraging viewpoint to easily integrate this issue into the operational industries. By dealing financially healthy practices by different distributed reports, this work provides a much more precise and grooming operational model considering the impact of a valve point, a carbon dioxide outflow.

The route and control framework for a stand-alone guided existing vehicle (AGV) used it to move substantial steel parts in a steel plant area. "Navigation Control Advancement" The car has exceptional cinematic sequences. The route depends on a combination of death sentence and transponder [3]. The transponders are aloof and cover the AGV in the soil every 5-10 m. The interface between certain vehicle control frame and a remote control station has been linked via remote correspondence.

Solitary advanced camera estimates of fluid levels. A photo-based estimates framework is proposed in this paper, use a solitary computerized camera and a round boom to quantify fluid tank fill levels [4]. The frames in the utilizing chrominance divergence and threshold systems, are determined by selecting the buoy in a shading alternatively from that of the fluid in the tank. In perspective of the developed connection between the pixel gauge of the body width in the image and the fired separation, the estimate framework can measure the level of fluid appropriately based on the photos taken [5].

In the current vehicles we face a typical issue of fuel meters not demonstrating precise outcomes. They can't show the careful measure of fuel left in the tank, regardless of whether they are simple fuel meter or a computerized one [6] (bar type advanced fuel meter).

III. Methodology

The fuel level recognition process is used to trace the fuel level in the tank. The gas sensor is used for explanation, the sensors are situated here to find the fuel level and the outpouring level sign is sent to the unit for further exercises. The fuel level identification circuit.

A. Working and Construction

The purpose of the sensor is to detect the presence of fuel in diesel fuel. The sensor is mounted inside of the fuel filter and has two main output signal stages, low level and high level, which identify the presence and absence of fuel. The output signal level is changed when fuel reaches a defined fuel level in the fuel filter. Overcurrent protective delay time for switching from fuel to fuel and from fuel to fuel, self-diagnostic function Self-test function identifies functionality of the sensor (in absence of fuel) during the start of vehicle. The output signal is changed to level identifying presence of fuel for short time, which can be adjustable and returns back to output level identifying absence of fuel.

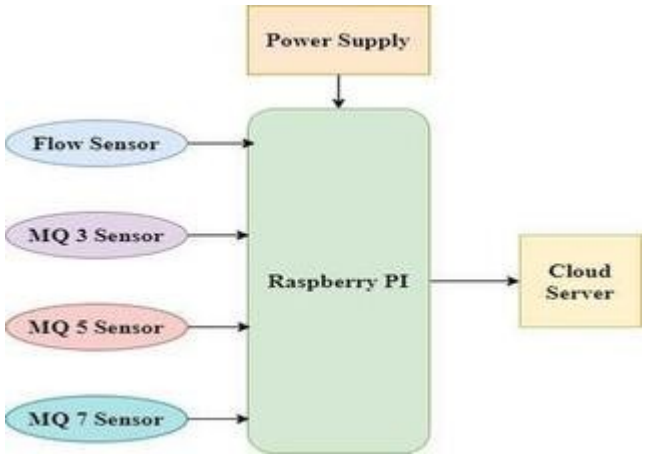

Fig. 1. Sensor Diagram

The working instructions for the MQ-5 gas sensor are as pursues: the sensor has a touchy SnO2 fiber. The sensor can be used in particular to detect diverse inflammable gases, methane, and is adequate for various applications with minimal effort. The sensor is placed in the fuel tank to detect fuel quantity and the indications from the sensor are sent to smaller unit to choose the precise level data. If the basic electric circuit is not too difficult to use, convert the conductivity changes into the associated gas fixation yield.

In this venture, the fuel can change the variable opposition situation associated with the buoy by placing a buoy type sensor within the fuel tank. In all cases, the fuel tank variable opposition is associated with the simple to advanced converter unit that indicates the fuel level in the fuel tank.

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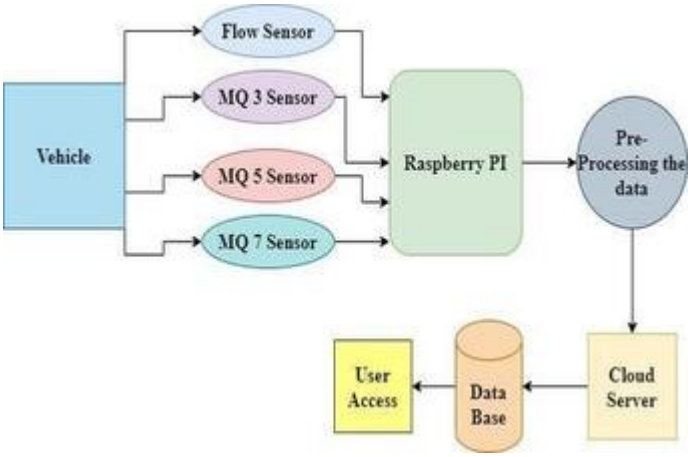

Fig. 2. Control Flow Diagram

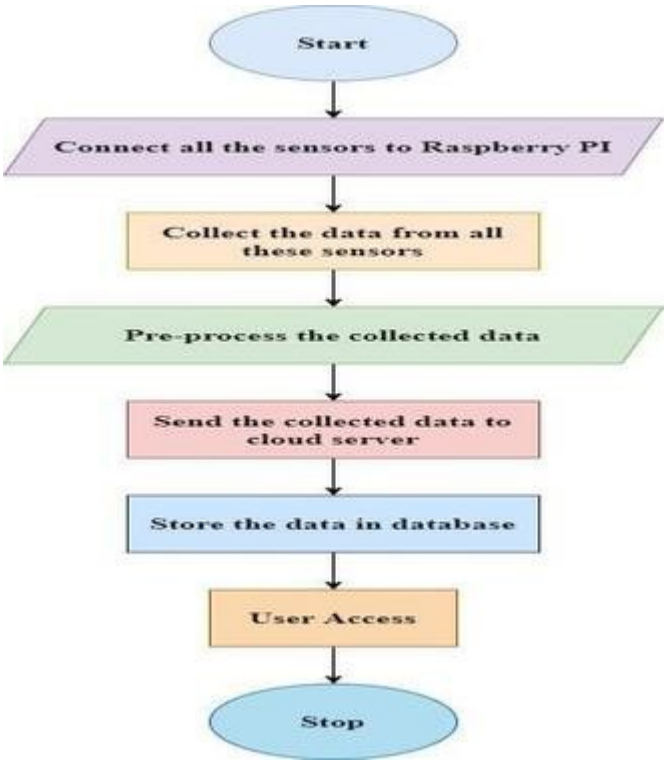

Fig. 3. Data Flow Diagram

IV. Materials Required

A. Hardware Required

a) Raspberry PI: In order to facilitate essential software engineering to examine and inspire each other with the support of PC equipment, programming and DIY-Do - it Yourself ventures, PC is a charging card which is estimated and structured by the Raspberry PI facility in the UK.

The Raspberry Pi comes in three various boards, maintaining Network component 14 (Premier Farnell), RS Components and Egoman to authorized assemblage. All manufacturing companies are equivalent to the equipment. The Raspberry Pi has an ARM1176JZF-S 700 MHZ, VideoCore IV GpU, Broadcom BCM2835, chip framework (SoC), which initially was shipped at 256 megaocytes of RAM. Subsequently upgrade to 512 MB (Model B and Model B+).

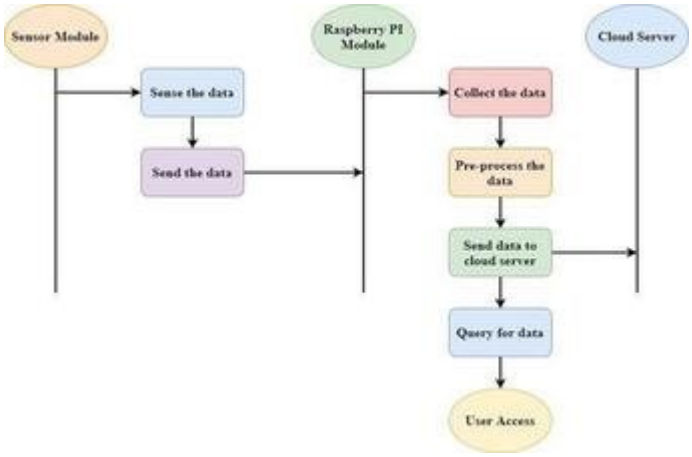

Fig. 4. Use Case Diagram

Fig. 5. Raspberry PI

b) MQ 3 Sensor: SnO2, which has a less conductivity in clean air, is delicate material of the MQ3 gas sensor. At the time when the target liquor gas is detectable, alongside the gas focus, the potential of the sensor improves ever more. Convert a conductivity change to compare the encoding sign of the gas focus if it is not too complicated to use basic circuit. The gas sensor MQ-3 has a high alcohol effect and great protection toward gas, smoke and fume upsets.

Touchy MQ-3 gas sensor material is SnO2, which has a lower clean air conductivity. The conductivity of the sensor improves alongside the concentration of the gas at the moment when the objective liquor gas takes place. Users can change the conductivity difference to relate the gas focus output sign to a basic circuit. The gas sensor MQ-3 has a high level of effect on liquor gas and it may prevent gas, smoke and fume obstruction.

Fig. 6. MQ 3 Sensor

c) MQ 5 Sensor: The MQ-5 gas sensor is used as a gas tracking material by SnO2, with lower conductivity, free air. In an environment in which flammable gas might be detectable, the gas sensor's conductivity raises along with the flammable gas intensity. MQ-5 has a deep touch with flammable gas. It illustrates the ability to perceive various flammable gasses and the lower cost, which is also the perfect option for various uses of the gas site. In regards to the convergence of different gases the obstruction guesstimate of the MQ5 sensor differs. Adjustment will be important to take gas focus point projections.

Fig. 7. MQ 5 Sensor

Overview:

- LPG sensitive, flame retardant, charcoal-gas
- Sustainability of output voltage in addition to centralization of deliberate increases in gases
- Quick response and recovery
- Signal output marker

Specifications:

- Standard 5V voltage + -0.1
- Temperature of operation – 10C to 50C (14F to 122F)
- Storage Temperature-20C to 70C-4F (to 158F)

d) MQ 7 Sensor: MQ-7 gas sensor sensing material is SnO2, which is conductive in clean air with lower capacity. It identifies high and low temperature cycle technology and identifies CO at low temperatures (1.5V heated). It cleans different gasses adsorbed in low temperatures specifically when they are high temperature (warmed by 5.0V). The gas sensorMQ-7 has a high carbon monoxide affectability. The sensor can also be used to trace numerous harmful gases that contain CO, easily and sensitively for various uses.

Fig. 8. MQ 7 Sensor

Characteristics:

- High impact on natural gas.
- Long life and minimum effort.
- Simple drive circuit.
- Good gas impact in wide range.

Specifications:

- Voltage: 3.3-5V working voltage
- Type: Analog Sensor

B. Software Required

a) Python: Python is a traduced, dynamic semantic programming language, located and substantial level. It is attractive to rapid application improvement, which is used in the mixture of dynamic structure and dynamic bundles to interferein existing segments with inherent information structures. Python's basic, simple sentence structure is compatible and lowers cost of maintenance. Python is enriched by the modules and bundles, that also help measured program quality and code reuse. On every top need in a source or parallel structure, the Python mediator and the enormous set library are fully accessible.

b) Raspbian Jessie: Raspbian is a Raspberry Pi computer system based on Debian. Raspbian is accessible in several versions including Raspbian Stretch and Raspbian Jessie. There is still active development of the operating system. For Raspberry Pi minimum-capacity ARM CPUs, Raspbian is highly optimized. Raspbian is a Debian-based free of cost operating system optimized for the hardware Raspberry Pi [6].

V. Experimentation

A. System Testing

The test is designed to find imperfections. Testing is the way of trying to find any deficiencies or weaknesses in a workpiece. It offers an approach for the value of segments, sub-communities, conferences and a completed item. It is the way to programming in order to make sure that the Software framework fulfills its requirements and customer demands and does not inadmissibly bomb. Various kinds of tests exist. Each type of rundown tends to have a specific request for testing.

B. Types of Tests

a) Unit Testing: Unit test is intended to approve the appropriate working and authenticity of program applications within the program rationale. All branches of choice, like the internal code stream, should be approved. It is the test for each product unit of the application before blending after a particular unit is finalised. This is a fundamental test, focused on emerging and intrusive information. Unit tests perform basic part tests and test the specific business method, application and frame establishment. The unit tests make sure that the archived relevant data and simply characterized information and expected results are concisely met through each of the typical business procedures.

b) Integration Testing: Integration tests are designed to test integrated software components to determine if they are usually carried out in compliance with one program. The combination of components is correct and the Integration test strives specifically to identify issues induced by the melding of the components [8], as illustrated by successful unit testing. Convergence testing implies that all components are individually satisfied.

c) Functional Test: Functional tests systematically illustrate that the operational tests, system documentation and user manuals are available in accordance with business and technical requirements [9].
Functional testing concentrates on the following points:

- Valid input: Identified classes for valid input must be accepted.
- Invalid Input: Invalid input classes identified must be ignored.
- Functions: function must be identified.
- Output: the application output classes identified have to be exercised.
- Systems/Procedures: Systems or procedures for interfacing need to be invoked.

Functional test organization and preparation relies on demands, key functions or special test cases. Consequently, systematic coverage of business process flows must be considered for testing, such as data sectors, predefined processes and successive processes. Further tests are classified and the effective value of the current tests determined before functional test is finished.

d) System Testing: System testing ensures the strict compliance of the software system. It tests a put-up to ensure which results have been known and predictable. The configuration orientated system integration test is an example of system testing. Process descriptions and flows were based on system testing, emphasizing pre-driven process links and integration points.

e) White Box Testing: System testing ensures the strict compliance of the software system. It tests a put-up to ensure which results have been known and predictable. The configuration orientated system integration test is an example of system testing. Process descriptions and flows were based on system testing, emphasizing pre-driven process links and integration points.

f) Black Box Testing: Testing Black Box measures software without knowledge of the module's ongoing operating, structure or language. Black box tests must be written from a definitive source document, as the most other kinds of tests, such as specifications or document requirements like specifications or requirements. It is a test in which the testing software is treated like such a black box. In it you can't "see." The test provides inputs and responses to outputs without believing about what the software functionalities.

C. Test Strategy and Approach

Field testing and functional testing will be performed manually.
Test features:

- Verify that the entries are in the correct format.
- All links should take the right page for the user.

D. Maintenance

This covers a vast range of activities including code adjustment and design errors. In order to minimize the need for long-term maintenance, we have defined the requirements of the user faster during the development process. This system has been developed to address the needs to the maximum extent possible, depending on the requirements. Thanks to technology development, many more features could be introduced in future based on requirements [10]. The coding, design, and maintenance is simple and easy to understand.

VI. Result

The reported project concept is brought into function. It has been experimented and worked. The project results have been successfully achieved.
Result contains:

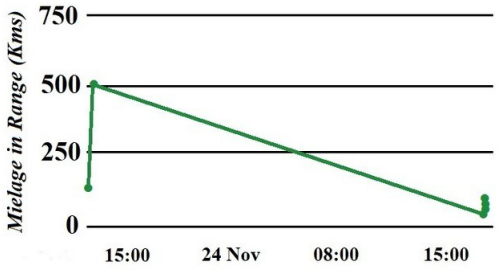

Fig. 9. Mileage

- Mileage chart: The mileage chart shows the real time mileage of the vehicle on the internet with 10 seconds advanced timing.

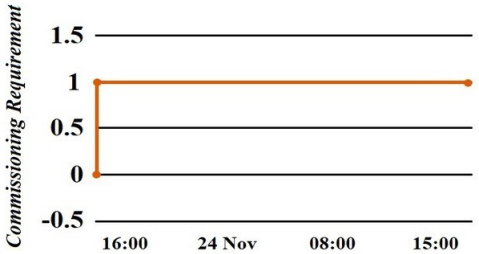

Fig. 10. Range

- Range chart: The range chart shows the real time range for how much the vehicle can run with the amount of remaining fuel in the vehicle.

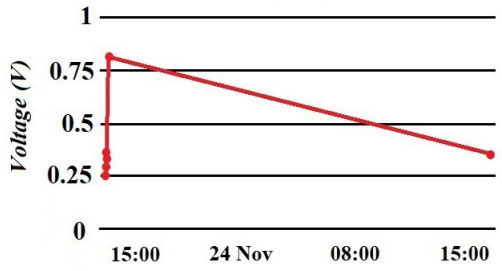

Fig. 11. MQ 3 Reading

- MQ 3 sensor reading: This sensor gives the reading of amount of flammable and volatile substance in the fuel. At the beginning voltage gets sudden rise up as the time passes it gradually decreases.

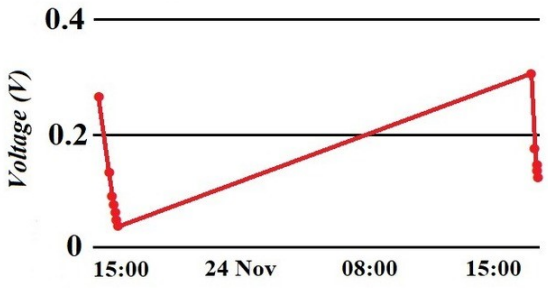

Fig. 12. MQ 5 Reading

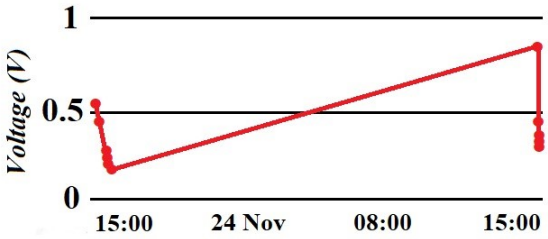

Fig. 13. MQ 7 Reading

- MQ 5 sensor reading: This sensor gives the reading of amount of organic gases (hydrocarbons) in the exhaust gas. At starting the voltage goes down and as time passes the voltage rise simultaneously and again it sudden drop in voltage.

- MQ 7 sensor reading: This sensor gives the reading of amount of carbon monoxide in the exhaust gases. At starting the voltage drops and as time passes then the voltage sudden gradually increases and at the end voltage drops.

VII. Conclusion

The Analog/Digital conversion of the MQ 3,MQ 5 and MQ 7 sensors successfully transmitted the data collected to the Raspberry PI and was sent to the cloud within seconds. The data was then reflected immediately reflected on the screen. The data was around 95 percent accurate and was accessable to the user. Continuous monitoring of data can be done with few more extra sensors to increase the accuracy and this method can be implemented for other parts of the vehicle to be able to access more data of the vehicle easily and efficiently. This technology can be made more efficient by designing the control modules with only the required parts and not raspberry pi.

References

[1] Jaimon Chacko Varghese, Binesh Ellupurayil Balachandran *The design of Low Cost Intelligent Real Time Fuel Mileage Indicator for Motorbikes.*
[2] P. Balachandar, S. Ganesa, N. Jayakumar, S. Subramanian *A Prototyping Model for Fuel Level Detector and Optimizer.*
[3] Hannu Mäkelä, Thomas von *Numers Development of Navigation Control.*
[4] N.Sriskanthan, A.Karande *Bluetooth based home automation system*
[5] Ti-HoWanga,Ming-Chih,Chen-Chien Hsu,Cheng-Chuan Chen Jia-DongTan *Liquid-level measurement using a single digital camera*
[6] Rishabh Neogi *Gasoline Mileage Indicator System*
[7] Dinesh Kumar, Manojkumar *Comparative analysis of adiabatic logic challenges for low power CMOS circuit design*
[8] Prashanth, K.P., Padiyar, K., Naveen, K.P.H. and Kumar, K.S., 2014. *Road accident avoiding system using drunken sensing technique.* International Journal of Engineering Research and Technology, 3(10), pp.818-823.
[9] Prashanth, K.P., Prajwal M and Deepak J., 2020. *Motorcycle headlight design for clear visibility and comfort riding.* Our Heritage Journal, 3(22), pp.240-248 (9).
[10] Tuan Nguyen Gia, Victor KathanSarker, IgorTcarenko, Amir M.Rahmani, Tomi Westerlund, PasiLiljeberg, Hannu Tenhunen *Energy efficient wearable sensor node for ioT-based fall detection systems.*

Conceptual Design and Fabrication of Groundnut Thresher Machine

Anil K C [1], Tejashwini H N [*2], Gunashree P [2]

[1]*Assistant Professor*, [2]*UG student*
Department of Industrial Engineering & Management,
Siddaganga Institute of Technology, Tumkur.
**tejutanya28@gmail.com*

Abstract: **World is mostly concentrating on new inventions and running with updated technology. Farmers are back bone for every country in the world. Without farmer's livelihood is difficult. Groundnut is grown on a small scale by farmer. The major problem in groundnut production in country like India is the lack of groundnut processing machines available to farmers. In the beginning the peanuts were separated from its shells by the workers. The output from this method was very less and could not satisfy the market demand as it was very time-consuming process. This project is mainly about to remove the barriers while removing the groundnuts. In this rotational mechanism is used. With the help this instrument the time gap reduces from removing of groundnut from plant and also the labor required reduces. This project makes the farmer to work easy and can save more time and investment. It is more efficient and can be available to all at minimum cost.**

The main objective of the project is to develop groundnut thresher considering needs of Indian farmers. Among the field operations concerned with groundnut cultivation, harvesting, threshing is the most laborious and costly endeavor. Existing harvesters and threshers are too huge to be useful for small scale farmers and in scenario like multi-cropping. Initially survey of typical groundnut farm field has been done followed by literature survey, fabrication, testing and design modifications.

I.INTRODUCTION

Groundnut or peanuts is a species in the legume or "bean" family. The peanut was probably first domesticated and cultivated in the valleys of Paraguay. It is an annual herbaceous plant growing 30 to 50 cm tall. Peanuts are known by many other local names such as earthnuts, ground nuts, goober peas, monkey nuts, pygmy nuts and pig nuts. Despite its name and appearance, the peanut is not a nut, but rather a legume. India is the second largest producer of groundnuts in the world in the order shown in the table Indian groundnuts are available in different varieties as bold or Runner, Java or Spanish and Red Natal. Groundnut is the major oil seed crop in India and it plays a major role in bridging the Vegetable oil deficit in the country. Groundnuts in India are available throughout the year due to a two-crop cycle harvested in March and October. Groundnuts are important protein crops in India grown mostly under rain-fed conditions. Indian manufacturer have the capability to prepare and supply edible peanuts conforming to highest standards. Apart from raw edible peanuts, India is also in a position to supply Blanched Peanuts, Roasted Salted Peanuts and Dry Roasted Peanuts and a variety of peanut based products.

The major growing state for groundnut is Gujarat, Andhra Pradesh, Tamil Nadu, Karnataka, Maharashtra Rajasthan, Madhya Pradesh, Orissa, and Uttar Pradesh. Groundnut is grown on small scale farmers in developing countries like India. The average kernel price is approximately twice the price of pod. Lack of groundnut processing machines, especially groundnut separation and Sheller machines, is a major problem of groundnut production, especially in our country India. Among the many fast growing cash crops, groundnut is always sought after by small farmers. But the major hardship in growing this crop is harvesting.

Harvesting groundnut are the most important and labor intensive operations in groundnut cultivation. During harvesting the fields need to be made wet the previous-day with scant irrigation, so that the soil becomes loose and the plants along with the pods can be pulled out easily from the-soil. Once plucked, the pods need to be stripped from the shell. Stripping the pods is a traditional practice done either by removing the pods manually or hitting the Bunches with the help of wooden sticks. A work for design, fabricate, and performance evaluation of a groundnut thresher consisting of feed hopper with a flow rate control device separating unit and power system. The performance of the machine was evaluated in terms of capacity, material efficiency and mechanical damage.

This project describes about the design of various

components of groundnut thresher machine. Hence in this design of various parts are necessary, and design of various parts due to which the design quality of those parts will be improved. Overall, this project involves processes like design, fabrication and assembling of different components etc.

Based on the result from the literature review, threshing is the important process in cultivation process. Also temperature level is very high during these days and the labor finds hard to undergo the removal of pods from plant under these climate condition. Hence it is required to find the easy method to perform the operation. The farm may be located at far distance from the power source hence the usage of motor is not used in most places. Hence it is essential to find the alternate power source like engine to serve the purpose of power source.

II.PROBLEM IDENTIFICATION

1. Present practice of manual harvesting and threshing consumes huge amount of labor

2. During peak season, due to non-availability of labor in time, delay in harvesting and threshing resulted in heavy loss to farmer

3. Even though power operated harvesters and threshers have been developed, their adoption level is very low due to varying power requirements and individual operation results in heavy loss to Farmers

4. Lack of groundnut thresher machines at affordable cost, is a major problem of groundnut production.

III.OBJECTIVE

To conceptually design and develop the simple, rigid and robust groundnut thresher machine that will minimise the rate of groundnut seeds damage.

IV.MATERIALS & METHODS

1. TABLE: All the part of the machine are mounted on the table. Table acts as a foundation and all the load acts on the table. Hence it must be strong enough to bear all the loads.

2. FEEDER: The groundnut legume is fed through this part.

3. THRESHING DRUM: It is the active or rotating portion of the machine. It consist of the cylindrical drum which is spirally bolted with bolts and it also consist of Shaft and two covering plate.

4. MOTOR: Motor are used to convert the electrical energy to mechanical energy. It is used as the driver. It Rotate the threshing drum through the chain transmission. The sprocket is provided with required ratio.

5. DESIGN SHAFT, PULLEY and BELT: The shaft for threshing has a diameter of 28mm with internal diameter of 25mm for bearing and was step down to 22mm for its pulley.

$N1\ D1 = N2\ D2$ (6)

Where: $N1$= Speed of driving pulley (rpm)

$N2$ = Speed of driven pulley (rpm)

$D1$ = Diameter of driving pulley (mm)

D2 = Diameter of driven pulley (mm)

6. BELT LENGTH: The effective belts length of conveyor

$Lb = \pi 2$

$(D1 + D2) + (D1 - D2)24\ x + 2x$ (7)

$D1$= Diameter of driving pulley (mm)

$D2$ = Diameter of driven pulley (mm)

x = Centre distance between driving and driven pulley mm

7. POWER TRANSMISSION: The power transmission of belt

P = (T1- T2) V

Where V= Belt velocity (m/s)

T1= Tension of the belt upper side (tighter side) (N)

T2 = Tension of the belt lower side (slacker side)

8. CALCULATION OF TORQUE: A research paper by J.M.Troeger et al, the peg attachment force or the tensile force required to separate peg from pod is 22.26 N. Here we use up to ten ground nut plants so the maximum force that is required to remove

groundnut pod is up to 300 N with considering the weight of shaft and other mountings.

Torque, T = Force x Perpendicular distance

Force, F = 250 N

Perpendicular distance is the distance from the axis of the drum to bolt mounted on the periphery of the drum is 132.5mm.

Torque T = 250*132.5= 33.125N-mm

T = 33.125-mm

9. POWER CALCULATION:

Power, P= 2∏ NT/ 60

Speed required, N = 330 rpm

P= 2∏* 330*33.125/60

P= 1144.71 W

P= 1.5HP

So we are using 1.5 HP motor. The first step, table is formed at the top next threshing drum is fixed, feeder is assembled at the rear side, next 1.5Hp motor along with pulley belt is placed at the bottom.

10. DESGIN PROCEDURE:

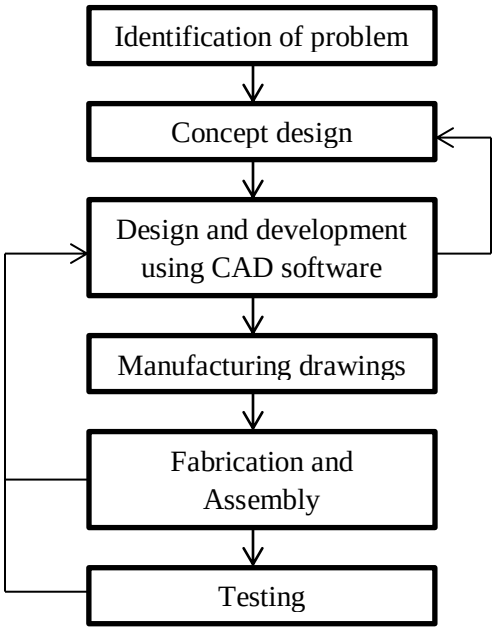

Figure.1: Groundnut Thresher Machine

V.WORKING

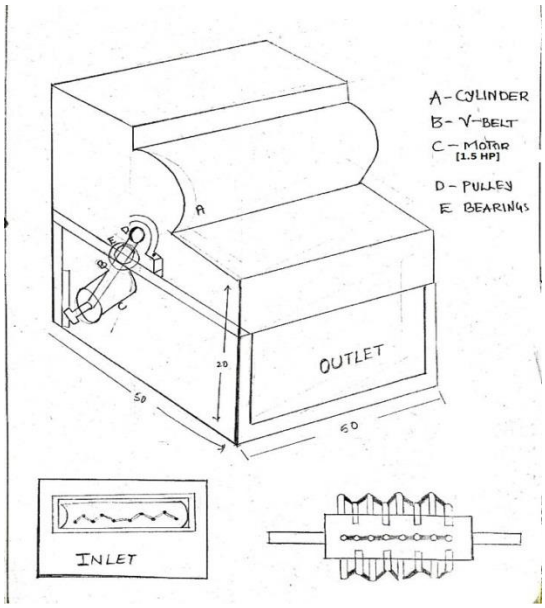

Figure 2: Block diagram of Groundnut Thresher Machine.

The Purpose of this groundnut threshing machine is introduced to change the evolution of the groundnut threshing process. In order to reduce the burden for farmers this machine gives the product earlier with

best quality it works in all different kinds of lands. This process totally reduces the need of labor. Because all, the separation process is done by a single machine, it collects the groundnut and stored in the storage tray.so, the farmers gets benefited. The requirement of labor is very less.

The farmer has to feed the groundnut legume to the feeder at backside and the machine will take entire plant inside and thresh the pod by spiral mechanism and the threshed pod will fall down at the front side.

VI.CONCLUSIONS

Groundnut thresher machine is a useful machine. It saves time and energy of the farmer also it reduces the cost and time. The feeder and spirally bolted threshing drum reduces the human intervention. The farmer has to feed the groundnut legume and the machine will take entire plant inside and thresh the pod by the spiral mechanisms. Also this machine are low cost and reliable for our farmer. The area occupied by this machine is less therefore it can be used anywhere thus it can be used in unconditional climatic condition also. If solar panels are added it will be more advantage for our farmer. The application of automation is now necessary to be employed in our today's fabrication.

REFERENCE

[1]. Rajnish R Dubey, Ravi M, Nandhu T, Nithin S A, Vijai R *"Design and Fabrication of Groundnut Thresher Machine",* JETIRC-Journal of Emerging Technologies and Innovative Research| Vol. 6, Issue 05 May 2019.

[2]. Rajasekrar M , Arunkumar S, Divakar S, Santhosh kumar R, *"Design and Fabrication and performance analysis of groundnut thresher",* International Research Journal of Engineering and Technology (IRJET),Volume 4, Issue 02 Feb-2017.

[3]. Benjamin Bello, A.Tokan, J D Jiya, Abubakar Ibrahim Musa, *"Design Model of Automated the Groundnut Threshing Machine"* ,Majlesi Journal of Mechatronic System, Volume 8, Issue 1 March 2019

BANGALORE INSTITUTE OF TECHNOLOGY

Application of Value Analysis Techniques on a Knapsack: A Case Study

AUTHOR PROFILE

Deepa.B.V - Second Year Engineering Student,Bangalore Institute Of Technology , KR Road ,V.V Puram ,Bangalore ,India.
Email ID- deepabv20@gmail.com

Akash.U – Second Year Engineering Student Bangalore Institute Of Technology, KR Road V.V Puram Bangalore,India.
Email ID- akashumashankar@gmail.com

Monisha.S – Second Year Engineering Student ,Bangalore Institute Of Technology , KR Road ,V.V Puram ,Bangalore ,India.
Email ID- monishas847@gmail.com

Prof V.S.Giri- Associate Professor ,Bangalore Institute Of Technology , KR Road ,V.V Puram ,Bangalore ,India.
Email ID- vsgiri.bit@gmail.com

ABSTRACT

Manufacturers are allocating more of their resources to achieve customer delight by providing a better quality product and additional features at the lowest possible cost not only to acquire the market for existing product but also to increase and secure the demand for future products.
With the increase in trend of travelling, the manufacturers need to meet and exceed the demands of their customers, the most vital demand of travelers are comfortable, reliable and multifunctional backpacks. Therefore, it becomes a necessity for manufacturers to control the cost and introduce new features to the knapsack.
The objective of this paper "Application of Value Analysis Techniques on a knapsack" is to perform a case study to improve and introduce new features in a rucksack through VA/VE methodology. The essence of value engineering technique involves the critical analysis of the functions of a product over all of its stages and producing a creative and innovative way to achieve the function at the lowest cost. Value analysis is an approach to improve the value of an item or process by understanding its constituent components and their associated costs. It then seeks to find improvements to the components by either reducing their cost or increasing the value of the functions. Upon application of VA methodology, a potential saving and multifunctionality is observed in the knapsack.

Keywords: Value Analysis, Functional Analysis, Decision Matrix, Evaluation Matrix, Multifunctionality, Knapsack, Backpack.

INTRODUCTION

Value Analysis is a function oriented, systematic team approach to improve the value of a product, system or process by the critical assessment of the product, system or service to achieve their essential functions at the lowest cost without compromising its performance, reliability, quality and safety.
A bag is a common tool in the form of a non-rigid container. A knapsack is a bag which in its simplest form can be carried on one's back and is secured with two straps that go over shoulders. knapsacks are often used by hikers, travellers and military to carry heavy loads and equipment.

CONCEPT OF VALUE

Value is the lowest cost to reliably provide the required function or service at a desired time and place within essential quality.
It can be described by the below equations:

- Value=$\frac{Function}{Cost}$

- To Increase Value:

$$\frac{F\uparrow}{C\downarrow} \quad \frac{F\uparrow}{C\downarrow} \quad \frac{F\rightarrow}{C\downarrow} \quad \frac{F\uparrow\uparrow}{C\uparrow}$$

$\uparrow$ *INCREASE* $\downarrow$ *DECREASE* $\rightarrow$ *MAINTAIN*

OBJECTIVES OF PAPER

1. To improve then functionality of the knapsack.
2. To make the knapsack ergonomic.
3. To reduce the cost of the knapsack.
4. To increase customer satisfaction.

1.INFORMATION PHASE

In this phase the relevant data and specifications of the rucksack is gathered and organized. Rucksacks are used to carry heavier loads and usually offload the largest part of the load onto padded hip belts, leaving the shoulder straps mainly for stabilizing the load. This improves the potential to carry heavy loads, as the hips are stronger than the shoulders, and increases agility and balance.

Specifications of Rucksack:

- Capacity: 50 liters. (General)
- Dimensions: 38cms x 7cms x 55cms.
- Materials: Cordura fabric, Nylon, Polyester, Canvas, Rip-Stop Nylon, PVC fabric.
- Target Customers: Hikers, Travelers and Military.

Case Study

A Knapsack is one of a widely used product by all kind of travelers, hikers, military and others. Seeing the current trend in travelling and a high demand of comfortable backpacks. It can be clearly understood that knapsack has a major potential of advancement and value increments through the application of Value Analysis techniques. Thus, it has been selected to perform a case study.

The Case Study is carried out in the following steps:

1. Function analysis worksheet is prepared for different parts of the product.
2. Functional analysis is done for each part.
3. Numerical evaluation sheet is prepared.
4. Creativity Worksheet is made.
5. Alternatives are selected through decision matrix.
6. Recommendations are made.
7. Conclusion.

REGULAR KNAPSACK

2.FUNCTIONAL PHASE

Function phase is one of the important phases of value analysis techniques which is used to detect precise areas where unnecessary costs are involved.

With this objective in this phase the functions of the parts of the Knapsack are divided into two categories

1. **Basic function**: The part that performs the main function required by the product.
2. **Secondary function**: A function that does not directly contribute to the main function but supports it instead.

Functional Analysis- Functional analysis of different parts of knapsack is explained in detail, shown in the table 1.

SL.NO	PART DESCRIPTION	Quantity	FUNCTION		CATEGORY	
			VERB	NOUN	Basic	Secondary
1	Sack	1	Store	Items	X	
2	Straps	2	Support	Load		X
3	Zip	6	Secure	Item		X
4	Cushion	1	Provide	Comfort		X
5	Buckle	2	Support	Load		X

Table 1: Function analysis- Identification of functions

Cost worth analysis - Cost worth analysis of the knapsack is shown in table2.

SL. NO	DESCRIPTION	FUNCTION	PRESENT COST (C)	WORTH (W)	VALUE GAP (C-W)	RANKING
1	Sack	Store Items	1700	350	1350	I
2	Straps	Support Load	250	50	200	II
3	Zip	Secure Item	40	5	35	V
4	Cushion	Provide Comfort	150	30	120	Ill
5	Buckle	Support Loads	100	20	80	IV

Table 2: Function cost worth analysis- Ranking alternative

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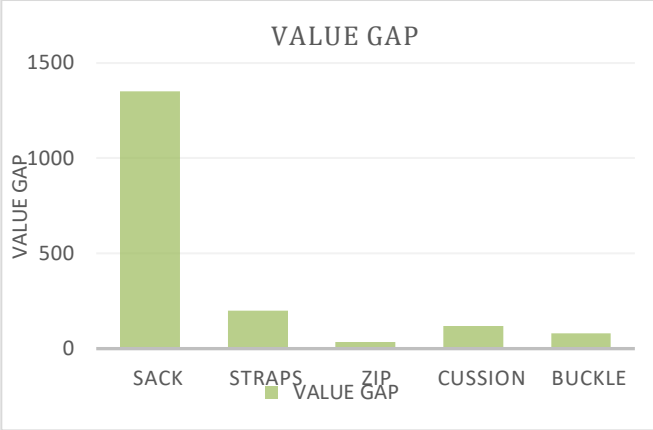

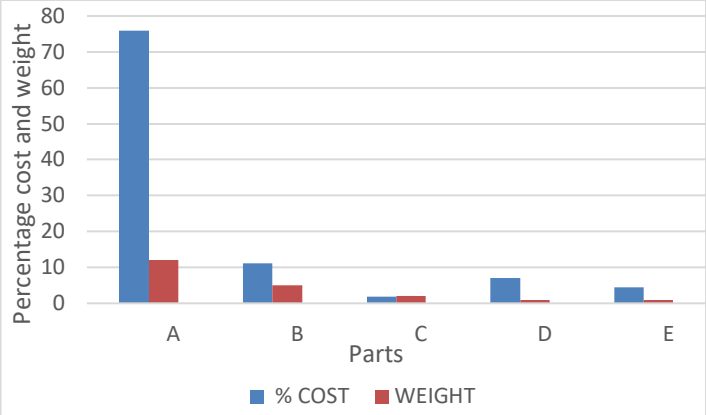

Graph 2: Parts vs Percentage cost and weight

The cost breakup for rucksack is shown in Table 3:

Key Letter	Part	Function	% Cost
A	Sack	Store Items	75.89
B	Straps	Support Load	11.16
C	Zip	Secure Items	1.78
D	Cushion	Provide Comfort	7.14
E	Buckle	Support Loads	4.46

Table 3: Cost Breakup

Numerical Evaluation Sheet

Minor Performance-1 Medium Performance- 2 Major Performance- 3

	B	C	D	E	Total
A	A3	A3	A3	A3	12
B	B1	B2	B2	5	
C	C1	C1	2		
D	D1	1			
E	1				

3.Creative Phase

The main aim of a creative phase is to find out what else maybe done in order to achieve the same function assuming cost as a constraint.

In this phase, team members used brainstorming technique to formulate new ideas for achieving the same functions which were drawn out through the discussion in functional phase. Through the brainstorming technique the following optimum alternatives were found:

1) Plastic Bag
2) Jute Bag
3) Canvas Bag
4) Leather Bag
5) Regular Rucksack Bag
6) Multifunctional Knapsack Bag (PROSACK)

4.Evaluation Phase

Sl No.	Ideas	State of Art 10: Off Shelf 1: New Technology	Cost of Development 10: No cost 1: High cost	Probability of Implementation 10: Excellent chance 1: No chance	Functionality 10; multi 1; single	Rating
1	Plastic Bag	10	8	3	1	22
2	Jute Bag	10	9	1	1	21
3	Canvas Bag	9	7	4	3	23
4	Leather Bag	9	6	5	4	24
5	Regular Rucksack Bag	9	3	8	6	26
6	Multifunctional Knapsack(Prosack)	7	3	10	10	30

Table 4: Evaluation of Ideas generated from Creative phase.

Ideas → / Parameters ↓	1	2	3	4	5	6
Durability	1	1	0	1	1	1
Maintenance	0	0	1	0	0	0
Ease of Use	0	0	0	0	0	1
Compactness	0	0	0	0	0	1
Weather resistance	0	0	0	0	1	1
Appearance	0	0	1	1	1	1
Total	1	1	2	2	3	5
%	16.66	16.66	33.33	33.33	50	83.33

1: YES 2:NO

Table 5: Evaluation of alternatives with respect to features.

5.Development phase

In this stage the team develops the selected ideas into alternatives and their advantages and disadvantages are listed and ranked based on which it is determined if the alternative should be implemented.

Parameters → / Alternative ↓	Ergonomic Rating	Weather resistance Rating	Cost	Total
Weightage →	9	8	7	
Pro Knapsack	4 / 36	3 / 24	4 / 28	88
Regular rucksack	3 / 27	3 / 24	3 / 21	72
Leather Bag	2 / 18	2 / 16	2 / 14	48
Canvas Bag	1 / 9	1 / 8	2 / 14	31

Table5: Evaluation Matrix

4	Excellent
3	Good
2	Fair
1	Poor

Sl.No	Ideas	Ranking	Advantages	Disadvantages
1.	Pro Knapsack	1	Multifunctional compact, Inbuilt features.	Careful handling of inbuilt accessories.
2.	Regular	2	Storage capacity ,ease of use.	Bulky Lack of accessories.

Table 6: Advantages and disadvantages of feasible ideas

6.Recommendation phase

From the evaluation matrix(Table 5) and the alternatives comparison(Table 6) of development phase it is observed that the alternative "**Multifunctional Rucksack**" is preferred over the existing and other proposed alternatives. The following table indicates the situation before and after the implementation of the proposed alternative.

Situation Before- Regular Rucksack	**Situation After**- Multifunctional Rucksack
Bulky	Compact
Inconvenient Handling	Hassle free handling
Uneconomical	Cost effective
Lack of accessories	Inbuilt Accessories (Sleeping Bag, Hydration Bladder, Pillow, Battery Pack)
	

Table 7: Before and After Comparison

Cost Breakup for the exsisting and proposed alternative is shown in the following tables:

Rucksack	**2500**
Sleeping Bag	**1300**
Pillow	**250**
Tent	**1500**
Water Bottle	**100**
Power Bank	**700**
Total Cost	**6350**

Table8: Cost Breakup for existing product with accessories.

Sack	**1500**
Sleeping Bag (Inbuilt)	**200**
Pillow(inbuilt)	**0**
Tent (Inbuilt)	**1000**
Hydration Bladder (Inbuilt)	**300**
Power Bank (inbuilt)	**450**
TOTAL COST (Pro - Knapsack)	**3450**

Table9: Cost Breakup for proposed alternative.

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7.Presentation Phase

In this phase the cost of exsisting rucksack and multifunctional rucksack is observed and the savings achieved through value anlysis methodology is calculated. The percentage saving and toatl saving is indicated in the following table:

Present Cost	**6350**
Proposal Cost	**3450**
Saving	**2900**
% Saving	**45.66%**

Table10: Savings achieved

The Proposed Alternative

8.Key Points on Implementation

- ✓ Return-on-Investment
- ✓ Inbuilt Accessories
- ✓ Lighter and Comfortable
- ✓ Increased Functions
- ✓ Cost effective and reduces high accessory cost

9.Conclusion

The Value Analysis techniques are generally well defined and well-understood at all levels in an industry. VA is recognized as an effective way to improve the performance of a product with reduction in cost and maintaining the quality. The quality of team (qualifications & experience) for brainstorming session is a key ingredient to the success of **The Value Analysis program**. It is more effective and influential on the performance, quality, and cost of a product when done relatively early in the production schedule.

The Value Analysis techniques are generally well defined and well-understood at all levels in the industry. VA is recognized as an effective way to improve the performance of a product with reduction in cost and maintaining the quality. The quality of team (qualifications & experience) for brainstorming session is a key ingredient to the success of the Value Analysis program. It is more effective and influential on the performance, quality, and cost of a product when done relatively early in the production schedule.

References

- Value Analysis of steam iron for cost optimisation
- Indian Value Engineering Society (1977-2017) – Survey of Forty Years and Selected Essays, Anil Mukhopadhyaya Techniques of Value Analysis and Engineering, 2nd Edition, Lawrence D Miles.
- https://diygearsupply.com/diy-guides/backpack/
- https://lifehacker.com/how-to-design-and-sew-a-backpack-1598587633
- Case Study on the Concept of Value analysis in Sheet Metal- IJERST
- 34th Invest International Conference Magazine.
- VA on Rucksack- A Case Study by Utkarsh Tiwari and Omprakash.P

Profit Optimization by Menu Engineering

PRADYOTH PRAKASH*[1], PRAJWAL HATWAR[2], SHOMIK GHOSH[3], Dr A P PARTHA[4]
Department of Industrial engineering and Management, Bangalore Institute of Technology
K R Road, V V Puram, Bangalore, Karnataka, India.- 560004 India
[1]pradyothprakash@gmail.com
[2]prajhathwar0403@gmail.com
[3]shomik.ghosh43@gmail.com
[4]appartha@gmail.com

***Abstract*—Menu Engineering can be described as a devised method for scientifically analyzing and segregating/bucketing different menu items to understand its impact on different factors which include – gross sales revenue, net profit realized, revenue due to increased popularity etcetera for different menu items in a restaurant firm. The main goal that menu engineering strives to achieve is to bring about optimization is cost, presentation, service and the overall functioning of the restaurant firm. The goal of this paper is to implement menu engineering methodology devised by Kasavana and Smith matrix model [1] on a multi- cuisine vegetarian restaurant named "MINT MASALA" located in Sadashivnagar, Bengaluru. Outcome is to design and present an optimized menu based on the findings of employing menu engineering methodology.**

***Index Terms*—Menu Engineering, optimization, Kasavana and Smith model, Gregg Rapp Stars, Dogs, Puzzles, Challenges, Workhorse, Plowhorse, Menu Engineering Matrix, Menu Engineering Metrics 2**

I. INTRODUCTION

Restaurants, a public venue for catering various cuisines, dates back to nearly 1700's. The first modern concept of a 'Restaurant' originated in Paris, France by Antoine Beauvilliers which consisted of a well-designed room, a set of people hired to cater to the needs of the guests and various cuisines to entertain and satisfy the guests. Even though the concept of serving guests with food was practiced from a much older time, the concept of fine dine began here and this flourished across the times to come. Currently, the restaurant industry is projected to reach 889 billion dollars around the world and the Indian market when narrowed down, has a industry valuation of approx. 75000 crores growing at 7% annually.[6]

II. TOPIC IN FOCUS: The Restaurant Industry

The food & beverage sector has seen leaps and bounds in trends and popularity around the world. Focusing on INDIA, the annual growth rate for the restaurant industry is placed at an average of 15 – 20 % [3]. The sheer size of the demography, the cultural diversities across India and the immense depth in the ethnicities are the sole reasons for the rise of multiple Indian cuisines across India.

With such tremendous growth in this sector lead to a set of challenges as well which pose as a blocker to this trend. Majority of the organized restaurants would be investing effort, time and money to face and eliminate majority of these challenges and for the unorganized restaurants they just learn to live with this. Some major challenges include-

1. FOOD COST INFLATION - The unfavorable seasonality changes, the change in world trade relations affecting the import/export, the unpredictable demand-to-supply ratio are the key points leading to instability in the food cost prices. With the advent of the pandemic, situation turned for the worse and impacted every sector of the society greatly with the food sector taking some massive blows. .[4]
2. DISTORTED MARKET – The Food service industry is highly fragmented into various sectors mainly due the popularity and the prevalent cultures across India. Each sectors have multiple competitors offering more or less the same assortment to the masses at competitive pricings and service. This creates a highly competitive environment and a business to succeed in this, it must outperform the others in multiple ways.[4]
3. OPERATIONAL INCONSISTENCIES – The majority constraints here include the lack of availability of skilled labors, instable logistics and cold-chain, outdated methods of operations, lack of implementation of various optimizations tools and services which helps with data analytics for problem solving.[4]
4. MENU – A menu is a crucial component for a restaurant. A menu needs to be crisp and must create an impression on the guests when they read them. The restaurant must take utmost care to devise its menu so as to leverage it for its advantage. It is a common practice in India to have a lot of items on the menu without inventing time and methods to understand what sells and what's profitable.

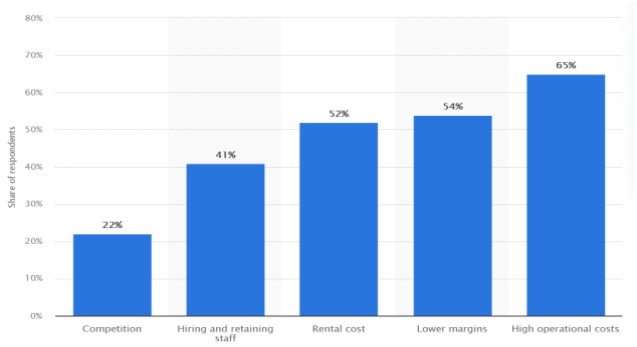


Fig.1 The effect of onset on the pandemic on the restaurant sector and what are the key contributing factors to the overall cost factor for a restaurant in India on an average note.[7]

We notice that out of all the factors, high operational costing adds up to be the major factor contributing to cost. It becomes crucial to address the operational cost and minimize it to the greatest extent possible. A major component accounting to the high operational cost includes the complexity of menus. A Menu's basic purpose is to represent what the restaurant has to offer to the guests. A menu needs to stand out, appeal to the guests and a smooth flow of information must be the primary goal of a menu. Hence, utilizing ME (Menu Engineering) to redesign the entire menu with the goal of cost optimization is the foremost step that needs to be implemented and practiced across both the unorganized and organized sectors of the food industry.

III. The effect of the COVID Pandemic

The onset of the COVID-19 pandemic immensely affected the restaurant industry. The multiple curfews, lockdowns, severe social distancing norms etcetera severely impacted both, the organized and unorganized sector of the restaurant industry. Nearly 40% of the total restaurants all over India have permanently closed shop due to the mounting losses. For the existing restaurants which managed to survive, its critical that they improvise and adapt to the new standards for catering to guests which includes increased importance to safety/ hygiene and social distancing practices as a standard practice that needs to be integrated into every operation. Hence, in order to bounce back from the current scenarios, its important for the restaurant to utilize menu analysis methods as a tool to increase the overall revenue turnovers so as to stabilize their foothold in the industry.

IV. MENU ANALYSIS MODELS

Menu analysis has long been practiced in our society. Basic approach of menu engineering model includes the use of historic data to understand the trend of the subject in focus. In Some models include-

- Minimum cost analysis – A simple and the oldest for of analysis, it involves finding the direct cost of each plate.
- Cost/Margin analysis – With direct food cost, the selling margin should also be considered. The items are categorized under those which have the maximum contribution with lower direct costs
- Menu engineering is by far the most recent/advanced method of studying menus. The items are fragmented into different bucket based one 4 criterions. This method of analysis goes in depth with a thorough analysis. This analysis model gives us a detailed categorization of products giving us insights on popularity, performance, profit margins etcetera.[8]

V. MENU ENGINEERING

The credit of formulating menu engineering is given to Michael Kasavana and Donald Smith.

The whole basic idea behind menu engineering includes finding out the popularity and profit realized factors for each menu item and the dividing factor for the segregation into categories would be 8% of the aggregate, which is represented as –

$$80\% * 1/n$$

Where n=number of competing items

Menu Engineering as a process can be described based on the below process –

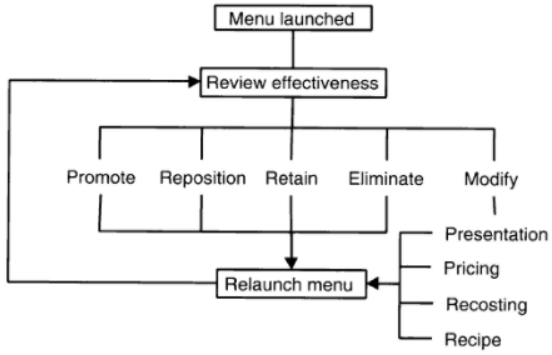


Fig 2 – Flow chart representing menu engineering methodology

Menu engineering methodology first begins with analyzing the current menu. *What is the number of items in each category? What are the competitors offering that we do not? How appealing is the menu to the guests?* Are some of the questions that need to answered. This boils down to one main reason, which items are sold in high volume with the best profit margins, and which do not. These can be plotted along and X axis (profit margins) to Y axis (volume sold). Based on this the items are bucketed into –

- STARS – Items which sold the most and the profit margins were significantly greater than the rest. There are the outperformers.
- WORKHORSES/PLOWHORSES – These items have high volumes of sales, but the profit margins made on these are comparatively low. These need to be worked on to make them your 'star' players.
- CHALLENGES/PUZZLES– These items are hard to sell. They have good profits but not popular among the common masses. The main goal is to somehow improve their popularity so that profits automatically start flowing in.
- DOGS/DUDS – These items need to be eliminated as they neither are popular nor do they bring in any profits to the business. Ideal strike these out of the menu or second case scenario, rework these items so that it proves to be a performer.

Based on which bucket these items fall into, those respective conclusions can be drawn and respective actionable must be performed for the category. These include-

1. STAR – These are your outperformers. They are the main attractions and are the 'popular cuisines' of your restaurant. Profit realized and the volume of sales recorded is very high. No actionable required for these dishes.
2. WORKHORSES/PLOWHORSES – These dishes have

great sales, i.e., the volume of sales recorded is high, but the profit margins realized on these are low. Actionable for the dishes falling into these categories are mainly to increase the profit from these items. This can be done by increase reducing the overall food cost price and expanding the profits gained.

3. CHALLENGES/PUZZLES – The dishes in this category have potential but aren't popular. The profits made from these are great, but these dishes do not sell in good volumes. The main goal here is to increase popularity and recognition for these food items so that the guests are subconsciously influenced to purchase these dishes.
4. DOGS/DUDS – These are the underperformers in your list. They neither are popular not do they bring in any profits. Action that needs to be taken against them – re-engineering the dishes to make them fall into the star category or eliminate them.

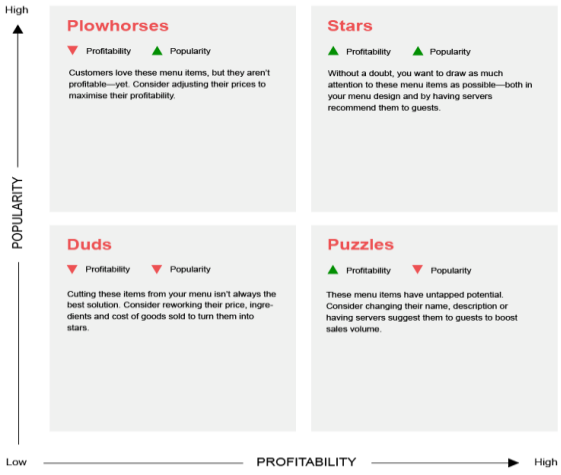


Fig 3 – The Four quadrants of menu engineering

VI. IMPLEMENTATION of ME leading to value addition

The core values being delivered by Menu Engineering includes the addition of value in the form of service. Gregg Rapp, a pioneer in the field of menu engineering, founded the site menuengineers.com which carried out many value-based services to the leading restaurant industry clients.

As an operational example, they successfully applied menu engineering on a local chain and increased profitability per guest by 4% on a quarterly basis and managed to increase 25 cents per item on the menu resulting annually profit increase by nearly $7500 roughly.[10]

Fig 4 – Greg Rapp, founded the site menuengineers.com

VII. Our Implementation of MENU ENGINEERING

As we realized how vital menu engineering can be in transforming the restaurant's sales and in boosting profitability, we found it necessary to deep dive into this discipline and experiment by ourselves to see how Indian menus can be transformed using menu engineering.

We approached the Mint Masala Restaurant (Sadashivanagar, Bangalore, Karnataka, India) and pitched in our idea of menu engineering. They were in line with the whole concept and were ready to co-ordinate and support us on our requirements to carry out the same. Bills of sample size of 10 days were collected to carry out the project. This provided us all the historic data needed to implement menu engineering methodology

Fig.5 – Sample Bills from Mint Masala

After the bills were collected from the restaurant it was time to harness the data collected and build a model to draw out insights. Once the aggregate data was ready and complied, the model was built on a Google spreadsheet where the standard metrics of menu engineering was used to categorize the items into stars, dogs, workhorses and challenges. Below is example of one of the categories for reference –

A	B	C	D	E	F	G	H	L	P	R	S
Menu Item Name APPETIZERS	Number Sold	Popularity %	Item Food Cost	Item Sell Price	Item Profit (E-D)	Total Cost (D*B)	Total Revenue (E*B)	Total Profit (H-G)	Profit Category	Popularity Category	Menu Item Class
VALKANICK MUSHROOM	4	1.9%	₹234.00	₹285.00	₹51.00	₹936.00	₹1,140.00	₹204.00	High	Low	Challenge
PANEER TIKKA	20	9.6%	₹234.00	₹285.00	₹51.00	₹4,680.00	₹5,700.00	₹1,020.00	High	High	Star
PANEER HARIYALI TIKKA	21	10.1%	₹226.00	₹275.00	₹49.00	₹4,746.00	₹5,775.00	₹1,029.00	Low	High	Workhorse
TANDOORI BABYCORN	21	10.1%	₹218.00	₹265.00	₹47.00	₹4,578.00	₹5,565.00	₹987.00	Low	High	Workhorse
THIL BABYCORN	19	9.1%	₹230.00	₹280.00	₹50.00	₹4,370.00	₹5,320.00	₹950.00	High	High	Star
PAPDI PANEER	4	1.9%	₹234.00	₹285.00	₹51.00	₹936.00	₹1,140.00	₹204.00	High	Low	Challenge
TANDOORI KUMBH LAJABDAR	4	1.9%	₹238.00	₹290.00	₹52.00	₹952.00	₹1,160.00	₹208.00	High	Low	Challenge
TIRANGA PANEER TIKKA	86	41.3%	₹230.00	₹280.00	₹50.00	₹19,780.00	₹24,080.00	₹4,300.00	High	High	Star
HARA BHARA KABAB	29	13.9%	₹218.00	₹265.00	₹47.00	₹6,322.00	₹7,685.00	₹1,363.00	Low	High	Workhorse

Fig.6 – Sample Calculations of a Category-Appetizers

After classification and bucketing items, insights were drawn based on number of stars, dogs, workhorses and challenges in each category of cuisine. Sales along different weekdays, Category wise sales contribution using the weighted average technique where the weights for amount and quantity sold was 2 & 1 respectively.

VIII. INSIGHTS FROM THE DATA – CONCLUSIONS DRAWN

Based on the methodologies of ME, Various insights could be developed regarding the aggregate data. The data post compilation could be seen from various angles thereby giving rise to multiple insights. Below includes some of the insights that we managed to populate based on our project implementation.

TABLE 1 - Category split of each quadrant

Category	Star	Challenge	Dog	Workhorse	Total Items
Soups & Salads	1	5	1	1	8
Quick bites	1	2	1	1	5
Tandoor Starter	3	3	0	3	9
Chinese Starter	2	4	4	1	11
Indian Main course	9	3	4	8	24
Indian Breads	3	6	1	4	14
Rice Delicacies	4	6	0	3	13
Beverages & Desserts	1	6	2	3	12
TOTAL	24	35	13	24	96

TABLE 2 - Revenue generated per day as recorded during experimental period

DATE	Order items	Amount	Weekday
4/10/2021	172	₹52,225	Sat
4/11/2021	200	₹62,430	Sun
4/12/2021	100	₹32,035	Mon
4/13/2021	101	₹32,150	Tue
4/14/2021	143	₹43,425	Wed
4/15/2021	114	₹37,710	Thu
4/16/2021	156	₹46,045	Fri
4/17/2021	180	₹48,830	Sat
4/18/2021	219	₹64,850	Sun
4/19/2021	98	₹23,105	Mon

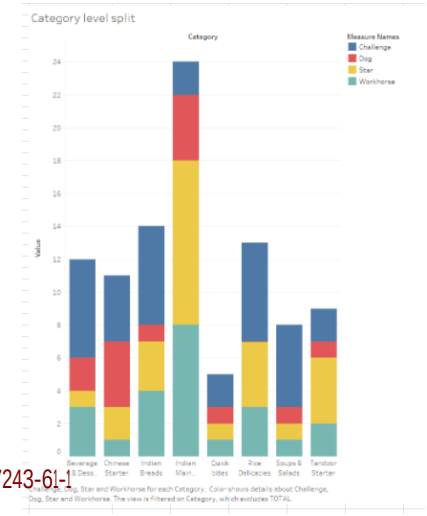
TABLE 3 - Quadrant wise sales generated– quantities sold under each category

Category wise Sales			
	# of items	Amount delivered by each category	Qty sold in each category
STAR	29	₹121,745.00	1061
WORKHORSE	20	₹68,555.00	936
CHALLENGE	33	₹52,480.00	463
DOG	14	₹22,165.00	148

TABLE 4 - Weighted contributions to sales per quadrant wise

	Weights		Contribution to sales
	2	1	
STAR	0.46	0.41	44%
WORKHORSE	0.26	0.36	29%
CHALLENGE	0.20	0.18	19%
DOG	0.08	0.06	7%

GRAPH 1 - A bar char for the category split



IX. ACTIONABLES BASED ON INSIGHTS

The insights gave us a clear picture as to what is the contribution of each category to the menu's sales & profits. Few actionable that we took after a detailed analysis are as follows:

Stars:

- We kept the stars unchanged as they satisfied both our constraints that are popularity and profitability. Not many changes or update were required for this cluster of items as their performance would be better irrespective of any changes.

Dogs:

- These are the redundant items that were removed from our final proposed menu as they did not contribute much in terms of profitability and were not popular among the customers.
- These items can be reintroduced in the future with a complete makeover in terms of look, taste and feel.

Workhorses:

- Workhorse being those set of items which are fast moving and highly popular will need no tweak to boost its popularity but requires some focus on increasing the profit margin.
- The portion size can be altered which will help cutting down the cost, at the same time not affecting the guest's psychology by using different cutlery than the regular big ones. Eg: Presentation of items play a critical role here. Using unique, attractive crookery to present dishes would divert the minds of the guest away from the slightly decreased portion sized.
- Affecting guest's psychology by making the price look low though the margin has been increased.

  Eg: Changing the selling price of an item to Rs.299 instead of Rs.300.

Challenges:

- These set of items are hard to sell as the popularity is low but the profitability is high. The key actionable here is to boost the popularity of the item.
- The recipes might require a bit of tweaking making it look more attractive and appealing to the guests.
- Upselling the items by educating the waiters to recommend the items in this category to increase the familiarity of these items.
- Wisely promoting these items thereby indirectly influencing the buying decisions of the majority of guests walking into the premise.
- Run exclusive campaigns and offers until the items gain popularity.
- Make these items salient by tagging it with symbols as best sellers.

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Revised Menu sample:

IMAGE 1 – Redesigned Chinese and Tandoor starters Menu Page

IMAGE 2 – Redesigned Indian Main Course page

X. Conclusion

By reading this paper the reader will gain knowledge on Menu Engineering and its principles on how Menu Engineering can transform the restaurant industry by making their business more profitable. Considering the current pandemic situation where many restaurants are being impacted badly, menu engineering can be a game changer and save restaurants from losses.

Future scope for this project would be to automate the billing ERP system with the model to obtain real time data so that the restaurants can monitor their menu health performance and make necessary changes.

Monitoring the menu health at the fingertips to increase profitability per guest at a very cheap investment is the *ultimate goal of this project*.

ACKNOWLEDGEMENT

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REFERENCES

- [1] *"Application of Kasavana& smith Menu Engineering Model to Menu of a ...."* http://www.i-scholar.in/index.php/jhar/article/view/38659.
- [2] *Prosper Montagné Prosper Montagné. "The New Larousse Gastronomique". Éditions Larousse. p. 97. Retrieved February 22, 2019.*
- [3] *https://theaims.ac.in/resources/rise-of-the-restaurant-industry-in-india.html*
- [4] *Issues and Challenges by Restaurant Industry*- NOVEMBER 19, 2013 - https://www.restaurantindia.in/article/Issues-and-Challenges-by-Restaurant-Industry.6121
- [5] *Menu Engineering: How to Increase Profits by 20%*,Apr 15, 2019 - https://restaurant.eatapp.co/blog/food-cost/menu-engineering
- [6] *Indian Restaurant Industry* - https://www.smergers.com/industry-watch/indian-restaurant-industry/
- [7] *Statista*- https://www.statista.com/statistics/1226932/india-challenges-due-to-covid-19-for-restaurants/
- [8] *Menu Analysis*- https://www.hospitalityupgrade.com/Hospitalityupgrade.com-0093-2016Redesign/media/hospitalityupgrade.com-0093/File_Articles/Sum02-BenchmarkingMenu-Kasavana.
- [9] *Menu development and analysis in UK restaurant chain*-https://www.jstor.org/stable/23743850?read-now=1&seq=8
- [10] *Menu Engineering*- https://www.menuengineers.com/

Production of Cotton Seed Oil Biodiesel and its usage in a C I engine with Methyl Ester and Al_2O_3 Additives

BASAVARAJ GANIGER*[1] and YUVARAJ B[2]
[1]Department of Mechanical Engineering, Sapthagiri College of Engineering Bangalore
basavarajganiger@sapthagiri.edu.in
[2]Department of Mechanical Engineering, Sri Venkataraju Institute of Technology Bangalore
yuvarajyuvi030@gmail.com

Abstract— **in this work, cotton seed crude oil was produced from the dried seeds collected from market in mechanical expeller. The free fatty acid (FFA) of cotton seed crude oil was found to 0.5076 then it was subjected to double stage transesterification process. The maximum yield of cotton seed biodiesel was found to 94.7% at optimized variables such as catalytic concentration, molar ratio and reaction time. In addition to pure (100%) biodiesel usage the neat diesel and Al_2O_3 nano particle additives were used to blend the biodiesel in different proportions. The properties of the blend made of 20% cotton seed biodiesel and 80% neat diesel and Al_2O_3 nanoparticles were found close to pure diesel properties. A single cylinder, four strokes diesel engine was tested at different loads by maintaining constant speed 1500 RPM with cotton seed biodiesel and its blends with neat diesel and Al_2O_3. It is observed that the brake specific fuel consumption (BSFC) was less with blend of 20% when compared with neat diesel.**

Keywords—**Cotton Seed, Biodiesel, Transesterification, Al_2O_3 BTE, BSFC & EGT.**

I. INTRODUCTION

The depletion of fossil fuel coupled with an increase in fuel prices has been encouraged the research for other substitutes such as biodiesel. A Biodiesel is an alkyl ester of fatty acids obtained from plants or animals by the transesterification of oils or fats with short chain alcohols such as methanol and ethanol. Biodiesel has numerous advantages over conventional diesel with respect to renewability, nontoxicity and biodegradability. Biodiesel contains lesser amount of sulphur compounds and a higher flash point (>1300C), lower CO2 and hydrocarbon emissions and also considerably lesser particulate matter.

Biodiesel in addition to reduction of dependency on foreign export crude oil, it has a helpful social impact by encouraging farmers to regenerate vegetable oil crops and earn an income. The source for biodiesel production is chosen according to the availability in each geographical area. Oils from different sources have different fatty acid compositions. The fatty acids are different in relation to the chain length, degree of unsaturation or presence of other chemical functions. There is a growing interest about high-yielding non-edible tropical crops such as Jatropha curcas, pongamia pinnata etc. It is found that an algae have oil productivities more than any land-based crops and can meet global demand for transport fuels.

Catalysts that are used in the biodiesel making process may either be base, acid, or enzyme materials. Sodium hydroxide, potassium hydroxide and sodium methoxide are the most commonly used catalysts. Base catalyzed reactions are relatively fast, with residence times from about 5 minutes to about 1 hour, depending on temperature, concentration, mixing and alcohol: triglyceride ratio. Acid catalysts include sulfuric and phosphoric acids. Compared to base catalysts, acid catalysts reactions have been found to be too slow for industrial processing.

In recent years high demands of petro-diesel as a result of hugely raise in cars. Higher worth of diesel and environmental problems, the biodiesel as an alternate fuel is extremely concern subject. The biodiesel is that the demand of country like Asian nation as an alternate fuel as a result of the price of Diesel is increasing day by day attributable to increasing the worth of oil. The economy of the country additionally depends on diesel price variation. The utilization of vegetable oils for cookery purpose produces principally the matter of their disposal. The correct utilization of those oils is an advantageous for biodiesel production. The vegetable oil alkyl radical organic compound might be one in all the nice sources for production of biodiesel that is an alternate fuel of diesel. In Asian nation particularly within the region of geographic region, high yield of cottonseeds takes place.

Energy acquired from non-renewable energy sources is greatly fundamental for the standard of life, prosperity and social advancement of the people in like manner with respect to financial process. Energy demand is generated through speed industrial enterprise and modernization. Demand in energy can be satisfied by paying earned financial gain to the majority of the developed countries. The surroundings can be affected catastrophically due to the utilization of fossil fuels which also affects a disaster in energy. Burning engines can be affected due to decrease in environmental pollution and non-renewable energy sources. Low-emission various fuels like fermentation alcohol, methyl ester and compressed fossil fuel (CNG) for diesel engines should be developed crucially [7].

Cheap oils can be used for C I engine if there is any shortage of oils. Biodiesel is popular because of its inexhaustibility; bring down fumes discharges, and biodegradability. Methyl ester can be manufactured by transesterification method. Comparing diesel oil with biodiesel the later is harmless, perishable and renewable. Compared to diesel oil biodiesel has higher cetane number and it is also free from foul smell [8].

II.METHODOLOGY

2.1 Biodiesel production

The process of biodiesel production is having several steps. They are shown in the Flow Chart. From the flow chart shown in figure 4.1, it is very easy to understand the processes behind biodiesel production. Here it explains the biodiesel production of cotton seed oil by alkali base transesterification process. And the detailed production process will be explained briefly step by steps below. In that the pretreated oils are carrying a transesterification process under the suitable alcohol generally methanol and catalyst at given temperature and reaction time.after the process taking reaction solution in separating flask

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to separate the glycerol formation and soap residuals. Based on their densities biodiesel, glycerol and residuals are separated in separating flask few hours later. And separate the glycerol and soap residual from the biodiesel and then carrying water wash to the biodiesel and then heat the biodiesel up to above 100oC then we are getting final product of biodiesel. Based on the oil yield the seed should be selected. The oil can be extracted from mechanical expeller if the seed contains 25% yield and if the yield is less than 25 % then solvent extraction method should be adopted.

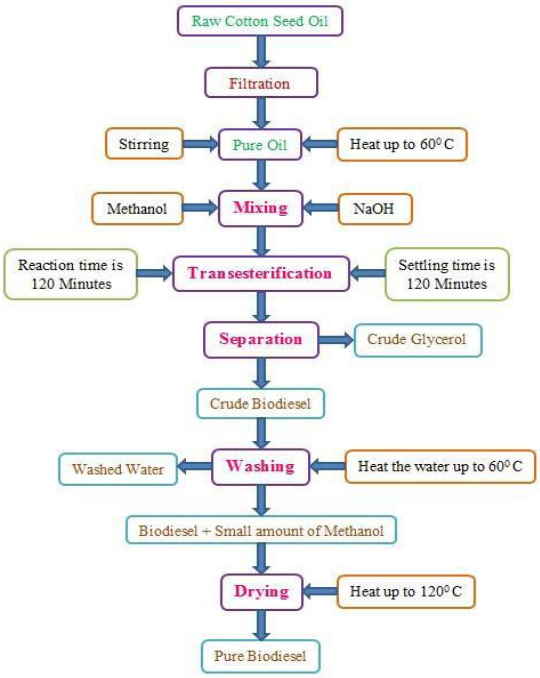

Figure 1 Production of Biodiesel from Cotton Seed Oil

50 kg Gossypium Hirsutum L. seeds are collected at a cost of 20 Rupees per kg. As the oil yield is between 25% and 30 % mechanical expeller extraction is used and got an oil yield of 25% means, 250 ml of oil per kg of Gossypium Hirsutum L. seeds and the seed cake and crude oil obtained.
In the production process it is necessary to filter the crude oil to remove some impurities. Since the FFA content is 0.5076% which is larger than 1%. Alkali acid transesterification is adopted.

The transesterification process was carried out by pouring one liter filtered pure oil into the 3 necked flasks and Fixed a condenser to the flask and mixing 5.5 grams of NaOH and 250 ml of methanol solution was prepared. The oil was heated up to 600°C using heater and simultaneously stirred uniformly using magnetic stirrer maintaining the speed around 600 rpm. The solution prepared by using NaOH and methanol poured into the beaker. The mixture was stirred for 120 minutes to achieve proper reaction. After achieving reaction pour the mixture into a separate flask.

Allowed the mixture to settle for120 minutes. After the settling time two phases formed in the separation flask; Methyl ester and Glycerol. Then remove the glycerol from the separation flask. Pour 1 liter of heated water (600°C) into the separation flask which contains methyl ester for water wash. To separate soap content repeat the water wash process for around 4 to 5 times. Later take out the methyl ester from the separation flask to open measuring glass and warm it utilizing electrical radiator for around 1200°C after that the rest of the methanol will get vaporized and got away from the methyl ester at long last filtered biodiesel stay in the flask. At that point measure the amount of biodiesel which is the transformation yield. Out of 1 liter of cotton seed oil 947 ml of biodiesel can be obtained.

The weigh balance, Pensky-Martin apparatus and Redwood Viscometer employed to notice the density, flash point, kinematic viscosity, free fatty acid content and calorific value of Crude cotton seed oil. Table shows the physical properties of waste cotton seed crude oil.

2.2 Preparation of Biodiesel Blends with and without addition of Aluminum Oxide Nano Particle

Biodiesel extracted from the cotton seed oil is blended with diesel and aluminum oxide nano particles added. The B20 (20% cotton seed oil and 80% neat diesel) taken in a beaker and 30 ppm Al_2O_3 (0.03 g per 100 ml) injected into B20 blend. To completely dissolve the additive present in the blend, the solution placed on magnetic stirrer at constant speed and maintain the temperature of 400°C, for 1 hour. Better results can be obtained by stirring the biodiesel solution with additives for two hours in the ultrasonicator. This Biodiesel blend with Al_2O_3 can be used directly for combustion in diesel engine without any modification.

The aluminum oxide nano particles added in distinctive proportion of 30 ppm and 60 ppm for B20 (20% methyl ester and 80% neat diesel), B40 (40% methyl ester and 60% neat diesel) and B60 (60% methyl ester and 40% neat diesel).

III. RESULTS AND DISCUSSIONS

3.1 Effect of Al_2O_3 additive on Cotton seed oil properties

The crude cotton seed oil has higher flash point compared to Biodiesel. The flashpoint of pure biodiesel is more compared to petro diesel but it is possible to reach the flash point of diesel by adding the aluminum oxide to biodiesel. From the Figure 2, it can be observed that as biodiesel percentage increases in the blends there is an increase in flash point. Among blends B-20 A-60 has flash point nearer to diesel (67°C). From figure 3, it can be observed that among blends B-20A-60 has fire point nearer to diesel (700°C). From Figure 3, it can be observed that among blends B-20A-60 has viscosity nearer to diesel (3.45 cSt). From Figure 4, it can be observed that when Al_2O_3 is added to biodiesel-diesel blends, increase in density was observed with the increase in Al2O3 percentage since the density of Al_2O_3 is more than biodiesel and conventional diesel. Cotton seeed biodiesel has maximum density of 900 kg/m3 and Al_2O_3 has a maximum density of 3700 kg/m3. Among blends B-20A-60 has density close to Diesel (833.8 kg/m3). From Figure 5, it can be observed that as biodiesel percentage in blends increases there is a decrease in calorific value. It is because of the reason that biodiesel is an oxygenated fuel; its calorific value is less compared to diesel. Diesel has a highest calorific value of 44800 kJ/kg and among blends B-20A-60 has calorific value nearer to diesel (44795.52 kJ/kg).

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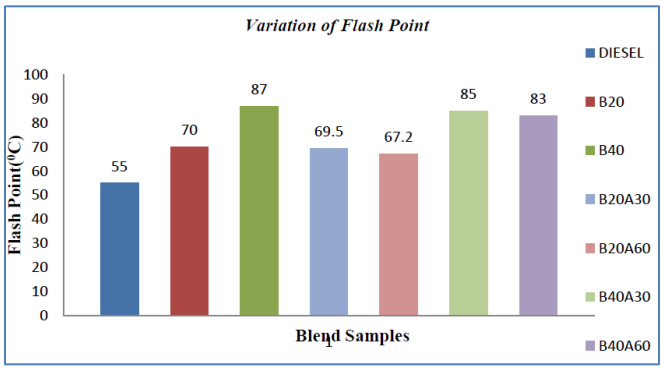


Figure 2 Flash Point variations in Diesel and Biodiesel blends.

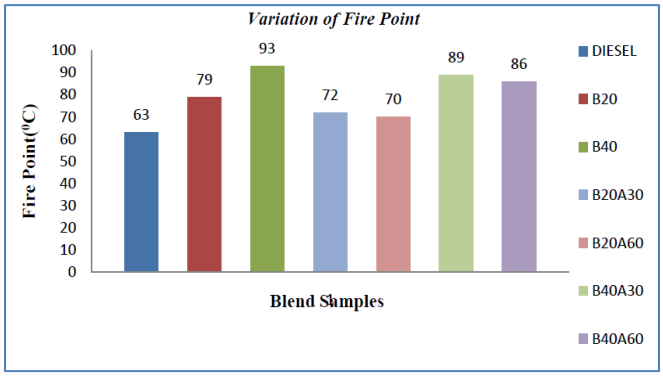


Figure 3 Fire Point variations in Diesel and Biodiesel blends.

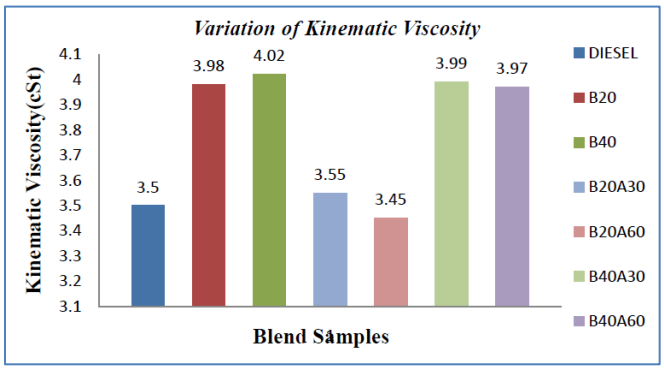


Figure 3 Viscosity variations in Diesel and Biodiesel blends

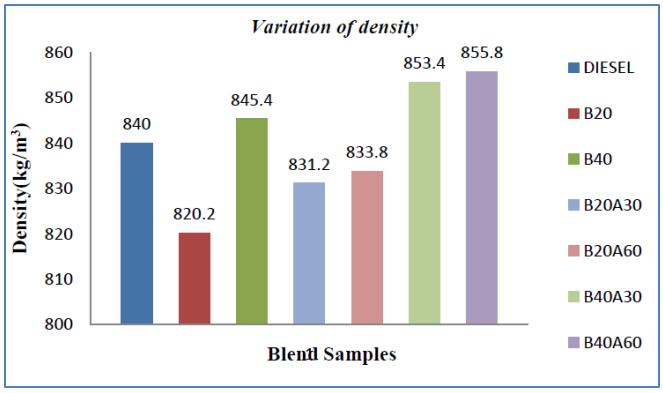


Figure 4 Density variations in Diesel and Biodiesel blends.

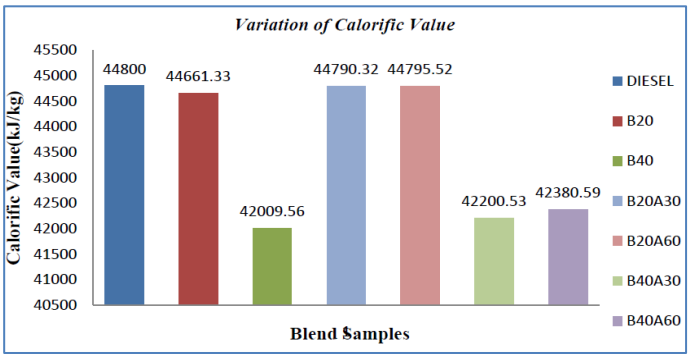


Figure 4 Calorific Value variations in Diesel and Biodiesel blends.

3.2 Effect of Al_2O_3 additive on Engine Performances

Brake Thermal Efficiency (BTE) is a parameter that shows the amount of heat energy of fuel converted into mechanical energy. The brake thermal efficiency with additives blends without and with Al_2O_3 nano particles addition have been presented in Figure 6 and Figure 7. It can be observed that addition of Al_2O_3 to biodiesel-diesel blends resulted in increase of BTE. Highest BTE was noticed for the blend B-40A-60 (48.18%). Even though the calorific value of blend B-40 A-60 is less than diesel highest BTE was achieved because of better mixing of fuel and air and good combustion.

Brake specific fuel consumption (BSFC) is another parameter that measures the amount of heat energy of fuel converted into mechanical energy. The brake specific fuel consumption with additives blends without and with Al_2O_3 nano particles addition have been presented in Figure 8 and Figure 9. The Al_2O_3 blended fuels have lower BSFC than blends without Al_2O_3 because at high temperatures it mixes properly with air, resulting in good combustion process, producing higher power output and reduced BSFC. Least BSFC of 0.0029 kg/kW-min recorded for the blend B-20A-60.

Exhaust gas temperature (EGT) of a fuel depends on properties like Kinematic Viscosity, Calorific Value and Cetane number. The Exhaust gas temperature with additives blends without and with Al_2O_3 nano particles addition have been presented in Figure 10 and Figure 11. From the Figure 10, it can be observed that, with the increase in load EGT also increases since more fuel is injected to maintain same power output. As biodiesel percentage increases in the biodiesel-diesel blends, EGT also increases compared to diesel fuel. It is because biodiesel has more viscosity than diesel which results in poor atomization, because of which proper mixing of fuel and air will not happen and hence incomplete combustion occurs during combustion process and increases EGT. It can be observed from Figure 11 that addition of Al2O3 to biodiesel-diesel blends increases the EGT compared to diesel, Lower the cetane number longer will be the ignition delay which again causes incomplete combustion of fuel during combustion process and Increases the EGT. Highest EGT of 312oCwas observed for the blend B40A60 at high load condition.

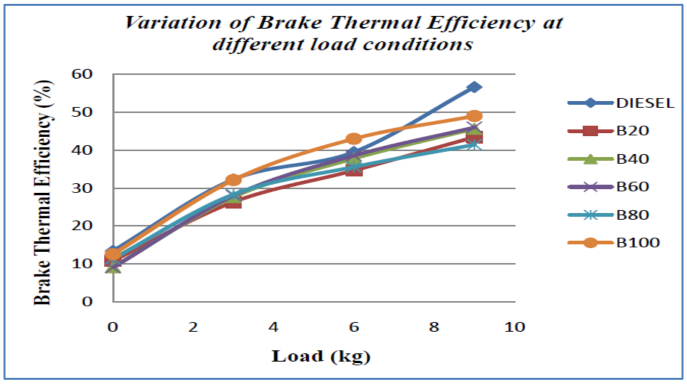


Figure 6 Variation of BTE without Additives at different Load.

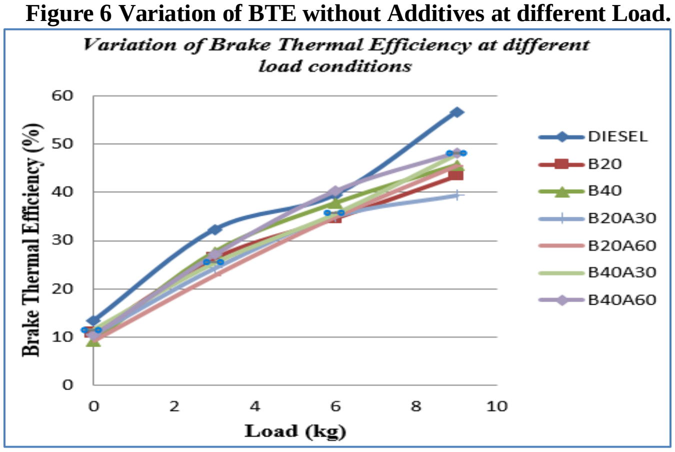


Figure 7 Variation of BTE with Additives at different Load.

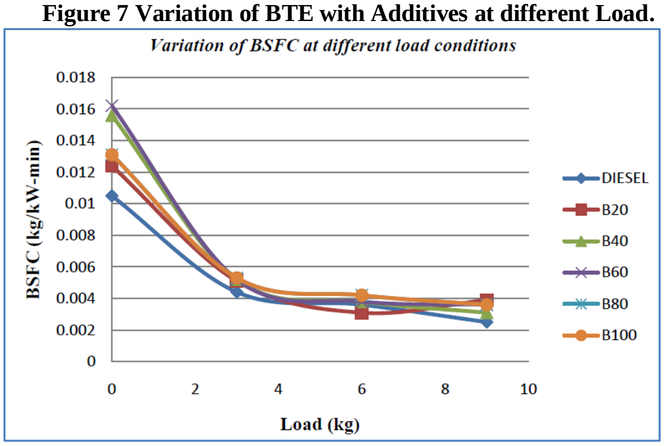


Figure 9 Variation of BSFC without Additives at different Load.

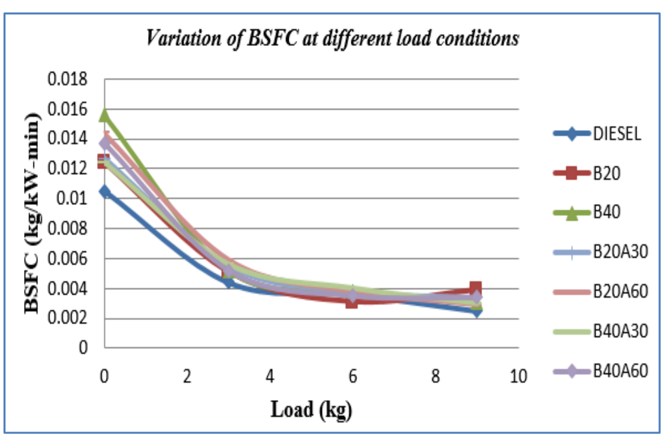


Figure 9 Variation of BSFC with Additives at different Load.

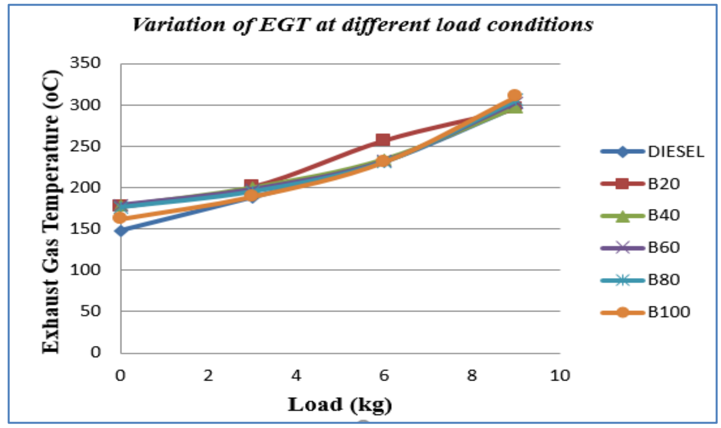


Figure 11 Variations EGT of at Different Load without Additives.

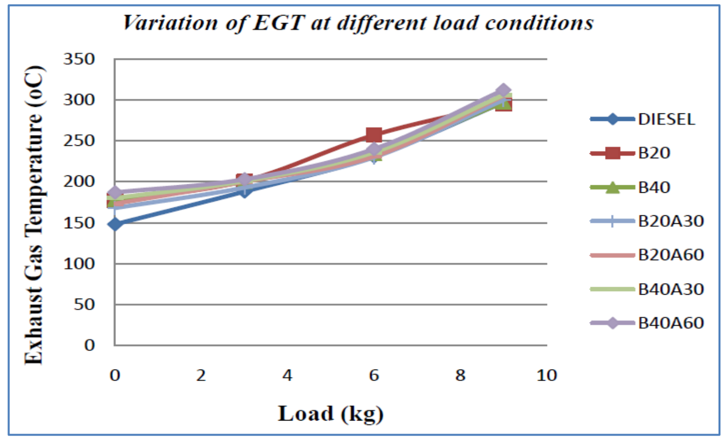


Figure 11 Variations EGT of at Different Load with Additives.

IV. CONCLUSIONS

- The wellspring of cotton seed is accessible in wide range and subsequently it is reasoned that the cost of biodiesel generation is not costly. The overall conclusion of this research incorporates simple and basic system utilized for the biodiesel generation, RSM procedure contributed towards finding the parameters to expand the biodiesel yield and furthermore investigation of fuel properties and performance study on diesel engine with biodiesel and its blend alongside added Al_2O_3 nano particles.

- When diesel and biodiesel mixes utilized for diesel engine, an increase of load showed reduction of brake specific fuel consumption. B-40 blend usage resulted in 0.0031 kg/kW-min BSFC than every other mix at most extreme load and it is more prominent than that with neat diesel fuel which is 0.0025 kg/kW-min. When Al_2O_3 is employed into blends and compared with B20 and B40 fuel, there is BSFC 0.0029 kg/kW-min in B-20A-60 and BSFC 0.003 kg/kW-min B-40A-30.

- Brake thermal efficiency is increased with an increase in load. B-20 fuel usage showed brake thermal efficiency (10.83%), B100 has 49.04% and neat diesel diesel 56.64%. When Al_2O_3 is employed into blends and compared with B20 and B40 fuel, there is BTE 45.43% in B-20A-60 and BTE 48.18% in B-40A-30.

REFERENCES

[1] M. Leenus et al. A comparative analysis of different methods to improve the performance of cotton seed oil fuelled diesel engine, Fuel, Elsevier limited 2012, volume 102 pp 372-378.

[2] Y. Alhassan, et al. Co-solvents transesterification of cotton seed oil into biodiesel: Effects of reaction conditions on quality of fatty acids methyl esters: energy conversion management, Elsevier limited, 2014, Volume 84, pp 640-648.

[3] Hong Li et al. Biofuel potential production from cottonseed oil: A comparison of non-catalytic and catalytic pyrolysis on fixed-fluidized bed reactor, Fuel Processing Technology, Elsevier limited, 2009, Volume 90, pp 1087-1092.

[4] Md. Nurun Nabi et al. Biodiesel from cotton seed oil and its result on engine performance and exhaust emissions: Applied Thermal Engineering, Elsevier limited, 2009,Volume 29, pp 2265-2270.

[5] Dominic O O et al. Optimization of biodiesel production from refined cotton seed oil and its characterization: Egyptian Journal of Petroleum, Elsevier limited, 2016,pp 1-8.

[6] D. Royon, et al. Enzymatic production of biodiesel from cotton seed oil using t-butanol as a solvent: Bio resource Technology, Elsevier limited 2007,Volume 98, pp 648-653.

[7] R. Senthilraja, V. Sivakumar et al.. "Performance, emission and combustion characteristics of a dual fuel engine with Diesel-Ethanol - Cotton seed oil Methyl ester blends and Compressed Natural Gas (CNG) as fuel: Energy", Elsevier limited,(2016),volume 112.PP 899-907.

[8] Pankaj S. Shelke, et al. Global Colloquium in Recent Advancement and Effectual Researches in Engineering, Science and Technology 2016: Procedia Technology, Elsevier limited,(2016),Volume 25, pp 1049-1055.

[9] Duple Sinha, et al. Biodiesel Production from Waste cotton seed oil using low cost Catalyst: Engine performance and emission characteristics: perspectives in science, Elsevier limited 2016, pp 1-8.

[10] Basavaraj M.S et al. Performance, emission &combustion characteristics of a semi-adiabatic diesel engine using cotton seed & neem kernel oil: Alexandria Engineering Journal, Elsevier limited 2016, pp 1-8.

Review Paper on Implementation of 5S in Different Industries

Satish Kumar Y.D[1] Thejas M.S[2] Dr.R.G.Deshpande[3]

([1]Assistant Professor, Department of Mechanical Engineering
Sapthagiri College of Engineering, Karnataka, India)
([2]Assistant Professor, Department of Mechanical Engineering
Sapthagiri College of Engineering, Karnataka, India)
([3]Associate Professor, Department of Mechanical Engineering
Sapthagiri College of Engineering, Karnataka, India)

ABSTRACT
This paper explains the methods and techniques of 5 S uses to increase the efficiency of all processes in the company. Special emphasis will be given to the implementation of 5S system and elimination of losses in the company. It can be observed that introducing the 5S rules bring the great changes in the company, for example: process improvement by cost reduction, increasing of effectiveness and efficiency in the processes, maintenance and improvement of the machine efficiency, safety, security, quality and reduction of the industry pollution, proceedings according to decisions. The 5S methodology permits to analyze the processes running on the workplace and establishment of 5Ssustaining well organized, clean, high effective and high quality workplace. Research clearly show, that very essential is training of workers about the 5S rules. Essential thing is to divide activities on some main steps and to maintain the continuous improvement. This method can be used in all companies. Its result is the effective organization of the workplace.

I. INTRODUCTION

5S is a technique originated from Japan and it was first developed by Hiroyuki Hirano. It include Five words Seiri, Seiton, Seiso, Seiketsu and Shitsuke, which means Sort, Set in order, Shine, Standardize and Sustain respectively. The 5S technique is included within Kaizen which means Change for the better. It allows the enhancement of efficiency and productivity. The 5S technique is a structured program to systematically achieve total organization cleanliness, and standardization in the workplace. The benefit of 5S technique is improvement in productivity, quality, health and safety [1, 6, 7, 12]. Term of 5S given as:
SEIR(sort): the removal of all unwanted, unnecessary, and unrelated materials in the workplace.

SEITON (set in order): This step consists of putting everything in an assigned place so that it can be accessed or retrieved quickly as well as returned in that same place quickly.

SEISO (shine/clean): It is consists of cleaning up the workplace and giving it a 'shine'.

SEIKETSU (standardize): It defining the standards by which personnel must measure and maintain cleanliness.

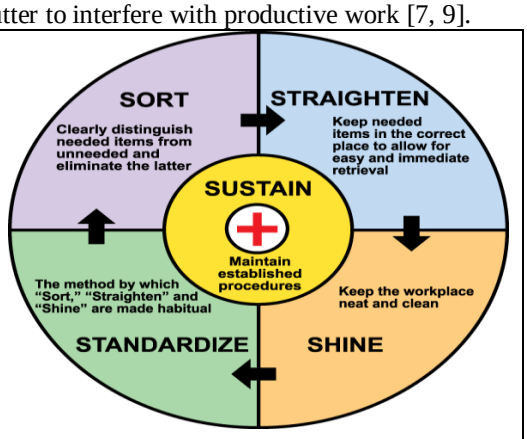
SHITSUKE (sustain): This last step is about 'Discipline.' It maintain orderliness and to practice the first 4 S as a way of life the introduction of the paper should explain the nature of the problem, previous work, purpose, and the contribution of the paper. The contents of each section may be provided to

II. 5S METHODOLOGY

SEIRI

The necessary and unnecessary materials understand easily about the paper.

Available in the workplace should be sorted and classified [2]. Through the suitable sorting it can be identified the materials, tools, equipment and necessary information for realization the tasks [6, 13]. Sort by the tools that are frequently used are placed within easy reach, and those that are not used often [8]. This leads to fewer hazards and less clutter to interfere with productive work [7, 9].



Methodology of 5 S

The 1S rules proceedings [6]:

A) On the first stage one should answer to so-calledControl Questions:

- Are unnecessary things causing the mess in the workplace?
- Are unnecessary remainders of materials thrown anywhere in the workplace?
- Do tools or remainders of materials to production lie on the floor (in the workplace)?
- Are all necessary things sorted, classified, described and possess the own place?
- Are all measuring tools properly classified and kept?

On the basis of the answer to the above questions it is possible the estimation of the workplace in terms of the 1S rule so littering the workplace. If on any question answer is yes, it should execute sorting of things, which are in the workplace.

B) On the second stage one should execute the review of all things which are in the workplace and group them according to the definite system. According to carried out sorting it should execute the elimination from the workplace the things, which were found "unnecessary".

C) To permanent usage the 1S rule is so-called the Programmed of the Red Label. It means giving the red label to things, which operator will recognize as useless.

BENEFIT:

- process improvement by costs" reduction,
- stock decreasing,
- better usage of the working area,
- prevention of losing tools,

SEITON

This means preparing the necessary items neatly and systematically so that they can easily be taken and returned in the original place after use [1,14]. Forming a regular workplace, avoiding time loss while searching for material and so improving the efficiency are the main objectives [2, 10]. The goal is to minimize the number of moves that a worker has to perform during operation [8]. Especially important is visualization of the workplace e.g. painting the floor helps to identify the places of storage of each material or transport ways, drawing out the shapes of tools makes possible the quick putting aside them on the constant places, coloring labels permit to identify the material, spare parts or documents[6]. Tools, equipment, and materials must be systematically arranged for the easiest and the most efficient access. There must be a place for everything, and everything must be in its place [7, 9].

Implementing the 2S rule [7]:

It should execute the segregation of things and mark the places of their storing. Used things should always be divided on these, which should be:

- In close access (1st degree sphere),
- Accessible (2nd degree sphere),
- In the range of hand (3rd degree sphere).

To the estimation of the workplace in terms of the 2S rule that is setting in order things serve the following Control Questions:

- Is position (location) of the main passages and places of storing clearly marked?
- Are tools segregated on these to regular uses and on specialist tools?
- Are all transport palettes stored on the proper heights?
- Is anything kept in the area of devices against the fire?
- Has the floor any irregularity, cracks or causes other difficulties for the operator's movement?

Things used occasionally and seldom should be on the workplace but outside the direct using sphere. Their distance and location from the place of work should depend on the frequency of using these materials or tools. Places of storage should be marked in the manner making possible their quick identification. It can be used colored lines, signs or tool boards.

BENEFIT:

- process improvement (increasing of effectiveness and efficiency),
- shortening of the time of seeking necessary things,
- safety improvement

SEISO

In order to realize effective tasks, it is essential to create a clean and regular working and living environment. This is because dust, dirt and wastes are the source of untidiness, indiscipline, inefficiency, faulty production and work accidents [2, 10]. Cleaning should become a daily activity. Work place should be cleaned at regular intervals [9]. To help identify dust lean factory floors, often painted in bright colors and enhance the light sources within the plant [8].

Implementing the 3S rule [9]:

The first step of realization the 3S rule is renovation the workplace. It is assumed that "the first cleaning" forces the exact checking of usage two of the previous rules. The usage of the 3S rule relies on everyday keeping in faultless cleanness the workplace. It is executed by the operator of the given workplace. To the estimation of the workplace in terms of the 3S rule, that is cleaning the workplace, serve the following Control Questions:

- Are the oil's stains, dust or remains of metal found around the position, machine, on the floor?
- Is machine clean?
- Are lines, pipes etc. clean, will they demand repairing?
- Are pipe outlets of oils not clogged by some dirt?

- Are sources of light clean?

BENEFITS:

- increasing of machines‟ efficiency,
- maintenance the cleanness of devices,
- efficiency,
- keep the clean workplace, easy to check,
- quick informing about damages (potential sources of damages),
- Improvement of the work environment, elimination of the accidents‟ reasons.

SEIKETSU

To establish standards of the best practice in the workplace and to ensure that the standards are compiled and to undertaking that the workplace is clean and tidy at all times [1]. The necessary systems are formed in order to maintain the continuance of these good practices at the workplace. Worked out and implemented standards in the form of procedures and instructions permit to keep the order on the workplaces. Standards should be very communicative, clear and easy to understand [6, 10]. Basic housekeeping standards apply everywhere in the facility. Everyone knows exactly what the responsibilities are. Housekeeping duties are part of regular work routines [7]. There is a need after some period to choose the best ways to practice sort, set in order and cleaning and abide by them [8].

To implementing 4 S rules (seiketsu) [1]:

To maintain high standard of housekeeping

- is attention given to keep workplace neat and clean?
- is workplace tidy but not completely clean?

BENEFITS:

- safety increasing and reduction of the industry pollution,
- working out the procedures defining the course of processes

SHITSUKE

Train employees disciplined for practicing 5S system continuously so that the habits and culture within the organization [1,14]. The task here is undertaken by the leader directors. The directors should explain the importance of 5S to the personnel through various trainings and the knowledge of the personnel about 5S should be kept updated through the 5S boards to be formed at the workplace [2]. To maintaining the standards and keeping the facility in safe and efficient order day after day, year after year [7].

It is also important to understand the need of executing the routine inspections of usage the 5S rule. This inspection is executed by helping of so-called Check List and created on its basis the radar graph of the 5S, which serves to estimation of the workplace. The inspection of realization of the 5S rule is executed once a month by chosen team implementing the 5S rule – the control team [3].

BENEFITS:

- increasing of the awareness and morale,
- decreasing of mistakes quantity resulting from the inattention,
- proceedings according to decisions,
- Improvement of the internal communication processes,
- Improvement of the inter-human relations.

III. ADVANTAGES OF 5S IMPLEMENTATION

The successful implementation and execution of the 5S principles in various organizations results several advantages as mentioned following.

1. 5S concept is very simple and easily understood by everyone because this only requires knowledge of the conventional discipline and high commitment. This practice can be implemented at all levels.
2. 5S will foster teamwork, discipline and will increase the sense of responsibility and compassion for company.
3. 5S will create clean, productive work environments and secure the delivery system towards a world-class.
4. On-going commitment from management and involvement are the cornerstone of all citizens for the successful implementation of 5S practices.
5. 5S is an on-going need to maintain excellent service delivery performance.
6. Assessment of Internal Audit will normally move the organization to continually repair the quality and effectiveness of services delivered to customers. Activities are planned and on-going audit to help people to be prepared to face the real 5S audits by the MPC to obtain and maintain certification of 5S.

IV. REVIEWS OF PAPER:

Shahryar Sorooshian *etal.*(2012) They have experienced of implementing a 5S program and paper involves presentation of a real case study, specifically the influence of 5S on some basic work environment problems and the compensation power on the choice of implementation of 5S. This paper is simply representation of basic information with all pros and cons about the concept of 5S. [1]

Derya Sevim Korkut *etal.* (2009) This study involves 5S system for ensuring order and discipline in the companies and ensuring the supervision of both simple and even the smallest details, has been reviewed in full details and they have been taken under the content of the research through selecting

the assembly department as pilot department for 5S activities which is applied at a yacht manufacturing company. 5S activities have been conducted during 28 weeks in the assembly department of the survey subject company. The obtained results are evaluated and it has been observed that the company came to a point better than the initial status. The clearly seen of the weekly results hang on 5S acknowledgment boards within the company by all personnel played an efficient role and involvement in the process. 5S approach is not a study covering a certain period of time rather it is a method defending the requirement of the standardization and continuation of all improvements need to be perform. [2]

J. Michalska *etal.* (2007) In this paper 5S implementation results in increasing of an efficiency, safety and reduction of the industry pollution. The proceedings to research clearly show that training of workers about the 5S rules is very essential. The important task is to divide activities on some main steps and to maintain the continuous improvement. It is also important to understand the need of executing the routine inspections of usage the 5S rule. This inspection is executed by helping of so-called check list and created on its basis the radar graph of the 5S, which serves to estimation of the workplace. [3]

Arash Ghodrati *etal.* (2013) This paper is aimed to determine performance factors and characteristics in industrial organizations and identifying the effectiveness of 5S implementation on organizational performance as well. Surveying method is used and data collection is carried out by distributing questionnaire among five target organizations which have implemented 5S techniques. The target organizations are chosen from different industries and diverse field of work. The results of this research obtained from a comparative measurement of organizational performance before and after 5S implementation. The results show that 5S is an effective tool for improvement of organizational performance, regardless of organization type, size, its production or its service. Consequently, 5S techniques would strongly support the objectives of organization to achieve continuous improvement and higher performance, identifying effectiveness of 5S implementation on the organization performance, has been achieved by using a comparative measurement between performance of organization before and after 5S implementation assisted by SPSS and Excel software. Finally it is concluded that 5S has positive effect on overall performance and could improve the quality, efficiency and productivity of industrial organizations. [4]

Jose H. Ablanedo-Rosas *etal.* (2010) In this paper results of an empirical study applied to some Mexican organizations with the aim of understanding their implementation experience, empirical relationships, and ongoing challenges associated with the 5S practice are elaborated. The 5S practice is used as the basis for advanced quality and continuous improvement philosophies and the organization measures the benefits from 5S implementation such as quality improvement. The 5S practice is worthwhile for production and service organizations and is universal to all organizations. The big challenge is how to incorporate the 5S practice in everyone's (employees) life. [5]

Prof. S. B. Khedkar *etal.* (2012) This research is dealt with the implementation of 5S methodology in the S. P. Plastic Industry MIDC, Hingna Road, Nagpur 16. 5S implementation impacts the instructors and workman of industry that work within the selected place. By following the 5S methodology, this research effort shows significant improvements to safety, productivity, efficiency, morale and housekeeping. The research documents improvements by using before and after pictures. [6]

Ravinder Kumar Panchal *etal.* (2012) This paper focus on the methodology adopted in 5S and implementation of the same in the production industry. The 5S rules bring the great changes in the company, for example: process improvement by costs‟ reduction, increasing of effectiveness and efficiency in the processes, maintenance and improvement of the machines‟ efficiency, safety increasing and reduction of the industry pollution and waste. [7]

Marko Milosevic *etall* (2013) This paper explain the methods and techniques of lean concept which uses to increase the efficiency of all processes in the company. Also show the results of the level of implementation this method in international and domestic production companies. It can conclude that large companies pay much attention to "lean" concept, both because productivity, and the satisfaction of their employees. [8]

Harsha Lingareddy *etal.* (2013) This paper involves the study and change in the work place of a manufacturing industry to implementation of 5S. This strategy helps in minimizing the time of manufacturing and also increases the area of work place. The solution found by 5S approach solely minimizes several kinds of wastes in the production process and which finally helps in the development of the organization. An Inspection process has been executed on the basis of 5S check lists and the results analyzed to confirm great changes like increasing efficiency in production and quality, improves safety. [9]

P. M. Rojasra *etal.* (2012) This paper explain the implementation of 5S methodology in the Krishna Plastic Company, Udhyognagar, Amreli, Gujarat. Out of the available various lean

manufacturing techniques, 5S offers good potential for required improvement. Ten week study is carried out in the company. The results after the 5S implementations states that production system efficiency is improved from 67% to 88.8% in the successive week. [10]

Mohammad Rasouli Dizaji *etal.* (2013) This paper includes research conducted at Tabriz- IDEM company in the Iran. For gathering required data, they have used three kinds of questionnaires that each one investigates the related area. The result shows that the company has successful actions in employing and implementation of 5S, Ergonomics and executing TPM and also their relations are meaningful. [11]

R.T. Salunkhe *etal.* (2011) In this paper, the objective of spare part management is to ensure the availability of spares for maintenance in minimum time with the help of different management techniques like 5s system, Kanban system and different Kaizens. The 5s system helps to understand the actual condition of spares in store department. It also helps to manage the spare parts effectively giving satisfactory results. The result shows that the improvement in reduction of searching time and also control the cost of inventory significantly accomplished through 5s, Kanban and kaizen systems. The searching time is reduced from 10 - 15 min. to 6 - 8 min. [12]

Gheorghe Dulhai *etal.* (2008) This paper presents a continuous improvement strategy, process-oriented and aiming to improve manufacturing at auto car exhaust. The improvement of auto car exhausts quality, using the "5S" rules, is accomplished at the initiative of the inferior levels of the organization coordinated and helped by the superior management. The efficient implementation of the „5S" strategy leads to a subsequent improvement of the exhaust's quality. [13]

Kaushik Kumar *etal.* (2012) In this paper, the steps undertaken for the implementation of the 5S emphasizing on the benefits to the organization. The successful implementation of 5S requires that everyone understand why it is being used and what the expected results are, as the removal of familiar (although unneeded) items and the reorganization of processes can be extremely unsettling. [14]

V. REVIEW REMARKS

The recommendation to implement 5S

1. To make the 5S practices more influential the top management are required to fully support this activity all through the company. In order to make the top management aware of the effectiveness of the 5S, they have to be shown the performance of product quality of this approach.
2. The organization should institute a system of benchmarking with other companies which are successful and make reference on a regular basis with the member of the Quality Team which will provide assistance to the companies in terms of further comprehending its vision and mission.
3. The involvement of all employees in the all departments in the program 5S. All staff should understand the five good reasons 5S program should be practiced at the workplace as it will result in a clean workplace with higher productivity, having a high quality, reducing cost, to ensure timely delivery and consequently, it is a safe workplace.

VI. CONCLUSION

The study these papers demonstrates the efficient implementation of 5S technique leads to subsequent improvement in productivity of the manufacturing company. The 5S improves environmental performance and thus relate primarily in reduction of wastes in manufacturing. It promotes neatness in storage of raw material and finished products. The 5S implementation leads to the improvement of the organization in many ways for instance. The implementation of the 5S system of rules leads to the following effects regarding the improvement in quality:

- Visible results within a short period of time (2-3 weeks),
- Workers get used to order and discipline,
- Labeling draws attention to change that is about to occur,
- Reduction of physical effort, less accidents during the production process,
- Increase of the workers" professional training, better organization of activities.

VII. ACKNOWLEDGEMENT

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REFERENCES

[1] Shahryar Sorooshian, Meysam Salimi, Shanthi Bavani, Hasti Aminattaheri, *Experience of 5S Implementation, Journal of Applied Sciences Research, 8(7), 2012, 3855-3859.*

[2] DeryaSevimKorkut, NevzatCakıcıer, E.SedaErdinler, GökselUlay and

AhmetMuhlisDogan, *5S activities and its application at a sample company, African Journal of Biotechnology Vol. 8 (8), 20 April, 2009, 1720-1728.*

[3] J. Michalska, D. Szewieczek, *The 5S methodology as a tool for improving the organisation, Journal of Achievements in Materials and Manufacturing Engineering, Volume 24(2), October 2007, 211-214.*

[4] ArashGhodrati, NorzimaZulkifli, *The Impact of 5S Implementation on Industrial Organizations' Performance, International Journal of Business and Management Invention, vol.2(3), 2013, 43-49.*

[5] Jose H. Ablanedo-Rosas, Bahram Alidaee, Juan Carlos Moreno and Javier Urbina *Quality improvement supported by the 5S, an empirical case study of Mexican organisations, International Journal of Production Research, Vol. 48 (23), 1 December 2010, 7063–7087.*

[6] Prof. S. B. Khedkar, Prof. R. D. Thakre, Prof. Y. V. Mahantare, Mr. Ravi Gondne, *Studyof Implementing 5S Techniques in Plastic Moulding , International Journal of Modern Engineering Research, Vol.2 (5), Sep.-Oct. 2012, 3653-3656.*

[7] Ravinder Kumar Panchal, *Improving the organization through 5S methodology, Proceedings of the National Conference on Trends and Advances in Mechanical Engineering, YMCA University of Science & Technology, Faridabad, Haryana, Oct 19-20, 2012.*

[8] Marko Milosevic , Ivan Macuzic , Petar Todorovic , Marko Djapan , Evanthia Giagloglou , jordje Vuckovic, *Implementation of 5S system as a factor for improving the quality management, 7th International Quality Conference, Center for Quality, Faculty of Engineering, University of Kragujevac May 24-2013.*

[9] HarshaLingareddy, G.Sahitya Reddy, K.Jagadeshwar, *5S as a tool and strategy for improving the work place, International Journal of Advanced Engineering Technology, Vol.4(2),April-June, 2013, 28-30.*

[10] P. M. Rojasra, M. N. Qureshi, *Performance Improvement through 5S in Small Scale Industry: A case study, International Journal of Modern Engineering Research (IJMER) . Vol.3 (3) May - June 2013, 1654-1660.*

[11] Mohammad RasouliDizaji, Reza Rostamzadeh, SaudahSofian and Kamal Rahmani, *Relation of 5S principles and Human Factors Engineering(Ergonomics) in Possibility of TPM Implementation, 2011 International Conference on Sociality and Economics Development IPEDR vol.10, 2011 © (2011) IACSIT Press, Singapore.*

[12] R.T. Salunkhe, G.S. Kamble, Prasad Malage, *Inventory Control and Spare Part Management through 5S, KANBAN and Kaizen at ABC Industry, Journal of Mechanical and Civil Engineering (IOSR-JMCE), 43-47. www.iosrjournals.org*

[13] Gheorghe DULHAI, *The 5S strategy for continuous improvement of the manufacturing process in autocar exhaust, Journal of Management & Marketing, Vol. 3(4), 2008, 115-120.*

[14] Kaushik Kumar, SanjeevKuma, *Step for implementation of 5S, Volume 2(6), June 2012, 402-416.*

Structural Design and Analysis of Calibration Device for Seismic Sensor for Lunar Application

Thejas.M.S*[1], Satish Kumar Y.D[2], R.G.Deshpande[3], Mohan.A.E[4]

Department of Mechanical Engineering, Sapthagiri College of engineering
#14/5 Chikkasandra, Hesaraghatta main road, Bangalore- 57 India
[1]thejasms@sapthagiri.edu.in
[2]satishkumaryd@sapthagiri.edu.in
[3]deshpande@sapthagiri.edu.in
[4]mohan@sapthagiri.edu.in

Abstract: ***A seismic sensor is an instrument to measure the ground motion when it is shaken by a perturbation. This motion is dynamic and the seismic sensor or seismometer also has to give a dynamic physical variable related to this motion. These sensors are widely used in orbit to gather useful information. In this regard, the present work aims to design, analyse, fabricate and calibrate the Seismometer and its calibrating devices.. The Seismometer design will be based on the seismic waves generated due to earthquakes and volcanic eruptions. The Calibration of this Seismometer is performed using a Shaft that is fixed at one end on the rotor table. The other end of the shaft is free and hence acts as a Cantilever. The Seismometer is placed at the free end of the shaft and is subjected to rotations in equal angular intervals (0 to 90 degree). Also the Seismometer will be placed in a thermal chamber and is tested at various temperatures between -45 C to +85 C. The results/deflections will be recorded in arc seconds. The Seismometer will be programmed according to the results obtained during the calibration. Seismometers are instruments that measure motions of the ground, including those of seismic waves generated by earthquakes, and volcanic eruptions and other seismic resources. Records of seismic waves allow seismologists to map the interior of the Earth, and locate and measure the size of these different sources.A simple seismometer that is sensitive to up-down motions of the earth can be understood by visualizing a weight hanging on a spring. The spring and weight are suspended from a frame that moves along with the earth‟s surface. As the earth moves, the relative motion between the weight and the earth provides a measure of the vertical ground motion. If a recording system is installed, such as a rotating drum attached to the frame, and a pen attached to the mass, this relative motion between the weight and earth can be recorded to produce a history of ground motion, called a seismogram.***

Keywords – Seismic Sensors, Lunar applications

I. INTRODUCTION

A seismic sensor is an instrument to measure the ground motion when it is shaken by a perturbation. This motion is dynamic and the seismic sensor or seismometer also has to give a dynamic physical variable related to this motion. A seismic sensor functions as a velocity sensor or an accelerometer that senses the ground vibration of the earth, which is widely used in the field of earthquake monitoring, resource exploration, and ocean bottom observation.

Several seismic experiments have been deployed on the Moon by the astronauts during the Apollo missions. These experiments provide a valuable resource of information.

In this context to explore more possibilities to collect data present work aims to design and analyse Seismic Sensor for Lunar Application. The Seismometer design will be based on the seismic waves generated due to moon quakes and volcanic eruptions on the lunar surface.

The quest to understand the seismic activity of the moon and also unravel the structure Apollo missions by NASA, USA have deployed both short and long period seismometers during 11, 12, 14, 15 and 16. A total of 12,000 moon quakes have been recorded by the lunar seismometers which were deployed during the Apollo missions. The quakes of focal depths are located within the crust and extend up to 900 km deep into the mantle. The interesting fact is the moon quakes are classified into four types with the shallow crustal moon quakes having the maximum magnitude recorded till date. The rock and regolith samples have provided valuable information in advancing our understanding about the moon. However, the internal structure of the moon is still rudimentary at the best. There are several questions still remain unanswered such as the composition and size of the moon‟s core, the crustal thickness, and several other question related to the evolution of the moon. Further, several attempts are underway to understand the sensitivity and noise requirements for a seismometer in the expected Lunar environment to be 10 times better than the Apollo Mission Long Period seismometers.

The French and the Japanese are the latest to plan for the installation of the Very Broad Band seismometers developed by the French and the short period sensors by the Japanese on the moon during the Selene 2 mission.

A considerable amount of research work has been carried out over the past few decades and an extensive body of literature is available. Following are the literature review on which the present work is based.

R. Yamada: This study reports the design and development of a “penetrator seismometer system for lunar seismic event observation”. The penetrator seismometer system (PSS) consists of two short-period sensor components, a two-axis gimbal mechanism for orientation, and measurement

electronics. To carry out seismic observations on the Moon using the penetrator, the seismometer system has to function properly in a lunar environment after a hard landing (impact acceleration of about 8000 G), and requires a signal-to- noise ratio to detect lunar seismic events. We evaluated whether the PSS could satisfactorily observe seismic events on the Moon by investigating the frequency response, noise level, and response to ground motion of our instrument in a simulated lunar environment after a simulated impact test. Our results indicate that the newly developed seismometer system can function properly after impact and is sensitive enough to detect seismic events on the Moon. Using this PSS, new seismic data from the Moon can be obtained during future lunar missions, mathematical equivalents. For most applications the result must be available as parameters of a mathematical formula, not as raw data; so determining parameters by fitting a theoretical curve of known shape to the data is usually part of the procedure. Peter Bormann: Featuring six Degrees of Freedom (DOF), the Hexapod motion platform is suitable for earthquake simulation, flight simulation and vibration. Bundled with QUARC, powerful rapid control prototyping software, the Hexapod is a reliable and easy to use test bed for advanced research. Its powerful features offer unmatched value and provide industrial-grade performance for research in vibration isolation, motion platforms, rehabilitation, low frequency sensing capability are conducted. A seismic foundation with best possible vibration isolation properties assisted with mathematical modelling of the noise will be used to evaluate the noise equivalent acceleration of the sensor.

Erhard Wielandt: Calibrating a seismograph means measuring (and sometimes adjusting) its transfer properties and expressing them as a complex frequency response or one of its immersive arcade games and structural dynamics

Thomas Forbriger: The instrument is designed to pick up acceleration input to the sensor. The instrument was calibrated adopting the guidelines for characterizing inertial grade accelerometers. However, additional tests to prove the low-g

II. DESIGN OF CALIBERARTING DEVICE

The instrument proposed here is designed to pick up acceleration input to the sensor. The instrument will be calibrated adopting the guidelines for characterizing inertial grade accelerometers.

The major tests will be:

- Tumble test with high accuracy rotation table to obtain the linearity Low-g
- Low-frequency shaker table to derive the dynamic response of the instrument
- Low noise platform for evaluate the noise equivalent acceleration.

A seismic foundation with best possible vibration isolation properties assisted with mathematical modeling of the noise will be used to evaluate the noise equivalent acceleration of the sensor.

Electrical and mechanical calibration:

The calibration of a seismograph establishes knowledge of the relationship between its input (the ground motion) and its output (an electric signal), and is a prerequisite for a reconstruction of the ground motion. Since precisely known ground motions are difficult to generate, one makes use of the equivalence between ground accelerations and external forces on the seismic mass, and calibrates seismometers with an electromagnetic force generated in a calibration coil. If the factor of proportionality between the current in the coil and the equivalent ground acceleration is known, then the calibration is a purely electrical measurement. Otherwise, the missing parameter - either the transducer constant of the calibration coil, or the responsivity of the sensor itself - must be determined from a mechanical experiment in which the seismometer is subject to a known mechanical motion or a tilt. This is called an absolute calibration. Since it is difficult to generate precise mechanical calibration signals over a large bandwidth, one does not normally attempt to determine the complete transfer function in this way. The present section is mainly concerned with the electrical calibration although the same methods may also be used for the mechanical calibration on a shake table.

General conditions:

Calibration experiments are disturbed by seismic noise and tilt and should therefore be carried out in a basement room. However, the large operating range of modern seismometers permits a calibration with relatively large signal amplitudes, making background noise less of a problem than one might expect. Thermal drift is more serious because it interferes with the long-period response of broadband seismometers. For a calibration at long periods, seismometers must be protected from draft and allowed sufficient time to reach thermal equilibrium. Visible and digital recording in parallel is recommended. Recorders themselves must be absolutely calibrated before they can serve to calibrate seismometers. The input impedance of recorders as well as the source impedance of sensors should be measured so that a correction can be applied for the loss of signal in the source impedance.

Calibration of geophones:

Some simple electrodynamics seismometers (geophones) have no calibration coil. The calibration current must then be sent through the signal coil. There it produces an ohmic voltage in addition to the output signal generated by the motion of the mass. The undesired voltage can be compensated in a bridge circuit (Willmore, 1959); the bridge is zeroed with the seismic mass locked or at a stop. When the calibration current and the output voltage are digitally recorded, it is more convenient to use only a half

bridge and to compensate the ohmic voltage numerically. The program has provisions to do this automatically.

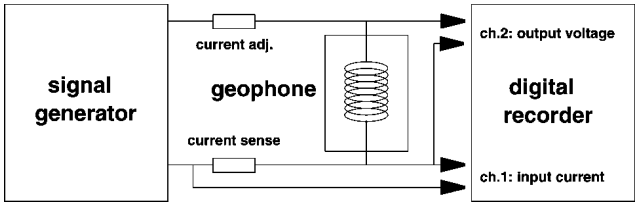

Fig:1 Half-bridge circuit for calibrating electromagnetic seismometers

Calibration with sine waves:
With a sinusoidal input, the output of a linear system is also sinusoidal, and the ratio of the two signal amplitudes is the absolute value of the transfer function. An experiment with sine waves therefore permits an immediate check of the transfer function, without any a prior knowledge of its mathematical form and without waveform modelling. This is often the first step in the identification of an unknown system. A computer program would however be required for deriving a parametric representation of the response from the measured values. A calibration with arbitrary signals, as described later, is more straightforward for this purpose.

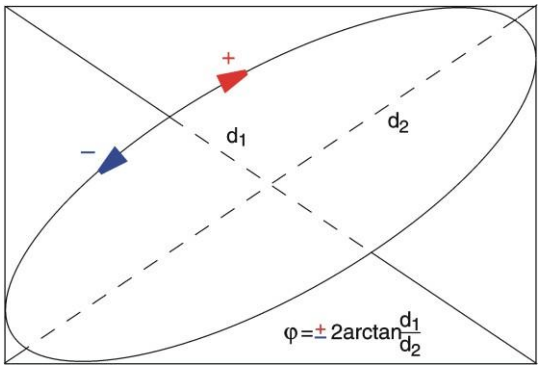

Fig:2 Measuring the phase between two sine-waves with a Lissajous ellipse.

Calibration with arbitrary signals:
In most cases, the purpose of calibration is to obtain the parameters of an analytic representation of the transfer function. Assuming that its mathematical form is known, the task is to determine its parameters from an experiment in which both the input and the output signals are known. Since only a signal that has been digitally recorded is known with some accuracy, both the input and the output signal should be recorded with a digital recorder. As compared to other methods where a predetermined input signal is used and only the output signal is recorded, recording both signals has the additional advantage of eliminating the transfer function of the recorder from the analysis.

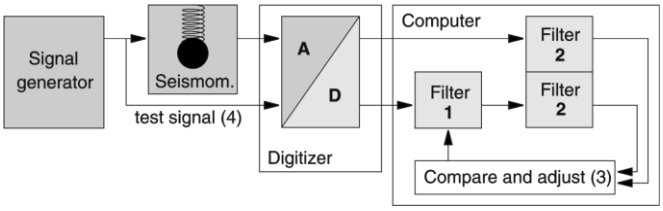

Fig:3 Block diagram of the CALEX procedure. Storage and retrieval of the data are omitted from the figure.

Specific Methods of Mechanical Calibration

Calibration on a Shake Table:
Using a shake table is the most direct way of obtaining an absolute calibration. In practice, however, precision is usually poor outside a frequency band roughly from 0.5 to 5 Hz. At higher frequencies, a shake table loaded with a broadband seismometer may develop parasitic resonances, and inertial forces may cause undesired motions of the table. At low frequencies, the maximum displacement and thus the signal-to-noise ratio may be insufficient, and the motion may be non-uniform due to friction or roughness in the bearings. Still worse, most shake tables do not produce a purely translational motion but also some tilt. This has two undesired side-effects: the angular acceleration may be sensed by the seismometer, and gravity may be coupled into the seismic signal. Tilt can be catastrophic for the horizontal components at long periods since the error increases with the square of the signal period. One might think that a tilt of 10 radian per mm of linear motion should not matter; however, at a period of 30 s, such a tilt will induce seismic signals twice as large as those originating from the linear motion. At a period of 1 s, the effect of the same tilt would be negligible. Long- period measurements on a shake table, if possible at all, require extreme care.

Although all calibration methods mentioned in the previous section are applicable on a shake table, the preferred method would be to record both the motion of the table (as measured with a displacement transducer) and the output signal of the seismometer, and to analyse these signals with suitable software. Depending on the definition of active and passive parameters, one might determine only the absolute gain (responsivity, generator constant) or any number of additional parameters of the frequency response. Recent versions of software's permit the elimination of tilt effects from a shake-table calibration, under the assumption that the tilt is proportional to the displacement.

Calibration by Step Wise Motion:
The movable tables of machine tools like lathes and milling machines, and of mechanical balances, can replace a shake table for the absolute calibration of seismometers. Moreover, a portable "step table" for seismometer calibration is now commercially available. The idea is to place the seismometer on the table, let it come to equilibrium, then move the table by a known amount and let it rest again. The apparent motion

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of the frame can then be calculated by inverse filtration of the output signal and compared with the known mechanical displacement. Since the calculation involves triple integrations, offset and drift must be carefully removed from the seismic trace. The main contribution to drift in the apparent horizontal frame velocity comes from tilt associated with the motion of the table. With the method subsequently described, it is possible to separate the contributions of displacement and tilt from each other so that the displacement can be reconstructed with good accuracy. This method of calibration is most convenient because it uses only normal workshop equipment. The inherent precision of machine tools and the use of relatively large motions eliminate the problem of measuring small mechanical displacements. A program named DISPCAL is available for the evaluation.

The precision of the method depends on avoiding two main sources of error:

- Restoring ground displacement from the seismic signal (a process of inverse filtration) is uncritical for broadband seismometers but requires a precise knowledge of the transfer function for short-period seismometers. Instruments with unstable parameters (such as electromagnetic seismometers) must be electrically calibrated while installed on the test table. However, once the response is known, the restitution of absolute ground motion is no problem even for a geophone with a free period of 0.1 s.

- The effect of tilt can only be removed from the displacement signal when the motion is sudden and short. The tilt is unknown during the motion, and is integrated twice in the calculation of the displacement. So the longer the interval of motion, the larger the effect the unknown tilt will be on the displacement signal. Practically, the motion may last about one second on a manually-operated machine tool, and about a quarter-second on a mechanical balance. It may be repeated at intervals of a few seconds.

Static tilt before and after the motion produces linear trends in the velocity which are easily removed. The effect of tilt during the motion, however, can be removed only approximately by interpolating the trends before and after the motion. The trace is de-convolved with the velocity transfer function of the seismometer. The trace is piecewise detrended so that it is close to zero in the motion-free intervals. Interpolated trends are removed from the interval of motion The displacement steps are measured and compared to the actual motion.

In principle, a single step-like displacement is all that is needed. However, the experiment takes so little time that it is convenient to produce a dozen or more equal steps, average the results, and do some error statistics. On a milling machine or lathe, it is recommended to install a mechanical device that stops the motion after each full turn of the spindle. On a balance, the table is repeatedly moved from stop to stop. The displacement may be measured with a micrometer dial or determined from the motion of the beam.

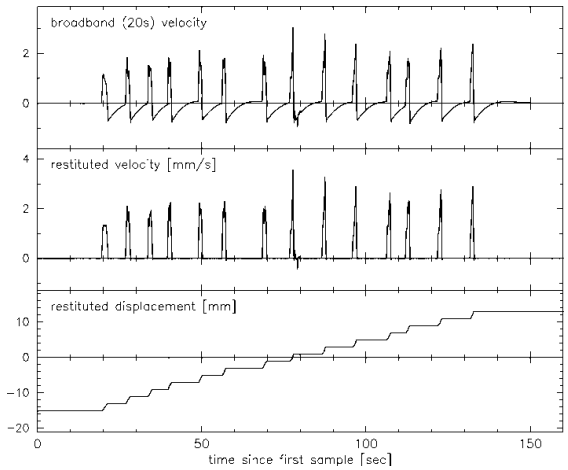

Fig:4 Absolute mechanical calibration of an STS1-BB (20s) seismometer on the table of a milling machine.

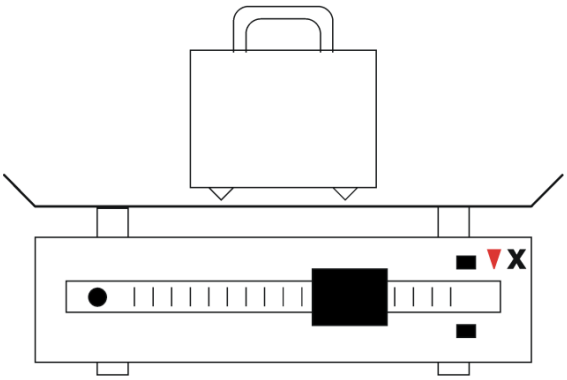

Fig:5 Calibrating a vertical seismometer on a mechanical balance.

When a mass of w1 grams at some point X near the end of the beam is in balance with w2 grams on the table or compensated with a corresponding shift of the sliding weight, then the motion of the table is by a factor w1/w2 smaller than the motion at X.

From the mutual agreement between a number of different experiments, and from the comparison with shake-table calibrations, we estimate the absolute accuracy of the method to be better than 1%.

Calibration with Tilt:

Accelerometers can be statically calibrated on a tilt table. Starting from a horizontal position, the fraction of gravity coupled into the sensitive axis equals the sine of the tilt angle. (A tilt table is not required for accelerometers with an operating range exceeding 1g; these are simply turned over.).

Force-balance seismometers normally have a mass-position output which is a slowly responding acceleration output. With some patience, this output can likewise be calibrated on a tilt table; the small static tilt range of sensitive broadband seismometers, however, may be inconvenient. The transducer constant of the calibration coil is then obtained by sending a direct current through it and comparing its effect with the tilt calibration.

Finally, by exciting the coil with a sine-wave whose acceleration equivalent is now known, the absolute calibration of the broadband output is obtained. The method is not explained in more detail here because we propose a simpler method. Anyway, seismometers of the homogeneous-triaxial type cannot be calibrated in this way because they do not have X, Y, Z mass-position signals.

The method which we propose (for horizontal components only) is similar to what was described earlier, but this time we excite the seismometer with a known step of tilt, and evaluate the recorded output signal for acceleration rather than displacement. This is simple: the difference between the drift rates of the de-convolved velocity trace before and after the step equals the tilt-induced acceleration. No baseline interpolation is involved. In order to produce repeatable steps of tilt, it is useful to prepare a small lever by which the tilt table or the seismometer can quickly be tilted back and forth by a known amount. The tilt may exceed the static operating range of the seismometer; one then has to watch the output signal and reverse the tilt before the seismometer comes to a stop.

The Calibration of this Seismometer is performed using a Shaft which is fixed at one end of the rotor table setup. The other end of the shaft is free and hence acts as a Cantilever. The Seismometer is placed at the free end of the shaft and is subjected to rotations in equal angular intervals (0 to 90 degree). The results/deflections will be recorded in arc seconds. The Seismometer will be programmed according to the results obtained during the calibration.

Calibration using Shaft:

The shaft is an assembly of three components:

- Loading Platform
- Shaft Tube
- Mounting Flange

1: **Loading Platform** is located at the free end of the calibration setup. The payload or Seismometer is placed for Calibration. The platform is assembled with the Shaft tube using a permanent binder.

2: **Shaft Tube** is a hollow cylindrical tube to which the loading platform is assembled. One the other end, it connected to the Mounting Flange.

3: **Mounting Flange** is another component which is connected to the shaft tube. It is the component which is fixed to the rotary table setup. The assembly is proposed to be done using a binder or suitable screws.

III. MATERIALS & METHODS

Material Selection for the Shaft tube was a challenging task as the deflection was to be minimum (in microns). Number of materials was suggested for the fabrication of shaft tube and finally CFRP was selected and suggested, due to its high strength and minimum weight. Whereas, the Loading Platform and the Mounting Flange are fabricated using Aluminium-Al 6061.

Table:1 Material Properties

Sl. No	Materials	Modulus of Elasticity, 'E' (Young's Modulus) GPa	Poisson's Ratio, 'ν'	Density, 'ρ' mg/m^3
01	CFRP	280	0.26	1.6
02	Al6061	68.98	0.33	2.711

Dimensions of Shaft:

Total Length of Shaft	=650mm (500 Shaft length+150mm Flange)
Platform Thickness	=15mm
Platform Area	=150*140 sq.mm
Shaft thickness	=10mm
Outer Diameter of shaft	=140mm
Inner Diameter of shaft	=120mm
Outer Diameter of Mount and Platform	=140mm

Fig:6 Top View of Shaft Assembly

Fig:7 Front View of Shaft Assembly

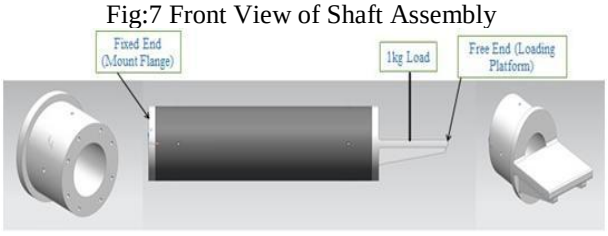

Fig:8 Shaft Assembly

IV. ANALYSIS AND RESULTS

Numbers of iterations were carried out for finalization of the dimensions and material selection of the shaft. Analysis of the shaft was performed by choosing different materials for achieving minimum weight and deflection. The results obtained for different materials are tabulated in the following table.

Table2: Results Obtained

Sl. No	Material	Modulus of Elasticity (E) In 'MPa'	Poisson's Ratio (v)	Deflection in 'Micron'	Slope,'θ' in 'degree'	Mass in 'kg'	Remarks
1	Aluminum (Al-6061)	68670	0.3462	3.952	3.483e-4	12.5	Less in strength and more deflection
2	Titanium (Ti-6Al-4V)	114000	0.32	2.292	2.020e-4	16.8567	Difficult for Fabricating
3	Beryllium Alloy	245000	0.12	1.952	1.7206e-4	11.0349	Costly and fabrication difficulty
4	CFRP Tube (Composite)	280000	0.28	1.788	1.576e-4	8.756	Material availability

Formulae Used for Calculating Deflection:

- Deflection, $\delta = \frac{W*L^3}{3EI}$

Where, W= Load Applied in, 'N'

L = Length in, 'mm'

E = Modulus of Elasticity (Young's Modulus) in 'N/mm^2'

I = Moment of Inertia in, 'mm^4'

$\longrightarrow I = \frac{\pi*(D_o^4 - d_i^4)}{64}$

- Slope, $\tan\theta = \frac{dY}{dX} = \frac{\text{Deflection } (\delta)}{\text{Length } (L)}$

$\longrightarrow \theta = \tan^{-1}(dY/dX)$, in 'degree'

Also,

- 1g=90°=5400min=324000sec

V. DISCUSSIONS

Analysis have been performed for the shaft model for different materials .viz. Aluminum (Al6061), Titanium (Ti 6Al 4V), CFRP Tube (Composite), and Beryllium Alloys.

It has been found that the deflection due to applied load of 1kg mass is very less for CFRP and Beryllium Alloy.

Whereas, the mass and total deflection of Beryllium Alloy is also found to be less compared to all other materials that have been tested so far. However Beryllium alloy will have fabrication issues like poisonous gas emission.

Hence, for present conditions, CFRP is suggested for the fabrication of shaft.

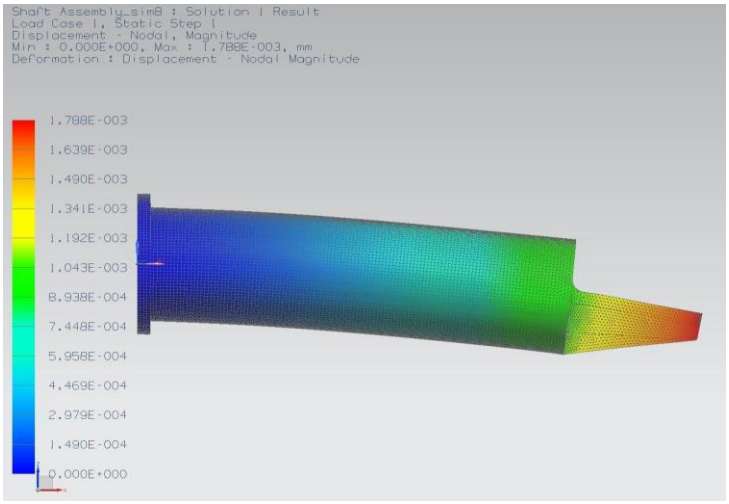

Fig:9 Deflection of CFRP Shaft
Load of 1Kg Mass with Self Weight
Deflection=1.788micron
Material: CFRP

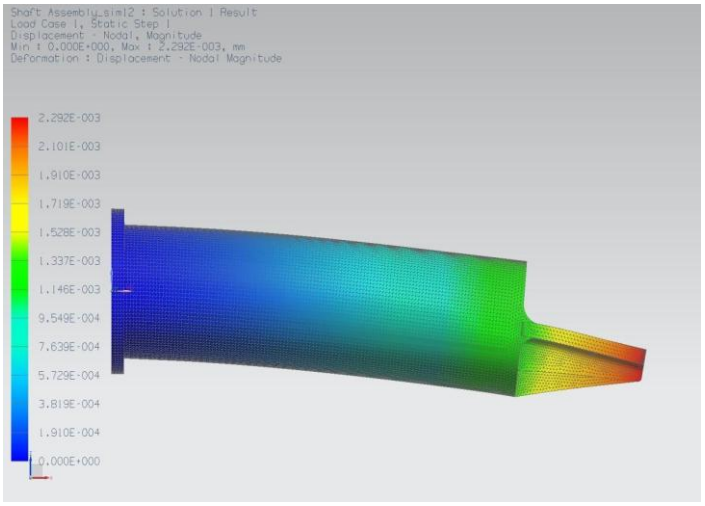

Fig:10 Deflection of Titanium Shaft
Load of 1Kg Mass with Self-Weight
Deflection=2.292micron
Material: Titanium (Ti-6Al-4V)

VI. CONCLUSIONS

Seismometry is a critical need for lunar science. After the Apollo experiments, there is a long gap in conducting seismic events studies on Moon. During this period, a lot of development has taken place in technologies like MEMS which can offer better sensors with higher sensitivity and wider bandwidth. MEMS based seismometers will be smaller, lighter and less power consuming than its classical counterparts. This offers the use of more number of sensors and better redundancy. Seismometers realized of the proven technology of MEMS can rejuvenate the planetary seismology and Chandrayaan-2 Lander is a great platform to conduct scientific experiments in this very interesting field. Modified microstructures and improved electronics incorporated to the proven inertial sensors realized at LEOS will be one of the best candidates to conduct the Seismic experiments on Moon for the Lunar Lander Mission because of the inherent advantages of the technology..

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REFERENCES

[1] Apollo Documents released by NASA

[2] Detection of the Lunar Deep Moonquake at Apollo 17 Site, Y Saito et. al. http://planetb.sci.isas.jaxa.jp/luna/pdf/AA0063723011.pdf

[3] **W Thomas Pike:** *A high sensitivity broad band seismic sensor for shallow sounding of the lunar regolith*, Lunar and Planetary Science XXXVI (2005)

[4] Broadband and short period seismometers, www.r-sensors.ru,

http://www.r- sensors.ru/seismometers.shtml#broadband

[5] Seismometer tested for Moon and Mars,

http://phys.org/news/2012-08-seismometer-moon-mars.html

[6] Optical MEMS based seismometer “Whigs”, Monitoring Research Review: Ground Based Nuclear Explosion Monitoring Technologies, NNSA and AFRL, 2008

[7] **John Merchant:** *MEMS Applications in Seismology*, Sandia National Laboratories

[8] **Bormann 2002Bormann, P.:** (editor)*IASPEI New Manual of Seismological Observatory Practice,* ed. P. Bormann, ISBN 3-9808780-0-7, GeoForschungsZentrum Potsdam 2002

[9] **Havskov&Alguacil 2004,Havskov, J. &Alguacil, G**.: *Instrumentation in Earthquake Seismology*. Modern Approaches in Geophysics vol.22, ISBN 1402029683, Springer Verlag 2004

[10] www.lpi.usra.edu/lunar

WATER TREATMENT USING BIOENZYME – A REVIEW

RAM KUMAR M[1], A M MAHESHA[2], MAHESH S[3], PRASHANTH KUMAR H P[4]
[123]*Assistant Professor, Department of Mechanical Engineering, Sapthagiri College of engineering*
[4]*Assistant Professor, Department of Biotechnology, Sapthagiri College of engineering*
#14/5 Chikkasandra, Hesaraghatta main road, Bangalore- 57 India
[1]ramkumarm@sapthagiri.edu.in
[2]ammahesha@sapthagiri.edu.in
[3]maheshs@sapthagiri.edu.in
[4]prashanthkumarhp@sapthagiri.edu.in

Abstract **- Water is an essential source for all living beings it is polluted by various means by industrial effluents, waste water and oil spillage. Unfortunately, water bodies are still used as sinks for wastewater from domestic and industrial sources. However, in recent times, the need to replenish our water resources has been receiving increasing attention. This has led to the development of strategies to return water to its source in the least toxic form possible, to enable reutilization of water. Water treatment can be done effectively in organic way by using Bio enzymes. Bio-enzyme is a natural, non -toxic, non-flammable, non-corrosive liquid enzyme formulation prepared by fermentation process of organic materials. In this review paper the effective use of Bio-enzyme in purification of water is discussed. There was decrease in the parameters like Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total Solids (TS), Total Dissolved Solids (TDS), Total Suspended Solids (TSS), pH, Alkalinity and other chemicals after treatment of water with Bio enzyme.**

Keywords – Bio-enzyme, water treatment, Organic cleaning

I. INTRODUCTION

India is a developing country where there is an increase in population and rapid industrialization. Among other industries, the dairy industry is also growing day by day due to increase in milk demand. These industries discharge large amounts of wastewater every day [1].

In past few years, researchers are working to find new techniques for reclamation of water focusing on biological or physical wastewater treatment methods rather than chemical ones [12].There are different types of water treatment and biological treatment is one such type. In a water body, organic matter is converted into inert mineralised products by purely natural mechanisms, characterising the self-purification phenomenon. In a waste water treatment plant the same basic phenomena occur, but the difference is that there is the introduction of technology.

Biological systems are able to bring about the degradation of the target chemicals primarily due to their enzymes. Hence enzymes, both intracellular and extracellular, are being explored as biochemical means of wastewater treatment [10]. Biological systems are able to bring about the degradation of the target chemicals primarily due to their enzymes. Hence enzymes, both intracellular and extracellular, are being explored as biochemical means of wastewater treatment. In general, enzymes are highly specific and extremely efficient catalysts. They can selectively degrade a target pollutant without affecting the other components in the effluent. Therefore, enzymatic treatment is suitable for effluents that contain relatively large amounts of the recalcitrant target pollutants in comparison to others. More importantly, they can operate under mild reaction conditions, especially temperature and pH. In this respect, enzymes outperform the regular catalysts (transition elements like Cu, Ni etc.). From the environmental perspective, enzymes are more acceptable due to their biodegradability. In the case of reactions wherein the target pollutant is oxidized, the enzyme receives one or more electrons from the substrate and donates these electrons to an electron acceptor. Hence, at the end of the reaction the enzyme is regenerated and is available for the next catalytic cycle. Some of the oxidative enzymes such as the peroxidases require hydrogen peroxide (H2O2) or alkyl peroxide (R2O2) to act as the electron acceptor. Others such as laccases utilize molecular Oxygen for this purpose [10].Use of bio-enzyme in biological treatment of wastewater could be a viable and eco-friendly solution.

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II. BIOENZYME PREPARATION

Bio Enzyme is produced by the fermentation process of citric fruit peels, water, and jaggery. To reduce the time of the fermentation process, yeast is added into the Bio Enzyme [1]. It is claimed as a multi-use solution for domestic and agricultural applications [9]. Enzymes were known to catalyse more than 5000 biochemical reaction types. The cell is the structural and functional unit of life the basic building block of living systems. Cells can effectively utilize biocatalysts, known as enzymes, which have outstanding catalytic efficiency and both substrate and reaction specificity. They have amazing catalytic power and their high level of specificity for their substrate makes them suitable for biological reactions. They are biological catalysts (also known as biocatalysts) that speed up biochemical reactions in living organisms. They can also be extracted from cells and then used to catalyse a wide range of commercially important processes. For example, they have important roles in the production of sweetening agents and the modification of antibiotics, they are used in washing powders and various cleaning products, and they play a key role in analytical devices and assays that have clinical, forensic and environmental applications. the active site of an enzyme is the region that binds substrates, co-factor & prosthetics groups and contains residual that helps to hold the structure. active sites generally occupy less than 5% space in the total enzymes. The active site has specific shapes due to the structure of a protein [13].

It is an effective alternative to harsh chemicals such as bleach, phenyl, and other chemical solutions we typically use in households to wash our bathrooms, clean toilets, wipe our floors, tiles and other surfaces. Chemically, they are a mixture of complex organic substances such as proteins, salts and other materials that are by-products of the bacteria/yeas that we will use to make bio enzymes. These organic substances are capable of the breaking down of chemical and other organic waste thus helping us in removing stains, odour, getting rid of other harmful microbes, etc. They also greatly neutralize toxins and pollutants [13].

Materials used in preparation of Bio Enzyme are Jaggery, citrus fruits peels, and water.

1. Citrus fruit peels- Citrus fruit peels contain carbohydrates in the form of sugars, sucrose, glucose, fructose, etc., Organic acid is also present in citrus fruit peels, such as citric acid, malic acid, oxalic acid, succinic acid. The organic acids help to convert carbohydrates to alcohol[2].

2. Jaggery- Jaggery is loaded with antioxidants and minerals like zinc and selenium. Among those zinc helps in killing bacteria and also has antibacterial properties [1].

3. Yeast-Yeast produces carbon-dioxide, alcohol and other compounds. Yeast is used to converting sugar, starch, glucose into alcohol(Ethanol) and produce carbon dioxide gas[3].

Proportion used in the preparation of bio-enzyme is 1 part of jaggery, 3 parts of citrus peels and 10 parts of water. The container should be airtight and the mixture prepared should be accommodated with 20% extra space. The extra space is provided for the gases released by the mixture when fermented like CO2, CH4, NOx, Hydrogen sulphide in traces. Normal process requires 90 days of fermentation whereas by adding yeast the time can be reduced to 25-30 days. When the fermentation begins, in the initial days lot of carbon-di-oxide gases are released by the fermented bacteria as it feeds on the sugar content and converts into alcohol .During this period the bubble formation can be seen in the container, the container lid has to be removed and closed tightly to ensure fresh air. This must be repeated for one week and from the second week it can be opened in alternative days as the formation of gases will be reduced. The enzyme prepared must be stored in a cool place at room temperature and should not be stored under direct sunlight. Settling of the citrus fruit peels in the bottom of the container and less bubble

A. MATERIALS REQUIRED:

Table1: Proportions of Materials required preparing Bioenzyme

Ratio	Kilograms	Grams	Kilograms
Jaggery	1	300	10
Citrus Peels/Vegetable waste	3	900	30
Water	10	3000	100

B. FILTRATION

Bio enzyme is separated from the solid residues by filtration. The obtained enzyme solution was light brownish yellow coloured. It was transferred to plastic bottles and stored in a cool and dry place. The residue obtained can be used as a fertiliser due to its high nutritious content [14].

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C.WATER TREATMENT:

After collecting water, samples were immediately transferred in ice container to labs for processing on the same day within 2 hours. Decoding and interpretation was done by separate independent team to ensure blinding (to avoid bias) in sampling, testing and reporting. Label codes were not disclosed to lab person so that blinding can be ensured in testing and reporting.

Thousand times dilution of enzyme has been reported to give best activity of enzyme for cleaning water.To achieve 1000 times dilution calculation of estimates of volume of pond water was done. The pond was of 80X60X10 ft. hence 48000 sq. ft. volume required 480 liter enzyme to treat water. One liter of water sample was lifted prior adding the enzyme in to pond water.Water samples were collected from midpoint of pond to test biochemical and physical parameters as per established parameters and methods.

The wastewater samples were digested for a period of 5, 15 and 25 days by mixing with 5%, 10% and 15% bio-enzyme solution. The parameters like pH, TDS, BOD5, COD, Ammonia Nitrogen and Phosphates were analyzed for present investigation. The results showed that bio-enzyme can remove TDS, BOD5 and COD characteristics of the wastewater; while complete removal of ammonical nitrogen and phosphate was observed with low concentration of bio-enzyme solution. No considerable variation in the characteristics pH was noted; it remains acidic. Bio-Enzyme can be used as an economic option to enhance wastewater attributes by treating it with bio-enzymes and make fit it for various purposes. Moreover, utilization of bio-enzymes can also help in checking disposal of chemicals during wastewater treatment processes making it environmentally sustainable [12]

D.TYPES OF TESTS AND RESULTS:

1. pH-(power of hydrogen) It specifies how acidic or basic a liquid solution is.

2. Alkalinity-This test is done to measure how much acid can be neutralized by the liquid sample.

3. Biological Oxygen Demand (BOD)-It gives the amount of oxygen consumed by microorganisms and bacteria [4].

4. Chemical Oxygen Demand (COD)-It is a measure of oxygen needed for oxidizing soluble organic matter in water [5].

5. Chlorides-It is done to represent the chloride ion concentration in the water sample.

6. Total Solids (TS)-It gives the measure of total dissolved, colloidal and suspended solids in the water sample[6].

7. Total Dissolved Solids (TDS)-It gives the concentration of dissolved substances in the water sample[7].

8. Total Suspended Solids (TSS)-It gives the concentration of suspended particles that are not dissolved in the water sample[8].

9. Oil & Grease-It gives the amount of oil and grease present in the sample.

III.RESULTS AND DISCUSSIONS

The Bio Enzyme was found to be acidic in nature and it contains large amount of organic materials. The results indicate that 2% and 4% can effectively reduce the parameters like Alkalinity, pH, COD, TDS, TS, TSS, Oil &Grease were reduced and satisfied the irrigation standards. The Bio Enzyme was found to be acidic in nature and it contains large amount of organic materials. The results indicate that 2% and 4% can effectively reduce the parameters like Alkalinity, pH ,COD, TDS, TS, TSS, Oil &Grease were reduced and satisfied the irrigation standards[1]. The study observed an increase in storage capacity, ground water levels, and serene environment around the pond and a green cover around the water body. There is a sustained positive impact on the water body post the enzyme treatment across 90 days. The BOD, COD reduced considerably within permissible limits [9]. Enzymes have been employed in numerous fields primarily for their immense catalytic potential.

In waste water treatment, enzymes can be utilized to develop remediation processes that are environmentally less aggressive than conventional techniques. Their versatility and efficiency even in mild reaction conditions gives them an advantage over the conventional physico-chemical treatment methods. The biological origin of enzymes reduces their adverse impact on the environment thereby making enzymatic

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waste water treatment an ecologically sustainable technique [10]. The eco- enzyme is found to positively affect pH (from 6.7 to 7.2) reducing solids (from 884 to 745) suspended solids-(from 121 to 47) hardness and chlorides in a stable water body- Pond. The eco- enzyme testing in drain water showed optimum water cleaning effect on 0.5% concentration by showing the reduction of Biological Oxygen Demand from 690 to 231, Chemical oxygen demand from 537 to 384, nitrates (from 5.54 to 3.39) Coliform count by 10%.

Considering cost-effectiveness of the enzyme it is considered feasible technique to mitigate polluted water bodies [11].

For drain water, for collection of water, sterilized bottles were used. Bottles were washed thoroughly and rinsed with distilled water for microbial analysis. Each dry bottle was rinsed with 0.5ml sodium thiosulphate (10% solution). It was observed that drain water (treated by 4 different concentrations) showed maximum purification with the least amount of enzyme at 0.5% [11].

III.CONCLUSIONS

Furthermore investigations can be done to find out the suitable additives or activators or enhancer on enzyme action. Investigation on pre-treatment for the reduction of high initial BOD and COD prior to action of enzymes can also be studied. The utilization of bio-enzymes in treating all types of wastewaters under different physico-chemical conditions can also be explored. The effect of bio-enzymes on characteristics of wastewater other than or along with the parameters discussed in present study can also be investigated [12].

Economic Feasability is studied under Yamuna river action plan, the old sewage treatment plants proposed to be rehabilitated at a cost of Rs.1656 crores (Loksabha, 2014).The cost of eco-enzyme is approximately Indian Rs.30-50/- per liter and its constant mixing with drain water also does not require high budget.

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REFERENCES:

[1] Srimathi.N, Subiksha.M, Abarna.J, Niranjana.T, '*Biological Treatment of Dairy Wastewater using Bio Enzyme from Citrus Fruit Peels'*, International Journal of Recent Technology and Engineering (IJRTE) ISSN: 2277-3878, Volume-9 Issue-1, May 2020

[2] Prachi Dessai ,Dr.Shwetha Prasanna –'*Treatment of Dairy Waste Water Using Low Cost Adsorbents*.' International Journal of scientific research engineering &Technology (IJSRET), ISSN2278-0882. Volume 5, Issue 12, December 2016.

[3] Prof. N.B.Singh , Ruchi Singh and Mohammed Manzer Imam – '*Waste Water management in dairy industry: pollution abatement and preventive attitudes*'. International Journal of science, Environment Technology ISSN2278-3687(o). Volume 3, No2, 2014,672- 683

[4] Bhavani penmatsa, D Chandra sekhar, bhagavathula s diwakar, tv nagalakshmi – '*Effect of bio enzyme in the treatment of fresh water bodies*.', International Journal of recent Technology & engineering (IJRTE), ISSN2277-3878. Volume 8, Issue 1S3, June 2019.

[5] Fazna Nazim, Dr.Meera.v. '*Comparison of Treatment of Grey Water Using Garbage And Citrus Enzymes*'.

[6] International Journal of Innovative Research in Science, engineering and technology. An ISO 3297:2007 Certified organization Volume 6, Issue 4, march 2017.

[7] Geetha Saramanda and Jyothi Kaparapu- '*Antimicrobial Activity Of Fermented Citrus Fruit Peel Extract*'. GeethaSaramanda .int.Journal of Engineering Research and Application. ISSN:2248-9622, Volume 7, Issue 11(part 7), November 2017,pp.25-28.

[8] NuramidahHamidon, NabilahNazzri, Mariah Awang, NorshuhailaMohdSunar, Mimi Suliza Muhamad, Nur AiniMohd Arish, Hasnida Harun, A.Hamid,R. Ali, Mohammad Ashraf Abdul Rahman-'*Surface Water Treatment Using Pomelo's Peel (Citrus Grndis) Nd Biosand Filter As Iron (Fe) Adsorption in Kangkar Senangar's River*'. ISSN:2278-3075, Volume 8, Issue-8S, June 2019.

ISBN: 979-85-27243-61-1

[9] Bhavani Penmatsa, D Chandra Sekhar, Bhagavathula S Diwakar, TV Nagalakshmi, *Effect of Bio-Enzyme in the Treatment of Fresh Water Bodies*, International Journal of Recent Technology and Engineering (IJRTE) ISSN: 2277-3878, Volume-8 Issue-1S3, June 2019

[10] Ambatkar mugdha and mukundan usha, '*Enzymatic treatment of wastewater containing dye stuffs using different delivery systems'*, sci. Revs. Chem. Commun.: 2(1), 2012, 31-40 issn 2277-2669

[11] N. Kumar, Y.A. Rajshree, A. Yadav, N. Himani Malhotra, N. Gupta, P. Pushp, *Validation of eco-enzyme for improved water quality effect during large public gathering at river bank*, Int. J. Hum. Capital Urban Manage., 4(3): 181-188, Summer 2019

[12] Anshal Kumar, Himanshu Kumar Sadhya, Dr. Esar Ahma3, Shashivendra Dulawat, *Application of Bio-Enzyme in Wastewater (Greywater) Treatment*, International Research Journal of Engineering and Technology (IRJET), Volume: 07 Issue: 05 | May 2020

[13] Varun Dhavale , Tejas Shimpi , Varsha Koli , Rutuja Kamble , Smita B. Patil, *Bio Enzymes From Organic Waste*, JETIR August 2020, Volume 7, Issue 8, 2021

[14] Ashish Joseph, Joan Grace Joji, Niksy Maria Prince, Renisha Rajendran, Dr. Mohanraj Nainamalai, Dr.Vishnu M, *Domestic Wastewater Treatment Using Garbage Enzyme*, ICSEE 2021, January 2021

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DESIGN AND FABRICATION OF 2 WHEELED FORKLIFT

(FOR INDUSTRIAL APPLICATIONS)

NIKITH D*[1], HARSHITH S[2], GAGANA KUSUMA K[3], PAVITHRA N[4], R.G. DESHPANDE[5]

Department of Mechanical Engineering, Sapthagiri College of engineering
#14/5 Chikkasandra, Hesaraghatta main road, Bangalore- 57 India

[1]nikithnik2407@gmail.com
[2]harshithharshi06@gmail.com
[3]gaganagowdak1999@gmail.com
[4]pavithranarasimha1998@gmail.com
[5]deshpande@sapthagiri.edu.in

***Abstract* - The mechanical field is improving day by day. Lots of innovative ideas are entering into the field. This project report is indeed to endow with a comprehensive study of the technical and theoretical aspects of "FORKLIFT" all the topics covered in this report are essential for the complete understanding and survey of the title "FORKLIFT". In the project we have studied and modified the product called Forklift machine. The reports engrosses different chapter and each is design in the organized style. Covering basic introduction, specification, application, and its uses in various industries**

I. INTRODUCTION

A forklift (also called lift truck, fork truck, fork hoist, and forklift truck) is a powered industrial truck used to lift and move materials over short distances. The forklift was developed in the early 20th century by various companies, including Clark, which made transmissions; the use and development of the forklift truck have greatly expanded worldwide. Forklifts have become an indispensable piece of equipment in manufacturing and warehousing.

A wheeled vehicle besides remarked as raise truck, fork truck hoist, and vehicle truck is also a high-powered industrial truck want to spice up and move material over short distance. The wheeled vehicle was developed inside the first twentieth century by varied firms like Clark, that created transmission, and Yale & Towne manufacturing, that created hoist. The implementation of warehouse transportation technique could be an important house of business for many company, blind of their size and profile. The value of use of internal transport square measure a typical a part of the company's accounting, whereas the environmental consequences associated with it square measure usually unmarked. In many cases, significantly in very little and medium organization, there is Associate in Nursing absence of awareness of the requirement to pay the environment fees incurred by the exploitation of internal transport suggests that that apply to off road vehicle, like wheeled vehicle, excavators or loaders usually, the wheeled vehicle is made public as a tool capable of lifting several kilograms of weight. A wheeled vehicle can be a vehicle form of somewhat truck that has two metal forks on the front accustomed carry merchandise. The wheeled vehicle operator drives the wheeled vehicle forward until the forks push at a lower place the merchandise, and will then carry the merchandise several feet inside the air by operative the forks. The forks, to boot brought up as blades or tines, square measure usually product of steel and will carry some of tons. Forklifts square measure machines that use levers and/or pulleys to hold necessary weights.

II. MATERIALS & METHODS

The frame, cab, boom, and body of a tele-scoping-boom rough terrain forklift are usually fabricated by the forklift manufacturer. Steel is the most common material for these subassemblies. Some steel or aluminium castings or forgings may also be used. Typically the material used to construct vehicle chassis and frames is carbon steel; or aluminium alloys to achieve a more light-weight construction. In the case of

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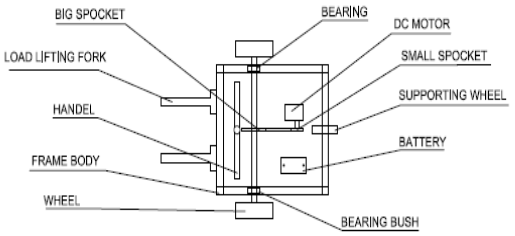
a separate chassis, the frame is made up of structural elements called the rails or beams. These are ordinarily made of steel *channel* sections, made by folding, rolling or pressing steel plate.

Fig.Methods involved

Methodology:

A forklift; is known as self-generated vehicle, and may be a battery-powered industrial machine; in which purpose is for material handling among compounds, especially the potential to raise weights to be positioned at certain height, also to lowers them as per needs. These are connected with specific attachments, the fork elevated machine is also made to perform alternative connected functions like the transfer masses from slip sheets onto pallets, also to clamp them or to invert them. The chassis was designed to sustain a static load of 80 kg. The rear wheels hold the motors and is attached to the frame or casing. The driving motors are housed below the frame. The frame incorporates hole for attaching front wheel, and; for attaching the fork lifter. D.C. motor is utilized in our project for moving fork, and carrying objects from one location to other; our project consists two motors to run the 2 wheels; whereas the lifting portion is completed by lead screw and it is connected to another motor. Battery provides power to motor. The battery is placed at the rear platform a 12-volt battery used to provide power.

Fig.2 Parts of forklift



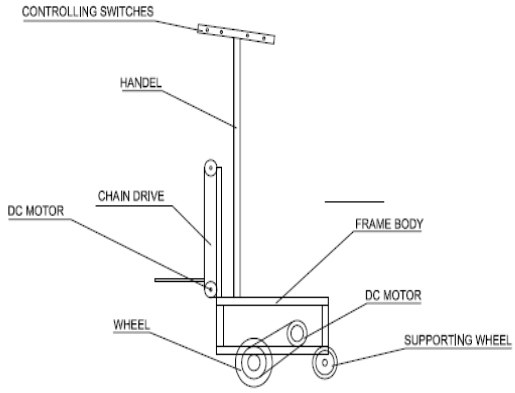
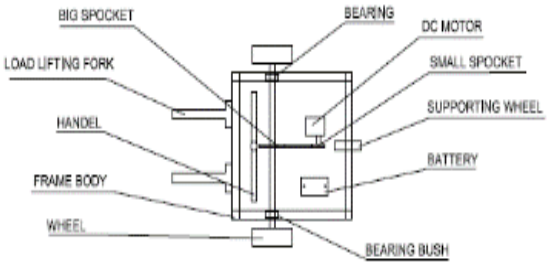
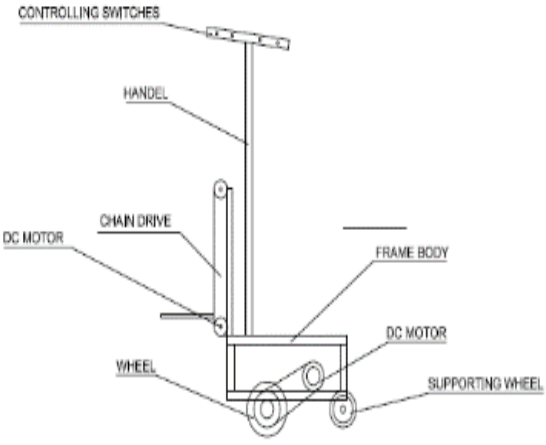


Fig.3 Final Design of Water purifier





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III. RESULTS & DISCUSSIONS

- This project work has been completed in a limited time and hence we are proud to announce that "The Two-Wheel Drive Forklift" is able to fulfil the expectations.
- All the parts are connected in such a way that the equipment can be maintained and assembled easily. In this work we are able to achieve the target of reduction of size of a forklift and hence the new model is able to move through narrow passages and lift the load in a store house.
- We successfully conducted the test of load lifting and we are happy to announce that the forklift design made by us was able to lift load of 80Kg under satisfactory conditions.

IV. CONCLUSIONS

This project has provided us a plethora of opportunities and experiences, within the bounds of our limited knowledge. Not only did it enlighten us with theoretical knowledge, it also inculcated practical knowledge regarding planning, purchasing, assembling and machining in us. It is a matter of immense of happiness and pride for us in having been able to complete this project successfully in a limited span of time. We have done everything in the best possible way we could by overcoming the various constraints and by utilizing all the available amenities. The current system can be modified for lifting heavy load by using bulky lead screw and high-power motor. The size of the forklift can be further reduced for easy handling and movement the foldable designs can be provided for transporting.

ACKNOWLEDGMENT

We would like to express our sincere gratitude to the Management, Principal Sapthagiri College of Engineering Bengaluru for the facilities provided and their support. Also we would like to thank the Head of department Mechanical Engineering and faculties for their encouragement and support.

REFERENCES

[1] S. S. Rattan, Theory of Machines, 2009.
[2] V B Bhandari, Design of Machine Elements, 2010.
[3] J. B. Gupta, Basic Electrical & Electronics Engineering, 2011.
[4] Brindley, James (December 2005). "The History of the Fork Lift". Warehouse & Logistic News. Archived from the original on 200
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Automated Sanitization Machine

PRANAV S VISHWAMITRA*[1], PRAJWAL BHARDWAJ A[2], PRADEEP S SUREBAN[3], SHRIVATSA S RAO[4], TULSIDAS D[5]
Department of Mechanical Engineering, Sapthagiri College of engineering
#14/5 Chikkasandra, Hesaraghatta main road, Bangalore- 57 India
[1]pranavsv.hubli@gmail.com
[2] prajwalbharadwaj1178@gmail.com
[3] pssureban98@gmail.com
[4] vathsavathsa356@gmail.com
[5]tulsidasd@sapthagiri.edu.in

Abstract- In the modern world as we are dealing with a global pandemic with Covid-19, keeping ourself safe from foreign pathogens has become most important aspect. In order to be healthy we need to keep our surroundings clean; it may be our home and workplaces. Cleaning large workspaces is big challenge as it requires lot of time and also require large number of staff to perform them. Another place where cleaning and sanitation is big challenge is in covid infected rooms in hospital. Cleaning and sanitation in covid infected rooms possess a threat of infection to the cleaning staff and also to the doctors and nurses treating the patient. The proposed system focuses on these two areas where we remotely operate the machine to sanitize the workplace area as well as covid infected hospital rooms using Arduino based system to control the machine. The work also involves analysing different parameters to for best sanitation of surrounding.

I. INTRODUCTION

Cleaning and disinfecting are very important steps in preventing the acquisition and spread of infectious diseases and viruses inside a closed environment such as hospitals, industries, apartments, community centres, shopping malls, etc. In particular, high-contact-point areas such as hospital beds, industry workplaces, Tools that are using in companies, doors, lifts, handrails, etc. are major sources of contamination. To avoid the virus transmission from humans-to-humans frequent cleaning and sterilization are important, especially in working places. Hence human involvement in cleaning and sterilization is risky, especially in hospitals and industries. To overcome these robots are suited for caring for the well-being of COVID-19 patients thus replacing at least sharing the workload of the medical staff in hospitals and staff workers in industries. It has the capability of overcoming risky work situations.

Hence Automation is the technology by which a process or procedure is performed with minimal human assistance. Automation can play a major role in increasing productivity and reducing costs in service industries. Automation is also done for spraying pesticides in agricultural field [1].In this regard, our work focuses on automating the sanitation process in hospital and closed workspaces by employing Arduino mega micro controller to carry out the processing and controlling the machine remotely through WIFI module. As per the guidelines for disinfection of infected places by WHO [2], the selected disinfectant chemical is sprayed onto the spaces by pumping the liquid from tank by DC pumps through nozzle. By automating healthcare processes, hospitals can enhance clinical precision, and also reduce the risk of contracting harmful pathogens and reduce exposure to harmful microbes.

II.Materials and method

Sanitation liquid for sanitation is achieved by mixing chlorine which as reagent with the water. The ratio of mixing of reagent is as per the research done by in 2019 [3]. We are using 5 litre tank hence as per ratio we have mixed 10g of chlorine to it. The resulting mixture is chlore dioxide which is corrosive n nature and hence the material used for the body of the robot is **Galvanized steel** which is non corrosive in nature. Galvanized steel is maintenance free, last longer as the life expectancy

is high in difficult environments. As per the work by Satyendra [4] in 2019, concluded that galvanized coating has unique metallurgical structure give high resistance to mechanical damage and corrosive resistance. The tank which will store the liquid is also made of the same material so as to resist the corrosion. Based on the work done by Mustafid [5] where performance of spraying system is carried out, which concludes that higher spray pressure will produce a smaller droplet for a given output hole diameter. The 3 hole nozzle has higher effective spraying width at spray pressure than 4 hole nozzle as the 4 hole nozzle has small funnel at the end nozzle, so the spraying can be more focused.

Methodology

- Conceptual framework: formulation of concept was done by discussing with our teammate and guide and decision was made
- Literature review: reading and analyzing the various research paper and journal paper of various author with respect to our work, so as understand the previous work done
- Preliminary calculations: various calculations relating to torque required for the motor and flowrate, pressure out of the pump, and weight calculation of the body was calculated and tested
- 3D modelling and prototyping: A conceptual design is made using Solid works by considering the dimensions and making accommodation of parts and 2D model is also drafted
- Stress Analysis: Static structural analysis is made by subjecting the body to expected load in order to determine stress concentration points on the body in Ansys 19.
- Selection and listing components: components are selected based on the calculations done and also selecting most economical based on the quality of the components
- Estimation of cost: cost of all the components along with fabrication cost is estimated
- Purchasing of materials: materials are purchased and verified
- Fabrication: fabrication of the body is done based on conceptual model and considering the preliminary calculation.
- Testing: testing of the functioning of different component present in system is done. The functioning of the robot is checked to meet the objectives of the robot

Working

Automated sanitation system works as per the instruction that has been coded into the Arduino Mega micro controller. This acts as the brain of the system. The robot can be controlled through any android device by connecting the device and the machine to a network. The robot consists of an UV sensor in order to detect the objects in front of it. As per the direction instructed by the user the robot moves by the movement of 4 DC geared motor. When instructed by the user the robot start spraying the liquid disinfected form the tank through the nozzle onto the surrounding or the objects. The sanitization liquid is prepared as per the guidelines of the WHO [2] and is stored in tank on the robot which can be refilled repeatedly. The liquid is pumped through by using DC pumps which are situated near the tank. The rate at which the liquid is sprayed is calculated prior based on the requirement. The whole robot is run by two 12V 5Amp Lead acid battery that are in series. The range from which the robot can be controlled is based on the strength of the Wi-Fi network and also the range of the android device.

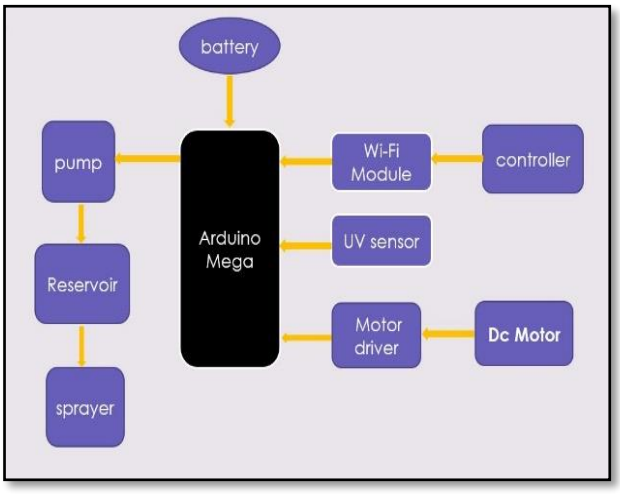

Figure 1: block diagram of process

III.Preliminary calculations

Design data requirement
Base plate thickness- 3mm
Top plate thickness- 1mm

Base plate dimensions- (length* breath)
(400*600) mm
Tank dimensions – (length*height)
(240*180) mm
dry weight of tank- 250g
reagent for sanitizer- chlorine dioxide

1. Tank weight calculation
   Density of water – 997kg\m^3
   Density of chlorine dioxide-1670kg/m^3
   For 1L mixing of Chlorine is 2*10^{-6} kg/m^3
   For 5L we are going to use 10*10^{-6} kg/m^3
   Total weight of liquid is 5kg
   Total weight of tank with liquid = **5.25kg**
   Density of Galvanized iron =**8.03kg/dm^3**

2. Weight of material
   Base plate
   = (0.4) *(0.6) *1.2*8.03*10^{-6}
   =**2.31kg**

   Top plate
   = (0.4) *(0.6) *1*8.03*10^{-6}
   =**1.92kg**

   Weight of a 12V 5amph battery
   =1.92kg
   For 2 batteries = **3.84kg**

   Total weight
   =5.25+2.31+1.92+1.0+2.0
   =**12.48kg**

3. Motor calculations
   Torque =Force *radius.
   Force = 12.23*9.81 = 119.97N
   Torque =119.97 * 0.07= 8.3979Nm
   Hence torque required for each wheel is **2.0994Nm**

IV.Analysis of base plate

In our project we used Galvanized iron sheet as the base metal plate which acts the base on which all of our electronic parts and storage tank will be placed. In order to determine the thickness and know the effect of forces on the base we conducted Static Structural analysis on base plate in Ansys 19. The body is initially subjected to fine meshing and then the force calculated is applied and results are analyzed

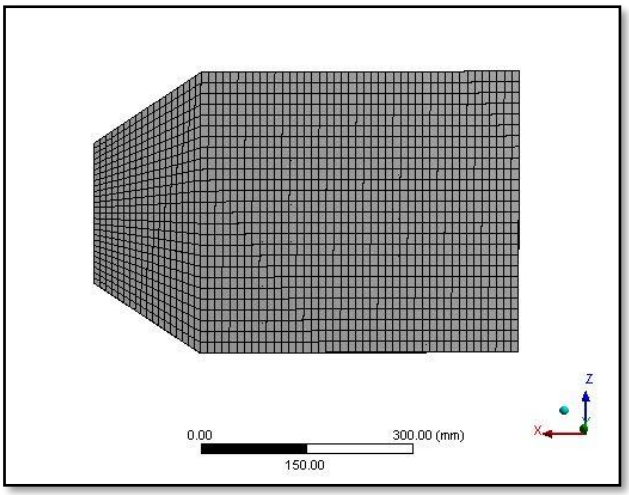

Fig 2: fine meshing of base plate

• Base plate with 1.2mm thickness

In this analysis we considered **1.2mm** as the thickness of the base plate as it was minimum thickness of plate available in market. Maximum weight that would be carried by the plate was calculated. The base plate is finely meshed and force is applied on it. From the analysis, the maximum **Von Moises stress** experienced by the plate is **21.38N.** As shown in fig 1, the majority of the area is covered in yellow, orange and red color which indicate high stress area.

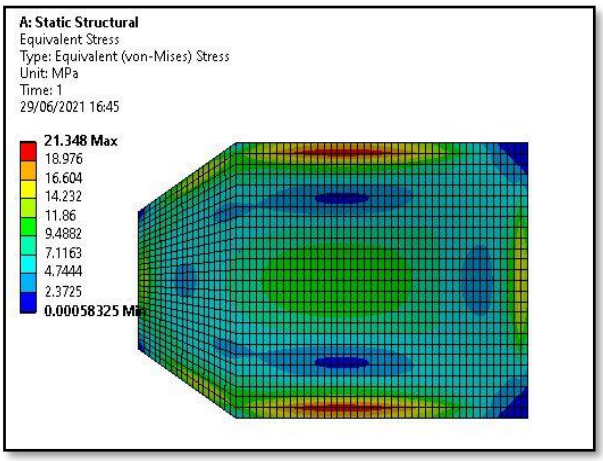

Fig 3: stress analysis of plate

• Base plate with 3mm thickness

In order to reduce the stress experienced by the plate, 3mm thickness base plate was selected. The plate is finely meshed and subjected to same amount of force as before. As the result, the amount of **Von-Moises stress** experienced is **3.98N** and majority of the base plate as shown in Fig 2 is covered in light blue and blue area which indicate low stress concentrated points. Hence by increasing thickness the stress concentration area is lowered by considerable margin. The amount of deformation also reduced after increasing the thickness.

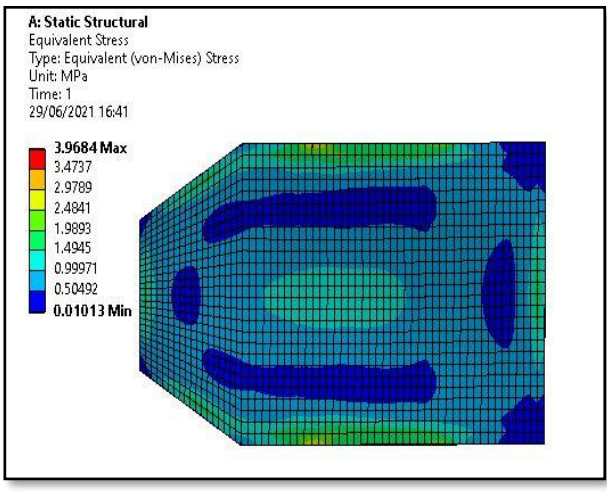

Fig 4: stress analysis of 3mm plate

Conceptual design

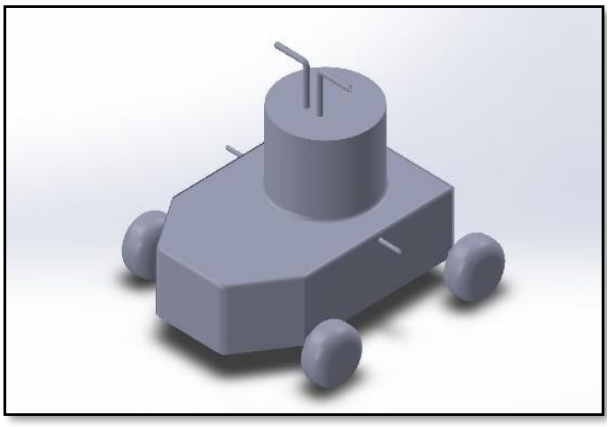

Fig 5: Isometric view of machine

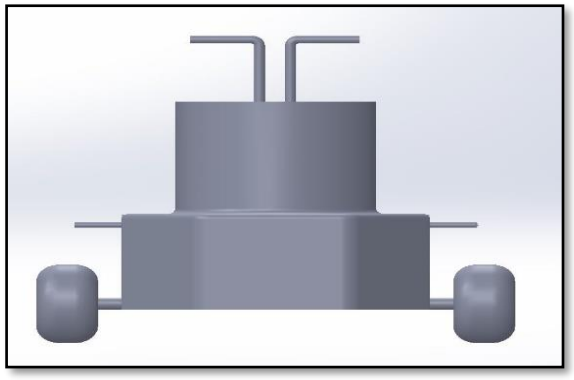

Fig 6: front view of machine

V.Result and discussion

After the fabrication and assembly of the parts, a well thought out inclusive test was carried out. It was found that the automatic room sanitizer was fully functional and was spraying as per the requirement. The machine due to its mobility covers a considerable area with ease by spraying sanitizer at an angle so that it spreads throughout the room. The selected sanitizer liquid was also found to be optimum to be used in crowded places. The machine is portable and the sanitizer can be easily procured without any hassle. The cost of sanitizing liquid is user friendly and is available at an affordable rate

VI.Conclusion

It is possible to design, fabricate an automatic sanitizer machine at an affordable price if the concept of economies of scale is utilized. The machine is safe and requires very little human intervention and can be used in hospital areas and wards where the sanitization needs to be done. The machine effectively covers the hospital wards without any hassle and sanitizes the whole room rigorously. This machine is found to be a suitable alternative which can be used at the hospital for sanitizing the rooms and wards without human intervention.

Acknowledgement

We would like to express our sincere gratitude to the Management, Principal Sapthagiri College of Engineering Bengaluru for the facilities provided and their support. Also, we

would like to thank the Head of department Mechanical Engineering and faculties for their encouragement and support.

References

[1]. P. Jian-sheng, "An Intelligent Robot System for Spraying Pesticides," *TOEEJ*, vol. 8, no. 1, pp. 435–444, Dec. 2014, doi: 10.2174/1874129001408010435.

[2]. Cleaning and disinfection of environmental surfaces in the context of COVID-19,WHO/2019-nCoV/Disinfection/2020.1,

[3] W. McGlynn, "Guidelines for the Use of Chlorine Bleach as a Sanitizer in Food Processing Operations," p. 2.

[4]. Satyendra, "Galvanized Iron sheets," July 2013

[5] M. A. Mustafid, I. D. M. Subrata, and G. Pramuhadi, "Design of Automatic Spraying System for Liquid Pesticide Application on Cabbage Cultivation," *IOP Conf. Ser.: Earth Environ. Sci.*, vol. 542, p. 012028, Aug. 2020, doi: 10.1088/1755-1315/542/1/012028.

Design and Fabrication of Mini Forklift Using Wi-Fi Module

SACHIN KG*[1], ARUN KUMAR S[2], ARUN M[3], CHETHAN S[4], MAHADEVASWAMY P[5]

Department of Mechanical Engineering, Sapthagiri College of engineering#14/5
Chikkasandra,Hesaraghattamain road,Bangalore- 57 India

[1]sachinkg2907@gmail.com
[2]arunkumarns015@gmail.com
[3]arungowda760@gmail.com
[4]schethan239@gmail.com
[5]hodmech@sapthagiri.edu.in

***Abstract*— currently, in warehouse storage systems are mainly still done in a traditional way using human operator to pick goods into specified location. This paper presents the design of a mini forklift that can pick up object to/ from specified storage using wireless control. The project is intended to construct and enhances the technology further, this prototype module is constructed with wireless technology, there by the operator can control and monitor the forklift for better visibility & the container can be placed accurately (precision position). This increases the safety of the operator. In this work a Wi-Fi based circuit system in order to run the mini forklift and Wi-Fi camera to monitor from a distance by receiving wireless control commands.**

***Keywords*— Fork lift, Wi-Fi module, Wi-Fi camera**

I. INTRODUCTION

In general the forklift can be defined as a tool capable of lifting hundreds of kilograms. A forklift is a vehicle similar to a small truck that has two metal forks on the front used to lift cargo. The forklift operator drives the forklift forward until the forks push under the cargo, and can then lift the cargo several feet in the air by operating the forks. The forks, also known as blades or tines, are usually made out of steel and can lift up to a few tons.

Forklifts are either powered by gasoline, propane, or electricity. Electric forklifts relay on batteries to operate. Gasoline or propane forklifts are sometimes stronger or faster than electric Forklifts, but they are more difficult to maintain, and fuel can be costly. Electric forklifts are great for warehouse use because they do not give off noxious fumes like gas powered machines. Forklifts are most often used in warehouses, but some are meant to be used outdoors. It is important for forklift operators to follow all safety precautions when using a forklift. Forklift is totally run on electric motors which are control by a remote operator by means of remote will connected with Wi-Fi transmit and receives to forklift circuits. With electrical motor it gives the motion to the forklift vehicle like forward, back, left turn, right turn and pallet controlling up down motion, which are controlled with remote and which will be transmitting signals to receiver and receiver will convert signals to operation. It helps the operator to operate the forklift from one position and he can monitor on the neighbor environment and can avoid the accident by operating with Wi-Fi camera.

II. LITERATURE REVIEW

The actual industrial forklift intend to operate alongside Human personal, to integrate Radio frequency identification (RFID) technology into a forklift truck to make it wireless to increase visibility and human safety designed and developed by Ugale Sachin [1]. Lobo Allwyn [2] Designed and developed the mechanical forklift works on semi- electric techniques. In this transfer the power from one form into another form using mechanical as well as electric components. The project works on technique of Transfer rotational motion into linear motion. A J Deokar ‘s [3] Human powered forklift works on the simple mechanism of the motion transmission. It consists of bevel gear mechanism where motion from wheel is transmitted to rear wheels with the help of chain and the device moves further. There is paddle attached to the front wheel axle to rotate and turn. The device can be used on any surface of ground as the wheels are made up of mild steel which is hardened to carry the entire load. Kaushik S Panara [4] worked on construction of battery operated forklift which control through wired communication for to increase the safety of operator by operating it by distance. P Naveenkumar

[5] has done new design where the stability of the fork lift results show that truck is safe to use its center of gravity remains in the safety triangle .they used it to get the maximum loading capacity then run stress analysis important parts and subassemblies using finite elements method (FEM).

In the present work a prototype of mini forklift is designed, which control through Wi-Fi module. In this work the range of the forklift which is high compared to the others with Wi-Fi camera to monitor in certain distances to increase the safety of the operator.

III. METHODOLOGY

The mechanical structure of this prototype module is constructed with square metal sheets & flats, this structure looks like a rectangular box & the vertical moving mechanism that contains metal forks is assembled over the structure at front side. Since it operates through a blink app, it doesn't contain any steering mechanism. The entire vehicle is designed to drive through three wheels, & two motors are used to drive two front wheels directly. These two motors are driven through a single 'H' bridge DC motor drive package. Both wheels are directly coupled to the motor shafts independently. The DC Motors are having reduction gear mechanism [6] internally, there by speed is reduced and torque is increased. The fundamental concept involved in the system is to create mechanical movements in the forklift according to the command signals generated and transmitted through the Blink app designed with WI-FI module. ESP microcontroller is used for controlling forklift, it has inbuilt Wi-Fi module which can operate 4 relay switches by using relay drivers. A Wi- fi camera is used to monitor the forklift from long distance using mobile phone.

In this concept, the command signal information produced through an activated key into Wi-Fi aced with data transmitting controller and based on the digital code generated by the controller chip, the data is super imposed over the carrier & transmitted as modulated signal. The received signal is demodulated through Wi-Fi receiver module & the output is fed to another micro controller unit arranged over the forklift. This controller is programmed to control the motors through H Bridge. This process is called Radio communication, and it is the process of sending information from one place and receiving it in another place without using any connecting wires. It is also called as wireless communication system. In general Radio waves are produced by rapidly changing currents flowing through a conductor. These radio waves spread out in space like ripples produced on the Wi-Fi ace of a pond when a stone is dropped in the water. When these fast moving radio waves strike some other conductor placed in their path at a distant point, they produce in the second conductor weak currents of the same nature as the original current which produced these radio waves. Thus a communication link will be established between two distant points.

MICROCONTROLLER

ESP32 is a series of low-cost, low-power system on a chip microcontroller with integrated Wi-Fi and dual-mode Bluetooth shown in Fig.(1). The ESP32 series employs either a Tensilica Xtensa LX6 microprocessor inbothdualcore, singlecore variations singlecore RISV m icroprocessor and includes built-in antenna switches, RF balun, power amplifier, low-noise receive amplifier, filters, and power-management modules. It is an ESP32 is created and developed by Espressif Systems, a Shanghai-based Chinese company, and is manufactured by TSMC using their 40 nm process. It is a successor to the ESP8266 microcontroller.

Fig.1 microcontroller

DC MOTORS

Permanent magnet DC motor responds to both voltage and current. The steady state voltage across a motor determines the motor's running speed, and the current through its armature windings determines the torque. Apply a voltage and the motor will start running in one direction; reverse the polarity and the direction will be reversed. If you apply a load to the motor shaft, it will draw more current, if the power supply does not able to provide enough current, the voltage will drop and the speed of the motor will be reduced. However, if the power supply can maintain voltage while supplying the current, the motor will run at the same speed. In general, you can control the speed by applying the appropriate voltage, while current controls torque. In most cases, DC motors are powered up by using fixed DC power supply, therefore; it is more efficient to use a chopping circuit.

IV. BLOCK DIAGRAM

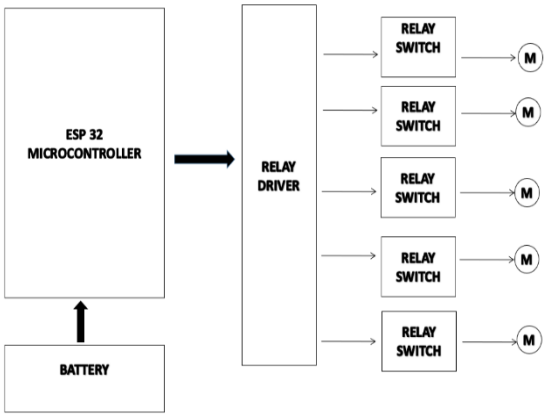

Fig.2 Block diagram

This system shown in Fig.2 consists of ESP32 Microcontroller which is integrated with both Wi-Fi and Bluetooth control system. Microcontroller are used to execute software that interprets inputs and controls the system. Microcontroller is connected to relays which control high voltage from lower voltage. This relays are intern connected to DC motor in order to drive and lift the loads. Here it requires 5 relays in order to control 5 motors. All this components are powered by the battery.

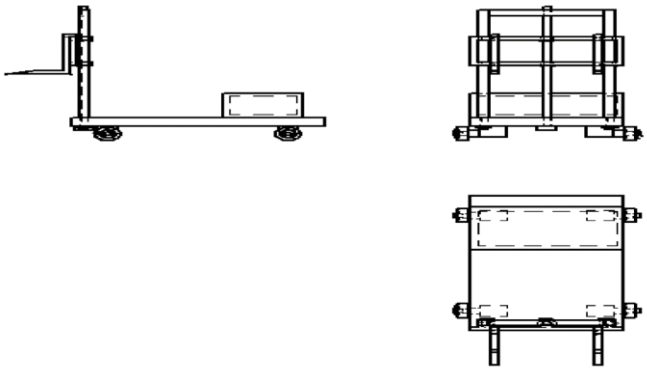

Fig.3 2D view of model

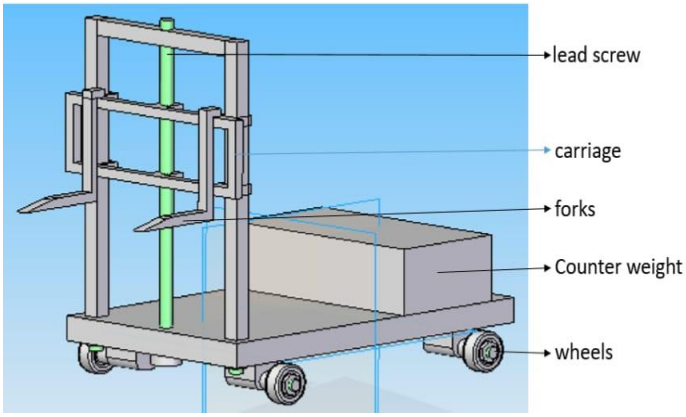

Fig.4 3D view of model

V. DESIGN CALCULATION

The design of forklift shown in Fig 4 involves such as. Determine maximum load capacity, thread parameters, torque required to rise and lower the load, counter weight, forces acting on the component. The material selected for the forklift is mild steel due to its properties like malleability, ductility, strong and low cost.

Weight capacity (M) =5kg
Length of screw (L) =609.6mm
Material =mild steel

1. Total load in Newton (W) :
W=mass*acceleration due to gravity
W=5*9.81
W=49.5N

Co efficient of thread friction (μ) =0.14
[From design data hand book table no 18.4]

2. Thread parameter:
Nominal dia (d) =10mm
Minor dia (d1) =8mm
pitch (p)=2
Area of core (Ac) mm2=50.3
Pitch diameter (d2) =(d+d1/2)
Load=P
Load=2
Tan α=(l/πd2)=(2/π*9)=0.070
α= tan -1 (0.070) α=4.04
φ= tan -1μ
φ= tan -1 (0.14) =7.97°

3. Torque Required to Rise load :
M_{ts} =W(d2/2)tan(φ+α)
=49.5*9/2*tan (7.97+4.04)
=46.95Nmm

4. Torque Required to lower load :
M_{ts} =W (d2/2) tan (φ-α)
=49.5*9/2*tan (7.97-4.04)
=15.16Nmm

5. counter weight :
W=(L*A*FOS)/B
W=counter weight
L=load capacity of fork lift
A=arm reach
B=distance between fulcrum point and center of gravity of counter weight
FOS (factor of safety)=2

W=(5*228.6*2)/482.6
W= 9.47kg

VI. CONCLUSION

The project work "Design and fabrication of mini forklift using Wi-Fi module" is aimed to control through wireless communication. The main advantage of using this technology is to increase the safety of operator by operating the forklift from certain distance. This increases the efficiency of the productivity. The system is designed and developed successfully, for the demonstration purpose prototype model (mini model) is constructed. Most of all human safety is a major concern's by using a remote controlled forklift. In this regard there is still scope of further improvement in the control structure by providing more flexible control. The mechanical design must be improved by using suitable gears and bearings. Speed must be increased, when the speed is increased, during emergencies breaking system must be employed. Likewise many modifications can be carried over in the future work.

VII. REFERENCES

[1] Ugale Sachin S: Design, Development and Modelling of Forklift, International journal of Engineering Research & Technology (IJERT), ISSN 2278-0181, Vol.3, Issue 4, April 2014.

[2] Lobo Allwyn M: Design and Development of Mechanical Forklift, International research journal of engineering and technology (IRJET), ISSN 2395-0072, Vol 05, Issue 03, March 2018.

[3] A J Deokar: Human Powered Forklift, IJEDR, ISSN 2321-9939, Vol 7, Issue 2, 2019.

[4] Kaushik S Panara: Construction of battery operated forklift, IJSTE, ISSN 2349-784X, Vol 2, Issue 4, October 2015.

[5] P Naveenkumar: Design and analysis of two wheel drive forklift for industrial warehouses, IJERT, ISSN 2278-0181, Vol 6, Issue 4, 2018.

[6] S S Rattan: Theory of Machines, Tata McGraw-Hill, 3rd edition, 2009.

FOLDABLE E-BIKE

RAKESH G K[1], ROHITH K C[2], SUMANTH S[3], VINOOP A[4], TULSI DAS D[5]

Department of Mechanical Engineering, Sapthagiri College of Engineering

#14/5 Chikkasandra, Hesaraghatta main road, Bangalore-57, India

[1]rakesh.kulkarni03@gmail.com

[2]rohithgowda032@gmail.com

[3]sumanthsundar99@gmail.com

[4]vinoopanil123@gmail.com

[5]tulsidasd@sapthagiri.edu.in

Abstract: **India is the second largest producer and manufacturer of two wheelers in the world. It stands next to Japan and China in terms of number of two wheelers produced and domestic sales. Indian two-wheeler industry has got a spectacular growth in last few years. The phase of auto industry that was redefined with the invention of fuel-efficient technology is all set to see dawn of new ear in two-wheeler industry. It's not petrol or diesel or any other fuel, its electricity that has initiated a revolution in automobile industry. In today's world travelling is very essential for human beings in order deal with their day-to-day activities, and to do so travelling should be done in minimum possible way. People also prefer for speed, comfort and cost for travelling between one place to another place. Generally, public transport is the best solution. But public transport has their specific routes and destination. People face difficulty in travelling from their location to station and from station to their destination. A Foldable E-Bike may be the possible solution to these problems. This bike can be folded and transported easily. This paper studies about design and development of different parts of the components such as controller, Brushless DC motor.**

Keywords: Foldable, E-bike, Compact, Brushless DC motor, Battery, Controller.

I. INTRODUCTION

In recent years, there are so many environmental problems caused by combustion Engines and caused a major fuel economy crisis. India is one of the top countries where people prefer bikes instead of cars, since cars are safer than bikes still people prefer bike over cars because of its advantages like small space for parking and milage but disadvantages also include such as pollution, scarcity of natural resources (petrol/diesel/gas). E-bike is an electric bike which is driven with the help of battery which is coupled to electric motor. There is a provision for charging the battery by ejecting it from the main system. A Foldable E-Bike is designed to fold into a compact form, facilitating transport and easily park. When folded, the bicycle can be more easily carried into buildings and workplaces or on public transportation and more easily parked in compact living quarters or to aboard the E-Bike in car, boat or plane.

The main objective of Foldable E-Bike are as follows:

- •To identify appropriate sectors of electric bike.
- •Promote greater use of less polluting and energy consuming modes of transportation.
- •To reduce the running cost of vehicle.

II. MATERIALS AND METHODS

2.1 MATERIALS/COMPONENTS: The key components of Foldable E-Bike are:

1. *Battery:* Batteries are the components that store electricity, allowing the motor of the vehicle in question to run. there's already an analysis between different sorts of batteries as seen within the table.1 below, the most materials that allow recharging are nickel cadmium, nickel zinc, nickel metal hydride, and lithium-ion/lithium-polymer, these are respectively listed as NiCd, NiZn, NiMH, and Li-ion/Li-Po on the battery analysis table. Specific energy is energy per unit of mass denotes a lighter battery because the value increases if the energy were to be kept constant.

Parameter	**NiCd**	**NiZn**	**NiMH**	**Li-ion/Li-Po**
Specific Energy (Wh/kg)	40-60	100	60-120	100-265
Energy Density (Wh/L)	50-150	280	140-300	250-730
Specific Power (W/Kg)	150	>900	250-1000	250-340
Charge/Discharge Efficiency (%)	70-90	80	66	80-90
Self-Discharge Rate (%)	10	13	30	8-5
Cycle Durability (cycles)	2000	400-1000	500-1000	400-1200
Nominal Cell Voltage (V)	1.2	1.65	1.2	NMC 3.6/3.7, LiFePo43.2

TABLE 1. Comparison between Batteries.

From this table lithium-ion battery was the foremost efficient choice for an electrical bike because it offers high energy density while remaining relatively light-weight and compact in size. Lithium-ion batteries are often very dangerous; therefore, it's essential to research the standard of the lithium ion cells and therefore the protective implementations used.

2. *Throttle:* The throttle mode is analogous to how a motorbike or scooter operates. When the throttle is engaged the motor provides power and propels you and therefore the bike forward.

3. *Brushless DC motor:* The utilization of the permanent magnets (PM) in electrical machines in situ of electromagnetic excitation leads to many advantages like no excitation losses, simplified construction, improved efficiency, fast dynamic performance and high torque or power per unit volume. A brushless dc (BLDC) motor may be a synchronous motor which is powered by DC electricity (DC) and which has as electronically controlled commutation system, rather than a mechanical commutation system supported brushes. In such motors, current and torque, voltage and rpm are linearly related. In BLDC motor the electromagnets don't move, instead the permanent magnets rotate and therefore the armature remains static. the development of recent brushless dc motor is extremely almost like the ac motor, referred to as static magnet electric motor. The stator windings are almost like those during a poly phase ac motor, and therefore the rotor consists of 1 or more permanent magnets. Brushless dc motors are different from ac synchronous motors therein the previous incorporates some means to detect the rotor position or (magnetic poles) to supply signals to regulate the electronic switches. the foremost common position/pole sensor is that the hall element, but some motors use optical sensors.

4. *Controller:* A controller may be a device or group of devices that serves to control in some predetermined manner of performance of an electrical motor. A motor controller might include a manual or automatic means for starting and stopping the motor, selecting forward or reverse rotation,

selecting and regulating the speed, limiting or regulating the torque, and protecting against overloads and fault. In this project we are using "sine wave vector controller". The battery block is interfaced with the motor controller block. The motor controller controls all the functional capabilities and is that the central component of the system. The basic requirement for the control is to manage the quantity of power applied to the motor, especially for DC motors. The motor controller are often adjusted to synchronize with other brushless motors. To drive and control the BLDC motor, the utilization of motor controller was implemented. The motor controller is an important device for any motor driven device. The motor controller is analogous to the human brain, processing information and feeding it back to the top user. Of course, the applications of a motor controller vary supported the task that it'll be performing. One of the only applications may be a basic switch to provide power to the motor, thus making the motor run. As one utilizes more features within the motor, the complexity of the motor controller increases. Field-Oriented Control (FOC) or wave vector controller is a crucial technology for motor systems, particularly those using permanent magnets (PM). In general, FOC provides an efficient thanks to control BLDC motor in adjustable speed drive applications that have quickly changing loads and may improve the facility efficiency of an BLDC motor.

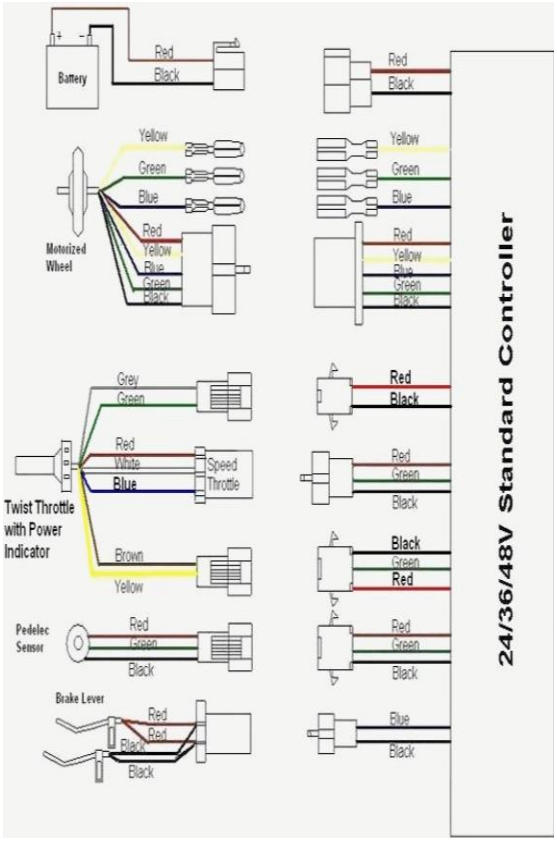

Fig 1. Key Components of Electric Bike.

2.2 CONCEPTUAL DESIGN: The basic design is done on the software as shown in figure which is used for fabrication.

Fig 2. Unfolded E-Bike.

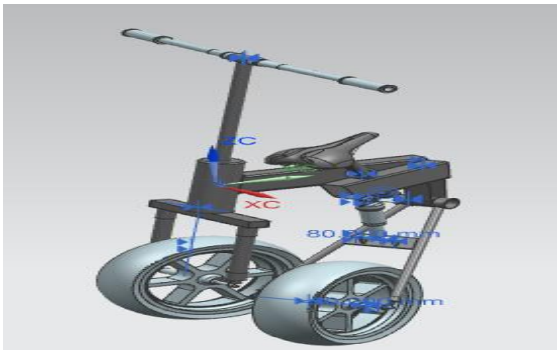

Fig 3. Folded E-Bike.

2.3 *PERFORMANCE ANALYSIS:*

Hub Motor Specification:
Volts = 36v.
Power = 360w.

Speed of motor in rpm:
N (speed in rpm) = K (speed in kmph) / (d (Diameter of wheel in cm) * 0.001885)
N = 25 / (25.4 * 0.01885)
N = 522 rpm.

Power Equation:
P = I*V
Where, P=POWER,
I= CURRENT,
V= VOLTAGE.
I= P/V = 360/36 = 9.722 ≈ 10 ampere.

Torque of motor(T):
T = (Power* 60) / 2*π*N
T = 360* 60 / 2*π*522
T = 6.40 N-m.

SELECTION OF MOTOR: For deciding the power rate of the vehicle dynamics like Rolling resistance, Gradient resistance and Aerodynamic drag etc, needs to be considered.

$F_{TOTAL} = F_{ROLLING} + F_{GRADIENT} + F_{AD}$.

Where, F_{TOTAL} = Total Force.
$F_{ROLLING}$ = Rolling Force.
$F_{GRADIENT}$ = Gradient force.
F_{AD} = Aerodynamic Drag Force.

1. **ROLLING RESISTANCE:** Rolling resistance, sometimes called rolling friction or rolling drag, is that the force resisting the motion when a body rolls on a surface. The formulae for calculating rolling resistance is given by,

Rolling Resistance Coefficient		
c	c_l (mm)	
0.001 - 0.002	0.5	railroad steel wheels on steel rails
0.001		bicycle tire on wooden track
0.002 - 0.005		low resistance tubeless tires
0.002		bicycle tire on concrete
0.004		bicycle tire on asphalt road
0.005		dirty tram rails
0.006 - 0.01		truck tire on asphalt
0.008		bicycle tire on rough paved road
0.01 - 0.015		ordinary car tires on concrete, new asphalt, cobbles small new
0.02		car tires on tar or asphalt
0.02		car tires on gravel - rolled new
0.03		car tires on cobbles - large worn
0.04 - 0.08		car tire on solid sand, gravel loose worn, soil medium hard
0.2 - 0.4		car tire on loose sand

Table 2. Coefficient of rolling resistance

$F_{ROLLING} = C_{rr} * M * g$
Where, C_{rr} = Co-efficient of Rolling Resistance. (0.006)
M = Mass in Kg = 125 kg.
G = Acceleration due to Gravity = 9.81m/s^2.
$F_{ROLLING}$ = 0.006 * 125 *9.81
$F_{ROLLING}$ = 7.35N.

2. **GRADIENT RESISTANCE:** The third force that acts on a vehicle is that the gradient force, and it occurs when the vehicle is driving on an uphill or a downhill road. The gradient force is thanks to the longitudinal component of gravity, namely mg where theta is that the inclination angle of the road. Gradient resistance is that the force created by gravity when moving a load or down a grade.

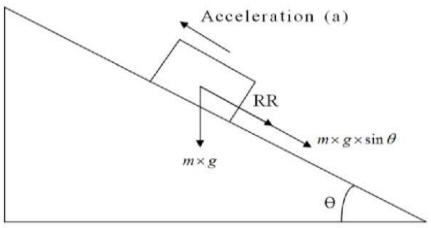

Fig 4. Free Body Diagram of a Vehicle moving up an Inclined surface.

$\mathbf{F_{GRADIENT}}$ = ± Mass * acceleration due to gravity * sinΘ (Θ = Angle of inclination)

$\mathbf{F_{GRADIENT}}$ = ± 125 * 9.81 * sin1
$\mathbf{F_{GRADIENT}}$ = 21.40N.

3. **AERODYNAMIC DRAG:** The force on an object that resists its motion through a fluid is named drag. When the fluid may be a gas like air, it's called aerodynamic drag or air resistance.

Vehicle	C_D	A_f
Motorcycle with rider	0.5-0.7	0.7-0.9
Open convertible	0.5-0.7	1.7-0.9
Limousine	0.22-0.4	1.7-2.0
Coach	0.4-0.8	6-10
Truck without trailer	0.45-0.8	6.0-10.0
Truck with trailer	0.55-1.0	6.0-10.0
Articulated vehicle	0.5-0.9	6.0-10.0

Table 3. Drag coefficient and frontal area of vehicle

$\mathbf{F_{AD}} = 0.5 * \rho * v^2 * C_D * A_F$

Where, C_D = Drag Co-efficient.
A_F = Frontal Area.
P = Air Density.
v^2 = Velocity in m/s.
$\mathbf{F_{AD}} = 0.5 * 1.1644 * (6.944)^2 * 0.5 * 0.7.$
$\mathbf{F_{AD}}$ = 9.820N.

$\mathbf{F_{TOTAL} = F_{ROLLING} + F_{GRADIENT} + F_{AD}}$.

$\mathbf{F_{TOTAL}}$ = 7.35 + 21.40 + 9.82.
$\mathbf{F_{TOTAL}}$ = 38.57N.

Then, the power required to drive a vehicle,

Power = Force * Velocity * (1000/3600).
Power = 38.57 * 25 * (1000/3600).
Power = 267.84W.

Hence, the power required to propel the vehicle is 267.84W, which is just below our motor specification 350W. So it is safe to use the required motor.

2.4 METHODOLOGY:

- Conceptual framework: Initially we had to get a compressive understanding about what we wanted to do. So, we researched about various elements that form the basics or the root to our project and learnt the needed prerequisites.
- Working mechanism: We planned and built a plan to achieve our desired result on the project.
- Study design: We studied the previously existing designs and further went on to innovate and redesign the structure as much as possible with the knowledge and accessibility to required equipment's.
- Literature review: For further knowledge on the type of project we are working and its advancement in the real world we went through several research papers published.
- Preliminary calculation, Analysis and design: After studying the published research papers we now had an idea about the required analysis about the design which should be done keeping in the aerodynamics, ergonomics, mass of the product as it's built to carry around when not used.
- Cost estimation: After all these analyses we now had an idea of the required components and a rough idea of the cost to fabricate the main body of the product. We now are planning to reduce the cost simultaneously while increasing the reliability.
- Purchase of materials like batteries, BLDC motor etc.
- Fabrication: As all the parts are now ready but needs to be assembled to work as one. Assembling of all the parts has to be started now.
- Testing: Based on all the necessary safety rules and reliability of the product we have to test for the durability of the body, Range of our foldable E-bike as it runs on battery all of these have to be tested.

III. RESULT AND DISCUSSION

- E-Bike mission is to form urban mobility in India seamless, shareable and sustainable. What started off as an initiative to scale back traffic jam and pollution in Indian cities, is now redefining urban mobility across the country.
- "Unlike China, Indian cities don't have the infrastructure for parking of shared mobility vehicles. So foldable E-Bike are often stored in less space.
- Many countries in Southeast Asia took the lead in using E-bikes as sustainable mode of transportation, and with the continual rise of urban pollution, there's an enormous future for E-bikes.
- If you employ the E-bike rather than a automobile it'll prevent money within the end of the day. Petrol and diesel are costly in most countries, and occasional price surges can really impact on your budget. While with E-bikes, you'll buy affordable batteries which may last you 18-50 miles after a full charge counting on the extent of assistance you utilize.
- The E-Bike comes equipped with a 36V battery-powered motor. E-bike can reach the highest of 25 KMPH.

IV. CONCLUSIONS

Now a days, utilization of fuel vehicles is increased rapidly which result into more air pollution. To control this, utilization of EV is must because it's several advantages like electric scooter is an eco-friendly product, it's more suitable for city because it can avoid the emission of harmful gases and thereby it can reduce the atmospheric pollution. Due to frequent increase in fuel prices, the electrically charged vehicle seen to be the most cost effective one compared to the normal vehicle. E-scooters are more suitable for rural areas where the numbers of petrol bunks aren't adequate, in order that the agricultural people can charge the vehicle with the assistance of electricity. To understanding the EV technology, this study helps to supply outline of EV (Scooter) and their various components.

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REFERENCES

[1]. K. S. Yun, "FOLDABLE BICYCLE". Seoul Patent US 2011/0193313 A1, 11 Aug 2011.

[2]. L. Ford Global Technologies, "FOLDABLE ELECTRIC BICYCLE". MI/US Patent US 9,469,364, 18 Oct 2016.

[3]. Beijing Onemile Technology Co., " FOLDABLE CYCLE AND FOLDABLE FRAME". Beizing Patent US 2017/0158279 A1, 8 Jun 2017.

[4] Ji-Young Byung-Chul Woo, Jong-Moo Kim and Hong Seok Oh "In-wheel Motor Design for an Electric Scooter" J Electr Eng Technol. Nov.2017.

[5]. V. Bhandari, Design of Machine Elements, Tata McGraw Hill Education, 2010.

[6]. 8. E. S Edward H. Yonkers, "COLLAPSIBLE BICYCLE". USA Patent 4,202,567, 13 May 1980.

[7]. C. P. Kuo Yi Chu, "FOLDING BICYCLE STRUCTURE". Hsinchu Patent US 6,883,817, 26 April 2005.

[8]. G. T. O. K. a. G. T. O. Ustun, "In Pursuit of Proper BLDC Motor Design for Electric Bicycles," IEEE, Copenhagen, 2016.

[9]. G. Rose, "E-bikes and urban transportation: emerging issues," Springer, LLC, 2011.

[10]. A. K. S. R. Z. M. Ajinkya Parab, "Urban Electric Bike," IJSRD, H. J. THEEM College of Engineering, 2015.

FIRE EXTINGUISHING ROBOT (Using ARDUINO)

DIKSHITH K A*[1], DINESH KUMAR A[2], MARUTHI A S[3], NIHAL M I[4], MAHESH S[5]

Department of Mechanical Engineering, Sapthagiri College of engineering
#14/5 Chikkasandra, Hesaraghatta main road, Bangalore- 57 India

[1]dikshith.ka8699@gmail.com
[2]diineshkumaar00@gmail.com
[3]maruhsd@gmail.com
[4]nihal1999mi@gmail.com
[5]maheshs@sapthagiri.edu.in

***Abstract* - Detecting fire and extinguishing is a perilous job for a fire extinguisher, it often threatens the life of that person. This project focuses on giving a technical solution to the mentioned problem. A robot is a mechanical design that is capable of carrying out a composite series of actions automatically, especially one programmable by a computer. Arduino is an open-source electronics platform that is easy-to-use hardware and software. Arduino board can be controlled by sending a set of commands to the microcontroller. Firefighting is the act of extinguishing fires, i.e., our robot sprinkles water onto a fire. A firefighter robot subdues and extinguishes fires to prevent loss of valuable lives and destruction of property and the environment.**

Keywords – Robot, Bluetooth, Remote controlled

I. INTRODUCTION

Fire is one of the common disasters that occur suddenly in place or mostly in household residences. Ordinarily, fire originates from a compound response between oxygen in the environment and some kind of fuel. There are several firefighting systems available for firefighting at residential areas and extinguishing forest blazes. Our proposed system is a small robot that can be used to control the fire from spreading the initial stage of an incident of fire. By using such robots, the work of fire detection and extinguishing missions can be carried out without placing the life of firefighters at a stake and in dangerous conditions. Arduino based firefighting robot has a dual advantage in which it can sense the fire and can put it off before the fire gets bigger and also it can put off the fire before it gets out of control. This robot is designed to have a flame sensor to sense the fire, mini pump will be used where the water will be sprinkled.

A. LITERATURE REVIEW

[1] Kristi Kosasih, E M Sartika, M Jimmy Hasygian (2010) under the title "The Intelligent Fire Fighting Tank Robot". The objective is to search the area with the help of white detector sound activation circuit, micro switch sensor and extinguish the fire. Tank robot is made from acrylic, plastic, aluminium, iron.

[2] Diwanji, M., Hisvankar, S., & Khandelwal, C. (2019) under the title "Autonomous Fire Detecting and Extinguishing Robot". a robot which extinguishes fire with the help of UV, IR sensors to detect fire. Robot capable of fighting a simulated tunnel fire, industry fire

[3] Bn, P., Kn, H., Bj, P., & R, H. (2019) under the title "Fire Fighting Robot". With the help of immoderate sonic sensor, Gas sensor, IR module the fire and the smoke are detected and with the help of water pump the fire will be extinguished.

[4] Ratnesh Malik, S.S. Kumbalkar, "Fire Fighting Robot: An Approach", Extinguish fire with the help of UV, IR sensors to detect fire. Robot capable of fighting a simulated tunnel fire, industry fire etc.

[5] Rakib, T., & Sarkar, M. A. R. (2016). Design and fabrication of an autonomous firefighting robot with multi-sensor fire detection using PID controller. The robot can operate over long distance. Light dependent resistors are used for detection of fire. Thus, helps in detect fire and extinguish it.

[6] Zaman, H. U., Khan, T. A., Falgunee, S. R., Rashid, G. M. S., & Talukder, F. H. (2018). Autonomous Firefighting Robot with Optional Bluetooth Control. Bluetooth is inserted so that if the fire breaks out it will intimate the connected device. If the temperature above

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40 degrees Celsius, the alarm will be rung alerting operator to control robot and avoid the damage of heat.

Fire Fighting robot is designed to be compact and it consist of components which are Arduino UNO, Relay Module, Motor Drive (L293), Pump, Water Tank, Chain Drive System.

ARDUINO UNO is a microcontroller board based, Uno means one in Italian and was chosen to mark the release of Arduino software. Its operating voltage 5V, input voltage 7-12V.

RELAY MODULE is operated electrically switch that allows you to turn on or off a circuit using voltage. It has normally closed, normally open, common contact parts.

MOTOR DRIVER (L293) it is a dal H-bridge motor driver integrated circuit (IC). It can be used to run Two DC motor with some IC, speed and direction control. It is popular 16-pin motor Driver IC.

DC MOTOR it is a machine that converts DC power into mechanical power is known as DC motor. It operates based on current carrying conductor is placed in magnetic field. DC motor -100 rpm 12-volts geared motor are generally a simple DC motor with a gear box attached to it.

FIRE SENSOR it is used for the short-range fire detection and can be used to monitor projects or a safety precaution to cut device off/on. The flame sensor is very sensitive to IR-wavelength at 760 nm.

PUMP it is a device that move fluids by mechanical action, typically converted from electrical energy into hydraulic energy.

WATER TANK is a container for storing water. It is used to provide storage and can be used for many purposes.

CHAIN DRIVE it is a way of transmitting mechanical power from one place to another. It is often used to convey power to the wheels of a vehicle. The power is conveyed by a roller chain, known as the driven chain or transmission chain.Fig.1 Sample model of rifle with stand

III. METHODOLOGY

This can be divided into three main parts namely mechanical structure, programming and hardware [3].

A. Mechanical Structure

For a strong base to the robot, a robot chassis s preferred. There are two wheels on the rear side and two wheels on the front side which are connected through a chain for the robot movement. The motors are connected to the rear wheels of the robot. For 360 degrees mobility to the robot, the motor connected to the rear wheels will help. The body of the robot can be made of acrylic sheets which can be resistant to high temperatures. This body is used to protect the internal electronic circuitry from external factors such as heat, and mechanical jerks [7]. The flame sensors are installed on the front side of the robot in three directions for detecting fire. The water container is placed on the middle of the chassis to maintain the center of gravity in the center and hence prevent the robot from tumbling.

II. MATERIALS & METHOD

B. Programming

Arduino IDE is used for programming the control of the robot which helps with mobility and fire detection and extinguishing it.

C. Hardware

The hardware used in this project are Arduino UNO board, L293D Motor Driver Module, DC geared motors, 5V DC Relay Module, 12V DC pump, Servo Motor SG90, General Purpose Board, IR Flame Sensors, Chain Drive.

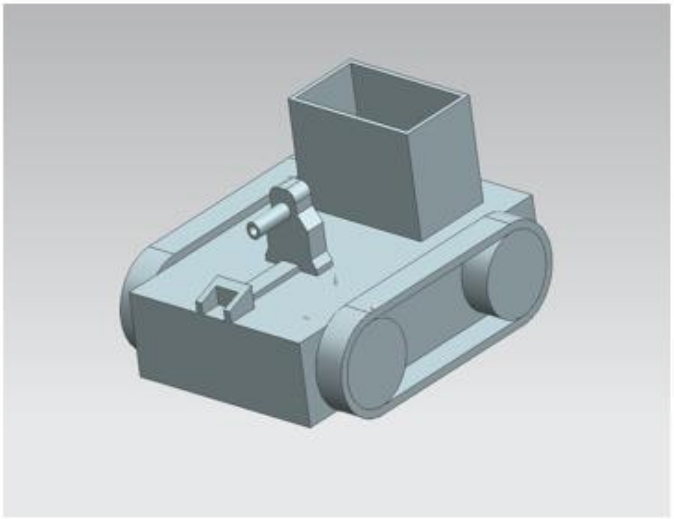

Fig.1 3D Isometric view of the model

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IV. BLOCK DIAGRAM AND EXPLANATION

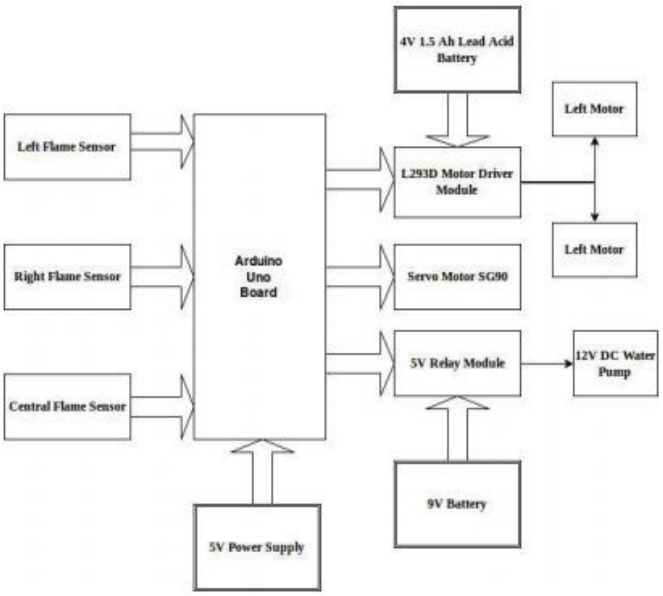

Fig. 2. Block Diagram

The above shown is the block diagram for the Autonomous Fire Detecting and Extinguishing Robot. Three flame sensors namely the left flame sensor, right flame sensor and centre flame sensor are interfaced with the Arduino Uno board as the input components [1]. L293D motor driver module is used for driving the two geared DC motors namely the Left DC Motor and the Right DC Motor. These motors are used to give direction to the robot according to the fire i.e., the input received from the flame sensors. The 12V DC Pump driven by an external battery with the help of a 5V Relay Module is used to extinguish the fire. A servo motor (SG90) is used to give axial direction to spray the water on fire.

The Arduino Uno board is powered by a 5V DC jack or 6V battery. The Motor Driver Module is powered by 4V, 1.5 Ah Lead Acid battery. The 12v DC water pump is powered by a 9V battery with the help of a 5V Relay Module. The servo motor SG90 is powered by the Arduino UNO board.

A. Circuit Description

All the three flame sensors namely the left flame sensor, right flame sensor and centre flame sensor and the servo motor are given Vcc and Gnd commonly through a small breadboard. The input pins of all the three flame sensors are connected to the Digital Pins of the Arduino Uno board (any pins from 0 to 13). The PWM pin of the Servo

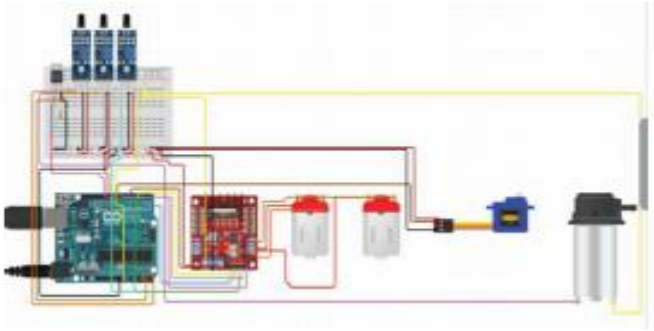

Fig. 3. Circuit Description

Motor SG90 is also connected to one of the digital pins. The pins IN1, IN2, IN3 and IN4 respectively of the L293D Motor Driver Module are also connected to the digital pins. The OUT1, OUT2, OUT3 and OUT4 pins of the Motor Driver Module are connected to the Left and the Right DC motor respectively. The 4V 1.5Ah Lead Acid is connected to the power terminals of the Motor Driver Module. The coil terminals of the 5V Relay Module are connected to a 9V battery. The 12V DC Pump is connected to the Normally Open (NO) terminal of the relay. The common terminal of the relay is connected to the digital pin of the Arduino UNO board to give excitation to the relay

V. ALGORITHM

Following steps are followed for the programming of the robot to detect and extinguish fire.

1. Start
2. Read the Inputs from the Flame Sensors
3. If no flame is detected, proceed forward (both the motors on)
4. If flame is detected by the right sensor, the move right and stop at a certain distance and start DC Pump and Servo motor. (Right motor off, left motor on)
5. If flame is detected by the left sensor, the move left and stop at a certain distance and start DC Pump and Servo motor. (Left motor off, right motor on)
6. If flame is detected by the central sensor, the move forward and stop at a certain distance

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and start DC Pump and Servo motor. (Both the motors on)

7. Stop

VI. RESULTS& DISCUSSIONS

A test was conducted to check the performance of the device and it was found that the robot can detect and extinguish the fire using water. The robot detects the fire around it up to the range of 3 feet. The motor controller and Arduino code ensures that robot avoids any obstacles in the surrounding. This robot is designed for indoor conditions. This robot is cost effective and doesn't cost much

VII. CONCLUSIONS

The circuit of our project was designed and set up using Arduino Uno which is very reliable & stable. The design was successfully implemented on a chain drive robot. The battery is mounted inside the robot to prevent any damage to the battery from an external fire source. The robot successfully detected multiple flame sources and extinguished them from a safe distance. The speed of the robots is reduced to the preferable speed in order to increase the operating time and effective detection of the flame source.

ACKNOWLEDGMENT

We would like to express our sincere gratitude to the Management, Principal Sapthagiri College of Engineering Bengaluru for the facilities provided and their support. Also, we would like to thank the Head of Department Mechanical Engineering and faculties for their encouragement and support.

REFERENCES

[1] Kosasih, K., Sartika, E. M., & Hasugian, M. J. (2010). The Intelligent Fire Fighting Tank Robot. 1(1), 8. 2010 International Standard Serial Number (ISSN), 1979-2867.

[2] Diwanji, M., Hisvankar, S., & Khandelwal, C. (2019). Autonomous Fire Detecting and Extinguishing Robot. 2019 2nd International Conference on Intelligent Communication and Computational Techniques (ICCT), 327–329. https://doi.org/10.1109/ICCT46177.2019.8969067

[3] Bn, P., Kn, H., Bj, P., & R, H. (2019). Fire Fighting Robot. 2019 International Conference on Information and Communication Technology Convergence (ICTC), 889–892. https://doi.org/10.1109/ICTC46691.2019.9025012

[4] Ratnesh Malik, S.S. Kumbalkar, "Fire Fighting Robot: An Approach", Indian Streams Research Journal, Vol.2, Issue, I/March;12pp.1-4.

[5] Rakib, T., & Sarkar, M. A. R. (2016). Design and fabrication of an autonomous firefighting robot with

multisensor fire detection using PID controller. 2016 5th International Conference on Informatics, Electronics and Vision (ICIEV), 909–914. https://doi.org/10.1109/ICIEV.2016.7760132

[6] Zaman, H. U., Khan, T. A., Falgunee, S. R., Rashid, G. M. S., & Talukder, F. H. (2018). Autonomous Firefighting Robot with Optional Bluetooth Control. 2018 4th International Conference on Computing Communication and Automation (ICCCA), 1–4. https://doi.org/10.1109/CCAA.2018.8777640

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Design and Fabrication of Areca-nut Tree Climbing Robot for Harvesting and Pesticide Spraying

SANKETH*[1], RUDRESH G[2], SANTHOSH KUMAR S[3], VISHAL VENKATESH BHANDARI[4], PADMANABHA G[5]

Department of Mechanical Engineering, Sapthagiri College of Engineering
#14/5, Chikkasandra, Hesaraghatta main road, Bangalore- 560057 India.

[1]sankethpoojari2@gmail.com
[2]rudreshg08@gmail.com
[3]santhoshskumar231099@gmail.com
[4]vishalbhandari05031999@gmail.com
[5]padmanabhag@sapthagiri.edu.in

***Abstract*— This paper is about "Design and Fabrication of Areca-nut tree climbing Robot for Harvesting and Pesticide Spraying". The device consists of Hexagonal base frame which supports all components to be built upon. It is fitted with two DC motors – Nylon tyres with rubber grippers at 120 degrees each other for ease of operation. A specially designed wireless (Wi-Fi) controlled spraying unit is mounted on frame. DC geared motors having reduction gear which ensures self-locking of the tyres and thus maintains the height. To accommodate for change in the diameter of Areca-nut tree as the device moves up and down, a spring loaded mechanism is used for exerting sufficient tension required for gripping the tree.**

***Keywords*— Areca-nut tree, Robot, spraying and harvesting mechanism.**

I. INTRODUCTION

Areca-nut plantation is the major cash crop cultivation in India. Finding skilled labor, who should be capable of climbing high altitudes of the Areca-nut trees is tough. It is very difficult to climb the high altitude during extreme weather conditions. Manual climbing is one of the conventional tree climbing method. This method is used for spraying the pesticides for Areca-nut crop in order to prevent the crop from disease like "Nut rot Disease". Large amount of crop will be wasted, due to this disease because usually this syndrome attacks the crop during rainy season. The major drawback of this method is that it is a risky and may cause harm for life. Many have lost their life during climbing tree or descending the tree. This project device will help to overcome all these difficulties.

It is mandatory to climb the tree for at least five times in a year for a successful harvest that is twice for the pesticide spraying against fungal disease and thrice to harvest the Areca-nut. This device consists of pesticide storage tank, pump and nozzle for spraying purpose also blades and arm for harvesting purpose. This single device will manage all process from pesticide spraying to crop harvesting hence it reduces the risk of life and prevents the crop from the fungal disease. The source of energy for this device is battery and it is controlled by Wi-Fi via mobile / smartphones.

II. LITERATURE REVIEW

[1] J.Sharana Basavaraja, Nagaraja R, Somashekar H Hegde Design and development of Areca Tree climber. IJRMMAE- Sep 2015.

J Sharma Basavaraja[1] has made use of rope in order to control the machine. Machine is concentrated on the two units. i.e, RH and LH. The RH unit create the downward movement of the pedal through which the steel wire rope is stretched and locks the tree. LH units lifts up by pulling the handle attached to it to limb until the climber reaches to the required height.

.

[2] Uvaraja V C, Manohar N, Murali Prasath. Design and fabrication of Areca-nut tree climbing machine IRJET March 2019

Uvaraja V C[2] carried a project by making use of a triangular base frame which is the supporting structure for all other components. Battery is connected with the motors for the power supply purpose by making use of wires and DPDT is used to control the machine. Self-locking of tyres is been achieved by DC motors which has less gears. As the machine climbs up and down there is a variation in the diameter. A spring stacked system is implemented for applying the suitable strain to hold the tree firmly.

[3] Mohit Rane, Ashish Toraskar, Utkarsh Naik, Rajat Harmalkar, Gauresh Lingwat, Shiva Krishna J, Gaurish Walke. Design of Semi-automated Areca-nut Tree climbing Plucker, JETIR-May 2019.

Mohit Rane[3] implemented Radio Frequency (RF) remote control wireless technology to control the machine and camera is fitted to view the high altitudes from the ground. This technology is user friendly. Main objective of this project was to increase the productivity and reduce human risks.

[4] Fasil TK, Jishnu K Das, Shabeeh AP, Xavier Saji, Prof.

Jacob Kuriakose, Prof. Vinod Yeldho Baby. Remote controlled Areca-nut plucking machine , IRJET ,Volume 5 April 2018.
Fasil T K[1] has fabricated the machine for Areca-nut plucking. The part consists of a base frame, collector, cutter, rollers, ropes, pulleys, rings and springs. Power to the rope-pulley mechanism is provided by the motors. Rope is winded and unwounded on to the drum which happens due to the rotation of motor. Machine is controlled by Bluetooth via mobile.

[5] R. Thirupathi, N. K. Adarsh, R. Akash , N. Lakshmana Prabhu, T. Karthikeyan. Design and Fabrication of a Areca-nut Climber and Harvesting , IJRESM, volume 4, March 2021.
R Thirupathi[5] has designed and fabricated a climber for harvesting, which consists of pulleys, springs, rollers, rope and clamps with rubbing padding. Machine climbs the tree by making use of rope, pulley and spring mechanism. Main objective of this work was to completely eliminate the cost of electricity and to avoid human risks.

[6] Pallavi H G, Vinay V, Sushma N, Sharath Kumar A J presented a paper "Automated Areca-nut tree climbing machine", IJERT, Volume-7, issue-10, 2019.
The device consists of a hexagonal base frame which supports all the components to be built upon. It is fitted with DC motors - nylon tires with rubber grippers. A specially designed remote controlled unit is mounted on the frame. Power from the battery is supplied to the motors using flexible wires. Movement of the dc motors and the spraying pump are controlled by the IR operated 8 channel relay system. To accommodate for change in the diameter of Areca-nut tree as the device moves up and down, a screw loaded mechanism is used for exerting sufficient tension required for gripping the tree. .

III. OBJECTIVES

- Existing traditional methods of climbing tree will be replaced by this project.
- To develop conceptual design of the model.
- To fabricate the model.
- To control the model using ATmega328 microcontroller.
- To spray pesticide against fungal disease.
- To harvest crop.

Our main aim is to represent our innovative concept which reduces the risk of life, while climbing the high altitudes. Existing traditional methods as well as the tree climbing machines has some disadvantages. In order to overcome these disadvantages, we have come up with an idea. Our objective is to design and fabricate the model which is more efficient than existing models. The machine is controlled by Wi-Fi via smartphones. The newly developed machine is capable of pesticide spraying and harvesting the crop can be done without any risk of life.

Methodology:

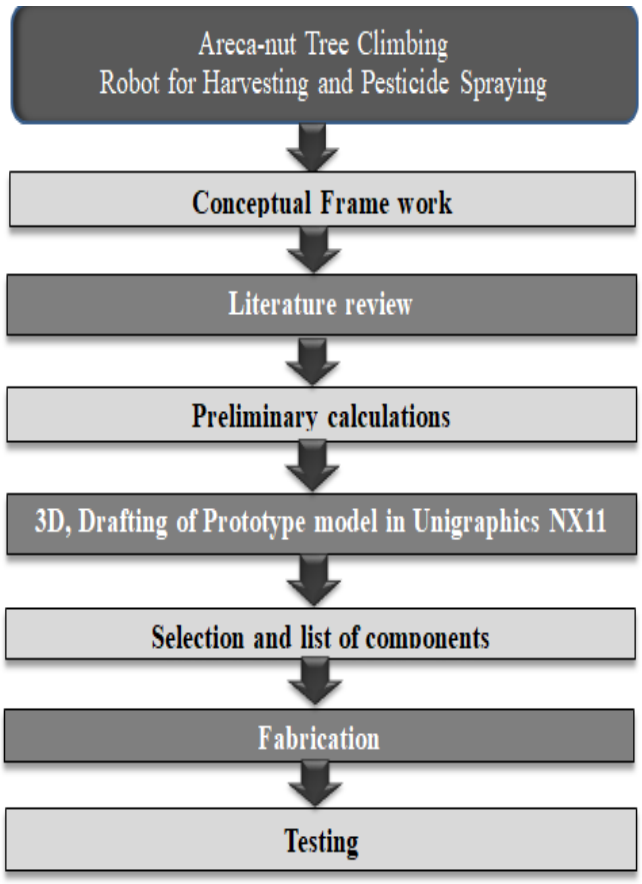


Fig 1 Methodology of Project

This project is selected based on the current problem in field of agriculture. The difficulties in the Areca-nut field like pesticide spraying and harvesting without any risk are mainly focused. Many Journal papers and articles were referred and gathered the information about improvements to be need in existing systems used in Areca-nut farming field. Design calculations are done, which includes force calculation and torque calculation to select the capacity of motor. Modeling is done in the Unigraphics NX11 software and 3-Dimensional and 2-Dimensional views are obtained. Components required for model are listed down. Further fabrication work is carried out and testing is done and necessary changes are implemented.

Block diagram

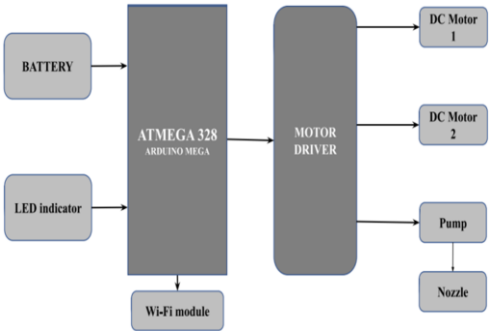


Fig 2 Block diagram .

IV. WORKING.

This project works on basic principle of friction that is the relative lateral motion of two solid surfaces in contact. The machine developed consists of a hexagonal base frame, springs are provided on each links, for the movement with the varying size of the tree with nylon wheels driven by three high torque geared DC motor. The frame of the Areca-nut tree climber can be opened up and held around the tree. In this tree climbing machine power is obtained from battery.

A motor driver used to control the motors. When motor driver is switched on, the motor rotates the shaft which in turn rotates the wheels in clockwise direction. Due to the friction between drive wheel and the bark of the tree machine rises up along the length of the tree. The contact friction between the wheel and tree is maintained with the help of grippers on the wheels. The only component which is in contact with the tree is the wheels which are made up of nylon. Hence it doesn't cause any damage to the tree. When the device reaches on top of the tree the motor is made to stop using command. The tension of the spring helps to retain the machine for varying diameter of the tree. Then the pump is switched ON by other command, then the pesticide is being sprayed. After which the pump is stopped, the whole device is brought down by changing the command. After reaching the ground the device is removed from the tree and attached to the next tree for spraying and harvesting.

DESIGN CALCULATION

Mass Calculation

Generally diameter of the Areca-nut tree will be 100mm to 150mm.

Total Length of the frame = 970.2 mm.
Total Length of the blade arm = 225 mm.
Mass of the frame (m1) = 9 kg.
Mass of the blade arm (m2) = 0.5 kg.
Mass of the other components (m3) = 3.140 kg.
Total mass of the machine (m) = 12.64 kg

Force Calculation

Mass of the machine,
m = 15 kg
W = 15 * 9.81 [W=m*g(9.81)]
W = 147.15 N

Assuming coefficient of friction between tree and rubber grip,
μ = 0.6

Actual Force to be lifted,
$F = \boldsymbol{W/\mu}$
F = 147.15/0.6
F = 245.25 N

Torque Calculation

Calculating motor torque,
Torque =Force * Radius(Wheel radius)
= 245.25×0.035
Torque = 8.58 Nm.

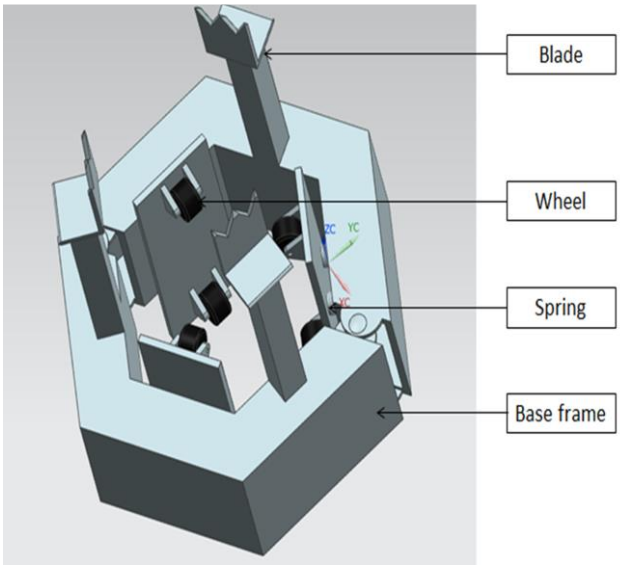


Fig 3 3-D view of Device

V. CONCLUSION

Thus, we have come up with machine which reduces the risk of life during pesticide spraying and harvesting. We have been able to design and fabricate Areca-nut climbing pesticide spraying and harvesting machine. In this paper the successfully attempt made for designing of Areca-nut tree climbing, pesticide spraying and harvesting.

VI. ACKNOWLEDGEMENT

We would like to express our sincere gratitude to the Management, Principal, Sapthagiri College of Engineering Bangalore for the facilities provided and their support. Also, we would like to thank the Head of Department Mechanical Engineering and faculties for their encouragement and support.

REFERENCES

[1] J.Sharana Basavaraja, Nagaraja R, Somashekar H Hegde. *"Design and Development of Areca Tree Climber"* IJRMMAE- Sep 2015.

[2] Uvaraja V C, Manohar N, Murali Prasath, Mohana Krishnan S, Vishnu Sankar S, "*Design and Fabrication of Arecanut tree climbing machine"* IRJET- Mar 2019.

[3] Mohit Rane, Ashish Toraskar, Utkarsh Naik, Rajat Harmalkar, Gauresh Lingwat, Shiva Krishna J., Gaurish Walke. *"Design Of Semi-Automated Areca-Nut Tree Climbing Plucker"* JETIR-May 2019.

[4] Fasil TK, Jishnu K Das, Shabeeh AP, Xavier Saji, Prof. Jacob Kuriakose, Prof. Vinod Yeldho Baby. "*Remote controlled Areca-nut plucking machine"*, IRJET ,Volume 5 April 2018.

[5] R. Thirupathi, N. K. Adarsh, R. Akash , N. Lakshmana Prabhu, T. Karthikeyan. *"Design and Fabrication of a Areca-nut Climber and Harvesting ",* IJRESM, volume 4, March 2021

[6] Pallavi H G, Vinay V, Sushma N, Sharath Kumar A J presented a paper *"Automated Areca-nut tree climbing machine",* IJERT, Volume-7, issue-10, 2019.

[7] Rahul V, Sebin Babu, Sameer Moideen CP, Vineeth VP, Nikhil Ninan. "A design of tree

climbing robot" Report 2017.

[8] C Sathishkumar, G Dineshkumar, K S Karthikeyan, P Prasanna. "*Development of Areca Nut Climbing And Harvesting Machine With Pesticide".* ICMMM 2020, 1059 (2021) 012074,doi:10.1088/1757-899X/1059/1/012074.

[9] Eldhose Paul1, Lovin Varghese, Ajo Issac John, George Jolly, Akash Paul Savio. "*Semi - Automatic Areca Nut Tree Climbing and Harvesting Robot".* IJAREM ISSN: 2456-2033 PP. 53-58, Vol. 03, Issue 07, 2017.

[10] Rakesh B K, Vineet L Kulkarni, Ruthvik S Vasistha, Monisha P, Madan K R. "*Drone Assisted Arecanut Harvesting Module".* IJRASET ISSN:2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429 Volume 8, Issue VII July 2020.

[11] Mohammed Said U Y, Shillin K S, Anil D Koola, Dr.Ragesh Sathiyan M, Dr.S.Senthil Kumar. "*Motorized Arecanut Climber And Pesticide Sprayer".* Volume-2,Issue-7, July-2019.

[12] C.Thiruvasagam, Sharun K G, Shamseer K, Sidharth Raj SR, Vibin kumar KV. "*Design and Fabrication of Coconut Tree and Palm Tree Climbing Machine".* Volume-3, Issue-4, April,2017,Paper-3.

[13] Salice Peter, Jayanth M, Arun Babu M.K, Ashida P.V, AkhilK. T. "*Design and Construction of a Tree Climbing Robot".* IJAREEIE, Vol. 4, Issue 4, April 2015.

[14] Mr. Vineet Awasthi, "*Tree Climbing Device".* International Journal Of Information And Computing Science, Volume 5, Issue 12, December,2018.

[15] Shivdeep D R. "*Design and Fabrication of Areca Nut Tree Climber and Harvesting Machine".* Volume: 06 Issue: 02, Feb 2019.

[16] M.J. Nanasagar Kamath, Jnanesh Bekal, Nixon D'souza, Manjunath K. *"Arecanut Tree Climber And Pesticide Spayer".* Project Reference No.: 40S_BE_1153.

[17] Tushar N. Kamate, Uday R. Solankure, Pavan Kumar R. Lohar, Prashant D. Ganthade. "*Arecanut Harvesting And Pesticide Spraynig Machine".* Project Reference No.: 41S_BE_0005.

[18] M. Tony, C. Johny, S. Sayooj, K. Yathish, J. P. Vas. "*Design and Fabrication of Arecanut Tree Climbing and Spraying Machine". Journal of Mechanical Engineering and Automation*, Vol. 6 No. 5A, 2016, pp. 93-96. doi: 10.5923/c.jmea.201601.17

DESIGN AND FABRICATION OF SHREDDER MACHINE FOR PLASTIC BOTTLE

BHARATH M [1], CHARAN G [2], KARTHIK TK [3], MANISH GOWDA [4], BASAVARAJU

Department of Mechanical Engineering, Sapthagiri College of engineering
#14/5 Chikkasandra, Hesaraghatta main road, Bangalore- 57 India

[1]bharath.m696@gmail.com

[2]charan1999@gmail.com

[3]tkkarthik.98@gmail.com

[4]manishgowda068@gmail.com

[5]basavaraju@sapthagi.edu.in

Abstract: **The context of this paperwork is the study of Recycling of plastic waste and design and Fabrication of Shredder Machine. Plastic, since is a non degradable material and is potential to cause bad environmental effects, should be recycled. So our attempt is to design and fabricate a Shredder Machine with maximum optimization of the available resources at minimum cost. This paperwork is divided into two parts where the first part deals with the understanding of the need of plastic recycling and its types and properties and how it can be recycled. The second part sheds light on the design and Fabrication of Shredder Machine and its component details, how to operate it, advantages and limitations of the same. In these, designs of Blade and machine frame are modified. For designing purpose AutoCAD 2D and SOLIDWORKS have been used.**

Keywords: Product Development, Plastic, Waste, Shredder, Recycling

I. INTRODUCTION

It would be difficult to imagine our modern world without plastics. Today they are an integral part of everyone's lifestyle with applications varying from common place domestic articles to sophisticated scientific and medical instruments. Plastic can take more than 500 years to decompose. Plastics are composed of major toxic pollutants, it has the potential to cause great harm to environment in the form of air, water and land pollution. Hence it creates negative impact on the natural environment and creates problems for plants, wildlife and even on human beings. Hence; there is the need to promote the recycling of plastic materials. Plastic recycling is bound to realize a lot of savings in production costs, conserve limited resources, and alleviate environmental pollution.

Machinery available to for nylon and plastic recycling is usually of very high cost, and bulky. This, to a great extent, imposes serious restrictions to the recycling of nylon and plastics in the developing countries. Therefore, in order to overcome these shortcomings, it was necessary to develop a machine specialized in its application in order to achieve the set objectives of reduced cost and size optimally using locally available materials. Plastic shredder is the machine designed to cut or reduce large materials into tiny pieces for easy handling. The materials that can be shredded include syringe, glucose bottles, water bottles, pure water nylon, and many other items. Shredder is an integral part of any Plastic Recycling Plant.

II. Literature Review

Dr. Fauzia Siddiqui - The different components designed along the blade are frame/stand, shaft, washers, gears, pully etc. thus the designing phase is briefly classified as the machine construction, cutting system and the transmission system. The total protect depends upon various parameters such as total knowledge about the system, design of a single blade and its arrangement of the main shaft, reduction in rotation.

Dr Muhammad Maqbool Sadiq, Muhammad Rafique Khattak- Plastic waste is silent threat to the environment and their disposal is a serious issue for waste managers. Now a day society does not have any alternative to plastic products like plastic bags, plastic bottles, and plastic sheets etc. In spite of all efforts made to limit its use but unfortunately its utility is increasing day by day. To circumvent this issue many efforts were made in the past to

reuse the plastic waste but no significant results were achieved.

Dr. Jassim M. Abdulkarim Jaff, Darewan A. Abdulrahman - I includes plastic collection, manual sorting, chipping, washing pelleting. The large particles of plastic need to be broken down into small pieces to reduce storage and transportation space requirement.

Atadious David and Oyejide Oluwaymi Joel - Shredding machine is designed to reduce large solid material objects into a smaller volume, or smaller pieces. Shredding machines are usually used to reduce the size and shape of materials so they can be efficiently used for the purpose intended to. Collected plastics wastes were shredded with the machine and the results obtained reveal that the machine performance is satisfactory.

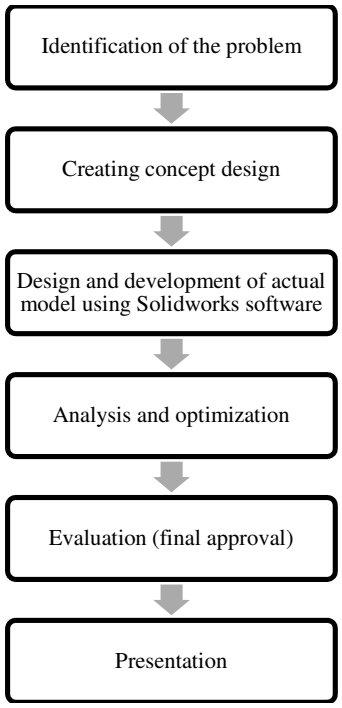
Karolina Glogowska, Jakub Rozpedowski - During the shredding process, the following parameter were analysed : electricity consumption, temperature inside the shredding chamber and the temperature of the obtained recycled. The study indicates the importance of the possibility to shape the workspace of the shredder and the energy relation of the process.

III. OBJECTIVE

The main objective of this project is to convert waste plastic to useful products.
To achieve this main objective we have designed shredder machine and a furnace, shredder machine which cuts waste plastics into small pieces and furnace is to converting plastic pieces into molten state. The molten plastic injected in molds for producing the useful products.

- The overall objective of the project is to reduce plastic in waste streams.
- To create the awareness on effective use of plastic materials.
- This project gives the effective way of transporting the waste plastic materials.
- We have designed the shredder machine in low cost, which converts the plastic bottles into the small plastic pieces.
- Use the waste plastics which effect the environment in proper way by recycling them to make different useful products.
- By recycling of waste plastic bottles, major problems like global warming and green house effect can be reduced

IV. METHODOLOGY



V. CALCULATIONS

Motor Calculations

A=W*T
A= cutting area made by the edge of the blade
W= width of cutting edge
T= thickness of cutting edge
Motor requirements: 1.5HP, 1440RPM max speed and 1.5 HZ

Torque exerting on the blade as well as shaft

Torque (T) = Force * Perpendicular distance

Power required

P = 2*3.14*N*T/60
CHECKING FOR DESIGN SAFETY
Blade material: mild steel (ultimate shear strength= 580Mpa)
Shaft diameter calculations:
Solid shaft diameter:
Shear strength = (16*T)/ (3.14*d)

Cutter design

This is a 4 point cutting tool which we are going to use in our project for shredding plastic waste. The material used for cutter is Carbide tip –Mild Steel 2062. The cutting

speed Vc = pi*D*n/1000. The outer diameter of the cutter is 100mm.

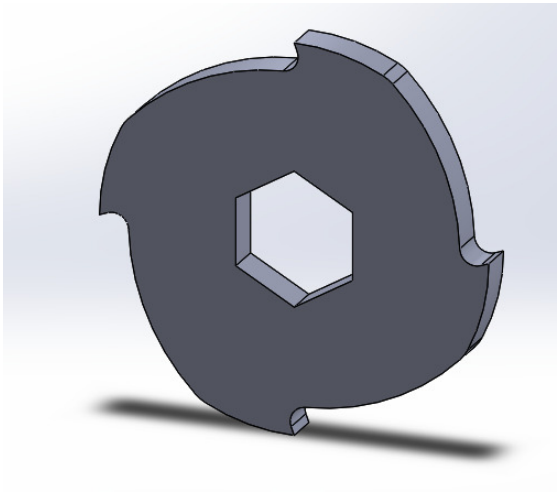


Fig.1 Shedder blade

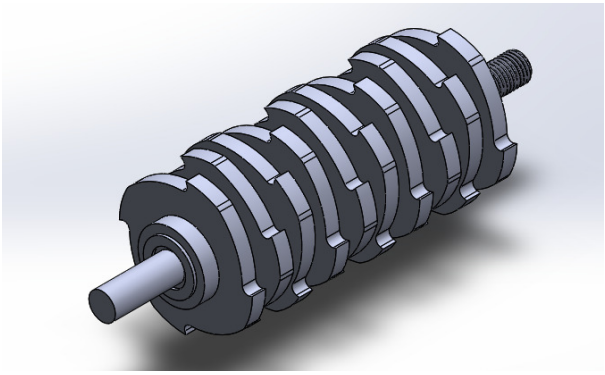


Fig.2 Shedder blade Assembly

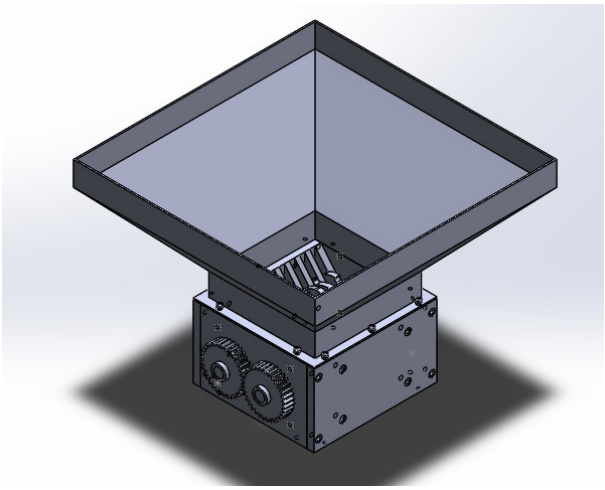


Fig.3 Shedder Assembly

VI. Outcomes

- Plastic shredders help recover waste during different industrial processes like moulding, trimming and casting.
- Shredded waste is easier to handle or re-use.
- Shredding is also an efficient waste disposal method, and this greatly reduces the cost of recycling for several industries.
- They convert plastic waste into reusable raw material for manufacturing plastic containers, PET bottles and PVC products.
- They also help recoup waste disposed form commercial units.

VII. CONCLUSION

A plastic shredding machine was designed and successfully con-structured. This was aimed at solving the problems of indiscriminate dumping of plastic solid wastes. The machine was evaluated for performance. Collected plastics wastes were shredded with the machine and the results obtained reveal that the machine performance is satisfactory. This machine when commercialized will meet the demand for plastic wastes management.

VIII. REFERENCES

[1] Krisha Therese T. Pajarillo, Cost efficient Dual Shredder for Paper and Plastic: A Prototype

[2] Akash.B. P, Christina, Darshan.K. S, Manoj, Plastic Waste Management by Mechanical Shredder Machine, IJARIIE-ISSN (O)-2395-4396 Vol-5 Issue-2 2019

[3] Prashanth.P, Mohammed Ali, Kaushik S Patel, Design and Fabrication of Water Bottle Crusher, International Research Journal of Engineering and Technology Volume: 04 Issue: 06 | June-2017

[4] ND Jadhav, Akshay Patil, Harad Lokhande and Deepak Turambe, Development of Plastic Bottle Shredding Machine, International Journal of Waste Resources, Jadhav et al. Int J Waste Resour 2018, 8:2 DOI: 10.4172/2252-5211.1000336

[5] Akash.B. P, Christina, Darshan.K. S, Manoj, Plastic Waste Management by Mechanical Shredder Machine, IJARIIE-ISSN (O)-2395-4396 Vol-5 Issue-2 2019

FABRICATION OF ECO FRIENDLY COOLING CABINET

RAKSHITH R[1], RAKESH D K[2], NUTHAN N[3], RENUKAPRASAD D U[4], PADMANABHA G[5]

Department of Mechanical Engineering, Sapthagiri College of engineering
#14/5 Chikkasandra, Hesaraghatta main road, Bangalore- 57 India
[1]rakshithrichi5@gmail.com
[2]charliepower81@gmail.com
[3]nuthangowda16@gmail.com
[4]Renukaprasaddu@gmail
[5]Padmanabhag@sapthagiri.edu.in

***Abstract* - The need to feel relax and comfortable in hot and humid condition. This comfortable has become a need now a day. Systems like refrigeration and air conditioning has been increased rapidly to attain comfortable. Air conditioning plays a very important role in thermal comfort. The systems like air conditioning and refrigeration are not suitable for villages due to longer power cut duration and also cost of the product is high. Now in market commercially dominant cooling systems are existed and they can consume high power. So that evaporative cooling pad system is used. When air is pulled through evaporative cooling pads that are saturated with water then cooling effect will be formed due to evaporation of water. In a cooling cabinet cool air fans are used so that reduction in temperature will take place. Solar power systems are considered as one of the sustainable energy system. If we considered solar cooling systems in villages, that will helps in reducing electricity and other features. It is essential that small scale vegetable and fruit producers need to use cold storage methods to maintain freshness and quality of vegetables and fruits. Our aim is to design an efficient cold storage unit using as much natural cooling and ventilation as possible that will store the vegetables and fruits also reduce the electricity cost. A solar powered evaporative cooling system is designed and constructed to increase the self-life of stored vegetables and fruits. Evaporative cooling systems help to save money.**

Keyword : Eco Friendly, Evaporative Cooling

I. INTRODUCTION

Evaporative cooling is a process which reduces the temperature of a substance due to the cooling effect from the evaporation of water. The conversion of sensible heat to latent heat causes a decrease in temperature and evaporated water gives cooling effect. The cooling system is used in both small and large industry. Several researches are going on to design evaporative coolers in least price. Evaporative cooling can provide longer life to fruits and vegetables. Humidity and hot climate condition can reduce the life span of fruits and vegetables. Market value of fruits and vegetables depend on its freshness and quality. Deterioration of fruits and vegetables is mainly because of temperature fluctuation. At high temperature fruits and vegetables can deteriorate at higher rate. Too lower temperature can also damage some of agriculture produce. Fruits and vegetables are kept in normal humidity condition to maintain quality. Damaged vegetables have shorter life span and these are kept at lowest safe temperature. Safe temperature can increase the storage life by reducing water loss and lowering respiration rate. In most of the country, the postharvest fruits and vegetables deteriorated due to lack of proper storage. Refrigerated cold storage is the best method for storage but it is very expensive. Evaporative cold storage is an alternative technique for storage of fruits and vegetables at a least cost. When air passes through wet pad towards preservation area, cooling will takes place. Cold storage plays a vital role in increasing the economy and growth of the country. The effective evaporative cold storage system can store fruits and vegetables temporarily before consumption. Evaporative air coolers are used for humidification, where dry air is humidified during cool weather. During this time windows and doors should be closed. Evaporative air coolers are environment friendly because they don't use any refrigerant gas.[1] [2] Chourasia M K and Goswami T K (2006) Vol. 02, No. 03.
Predicted values of air velocity, product temperature and moisture loss from the potato in the stack were found to be in good agreement with experimental values. There is no doubt that the temperature of the product is one of the most significant factors that govern the extent of storage losses and hence, the economic viability of the storage system. Moisture loss is an equally important parameter as product temperature, as the former affects the quality and quantity of the saleable product.[2] Y H Yau (2010), Vol. 31, No. 4 Analysis for heat recovery ventilation systems and concluded the heat wheel system was the best system as it has the highest total energy saving, shortest payback period and providing the most stable indoor air conditions. [3] Ephraim M Sparrow, Jimmy C K Tong et al. (2007), Vol. 50 presented the special features of a

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test facility capable of providing highly accurate data for air to air heat/moisture exchangers. Aside from the features that have already been described, there are others that are worthy of note. One is the low cost of the facility, both with regard to materials of construction and to the time required for fabrication. Low cost and simple fabrication are hallmarks of flexibility. This flexibility enables easy accommodation of the test facility to a wide variety of heat/moisture exchanger types and sizes.

II. MATERIALS & METHODS

1.Solar panel: The term solar panel is used colloquially for a photo-voltaic (PV) module. A PV module is an assembly of photo-voltaic cells mounted in a framework for installation. Photo-voltaic cells use sunlight as a source of energy and generate direct current electricity. A collection of PV modules is called a PV Panel, and a system of Panels is an Array. Arrays of a photovoltaic system supply solar electricity to electrical equipment. Panel Size 1 ¼" — x I" Cost of the Panel Rs.700 - Rs.1,000/-. Weight of the Panel 1kg.Voltage 12 volt .Current 7.5 A. Power 20 watt.

2.Battery:A battery is a device consisting of one or more electrochemical cells with external connections for powering electrical devices such as flashlights, mobile phones, and electric cars. When a battery is supplying electric power, its positive terminal is the cathode and its negative terminal is the anode. The terminal marked negative is the source of electrons that will flow through an external electric circuit to the positive terminal. Weight of the battery 2 kg.Cost of the battery Rs.500 – 600.Output power 86.4 watt. Operating voltage 12 V .Current 7.5 A.

3. DC Motor: A DC motor is any of a class of rotary electrical motors that converts direct current electrical energy into mechanical energy. The most common types rely on the forces produced by magnetic fields. Nearly all types of DC motors have some internal mechanism, either electromechanical or electronic, to periodically change the direction of current in part of the motor. DC motors were the first form of motor widely used, as they could be powered from existing direct-current lighting power distribution systems. A DC motor's speed can be controlled over a wide range, using either a variable supply voltage or by changing the strength of current in its field windings. Small DC motors are used in tools, toys, and appliances. The universal motor can operate on direct current but is a lightweight brushed motor used for portable power tools and appliances. Larger DC motors are currently used in propulsion of electric vehicles, elevator and hoists, and in drives for steel rolling mills. Operating voltage 12 volt, Operating current 1.5 A, Motor Speed 80 RPM, Cost of the DC Motor Rs.600/- to Rs.800/-

4. Submersible Pump: A submersible pump (or sub pump, electric submersible pump (ESP)) is a device which has a hermetically sealed motor close-coupled to the pump body. The whole assembly is submerged in the fluid to be pumped. The main advantage of this type of pump is that it prevents pump cavitation, a problem associated with a high elevation difference between the pump and the fluid surface. Submersible pumps push fluid to the surface, rather than jet pumps, which create a vacuum and rely upon atmospheric pressure. Submersibles use pressurized fluid from the surface to drive a hydraulic motor downhole, rather than an electric motor, and are used in heavy oil applications with heated water as the motive fluid.

Methodology:

- Construction of fabricated solar refrigerator that can store vegitables under required conditions
- Developing a refrigerator that does not use cfc or emits cfc unlike regular refrigerator.
- In order to maintain cool temperature inside the refrigerator, we use water as an alternative for cfc.
- Designing the model which satisfies the desired requirements.
- The list of components required are made and bill of the materials are collected.
- The parts are assembled and testing are done in various conditions.
- Based on testing results, required changes are made and final product is obtained.

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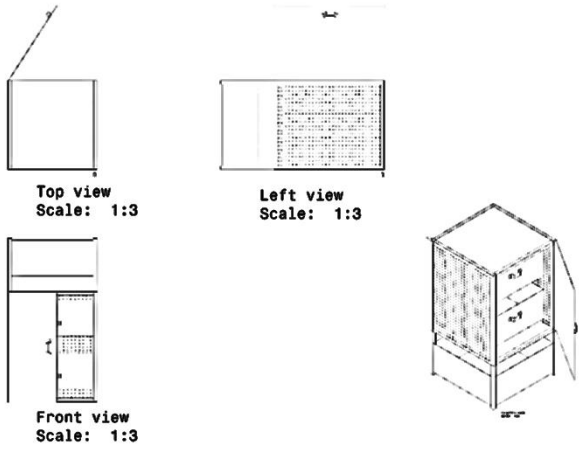

Fig.1 Final Draft Design of Cooling Cabinet

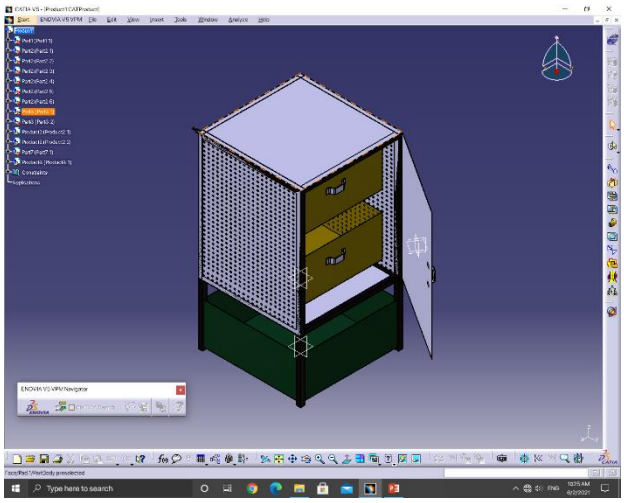

Fig.2: 3D Model of Cooling Cabinet

Body Fabrication:

- A basic sketch has to drawn to furnish on software.
- Required design is done on the software and converted into draft.
- Material selection and procurement are done.
- Fabrication of body is done based on the final design
- Required connections are done correctly.
- After completion of the assembly, testing is done on various terrains
- Temperature less than the atmosphere is achieved

III. RESULTS & DISCUSSIONS

The machines generally utilize environmentally friendly refrigerant water which has no greenhouse potential. Because the systems merely require auxiliary energy for the operation of pumps and heat rejection they utilize significantly less power (or no other power). Solar machines have few moving parts and a long life if designed correctly. The electricity grid is also relieved, since the mass operation of electrical air-conditioners in summer occasionally leads to severe strain on the electricity grid. In addition to cooling, the solar collector system can also provide thermal energy for domestic hot water preparation and heating support which leads to a further reduction of emissions. Furthermore, noise emissions are significantly lower since machines work without compressors. A variety of products are stored in these refrigerated warehouses, depending on the product characteristics and storage requirements.

IV. CONCLUSION

Considering natural resources and pollution constraints, an effort has been made to prepare solar powered and eco friendly cooling cabinet. Hence, it can be concluded that: The cooling cabinet provides a cost effective method freezing of fruits and vegetables. It is essential for increasing the self-life of fruits and vegetables. The cooling cabinet has been designed and fabricated. It has successfully demonstrated its ability to increase self-life of fruits and vegetables. The equipment has high efficiency and high productivity. The overall equipment cost is less. The equipment has zero maintenance cost.

ACKNOWLEDGEMENT

We would like to express Acknowledgement our sincere gratitude to the management ,principle sapthagiri college of Engineering Bengaluru for the facilities provided and there support.Also we would like to thank thus head of the department Mechanical Engineering and faculties for their encouragement and support.

REFERENCES

1] Chourasia M K and Goswami T K (2006), “Simulation of transport phenomena during natural convection cooling of bagged potatoes in cold storage, Part I: Fluid flow and heat transfer. Bio- systems engineering”, in press, Bio-systems

ISBN: 979-85-27243-61-1

Engineering, Vol. 02, No. 03.
[2] Chourasia M K and Goswami T K (2007), "Steady state CFD modelling of airflow, heat transfer and moisture loss in a commercial potato cold store", International Journal of Refrigeration, Vol. 30, pp. 672-689.
[3] Yau Y H (2010), "Analyses of heat recovery devices in the HVAC system in an operating theatre in the tropics", Building Serv. Eng. Res. Technol., Vol. 31, No. 4, pp. 341–355.
[4] Ephraim M, Sparrow Jimmy C K and Tong et al. (2007), "Heat and mass transfer characteristics of a rotating regenerative total energy wheel", International Journal of Heat and Mass Transfer, Vol. 50, pp. 1631-1636.

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FABRICATION OF EXOSKELETON ARM

CHETHAN M*[1], BHARATH G[2], BHARATH DM[3], ANKUSH UP[4], PRAMOD SV[5]

Department of Mechanical Engineering, Sapthagiri College of Engineering
#14/5 Chikkasandra, Hesaraghatta main road, Bangalore- 57 India

[1]55chethan159@gmail.com
[2]bharathkavya1212@gmail.com
[3]gowdabharat789@gmail.com
[4]ankushup881999@gmail.com
[5]pramod@sapthagiri.edu.in

Abstract **- Humans have been developing machines from the dawn of time for tasks which are labour intensive for our species. By subtle engineering and imagination, this has led to the development of powered exoskeleton. An exoskeleton enables a human being to perform tasks which are beyond the physical powers by amplifying the muscular strength. The main function of the exoskeleton arm is to assist the wearer by boosting their strength, endurance and durability. The real challenge is to build an exoskeleton that is inexpensive, wireless and streamlined. our solution is unique as we use ergonomic device actuated through sensors measuring the users motion. They can primarily be used for medical and industrial purposes. The aim of this project is to provide a basis for future automated powered exoskeleton, where it can provide a huge impact on industry and medical research field.**

Keywords –Exoskeleton, automated, arm

I. INTRODUCTION

Exoskeletons are a type of skeletal architecture that surrounds the wearer instead of the traditional internal design. Employing powered joints that are worn by a man to augment and amplify his muscular strength and to increase his endurance in the performance of tasks requiring large amounts of physical strength.

In the developed concept, the Man Amplifier would consist of a structural exoskeleton with appropriate articulated joints, compatible with those of man. All external loads, as well as the weight of the man amplifier itself, are borne by this structural skeleton. Each joint is powered by one or more servomotors or hydraulic system which provides the necessary torques and power boost. In the original concept, a portable, self-contained power pack is attached to the back of the exoskeleton to provide the necessary power. Preliminary investigations of the Human Amplifier concept consists of analytical studies which help to define some of the major problem areas, which must be examined in detail. A focus on humans using exoskeleton puts emphasis on the adaptability and task specificity. At the same time safety of interaction and preventing harm and discomfort is mandatory. The development and use of robotic manipulators as rehabilitative and assisting tools is relatively a new occurrence. A robotic suit is specifically designed for the different types of domains of application.

The aim of this project was to develop the mechanical design of the exoskeleton arm that has the capability of assisting for the required task with respect to the application without significantly limiting their capabilities of functioning of the wearer.

II. LITERATURE REVIEW

[1] The first attempt to create a powered exoskeleton came in the 1960's. General Electric was the first move into this field of exoskeletons. The "Hardiman" was created by General Electric with the intention of being used for bomb loading on aircraft carriers and underwater as well as space construction. Unfortunately for General Electric, by 1970 only one arm had been created. This arm could lift 750 pounds, but itself weighed almost three quarters of a ton. Each attempt they made to create a leg that could easily be lifted failed [2] Pooja Jha (2018) worked on Exoskeleton Arm In this paper, the propose the design of an efficient and comfortable option to commercial exoskeletons [3] Shahaan Khatri (2019) has discussed on Design and Development of an Exoskeleton Arm with Pneumatic Muscle Actuation where he proposed an exoskeleton arm which successfully addresses the issue of expensiveness prominent in the entire exoskeleton industry and implements simple solutions to reduce its costs [4] Pushkar Kulkarni (2020) through his work has demonstrated Mechanical arm for amputee using an inexpensive and user-friendly system and also he used lead screw mechanism instead of hydraulic actuator and replaced aluminum parts with hard plastics wherever necessary.

III. OBJECTIVBES

· The main objective is to reduce human efforts while lifting a certain amount of weight.

· To help handicap and injured people in rehabilitation.

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· This study will be useful for people in manufacturing and production for fast and strong movement, comparable to human hand to lift heavy objects.

· Also, this mechanism can be used in industries.

IV. HARDWARE

ARDUNIO UNO

Arduino ATMEGA-328 microcontroller consists of 14 input and output analog and digital pins (in which 6 pins are considered to be the PWM pins) out of which 6 are analog inputs and the remaining are digital inputs. Power jack cable is used to connect the Arduino board with the computer. Externally, the battery is connected with the Arduino microcontroller for power supply. Arduino is an open source microcontroller. The operating volt ranges from 5v.

Fig.1 Ardunio uno

FLEX SENSOR

Flex sensor are sensors that change in resistance depending on the amount of bend on the sensor. They convert the change in bend to electrical resistance the more bend the more the resistance value. They are usually in the form of a thin strip from.

· Size: 7.3x0.2x5.5cm, 10 grams

. 45K- 250K ohms resistance range.

· Voltage: 5 to 12 V

Fig.2: flex sensor

SPDT RELAY

Relay is an electromagnetic device which is used to isolate two circuits electrically and connect them magnetically. They are very useful devices and allow one circuit to switch another one while they are completely separate. We used SPDT relay (single pole double throw) to interchange the flow of current to the actuator. It was 12v two channel relay

Fig.3: SPDT relay

LINEAR ACTUATOR

A linear electrical actuator is an actuator that creates motion in a straight line, in contrast to the circular motion of a conventional electric motor**.** When the power supply is given, the motor inside will rotate with the help of gear mechanism, rotary motion is converted in linear motion with help of lead screw. We used 150 mm stroke length actuator.

Fig.4 : linear actuator

BATTERY

Battery provides the necessary energy for the working of the actuator and microcontroller. A 12V, 32Ah Lead acid battery is used in our project to drive the actuator as it can provide charges for 3- 4 hours and reduces the need of multiple batteries.

Fig.5: Battery

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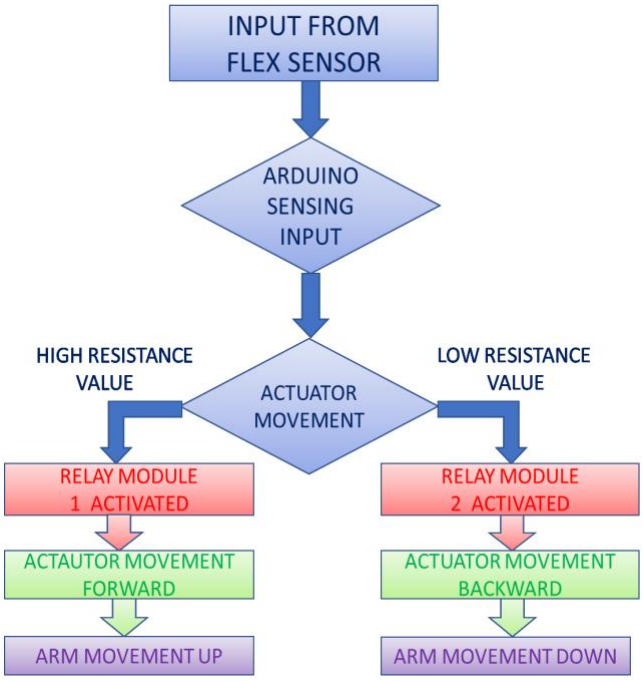
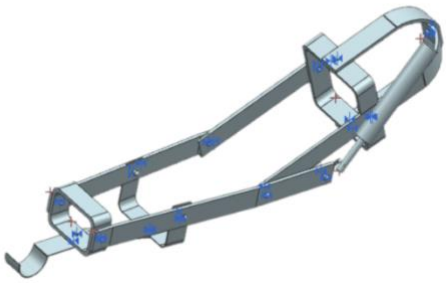
V. METHODOLOGY



VI. 3D MODEL



VII. CONCLUSIONS

The idea behind this project is to develop an inexpensive and user friendly exoskeleton arm. This project shows that it is simple in construction, design and cheaper. It gives quick response and flexible compared to hydraulic and pneumatic type exoskeleton. This can be achieved while maintaining simplicity, ease of use, implementation and maintenance. Our project is not only used to lifts weights but also is applicable in rescue operations, military, industries. It makes physically disabled people to carry weights and also helps for rehabilitation.

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We would like to express our sincere gratitude to the Management, Principal Sapthagiri College of Engineering Bengaluru for the facilities provided and their support. Also we would like to thank the Head of department Mechanical Engineering and faculties for their encouragement and support.

REFERENCES

[1] **A. Akshaya, R. Aravind**: *Human Hand Movement Training with Exoskeleton Arm,* IRJET, Feb 2019.

[2] **Manthan V Pawar**: *Experimental Modelling of Pneumatic Artificial Muscle Systems Designing of Prosthetic Robotic Arms,*2018 3rd International Conference for Convergence in Technology.

[3] **Thunyanoot Prasertsakul, Teerapong Sookjit,** *and* **Warakorn Charoensuk**: *Design of Exoskeleton Arm for Enhancing Human Limb Movement,* Proceedings of the 2011 IEEE International Conference of Robotics and Biometrics.

[4] **Abhishek Gupta**, *student member, IEEE, and* **Marcia K. O Malley** : *Design of a Haptic Arm Exoskeleton for Training and Rehabilitation,* IEEE/ASME TRANSACTIONS ON MECHATRONICS, IN2016

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FABRICATION OF RESCUE DEVICE FOR THE CHILD STRUCK IN PIT

1)MOHAMMED AZEEM,2)CHARAN KUMAR.M,3)CHETHAN .N,4)VEERESH.B
Department of mechanical engineering ,Sapthagiri college of engineering
#14/5 Chikkasandra, Hesaraghatta main road ,Banglore-57 india
1] mdazeem584101@gmail.com
2] charankumar5025@gmail.com
3] veeresh7899460767@gmail.com
4] nchethan765@gmail.com
5] deshpande@sapthagiri.edu.in

I .ABSTRACT—Now a days child often fall down in the borehole which is left uncovered and get trapped. It is very difficult and also risky to rescue the trapped children. A small delay in the rescue can cost the child his or herlife.This paper borehole robot for the rescue of a child is to rescue a child from borehole, children often fall down in the bore well which have been left uncovered and get trapped. The rescue of this trapped child is not only difficult but also risky. A small delay in the rescue can cost the child his or her life. To lift the child out the narrow confines of the bore wells is also not very easy.The child who has suffered the trauma of the fall and is confined to a small area where, This Robot for bore well rescue offers a solution to these kinds of situations with ultrasonic sensors,wireless camera,and led light..Now a days child often fall down in the borehole which is left uncovered and get trapped. It is very difficult and also risky to rescue the trapped children. A small delay in the rescue can cost the child his or her life.

This paper borehole robot for the rescue of a child is to rescue a child from borehole, children often fall down in the bore well which have been left uncovered and get trapped. The rescue of this trapped child is not only difficult but also risky. A small delay in the rescue can cost the child his or her life. To lift the child out the narrow confines of the bore wells is also not very easy. The child who has suffered the trauma of the fall and is confined to a small area where, This Robot for bore well rescue offers a solution to these kinds of situations with ultrasonic sensors,wireless camera,and led light

It is fast, Economical and safe. Moreover, it has the facility to monitor the trapped child and provide a supporting platform to lift up the child. The borewell rescue robot is capable of moving inside the same borewell where the child has been trapped and performs various actions to save the child, camera is used to continuously monitor the child's condition and also help to decide the actions which have to be performed by the robot .So that, the system will go fit to the walls of the hole which make the robot to move inside down without any sliding and Robot consists an arm which is used to pick up the baby from the borehole.the whole motor is controlled by toggle switch.

.

II .INTRODUCTION

There is no proper technique to rescue victims of such bore well accidents. The existing technique which involves digging the parallel hole to rescue the child next to the bore well in which the child has trapped actually. Moreover, it involves a lot of energy and expensive resources which are not easily available everywhere and in this process, we always need big space around the trapped bore that we can dig a parallel bore.

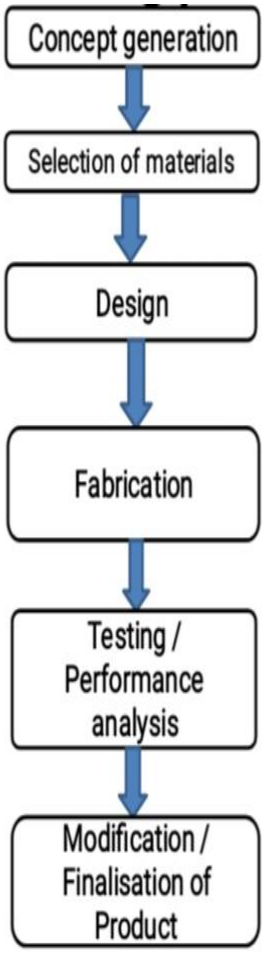
These ad-hoc approaches involve heavy risks, including the possibility of injuries to the body of the subject during the rescue operation. Also, the body may trap further in the debris and the crisis deepens even more means death. In most cases, we rely on some make shift arrangements.

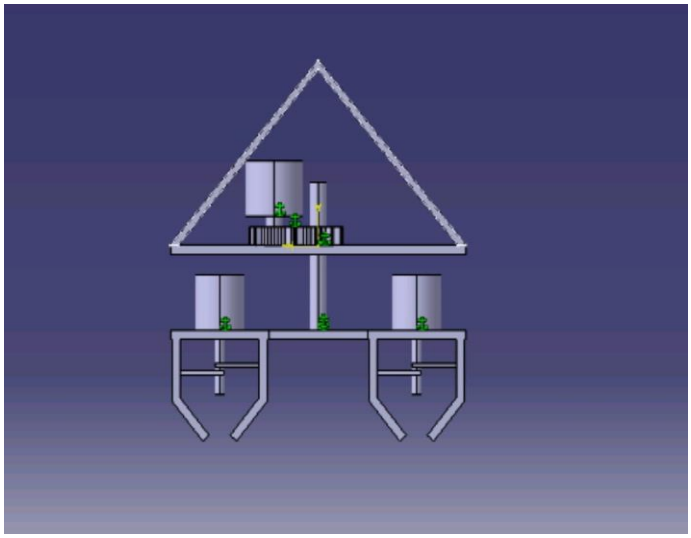
This does not assure us of any long term solution. In such methods some kind of hooks are employed to hold the sufferers clothes and body. Recently many accidents occurred in India. Forty five deaths of children have been reported in the country since September 2009, from that we have only nineteen with the proof of a newspaper After studying all the cases, we found a solution to do, which results a robotic machine which can go through the trapped bore well without any support

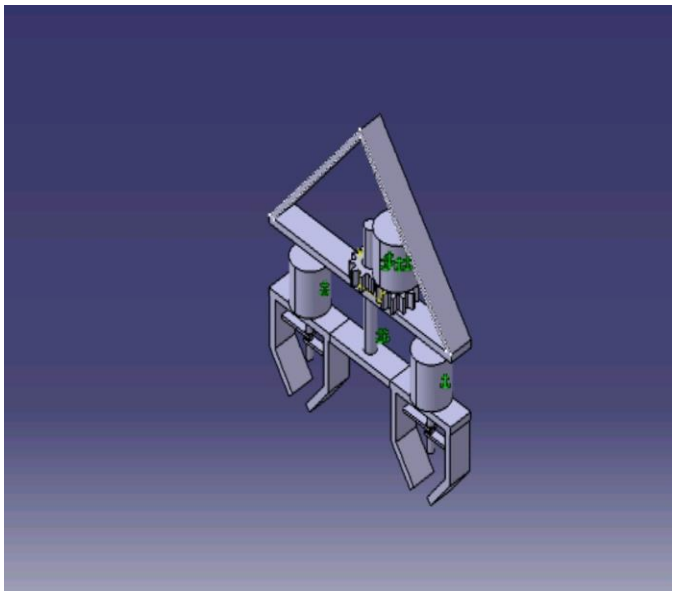
III. LITRATURE REVIEW

SL NO	AUTHOR AND YEAR	TITLE	OBSERVATION
1	Nitin Agarwal,Hitesh singhal,shobhit Yadav-june 2019	child rescue system from open bore wells	In the current design of borewell child saver machine is used to save the child in short time.
2	S.Magibalan, A,Mohanraj, S.Navin,N.Nirmal kumar 2020	child rescue from bore well	new design with help of sensors helps in recuing the child
3	P.Sumathy,A.Monika,R.Dhanshree 2018	Smart andsafe child rescue system	rescue of child is highly reliable
4	M R Chaitra, Monika P, Sanjana M, april 2018	Smart Child Bore well Robot rescue system	rescue of child in low lighting conditions

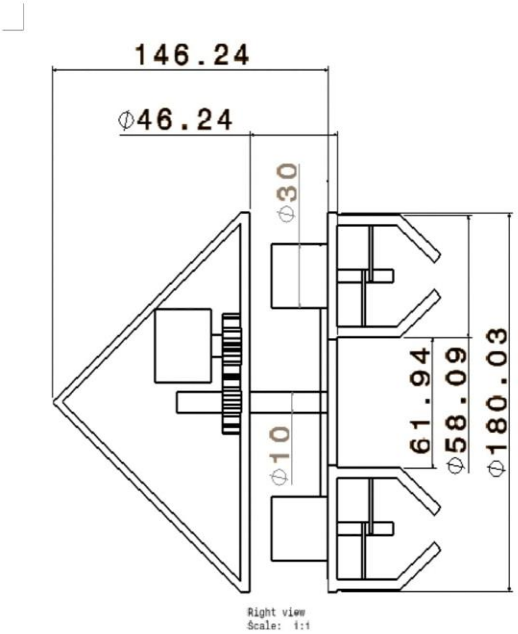
IV .METHODOLOGY







V .DESIGN OF ARM



VI . PRESENT DAY RESCUE DEVICE

When the child plays near the uncovered bore, without noticing they slip into the bore.
Initially people call the rescue team or army team to save the child life .
When the army people come into place, they use ropes and vision camera to find the distance of child trapped from the ground.
Then oxygen and food supply is provided to the child. Finally the rescue team makes a new hole adjacent to the bore where the child is trapped. Seventy percentage

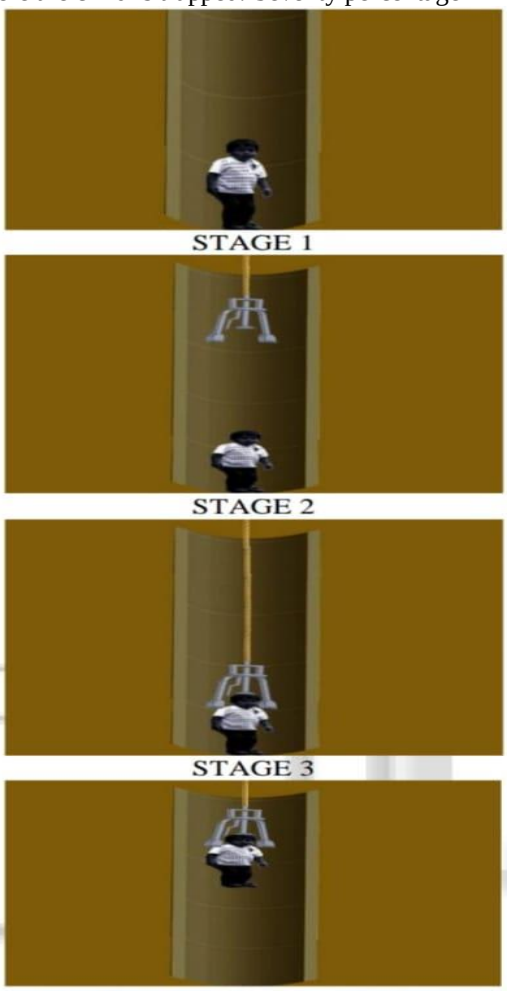
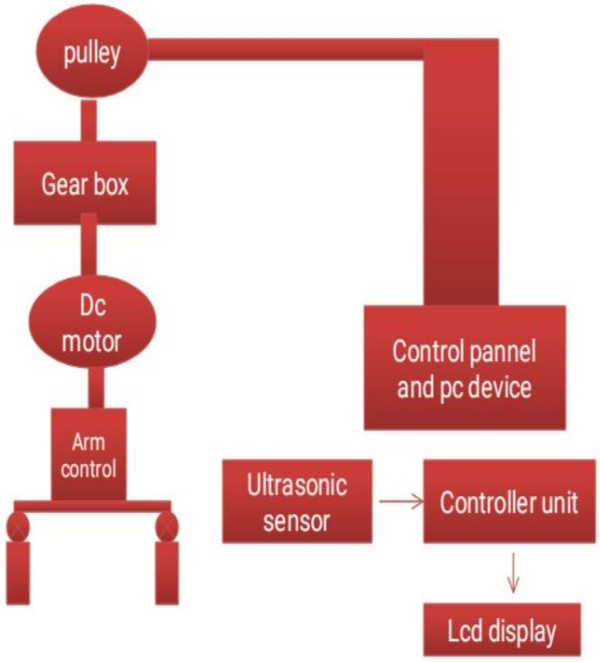


Fig. 4: Different Operations of Robotic Arm

VII. BLOCK DIAGRAM



VIII .WORKING

Camera is used for continuous monitoring and records each and every action of the child and display can be observed on monitor. With the help of this, the child's position can be inferred.
Usually the Bore well diameter varies from 8 to 12 inches accordingly arm is constructed with in the parameter basically arm is made of mild steel flat metal connected to the dc motor for open and close the arm.
The arm is connected by the spur gears through second motor, which can rotate 360 degree
Other motor is placed at the top connected to the chain drive with sprocket were arm is moved up and down
Battery power is required for the motor to drive and toggle switch is controlled for forward and reverse direction
Microcontroller is used for Distance measurement of obstruct or child is been measured when get closer through ultrasonic sensor
Wireless camera give more clear picture or video through phone or laptop

IX. .CONCLUSIONS

This chapter has introduced the main concepts of robotic arm. In the last decade, several research groups and companies around the world have been developing a new class of roborts, aimed at saving the child struck under the pit. This kind of technology is usually referred to as robotic arm.

X .ACKNOWLEDGMENT

I am extremely grateful to Dr. P Mahadevaswamy, HOD Department of Mechanical engineering Sapthagiri college of engineering, Bangalore for his valuable support on the completion of this paper. I like to thank my Project guide Dr. R G Deshpande sir for supporting me for this benificial concern and helping me achieve this Finally,thank my whole team members for their support.

XI . REFERENCES

[1] G. Kavianand,K. Gowri Ganesh, P. Karthikeyan, “Smart child rescue system from borewell”(SCRS), Published in: Emerging Trends in Engineering, Technology and Science(ICETETS), International Conference on, 24-26 Feb-2017.

[2] N. M. Kurukuti, M. Jinkala, P. Tanjeri, S. R. Dantla and M. Korrapati, “A novel design of systemic system for rescue in bore well accidents”, 2016 International Conference on systemics and Automation for Humanitarian Application (RAHA), Kollam, 2016, pp. 1-5.doi:10.1109/RAHA.2016.7931875.

[3] Palwinder Kaur, Ravinder Kaur, Gurpreet Singh “Pipeline Inspection and Bore well Rescue System”,IEEE, VOL3,NO. 4,April2014.

[4] K. Saran, S.Vignesh, Marlon Jones Louis “Bore-well Rescue System” International journal of research aeronautical VOL1, Issue 4, pg.61-80, April 2014.

[5] B. Bharathi, B. Suchitha Samuel “Design and Construction of Rescue System and pipeline inspection using Zigbee” International Journal of Scientific Engineering and Research(IJSER) Volume 1 Issue 1, September 2013.

[6] G. Nithin, G. Gautam, G. Venkatachalam and S. Narayana “Design and stimulation of the bore-well rescue system- Advanced Asian Research Publishing Network (ARPN)” Journal of engineering and applied sciences.

[7] John Jose Pottery, “system for bore well rescue”, amaljothi college of engineering, vol.10, Jun 2017.

Self-Operated Water Purifier (Using Fruit Peels)

CHIRAG P HEDGE*[1], ABHILESH D[2], ANIL PARAMESHWAR GOUDA[3], ASHRITH R[4], R.G. DESHPANDE[5]

Department of Mechanical Engineering, Sapthagiri College of engineering
#14/5 Chikkasandra, Hesaraghatta main road, Bangalore- 57 India

[1]chiraghegde1999@gmail.com
[2]abhimanoj8623@gmail.com
[3]anilgouda305@gmail.com
[4]ashrithr1@gmail.com
[5]deshpande@sapthagiri.edu.in

Abstract **- Water is one of the major resources in demand for many decades for many requirements including drinking applications. Providing pure & drinking water to the needy is a big challenge. Many water purifying systems are in use and are providing potable water to meet the major requirements of society but in rural areas, people are facing health issues related to contaminated water. In this regard, this work aims at designing and developing a portable self-operated easy to afford water purifying system for application in rural areas and also where electricity and drinking water are scarce. The proposed system is self-operated with the filtering element being used is fruit peels which otherwise are discarded as waste. The work involves analyzing the best parameters for filter material to work with maximum efficiency.**

Keywords – Self-operated, Water filter, Fruit peels

I. INTRODUCTION

Water is a basic requirement of every being for its survival. Due to rapid and urbanization and industrialization, the water has turned filthy and polluted. Villages don't have an access to proper drinking water. Even though many water purifying systems are used, the people in the rural area are finding it difficult to afford a filter and are dependent on the lake or contaminated water. In this regard, our work aims at identifying and analyzing the various contaminants in water samples collected from different parts of Karnataka state and to choose the most efficient organic adsorbents (Fruit peels) depending on the contaminants present in the water. In addition to this, Pre-Processing and preparation of activated carbon of chosen organic adsorbents for treatment are also done. Finally, the testing of purified water is done as per standards to check the fitness for drinking purposes. Work by [1] Nurul Nadia Rudi (2020) shows the benefit of using agricultural waste as filter material in obtaining pure drinking water. [2] Ramakrishna Mallampati (2015) also demonstrated through his work that, Fruit peels as Efficient Renewable Adsorbents can be effectively used for obtaining drinking water in rural areas and also has discussed on the removal of Dissolved Heavy Metals and Dyes from Water. In his paper [3] Jonathon Gagnon Nathan Calvert (2016) has discussed Design and Development of a Portable Water Filtration System using vegetables and fruits as filter material. Further [4] V. Goncharuk A.V. (2013) through his work has demonstrated that Aspergillus fumigatus, Aspergillus niger, and Penicillium expansum must not be present in the water and has discussed controlling the above elements by treatment with specific chemicals. [5] Renata S. D. Castro et al. (2017) have discussed the use of Banana Peel Applied to the Solid Phase Extraction of Copper and Lead from River Water to get drinking water. Hence it is possible to use the fruit peels as filter elements to remove the contaminants from various water sources to obtain drinking water.

II. MATERIALS & METHODS

The Water purifier is designed to be compact and handheld in design. Simple and modular is the design language of our purifier. It has a single stage filtration process. The filter contains activated carbon fruit peels that act as absorbents to absorb impurities in water. This fruit peel (activated carbon) powder is suspended on a cloth and a copper mesh is present below the activated carbon powder. The water purifier is non-electric keeping in mind village and e-waste reduction. This project is aimed to produce a self-operating water purifier using fruit peels (epicarp) for non-electric water purifier.

The water flows inside an opening and falls onto the activated carbon powder, this absorbs the impurities and removes impurities, the water standards are maintained and essential minerals are not removed during the filtration through activated carbon. The water then passes through the copper mesh thus removing bacteria and other unwanted minerals. This purified water is collected at bottom of the water purifier, and it is assessable through the tap below. For fruit peels, citrus fruits and kiwi peels are used as they are better adsorbents and adsorbs the impurities. This makes sure the water at the outlet is fit for drinking. The water from the purifier is tested in labs to check whether the water has as the desired ppm TDS levels, pH levels, mineral contents, etc... and the body is tested for durability, user-friendliness, non-contaminating properties, etc. Looking at our villages and college surrounding area, people who are deprived of safe drinking water and consume contaminated water, our team decided to take up a project to provide a safe and low-cost water purifier to society so, that their children can drink water with a smile on their face and trust in their hearts.

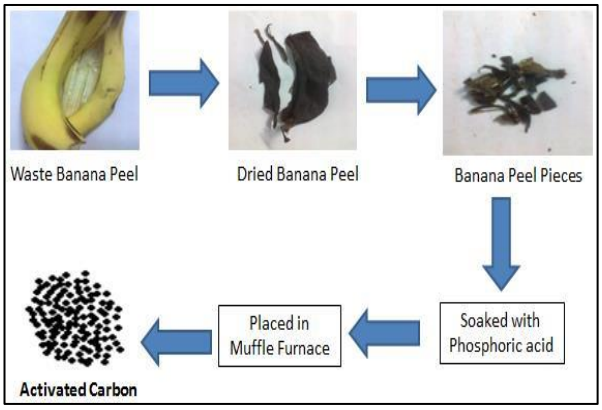


Fig.1 Steps in producing activated carbon

In Fig 1, the steps and process in converting the waste fruit peel into a useful ingredient for filtration are showed. The methodology of preparing an efficient filter out of fruit peels and inculcating them inside a water purifier is described pointwise below:

Methodology:

- Identification & Characterization of impure water.
- Collected epicarp should be shade dried and blended to powder then sieved, Separated and stored.
- For better efficiency and shelf-life, epicarp powders are treated with ethanol and NaOH.
- Diluted Orthophosphoric acid is added to treated epicarp powders and heated at a high temperature (200ºC).
- Based on certain parameters' adsorption capabilities of the treated epicarp powder and activated carbon is obtained.
- Study the absorption process of particular adsorbents on different isotherm models by varying different parameters.
- Designing of various parts of the filter, fixture specifications of filter and, detailed drawing of the filter with proper dimensions.
- Procuring required desired materials for filter, components, and filter materials.
- Assembling the finished parts of the filter.
- Testing, validating and certification of water from the water filter.

Peel (activated carbon) powder is suspended on a cloth and a copper mesh is present below the activated carbon powder. The water purifier is non-electric keeping in mind village and e-waste reduction; we aimed to produce a self-operating water purifier. The water flows inside an opening and falls onto the activated carbon powder, this absorbs the impurities and removes impurities, the water standards are the filter contains activated carbon fruit peels that act as absorbent to absorb impurities in water. This fruit is maintained and essential minerals are not removed during the filtration through activated carbon. The water then passes through the copper mesh thus removing bacteria and other unwanted minerals this purified water is collected at bottom of the water purifier, and it is assessable through the tap below. The water purifier is designed to be compact and handheld in design. Simple and modular is the design language of our purifier. It has a single-stage filtration process. For fruit peels, citrus fruits and kiwi peels are used as they are better adsorbents and absorb the impurities. This makes sure that water at the outlet is fit for drinking. The water from the purifier is tested in labs to check whether the water has the desired ppm TDS levels, pH levels, mineral contents, etc. and the body is tested for durability, user-friendliness, non-contaminating properties, etc.

Body Fabrication:

- A Basic sketch has to be drawn to render on software.
- A Basic rendering is done on software as shown in fig 2. Using the drafts of the basic design, a much-advanced design is designed for final fabrication.
- Material selection and procurement are done.
- Fabrication of the body according to the final design and final dimensions as shown in Fig 4 is done.
- The lower filter is assembled first and tight fitted.
- The upper filter is assembled and placed onto the purifier body as it acts as a cap or a cover for the filter.
- This filter not only filters the dirt and other debris present in water but also acts as like a seal to purifier thus minimizing air contamination.
- The body is assembled and tested for stress and load capacity.
- A 4-liter water purifier is the final output.
- It is coated with agents that prevent rust, contamination.
- Water is tested and checked for impurities, once cleared from the lab it is ready to be used.

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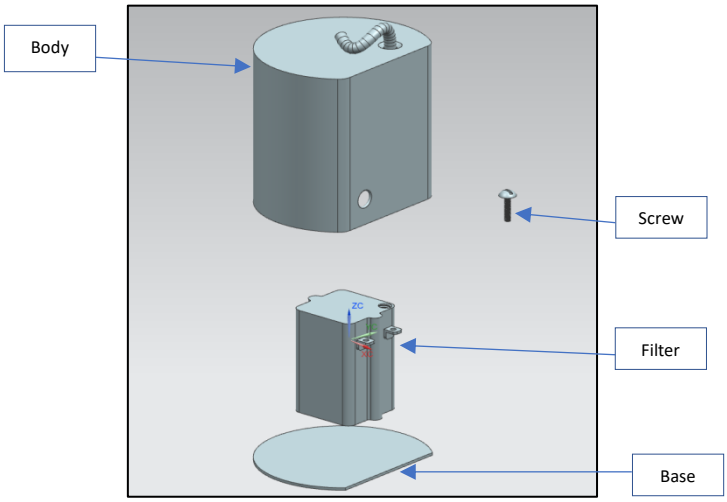

Fig.2 Parts of Filter

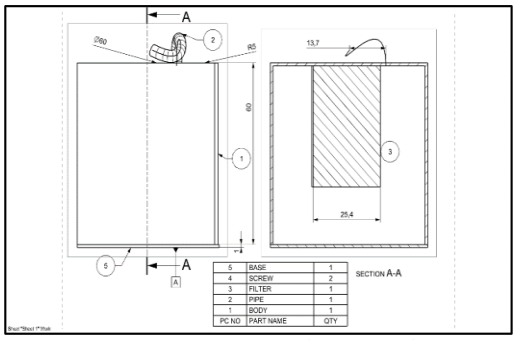

Fig.3 Basic Design of Water purifier

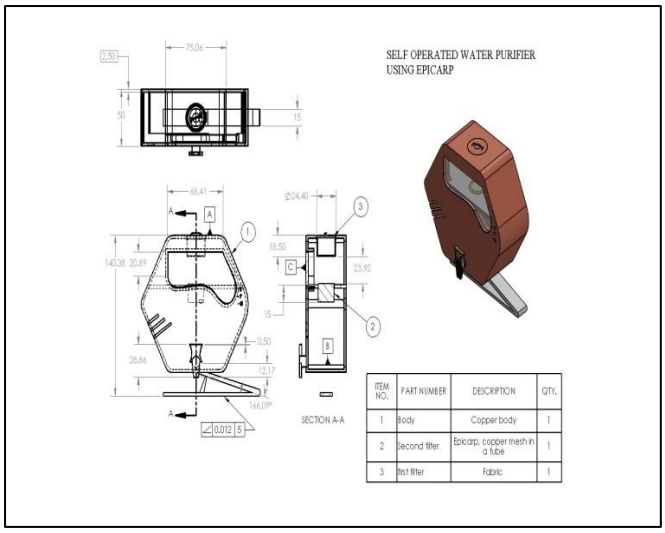

Fig.4 Final Design of Water purifier

III. RESULTS & DISCUSSIONS

A performance test was carried out on the water purifier and was found that it can filter around 6 to 10 litres of water in around 45 minutes. The quality of water passed the fitness test and was certified to be fit for drinking purposes. PH level and hardness of water were well under control and can be refined to the requirements of availability water and region. The device is portable in design and provision for wall mounting is also provided. It is easy to clean and the filter material needs to be changed once in 25 to 30 days. The availability of filter material can be easily made as it costs a very minimum amount. The net cost of the filter comes less than 1500/- rupees with operating costs almost minimum.

IV. CONCLUSIONS

It is possible to develop an affordable, safe, and self-operating water purifier for people who require drinking water. A modular, compact and affordable water purifier can install at places where drinking water is not fit for drinking. The water purifier is easy to install, operate and maintain. Filtration material is natural and eco-Friendly as it's made from fruits. The device can effectively filter polluted water and is designed to be used in any place or environment.

ACKNOWLEDGMENT

We would like to express our sincere gratitude to the Management, Principal Sapthagiri College of Engineering Bengaluru for the facilities provided and their support. Also, we would like to thank the Head of Department Mechanical Engineering and faculties for their encouragement and support.

REFERENCES

[1] Nurul Nadia Rudi: *Evolution of adsorption process for manganese removal in water via agricultural waste adsorbents*. Heliyon, Volume 6, issue 9, E05049 September 01,2020, https://doi.org/10.1016/j.heliyon.2020.e05049.

[2] Ramakrishna Mallampati: *Fruit peels as Efficient Renewable Adsorbents for Removal of Dissolved Heavy Metals and Dyes from Water*. CS Sustainable Chem. Eng. 2015, 3, 6, 1117–1124, ACS Publication, April 8, 2015 https://doi.org/10.1021/acssuschemeng.5b00207.

[3] Johnathon Gagnon Nathan Calvert: *Design and Development of a Portable Water Filtration System*. Proceedings of the 2016 ASEE North Central Section Conference 2016, American Society for Engineering Education.

[4] V. Goncharuk et al. *new standards for Drinking Water*, Journal of chemistry 2013. Volume 2013, Article ID 321609,https://doi.org/10.1155/2013/321609

[5] Renata S. D. Castro et al. *Banana Peel Applied to the Solid Phase Extraction of Copper and Lead from River Water: Preconcentration of Metal Ions with a Fruit Waste, Industrial & Engineering Chemistry Research*, ACS Publications 2011. Ind. Eng. Chem. Res. 2011, 50, 6, 3446–3451, Publication, February 16, 2011, https://doi.org/10.1021/ie101499e, American Chemical Society.

Versatile Pneumatic Based Exoskeleton

SHETTY VARUN CHANDRASHEKAR[1], TEJAS MN[2], TEJAS V[3], VIJAY HP[4], P MAHADEVASWAMY[5]

Department of Mechanical Engineering, Sapthagiri College of engineering
#14/5 Chikkasandra, Hesaraghatta main road, Bangalore- 57 India

[1]vshetty210@gmail.com

[2]tejasmn08@gmail.com

[3]goodmantejas@gmail.com

[4]vijayh788@gmail.com

[5]hodmech@sapthagiri.edu.in

Abstract **– The Exoskeleton is a device that can be worn on the body like a suit. Sometimes, people who work at construction sites, suffer from back problem due to continuous carrying of loads on their back; People who have weak limbs need someone by their side to perform any activity. In order to prevent and tackle these problems, Low cost and Easy Maintenance Pneumatic based Exoskeleton is designed which has the capability to provide external skeletal structure to the wearer; To mimic the movements of the human body so as to help the wearer to exhibit body movements; To enable the wearer to lift loads beyond his capability and to demonstrate the pneumatic applications. The applications also finds in Medical Domain, helping people in rehabilitation and in Military domain – helping soldiers to carry weight for long duration with ease.**

Key words – Low cost, easy maintenance, mimicking body movements, External skeletal support

I INTRODUCTION

The Exoskeleton is a term which is classified under wearable robots that describes a robotic field which studies the interaction between the human body and robotics. It is a type of skeletal structure that surrounds the wearer. Exoskeleton wearable robots follow the principle of having the pivotal structures outside its user which allows the mechanical system to be used as a suit. In these systems, a Mechatronics structure is attached to different parts of the human body, and the wearer commands the mechanical system using physical signals (like electronic simulation produced by the orders of the brain, or by using a simple switch). The Exoskeleton suit can be made based on Hydraulics, Pneumatics, and Gear chain system powered by Motors. Each one has its own advantages and disadvantages. An artificial muscle is another type of pneumatic based Exoskeleton where instead of pneumatic cylinders, artificial muscles are used. Artificial muscles are nothing but an inflating tube placed inside a fixed length shell, when air supplied, the shell is made to contract which is used to lift weight. The above types can be classified as active Exoskeletons. Passive type Exoskeleton (there is no power supply for this type of exoskeleton) is also available. This type uses springs to help the wearer to lift weight and carry it for large amount of time with ease. The counter torque developed by the tension of the spring cancels the torque developed by the load which helps in carrying the load.

II LITERATURE REVIEW

Gopal Krishna U [1] reported work on a comprehensive design and fabrication of hand exoskeleton technologies for rehabilitation and assistive engineering by actuator technology. Michael Scott Liszka [2] worked on the design of exoskeleton for shoulder rehabilitation and process of design, kinematics, actuators, transmission and mechanical analysis. Roger Michcheal Pereira [3] suggested a low cost exoskeleton built with the help of pneumatic system which is portable to anywhere. Sheeba P.S [4] developed usage of flex and sensors in pneumatic systems instead of manual switch operated. There is a scope for next level advancement in exoskeleton technology. The present work focuses upon the designing an Exoskeleton Suit which has the feature of length adjustment and varying weight lifting ability of the suit.

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III METHODOLOGY

A. Components of the Device

1. Air Compressor – Max 150 PSI (Working pressure 110 to 130 PSI)
2. Pneumatic Cylinders – Bore Diameter – 32mm and Stroke Length – 200 mm & Bore Diameter – 32mm and stroke length – 125mm. Piston end mounting – Clevis Rod End.
3. Direction Control Valves – 3/2 Solenoid valve
4. Flow Control Valve – One Direction Flow Control Valve and Two Direction Flow Control Valve
5. Arduino – Arduino Uno; Accessories – Stepper Module, Red and Green Color Lights, Resistor & 24V Battery
6. Kinematic Links – Aluminum Extrusions & Stainless Steel square tubes and Sheets

B. Working of Pneumatic System of Exoskeleton

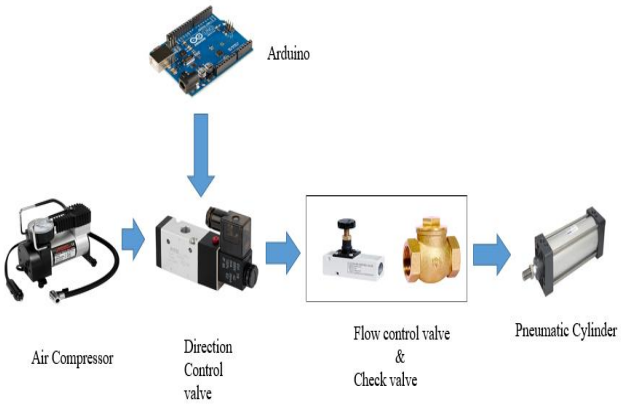

Fig. 1 – Schematic representation of working of Pneumatic System.

All the components related to Pneumatic System are connected through hose pipe is shown in Fig. 1. Air Compressor sucks the air from the atmosphere, compresses it to high pressure and stores it in the cylinder. Direction control valve is used to allow the compressed air to the Pneumatic Cylinder when required. 3/2 Solenoid Direction Control valve is used to control the flow rate of the compressed air, Flow control valve is used to allow the flow of compressed air in one direction. The compressed air stored in the cylinder is supplies to the pneumatic cylinder through Flow control Valve and Check Valve. The Solenoid valve is controlled via Arduino. When Arduino sends the signal to the solenoid valve, piston extension takes place.

C. Conceptual Design of Exoskeleton

Upper Limb Exoskeleton

The Kinematic Links are used to give external structural support. The device is to be operated using two switches, where each controls the either, one of the arm or one switch controlling only one arm. 3rd Switch can be used to control the movement of both the arms at the same time.

Lower Limb Exoskeleton

The Device is to be controlled through a switch. The process is to be completely automated. The Mechanism used here should be able to replicate the lower limbs movement while walking.

D. Designing of Exoskeleton

Upper Limb Exoskeleton

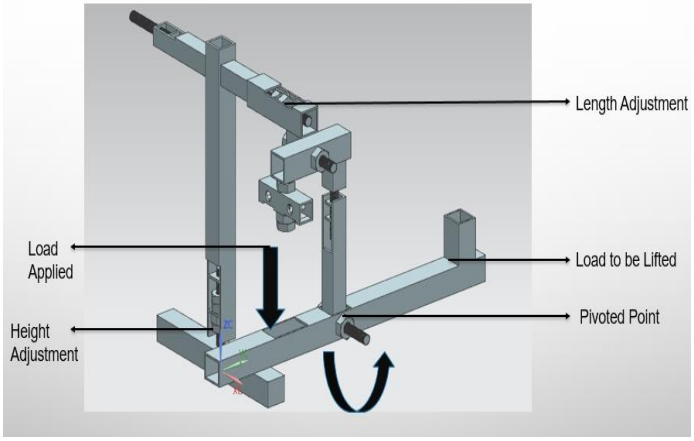

Fig. 2 – 3D Modelling of Upper Limb Exoskeleton

The 3D modelling of the Upper Limb Pneumatic based Exoskeleton was made in the software NX 11 is shown in Fig.2. The Mechanism used for the upper limb exoskeleton is Lever Mechanism, which include a rod having two ends with a pivoted point. The main attraction of this mechanism is that, by applying low amount of force, any amount of torque can be generated by adjusting the distance between the pivoted point and the point at which load is being applied. The elbow joint of our body acts as the pivoted point and a long rod is strapped to the arm. On the front end, the load to be lifted is placed and at the rear end, force generated by the Pneumatic Cylinder is applied. The extension of the piston results in generation of required torque to lift the load.

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Lower Limb Exoskeleton

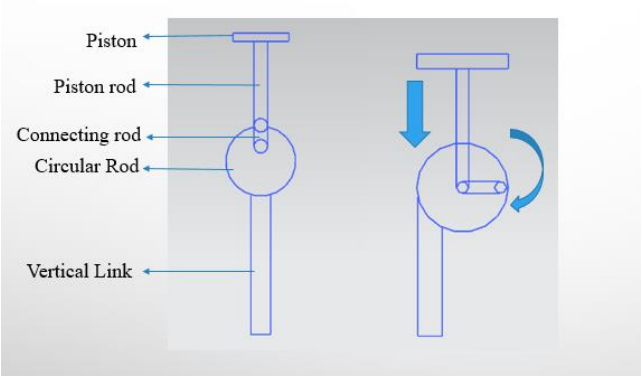

Fig. 3

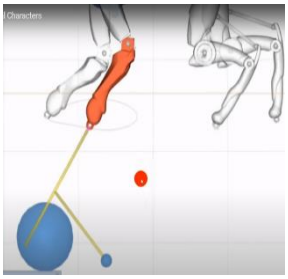

Fig. 4

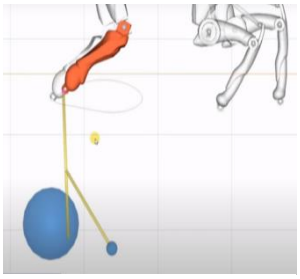

Fig. 5

The Lower Limb Exoskeleton is powered by pneumatics. The reciprocating movement produced by the piston movement of pneumatic cylinder is converted into circular motion as shown in Fig. 3. The Piston end is connected to a circular disc on one side and one the other side of the disc, a vertical link is attached. The vertical link traces the rotation of the circular disc. To replicate the walking pattern of the human being, an additional link is attached to the vertical such that a mechanism is formed whose end result is generating accurate relative movements of the link which is similar to that of walking pattern [5] as shown in Fig. 4 and Fig. 5.

E. Numerical Calculation

Calculation for determining the load that an Upper Limb Exoskeleton can lift is determined with the help of fIg. 6 which is showing the loading conditions.

Pressure produced by air Compressor, P = 120 PSI = 827371N/m^2

- Cylinder Bore Diameter = 32mm
- Force applied by Pneumatic cylinder = A*P = $(\frac{\pi*0.32*0.32}{4})$*827371 = 665.4115N/$m^2$
- Torque Produced = 665.115*0.165 = 109.744Nm

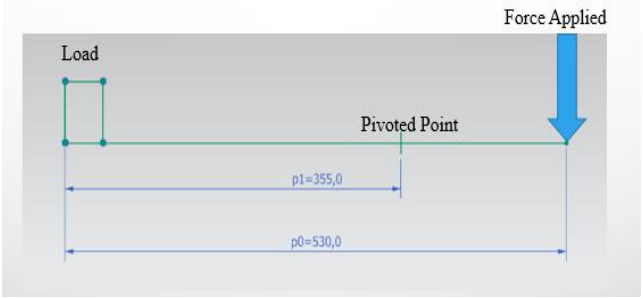

Fig. 6

- When Load, L = 30Kg
- Torque produced by the load to be lifted = 30*9.81*0.365 = 107.42Nm
- According to calculation, the total load that can be lifted by using one cylinder is 30Kg.
- By 2 cylinders = 30*2 = 60Kg

F. Controlling the Speed of Actuation

One of the major aspects is controlling the extension and retraction of the piston of pneumatic cylinder because, sudden actuation results in affecting to the body part. The extending of piston depends upon the load that need to be lifted. If small load is to be lifted and piston extension is rapid, there are chances of the load hitting the wearer face. When the retraction of the piston is rapid then the sudden jerk experienced by the arm is dangerous as it results in damaging the arm. Hence the following pneumatic circuit is used to control the actuation of the piston. Both Supply Air Throttling and Exhaust Air Throttling method is used. The Pneumatic part of the Exoskeleton is represented in the form of Pneumatic circuit diagram as shown in Fig. 7.

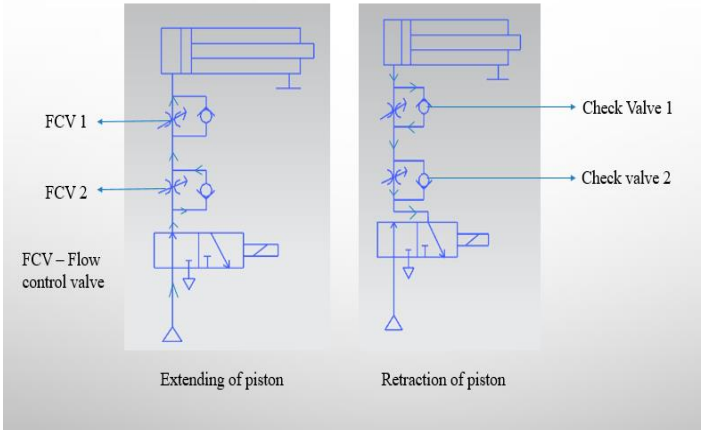

Fig. 7 – Pneumatic Circuit Diagram

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IVRESULT & DISCUSSION

As per Theoretical Calculation, the maximum load that can be lifted by using one cylinder is around 30Kg and by 2 cylinders, it is 60 kg. For increasing the lift capacity, we can use pneumatic Cylinder of bigger diameter or we can use Air Compressor of higher PSI. Since length adjustable feature is included, anybody can wear the suit.

CONCLUSION

The Pneumatic based Exoskeleton is a low cost device which is different from the present Exoskeleton, the design give the wearer the option of changing the distance between the pivoted point and the applied load point so as to increase the weight lifting ability and shoulder length adjustment feature enabling anyone to wear the Exoskeleton suit. The Suit provides an external skeletal structure for the wearer which also involves in helping the wearer to exhibit body movements produced by the Exoskeleton Suit.

REFERENCES

[1] Gopal Krishna U: Design and Fabrication of a Pneumatic Powered Exoskeleton suit for arms, IRJET volume 5 issue: 04, 2018.

[2]Michael Scott Liszka: Mechanical Design of a Robotic Arm Exoskeleton for Shoulder Rehabilitation, Department of Aerospace Engineering, university of Maryland, 2007.

[3]Roger Michcheal Pereira: Design and Fabrication of a Pneumatically Powered Human Exoskeleton Arm, Journal of Mechanical Engineering and Automation,7(3),85-88 2017.

[4]Sheeba P.S: Exoskeleton Arm with Pneumatic Muscle Actuation, International journal of Advanced Engineering and Innovative Technology, Vol 3(1),1-7,2016

[5]Stelian Coros and Robert W. Summer, Computational Design of Mechanical Characters.

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COMPOSITE MATERIALS: CHARACTERIZATION OF POLYMER NANO COMPOSITE

SHIVASHANKAR R*[1], NAVEEN L[2], KEERTHI S[3], PRATHAP S[4], RAMESH N G[5]

Department of Mechanical Engineering, Sapthagiri College of engineering
#14/5 Chikkasandra, Hesaraghatta main road, Bangalore- 57 India

[1]shiva1504199@gmail.com

[2]imnaveen006@gmail.com

[3]keerthigowda0325@gmail.com

[4]prathapsrinivas1100@gmail.com

[5]rameshng@sapthagiri.edu.in

Abstract **- The polymer nanocomposites have been the exponentially growing field of research for developing the materials in last few decades. The remarkable improvement in the polymer nanocomposite is found when a small amount of nanosized particles are added to a polymer matrix. The addition of inorganic solid nanoparticles (typically in the form of fibres, flakes, spheres or fine particles) into polymer matrix increases their physical, structural and mechanical properties. Since the polymer-nano composites have been the staple of mod- ern polymer industry, their durability under various environmental conditions and degradability after their service life are also essential fields of re- search. This leads to focus on preparation & characterization of polymer nanocomposite. This article is intended to review the status of worldwide re- search in this aspect. The successful application of nano particles depends upon both the correct preparation techniques followed by testing through characterization. Surface modification can improve the inherent characteristics of the nano particles and serve to prepare nano composites inexistent in nature. Therefore, some tools as their various properties like electrical, optical and morphological can be used to optimize the preparation of polymer nano composites. This chapter will make an overview about different routes to prepare polymer-based nano composites by extrusion, synthesis of nano particles by sol-gel reactions, sputtering and mainly by physical evaporation de-position method.**

Keywords **- Silver Nano-Particle, Polymer Composite, Electrical Properties, Optical Properties, DSC, FTIR, SEM, Morphology**

I. INTRODUCTION

What are Composite Materials?

Composite materials in general are materials which are engineered combinations of two or more reinforced materials intimately combined with basic matrix to attain the desired properties. The matrix phase and reinforcement phase with significantly different physical or chemical properties, which are constituents of any composite material when combined produce a material with new characteristics different from the individual components.

What are the types of Composite Materials

Figure 1.1 (a) Classification of composite materials based on matrix phase 3

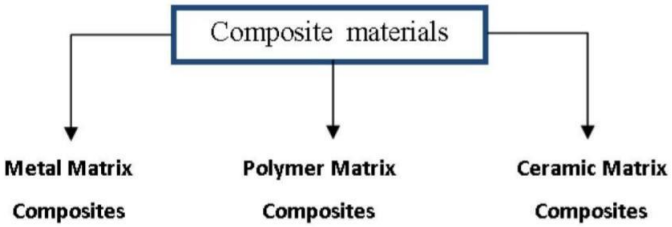


Figure 1.1 Classification of composite materials based on reinforcement phase

Polymer Composite: A polymer composite is a multi-phase material in which reinforcing fillers are integrated with a polymer matrix, resulting in synergistic mechanical properties that cannot be achieved from either component alone.

II. LITERATURE REVIEW

- Sabu Thomas, Kuruvilla Joseph, Dr. S. K. Malhotra, Prof. Koichi Goda, Dr. M. S. Sreekala (2013)

Polymer Composites

- Polymer Composites are materials in which the matrix polymer is reinforced with organic/inorganic fillers of a definite size and shape, leading to enhanced performance of the resultant composite.
- These materials find a wide number of applications in such diverse fields as geotextiles, buildings, electronics, medical, packaging and automobiles.

- David Roylance (2000)

An introduction to composite materials

- The two constituents are reinforcement and a matrix.
- The main advantages of composite materials are their high strength and stiffness combined with low density when compared to classical materials.

- W. Scott Beckwith (2012)

Manufacturing defects in composite structures

- It is found that the manufacturing processes are responsible of many defects which may arise in fibers, matrix and lamina.
- These defects, if they exist include misalignment of fibers, cracks in matrix, non-uniform distribution of the fibers in the matrix.

III. OBJECTIVE

- The project work is development of a polymer nano composite. Polymer: - Disemeldheyde & Nano Composite: - Graphene
- The study effect on filler reinforcement with polymer composite by varying the percentage of volume fraction of filler.
- Property measurement to investigate Mechanical properties like strength stiffness and various other properties of nano filler reinforcement with polymer.
- The characterization of chemical composition and composition homogenic.

IV. METHODOLOGY

[a] Polymer: - Polybismaleimides

- They are high performance thermosetting addition type polyimides.
- Have high strength and rigidity at elevated temperatures.
- Long term heat and oxidative stability, excellent electrical properties, long term creep resistance.
- Hence it can replace metal and other materials in many structural applications.
- Usually not used in their pure solid form, they are often blended with reactive co-monomers (vinyl and allyl compounds) (easier to process due to its paste like consistency).
- Is synthesized by condensation of phthalic anhydride with aromatic diamine at **molar ratio 2:1**, it yields bismaleimide.
- The addition Polymerization is carried out with excess of bismaleimides to produce maleimide end-capped resins.
- The polyaddition of bismalemides results in three dimensionally cross-linked thermoset structure that exhibit high temperature resistance.
- The most important bismalemide monomer is **4,4'-bismalemide diphenylemethone.**
- They are often sold as low molecular weight dry powder resins containing inside structures already in monomer form.

[b] Nano Particles: - Graphene

- It is a two-dimensional allotrops of carbon consisting of a single, flat layer of carbon atoms bonded together in a hexagonal lattice in which one atom forms the vertex of each hexagon.
- Carbon atoms have 6 electrons. Each carbon atom is bonded to three other carbons by strong covalent sigma bond leaving a electron in each carbon atom to wander.
- These highly mobile electrons are called π electrons and are located above and below graphene sheet.
- This 2D carbon graphene lattice is found in form of platelets about 0.3nm thick and 0.5mm in lateral dimension.

[c] Properties of Graphene:

- It is 200 times stronger than steel, light weight due to strong covelent bonding between C atoms.
- Tough, flexible and a perfect barrier because of its compact structure.
- Thinnest material, chemically inert.
- Electrically and thermally conductive.
- Stretchable.

FABRICATION TECHNIQUE

Polmer matrix Nano composites can be fabricated either by chemical or mechanical process. Uniform and homogeneous dispersion of nanoparticles in the polymer matrix is one of the major problems encountered in polymer Nano composite fabrication. The Nano fillers have a tendency to aggregate and form micron size filler cluster, which limit the dispersion of nanoparticles in the polymer matrix thereby deteriorating the properties of Nano composites.

General method applied to fabrication of Nano composites:

- Intercalation method: Based on exfoliation of layered silicates.
- In site polymerization: In presence of nano fillers.
- In site formation: formation of nano fillers and in site polymerization.
- Direct mechanical mixing: mixing of polymer and Nano fillers.

[i] Metal Roller:

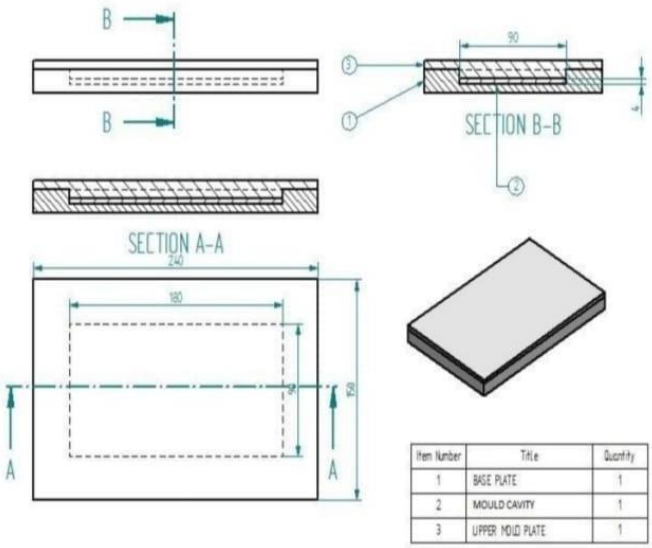
Metal roller is used for uniform distribution of glass fiber and also to remove air bubble.

[ii] Mould Release Spray:

Mould release spray is an anti-stick agent for types of general moulding, various types of plastics, rubber, bakelite and nonferrous metal die casting. Water repellent for natural and synthetic fibres, batteries etc.

STEP 1: MOULD PREPARATION:

First of all, the mould for the composite is prepared. We have prepared a compression mould to get specimen of required dimension i.e. 180 x 90 x 4 mm. The material used for preparation of compression mould is mild steel. The overall dimension of the mould is 240 x 150 x 40 mm. The upper plate has a protrusion. This protrusion serves two main tasks, one is to make sure to get the required thickness and the other is apply pressure on the specimen.



TESTING:

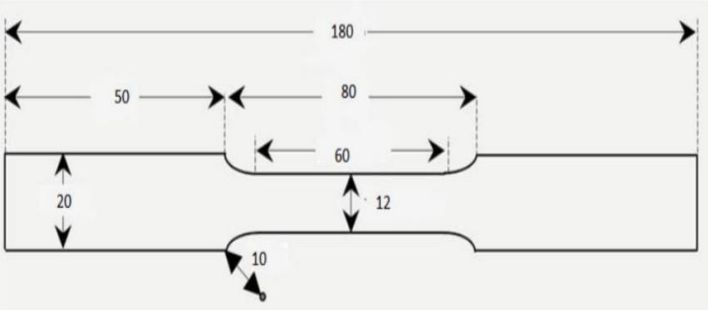
- **Tensile testing**

The value of gauge length (L), width (d), thickness (t) of the specimen used in the experimentation are 50mm,12.5mm,4mm respectively. The test was performed with a constant test rate of 10mm/min. Tensile strength can be calculated by the formula:

S=F/A

Where,

F= maximum load (in Newton's law) S= cross section area of the specimen



Hardness:

Hardness is the ability of a material to resident deformation, which is determined by a standard test where the surface resistance to indentation is measured.

Wear Test:

Wear test is carried out to predict the wear performance and to investigate the wear mechanism. Two specific reasons are as follows: - From a material point of view, the test is performed to, evaluate the wear property of a material so as to determine whether the material is adequate for a specific wear application.

V. REFERENCES

[1] International Organization for Standardization (ISO). Nanotechnologies—Vocabulary. In Part 4: Nanostructured Materials; International Organization for Standardization: Geneva, Switzerland, 2011.

[2] Schmid, M.; Benz, A.; Stinga, C.; Samain, D.; Zeyer, K.P. Fundamental investigations regarding barrier properties of grafted PVOH layers. Int. J. Polym. Sci. 2012, 2012, 637837. [CrossRef]

[3] Hosokawa, M.; Nogi, K.; Naito, M.; Yokoyama, T. Nanoparticle Technology Handbook; Elsevier Science: Oxford, UK, 2007.

[4] International Organization for Standardization (ISO). Nanotechnologies—Vocabulary. In Part 2: Nano-Objects; International Organization for Standardization: Geneva, Switzerland, 2015

[5] S.R. White, P.H. Geubelle, J.S. Moore, M.R. Kessler, S.R. Sriram, E.N. Brown, S. Viswanathan, Autonomic healing of polymer composites, Nature 409 (2001) 794e797.

THERMAL ANALYSIS OF ELECTRONIC PROCESSOR COOLING SYSTEM USING ANSYS

Dr. BASAVARAJ GANIGER, GANESH NISCHAY S*, HEMANTH KUMAR G, AMOGH G, AKSHATHA J PRAKASH
Department of Mechanical Engineering, Sapthagiri College of engineering
#14/5 Chikkasandra, Hesaraghatta main road, Bangalore- 57 India
*ganeshnischayshroff@gmail.com

***Abstract*— Distinguishing rapid developments in the field of electronic technology have been extending their influence over our routine life to become an integral part thereof. Heat release has increased significantly over the past few years due to multi-functioning, shrinking package size, high clock speed and higher power dissipations. Dissipation of heat generated in the processor is enhanced by incorporation of fans. A 2000 series aluminum material was used for both stationary and rotary parts of the processor fan.**

Modeling and Analysis was carried out using the 'ANSYS Icepack' software. Convective boundary condition is applied to the casing and fans for flow of heat from the processor to surroundings. Increase in the number and orientation of fans lead to decrease in the maximum temperature resulting in proportionate increase in the heat flux of the processor, whereby the distribution of temperature and heat flux characterized by variation in the number of fans has recorded. Analytical results have proved that "ANSYS IcePak" software can be used effectively to solve the challenge of heat transfer problems electronic processor systems and any electronic devices.

Keywords—Rotating fins, Stationary fins ANSYS IcePak software, Heat sink, electronic devices.

I. INTRODUCTION

An electronic appliances and devices are now a part of our daily life with the rapid development of electronic technology. The heat liberation has increased significantly over the past few years due to the condition of multifunctioning, shrinking package size, high clock speed and higher power dissipations. Emerging days of the computer era had witnessed central processing units (CPUs) being made to operate largely without a heat-sink even though the first processor was already producing considerable amount of heat. Fortunately, a little later, as the processing speed increased, these processors demanded a passive heat-sink for trouble-free operation. The processors getting increasingly powerful, it has now become inevitably essential that CPUs need multi-fan heat-sink and fan that ensure reasonable flow of air through the cooling fans. A heat sink is a device used in computers to remove considerable amount of heat generated by the components including chipsets and graphic cards during their operation. A heat sink is used to increase the surface area which dissipates the heat faster and keeps the processor under safe operating temperature. Heat sink ensures that processors have increased life span. The most significant component of a heat- sink is a metal device made of copper or aluminum with many fans. In this empirical study plastic fans are replaced by metallic fans made-up of rotating and stationary parts.

Hao Wengang et al. (2017) conducted an experiment on thermal Performance of LED array heat sink using computational fluid dynamics (CFD) and concluded that both the average convection heat transfer coefficient and the heat resistance decrease with the increase of number of fins [1]. Jeffrey P Koplow (2015) studied the a method for heat removal and reported that the process of heat transfer can be achieved in various method such as by varying the fins design from linear to circular shape, number of fins, thickens, angle, compactness [2].The fins were designed in a circular manner to create a turbulent flow for heat exchange and reduced the height of the fins.

Waqidi Fallcoff (2013) conducted an experiment on heat sink with helical fins and concluded that the helical shaped air passage can enhance thermal performance by 30% over the conventional fins and can perform well in variety of orientations (horizontal, vertical) and fixtures [3]. Rajesh Sharma et al. (2016) conducted experiments on micro channels heat sink (MCHS) and noticed that classical approach agrees with experimental results of heat transfer in micro channel. Copper was used as material in MCHS and water was used as cooling agent in experimental study. The micro channels were made with EDM machines and investigated on heat transfer rates, effect of friction factor, temperature distribution. It is observed that with decrease in velocity flow friction also decreases [4]. Channamallikarjun (2014) also studied the thermal analysis of CPU with variable baseplate Heat Sink by using CFD packages [5].

In the present experimental work, a processor made of copper with thermal conductivity of 385 W/m-K and generates heat at the rate of 1 W has selected. The enclosing container is made of steel with thermal conductivity of 45 W/m-K. The fins are made of aluminum with thermal conductivity of 205 W/m-K. There is convection along all the boundaries except the bottom, which is insulated. An attempt has made to decrease the maximum temperature and increase the heat flux in the electronic component by varying the number of fins to ensure the optimal working of the component. To justify the application of fins, effectiveness is to be determined which is the sole reason of conducting the Experiment.

II. METHODOLOGY

A. CAD model:

Solid modeling is done in CATIA V5 using standard unit and dimensions and transported to ANSYS software. The models of Processor, stator, rotor and assemblage of stator and rotor are shown in Fig. 1 (a)-(d).

B. Pre-processing:

Model is imported in the pre-processor and defined the problem using all the parameters:

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- Place .igs file in the cubical cabin of the IcePak software.
- The sides parallel to the model are opened and named inlet and outlet respectively.
- Inside the Cabin a Hollow Rectangular block is inserted at a particular distance from the model.
- Then a dummy fan is inserted inside the hollow block to facilitate air flow.
- Apply basic parameter to the problem defined such as gravity, Ambient temperature, Flow regime (turbulent), thermal specifications, number of iterations.
- Add monitoring point to the processor model to obtain temperature value.
- Generate an auto mesh to the model in required mesh size.
- Solve the problem Defined.

C. Solution

It includes assigning values, constraints and solving; here we specify the constraints and finally solve the resulting set of equations. In this problem the turbulent flow is seen.

ROTOR FINS DESIGN

Fin spacing = $2.714*L*Ra^{1/4}$.
L is length=75 mm
Number of fins = Base Plate Width
= Fin thickness +Fin spacing

Ra=Rayleigh's Number
$Ra = (g*\beta*\Delta T*L^{3*}Pr)/\sqrt{2}$

Pr at fluid average temperature, $T_f = (Ts+T_\infty)/2$

Ts is hot surface temperature

T_∞ is ambient air temperature

Re=Reynolds Number

For Re <5000; Laminar flow

For Re >5000; Turbulent flow

STATOR FINS DESIGN

Fin spacing = $2.714*L*Ra^{1/4}$ =2.7154 mm.
L is length=125 mm
Number of fins = Base Plate Width
= Fin thickness +Fin spacing

Ra=Rayleigh's Number
$Ra = (g*\beta*\Delta T*L^{3*}Pr)/\sqrt{2}$

Pr at fluid average temperature, $T_f = (Ts+T_\infty)/2$

Ts is hot surface temperature

T_∞ is ambient air temperature

D. Post-processing

After getting solution results are analyzed in post processing. It includes further processing and viewing of the results. In this stage the following are obtained; temperature of the processor in T (Fig.2 a) and Velocity of air in m/s (Fig. 2 b).

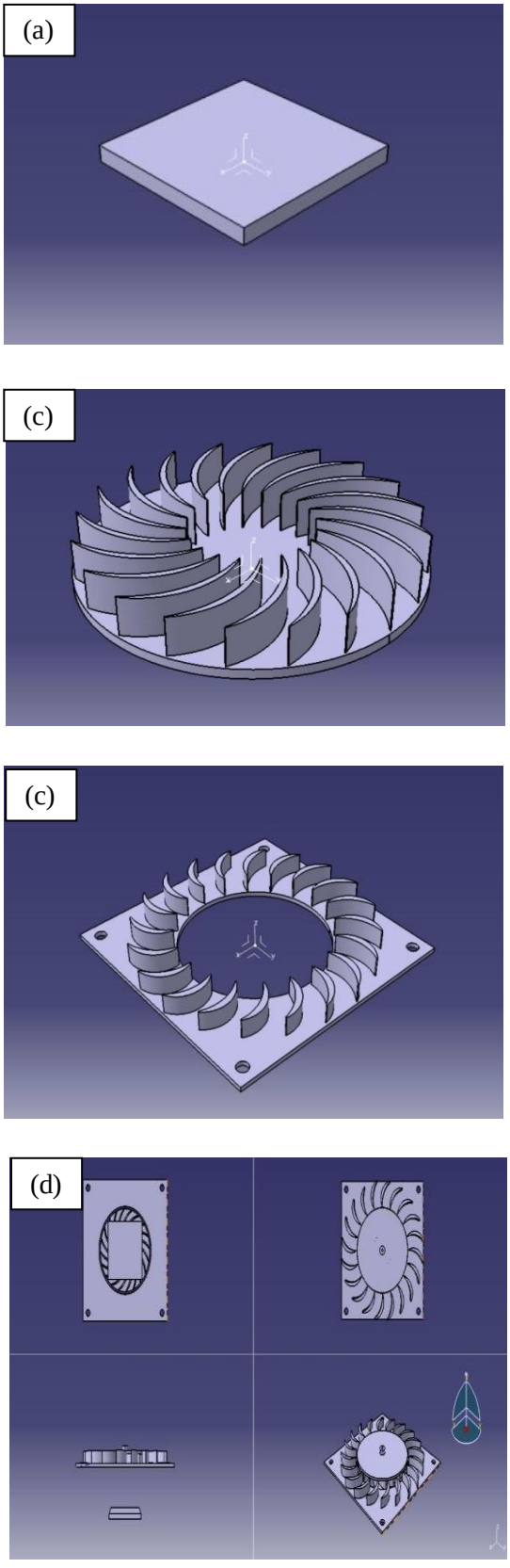

Fig. 1 (a)-(b); Models of Processor, stator, rotor and assemblage of stator and rotor

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III. RESULTS AND DISCUSSIONS

An analysis was done for the determination of heat transfer rate and effectiveness of the heat sink, it can be deduced from the graphs plotted and also from the values determined that various factors such as velocity of fluid, ambient temperature, heat transfer coefficient, play a . vital role in influencing the Heat Transfer rate.

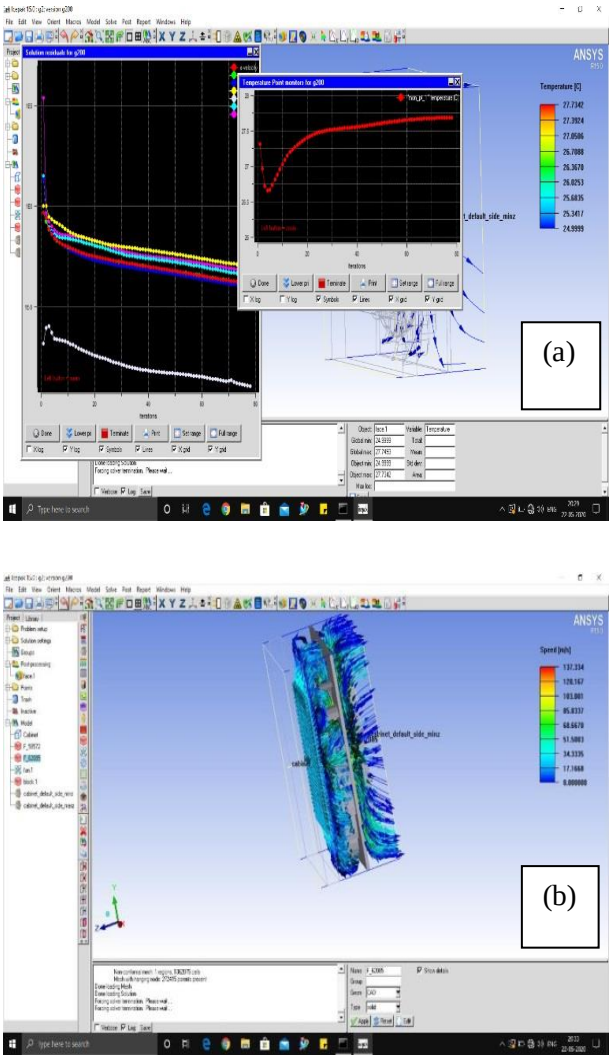

Fig. 2 (a) & (b); Temperature of the Processor-27.73˚C and Velocity of air-17.16m/s.

IV. CONCLUSIONS

- The orientation of heat sink with respect to direction of flow of fluid influences greatly on effectiveness of fins
- The heat transfer rate and effectiveness of fins is noticeably more in case of model where the fins are inclined to base plate. A greater change in enthalpy across the Heat sink, and comparably higher pressure drop occurring due to convergence, increases velocity of the fluid thereby allowing more cold air molecules to interact with hot air molecules.
- Thermal analysis for processor cooling system with different shapes of fins can be done and optimize the same.
- CFD analysis of the fins, to understand air flow around the fins is the effective method and hence cost reduction can be achieved.

REFERENCES

[1] Hao Wengang, Wei Lulu, Zhang Zongmin, Lai Yanhua and LV Mingxin "Research on Simulation and Experimental of Thermal Performance of LED Array Heat Sink" October 2017. Elsevier ISHVAC 2017.

[2] Jeffrey P Koplow, "Heat exchanger device & method for heat removal or transfer", July, 2015.

[3] Waqidi Falicoff, "Heat sink with helical fins and electrostatic augmentation" Janaury, 2013, Patent No. US 8354779 B2.

[4] Rajesh Sharma, Amoljt Singh Gill and Vikas Dhawan, "Experimental Analysis of Heat Transfer and Fluid Flow in Micro-Channel Heat Sink", August 2016.

[5] Channamallikarjun, "Thermal Analysis of CPU with variable Baseplate Heat Sink using CFD", May 2014. IJRET, eISSN: 2319-1163, pISSN: 2321-7308.

Design and Fabrication of Tilting Mechanism for Tricycle with Brushless Motor

Prajwal S[1], Rakesh D M[2], Roshan A P[3], Raghunatha K R [4]

Assistant Professor ***Ramesh N G[5]***
Department of Mechanical Engineering
Sapthagiri College of Engineering
14/5 Chikkasandra, Hesaraghatta Main road, Bangalore-560057, India

Abstract - *This project mainly focuses on the design and fabrication of tilting mechanism for tricycle with brushless motor and is entitle as, "**DESIGN AND FABRICATION OF TILTING MECHANISM FOR TRICYCLE WITH BRUSHLESS MOTOR.**" This objective of our project is to come up with a tilting mechanism for tricycle with brushless motor. The method we have used is a simple mechanical tilting system. A two wheeled vehicle such as bicycle and motorcycle tilt in the turn to counter the centrifugal forces acting on the vehicle, while other vehicles including three-wheeler, motorcar and quad bike rolls slightly out of the turn. These increases load on outer wheels and limits the velocity of turning of vehicle. Tilting a vehicle can provide many performance and design advantages including greater stability while turning, reduced load transfer to outer wheels as well as reduce probability of rollover while taking a turn. This tilting mechanism if successful should dramatically increase the maximum speed in curves. This should also provide the advantages of increased passenger comfort and handling.*

A motor converts supplied electrical energy into mechanical energy. Among this, brushless DC motors feature high efficiency and excellent controllability, and are widely used in many applications. In brushless DC motors current is passed through coils that are arrange within a fixed magnetic field. The current generates magnetic fields in the coils, this causes the coil assembly to rotor. This rotation mechanism is used for our tricycle for movement.

***Key Words*: Tadpole, Trike, Skidding, Directional Stability, Parallelogram linkage**

1. INTRODUCTION

Today, the use of more efficient vehicles is being discussed to improve the energy performance and to better utilize the space of existing roads in the cities. To solve the problems relating to traffic in cities, the design of smaller vehicles, with a better weight/load relation are to be developed. According to design three wheeled automobiles has two main types that is Delta and Tadpole. When there is one wheel at front and two at rear configuration is called as delta whereas two wheels at front and one wheel at rear configuration is called as tadpole or reverse bike. Tadpole designs are more stable than delta configuration because the rear wheel drives the vehicle while the front two wheels are responsible for steering. Our tilting bike has tadpole design. Tilting three wheelers are designed as they can lean while cornering like a motorcycle. A tilting three-wheeler tilt in the direction of the turn such vehicles can corner safely even with a narrow track.

The implementation of the Direct Drive Motor is placed at the exact centre of the rare wheel, where one part of the Direct Drive Motor is fixed to the chase and the rotating part of the motor is alined to the spokes of the trike. The rotation of the motor is used by the trike to gain more speed than initial speed of the trike.

1.1 NEED OF OUR PROJECT

Nowadays most of the accidents occur on two wheelers are because of the instability of vehicles in slippery conditions and the skidding of vehicles. Travelling in bikes during rainy season or snowy seasons are risky. Safety of passenger must be considered as the primary concern. Trikes are designed in order to provide maximum safety to passenger. Avoid skidding during ride is very much important factor for a bike. For such situation trikes play a major role to provide safety to passenger. The Tilting trike is much safer than motorbikes and scooters, and much smaller and lighter than any car. The third wheel offers better braking as well as increased stability while braking. It offers more traction when roads are slippery.

1.2 PRINCIPLE

The design consists of a parallelogram link which connects the two individual suspensions with tyres and the body of the bike. The parallelogram link allows tilting of the tires. The link is connected to the body of the bike using two bearings which is primarily welded and fixed to the body. Tilting occurs by the action of parallelogram link. During turning the parallelogram link will tilt and thereby the fork attached to it will also tilt. Thus, tilting of wheels occurs. It is very essential to tilt in order to avoid skidding of vehicles.

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2. LITERATURE SURVEY

Deaths in India due to accidents [2]

The incidence of accidental deaths has shown an increasing trend with 51.8% in the year 2012 as compared to 2002; however, 0.2% decreases was observed in 2003 over previous year 2002. The population growth during the period 2003-2012 was 13.6% whereas the increase in the rate of accidental deaths during the same period was 34.2%. A total of 1,18,533 males and 20,205 females totaling

1,39,091 persons were killed during the year 2012 A total of 32,318 persons (23.2%) were died due to accidents of 'two-wheelers', 'truck/lorry' accounted for 19.2%, 'cars' accounted for 10.1% and 'buses' accounted for 9.4% of accidental deaths during the year 2012.[2]

Stability Analysis of Three-Wheeled Motorcycles. [3]

Modal analysis of a three-wheeled tilting motorcycle is explained in this work. This vehicle has a tadpole design consisting of two front wheels and a single rear wheel, but can be driven like a normal motorcycle. In order to study the stability of the system in straight running, two models have been developed: a simplified motorcycle model, with locked suspensions and rigid and thin tires and a model having 14 degrees of freedom, in which the stiffness and damping of suspensions and the radial stiffness of tires have been taken into account. In both models the frame has been considered as rigid and the driver was assumed to be fixed to the frame. A linear model with transient behavior has been employed for describing the tire behavior. Analyzed and discussed in this work. Two different models of the vehicle have been set up, by taking or not into account the compliance of suspensions and tires. In order to compare the stability analysis of such vehicle with a similar two-wheeler, a model for this latter vehicle has been also developed. The obtained results have shown how in straight running the three wheeled motorcycle has a higher stability of the weave mode if compared to the two wheelers; indeed, it has been found stable in the whole examined speed range. [3]

Review on tadpole design – issues & challenges [4]

The three-wheel configuration allows the two front wheels to create the wide round surface of the vehicle. The single rear wheel allows the vehicle to taper at the back. Having one less wheel also increases fuel efficiency because of decreased rolling resistance. The disadvantage of a rear drive, non-tilting three-wheel configuration is instability – the car will tip over in a turn before it will slide, unless the centre of mass is much closer to the ground or the wheelbase is much wider than a similar four-wheel vehicle. To improve stability some three wheelers are designed as tilting three wheelers so that they lean while cornering like a motorcyclist would do. The tilt may be controlled manually or by computer. Electric three-wheelers often lower the center of gravity by placing the heavy battery pack at the base of the vehicle. This conclusion is easily understandable if a 3-Wheeler with two front wheels is considered. If the center of gravity of the vehicle occupants assembly is sufficiently low to be under the pyramid, the vehicle will not roll sideways in a curve and will not tip backward when accelerating or tip forward when braking.[4]

3. DESIGN METHODOLOGY

We have come up with one of the simplest and elegant design for our tilting trike. Earlier developed trikes had complex wishbone type suspension at the front end. It also had a tyre span almost equaling a small car. This makes it difficult to be used in high traffic conditions. It also increases the turning radius of the time. Further it made the vehicle very heavy which result in lowering of overall efficiency. We designed our trike to be more compact and user friendly. It does not add much weight and therefore is much efficient compared to previous trike designs. Compact design allows it to be used in all traffic conditions. The design consists of a parallelogram link which connects the suspensions with tyres and the body of the bike. The parallelogram link allows tilting of the tyres. The link is connected to the body of the bike using rod end bearings which is primarily weld fixed to the body. Suspension is used which is basically using forks side by side as a single unit.

The calculation at the rare to mount the Direct Drive Motor are calculated which connects the centre axle and working of the motor is analyzed, Speed of the trike is measured.

We used Design Software Fusion 360 for designing Tilting Mechanism for Tricycle as shown

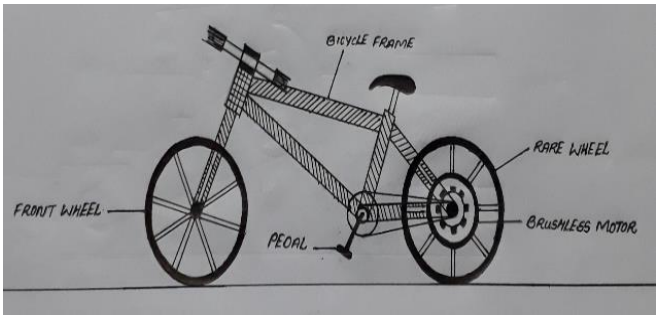

Figure.1 2D Side View

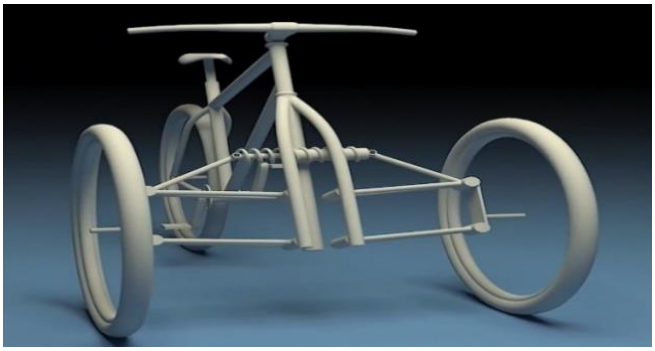

Figure.2 3D Front View

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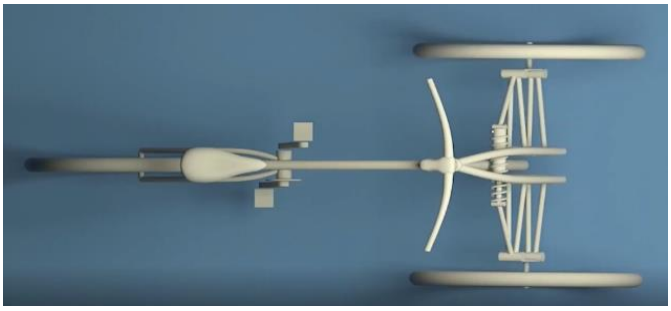

Figure.3 3D Top Bottom View

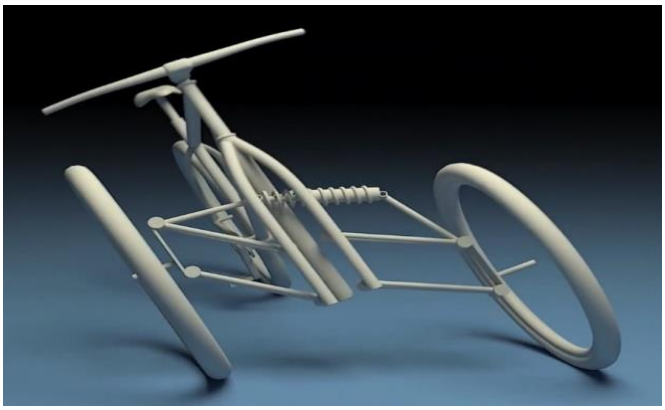

Figure.4 3D Right Side Tilting

Figure.5 3D Left Side Tilting

4. FABRICATION

The front suspension was disassembled. The disassembled parts include the head, forks, wheels etc. Two extra forks are collected. Two of them are joined together to form a single suspension. Joining two forks together gives more strength compared to single fork. The dual fork suspensions and wheels are then joined together. The two front plates are then properly fixed. Now the rod end bearings are weld fixed one below the other with the help of iron bars. These bearings are on which the parallelogram link is fixed. The tilting mechanism includes two lateral links and two vertical links. The fork suspension makes up the vertical links. The centres of two lateral links are fixed to each of the rod end bearings. Caser and camber angles are properly adjusted and the whole assembly is fixed or welded.

At the lone Direct Drive Motor is a fixed at the centre of the rare wheel, where the spokes of the wheel are connected to the motor in such a way that coil part of the motor is fixed to the chase and the rotating part is connected to the spokes of the trike, thus the motor is implemented with the rare axil of the tricycle.

5. CONCLUSIONS

We have successfully designed and fabricated a model of tilting trike, attachment of the Direct Drive Motor at the rare wheel which combines the advantages of reverse trike and leaning mechanism. From the study we know that the most of the accidents take place due to skidding of the front wheel in the sudden braking condition while taking a turn, our design has two wheels in the front and also the ability to lean, which prevents the vehicle from skidding and losing control of the vehicle on road. The performance, handling and safety of the tilting trike are much better than any other commercially available three wheelers.

6. REFERENCE

- Kaustubh Dilip Patil, Prashant S. Mulmule, Vikrant S. Satalkar and Ramesh S. Thorat, “Design and Manufacturing of Tilting Trike Tiltra Msx-1” International Journal of Innovative Research in Science, Engineering and Technology, Vol. 4, Issue 9, September 2015
- Report on Road transport research, ministry of road transport and highways, Government of India page 1114.
- Palash Patodi, Vinay Saxena, Yogesh Rathore “Review on tadpole design – issues & challenges” international journal of research in aeronautical and mechanical engineering Pages: 122-128, March 2014
- Jawwad A. K. Lodhi and Nafees P. Khan, Performance Evaluation of Leaning Reverse Trike, Journal for Research | Volume 02, Issue 10, December 2016

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Fabrication of Solar Powered Multipurpose Agricultural Vehicle

CHETHAN GOWDA N*[1], DHANUSH S [2], HEMA M [3], KARTHIK KUMAR A [4], BASAVARAJ GANIGER[5]

Department of Mechanical Engineering, Sapthagiri College of engineering
#14/5 Chikkasandra, Hesaraghatta main road, Bangalore- 57 India

[1] cgowdan@gmail.com

[2] dhanushshivalinga1999@gmail.com

[3] hemam2820@gmail.com

[4] karthikkarthi14399@gmail.com

[5] basavarajganiger@sapthagiri.edu.in

***Abstract*: - The objective of this paper is to develop "Multipurpose Agriculture Vehicle". This Agricultural vehicle is an agricultural machine of a considerable power and great soil clearing capacity. This multipurpose system gives an advance method to sow, plow, soil leveling and spraying water with minimum man power and labor making it an efficient vehicle. The machine will cultivate the farm by considering particular rows and specific column at fixed distance depending on crop. Moreover, the vehicle can be controlled manually by driving the vehicle using seating arrangement. This agricultural vehicle will be running with batteries. Batteries will be charged using Solar Energy. So ultimate aim is to develop a agricultural vehicle which uses renewable sources for operation.**

Agriculture being one of the major occupations in India, Agriculture plays a vital role in the Indian economy. Indian agriculture has registered impressive growth over last few decades. It is very essential to discover and implement new idea in this field, though lot of work has been done in this area. It is unfortunate that, these ideas are not being implemented properly in actual field. This is due to high cost and is complicated for rural people. Multipurpose agriculture or farming machine is basic and major machine involved in agriculture for maximum yielding.

Keywords: Agriculture vehicle, Solar panel,* DC motor, *battery.

I. INTRODUCTION

India is an agriculture-based country in which, 70% of people depends on the outcome of farming. The written history of agriculture in India dates back to the Rig-Veda. India ranks second worldwide in farm output. Still, agriculture is demographically the broadest economic sector and plays a significant role in the overall socioeconomic fabric of India. In recent years if we compare production rate or efficiencies of Indian farms to other nations then we realize India certainly lagging behind. The main reasons for India to lag behind in the development in the field of agriculture are: Lack of proper mechanization in the farms, Smaller size of farms, financially poor background of many farmers, Excess efforts required in performing various processes separately, Excess time required for performing individual processes separately, Unorganised farmlands in India. Because the consequence of the above-mentioned problems, many farmers cannot afford to purchase heavy agricultural machines (vehicles) due to smaller size of lands and financial constraints. Also, the conventional equipment's and methods often require lot of human effort and multiple operations. Thus, agricultural mechanization is a necessary concept to improve the efficiency and reduce the cost of production.

Multifunctional agricultural vehicle deals with the problems faced by farmers i.e., seed sowing, fertilizers spraying, cultivation and digging. We are looking this project as revolution in small farms in India, which is most uncovered area in this sector, in a cost effective and more efficient way. These vehicles are capable of working 24 hours a day all year round, in most weather conditions. Moreover, such a system may have less environmental impact if it can reduce over application of chemicals and high usage of energy, such as diesel and fertilizer, by control that is better matched to stochastic requirements. The inclusion of the solar panels to charge the battery and run the vehicle is also an added advantage by reducing the usage of fossil fuels. The main components of the vehicle are solar panel, battery, DC motor. The function of this agricultural vehicle depends on the amount of solar energy that the solar panel receives and this solar energy is used to drive the different parts of the vehicle. The crystal based solar panel is use to charge a rechargeable battery of 12 volts. From the battery the stored electrical energy is sent to DC motor which is used to drive it. The motor converts electrical energy to mechanical energy and this energy is used to perform different operations like water spraying, weeding with the help of switch control mechanism. The power transmission is done by using manual power. Our model is designed in

such a manner so that it can be run even in small farms and performs the various operations like digging and ploughing, water sprinkling, and seed sowing effectively.

III. METHDOLOGY

The objective of this paper is to develop a multipurpose agricultural vehicle shown in figure 1 and figure 2, which can perform various agricultural operations such as ploughing and digging, seed sowing and water spraying. The vehicle is powered by solar energy, by collecting the energy from the sun and storing it in the battery. Thus, we can reduce the emissions caused by the usage of fossil fuels by utilizing solar energy. The various agricultural operations are controlled by electrical switches, each to drive the vehicle, to run the centrifugal pumps for water supply and to run the seed sowing mechanism.

3.1 Details of the components of vehicle

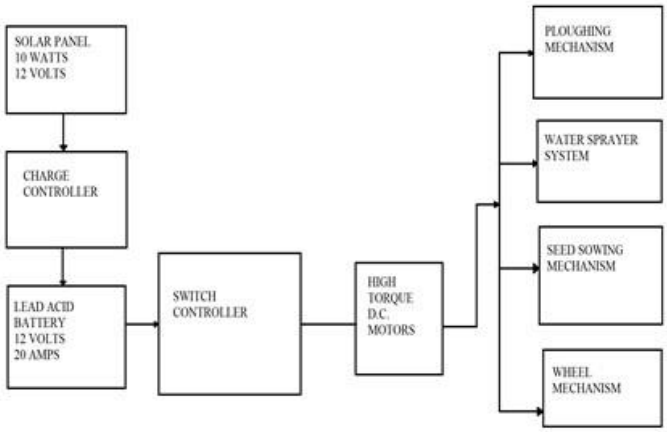


Figure 1: block diagram of Multipurpose Agricultural Vehicle

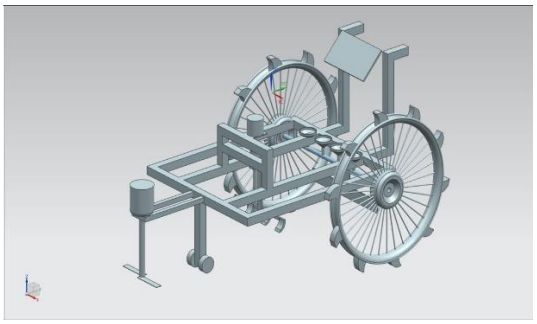


Figure 2: Prototype model of multipurpose agricultural vehicle

Methodology used for whole processing is given below; this methodology gives way about how work is to be carried out in systematic way. It is standard process of describing process, how it is done in simplest manner.
Design consists of application of scientific principle, technical information, and imagination for development of new mechanism to perform specific function with maximum economy and efficiency. Hence careful design approach has to be adopted. The total design work has been split into two parts.

1. System design

2. Mechanical design

System Design: System design is mainly concerning the various physical constraints and ergonomics, space requirements, arrangement of various components on frame at system, man-machine interaction, no. of controls, position of controls, working environments, of maintenance, scope of improvement, weight if machine from ground level, total weight of machine and a lot more. In system design we mainly concentrated on the following parameter: - System selection based on constraints Our machine is used in small-scale so space is major constrain. The system is to be very compact so that it can be adjusted in small space.
In case of any failure are important criterion of design. Factor of safety while doing design should be kept high so that there are less chances of failure. Moreover, periodic maintenance is required to keep unit healthy. Servicing facility Layout of components should be such that easy servicing is possible. Those which require frequent servicing can be easily disassembled.
Scope of future improvement Arrangement should be provided in such way that if any changes have to be done for future scope for improving efficiency of machine.

3.2 Technical specifications

- Title of the project: Fabrication of multipurpose agricultural vehicle powered by solar energy.
- Solar panel: 12V photovoltaic cell, 10W
- Battery: 12V, sealed lead acid, 7Ah
- Internal shaft dia 15 mm
- Chassis material: Ms frame 1-inch Square pipe 18 gauge.
- DC motor: 12v 2amps 60rpm.

3.3 Working of prototype model

Base frame is made for the robot with 2 spike wheels connected each with the dc motors.
One end of the frame, plowing tool is fitted with lead screw and dc motor to vary the depth, this plowing tool moves up and down when motor rotated clockwise and anticlock wise, in normal condition the tool can be lifted up to reduce the drag force of the chassis
Seed Funnel fitted perpendicular to the seed shaft which rotates along the main drive of the wheel, the seed shaft is made hole to enter the seeds to flow through the hole, so each seed flow one after the other with constant distance can be achieved.
After seeding process sheet plate is placed to close the seeds in to the soil, sheet plate as nut and bolt system to adjust accordingly
Next process is water sprayer water tank fitted on the chassis along with dc sub pump which sucks water and through to the nozzle and sprays towards the soil
Solar is placed on top of the chassis, Thus the max power is utilized from the sun by the solar panel stores

to the battery, the whole system need dc power from the battery to drive the motor

The motors are controlled by the toggle switches, connected to the motors individually.

IV. RESULT

The "Multi-Purpose Agriculture Vehicle" aims to perform various agricultural operations.The developed model runs successfully performing all the agricultural operations, i.e. ploughing and digging, seed sowing and water sprayer both simultaneously and individually with the help of electrical switches. Also the use of solar power to run the vehicle is an added advantage being a renewable source of energy. Thus, being a multi-utility vehicle, it has other advantages like reduced manpower, increased rate of productivity and better efficiency as it is battery operated. It is cost effective which is affordable even for the poor farmers. Also by the use of effective seeding mechanism, the wastage of the seeds is reduced. The electrical switch mechanism makes it much easy to operate for the farmers. The vehicle can also be used for material handling and hence makes it feasible to move heavy loads.

V. CONCLUSION

The "Multi-Purpose Agriculture Vehicle" aims to perform various operations of the agriculture, which are accomplished by using various components like solar panel, centrifugal pump, D.C. motor and motion transmission mechanisms. The various components required for building the multipurpose agricultural equipment has been designed as planned. Multipurpose agricultural vehicle is single system which can perform multi operations like sowing, water sprayer, ploughing and digging. It can also be used for local transportation purpose for material handling. Multipurpose agricultural vehicle will reduce external charges like fuels; electricity etc. and this will be helpful for poor farmers. Multipurpose agricultural vehicle is a single system which contains multi attachments. The equipment weight is around 8 to 10 kg thus it can be carried easily in farmland. The equipment can do the work of 4 labours a day which reduces the labour cost of the farmer.

REFERENCES

[1] V.K. Mehta, Rohit Mehta**,** Principles of Electrical Engineering, S. Chand Publications.

[2] Kripal Singh, Automobile Engineering, Standard Publishers Distributors.

[3] V.V. Bhandari, Machine design, Tata McGraw Hill Publishers. [4] R. K. Bhansal, Fluid Mechanics, Laxmi Publications.

[5] Rahul Shukla and Rahul Shukla, "Mechanization of Agriculture: Implications for the Farming Community in India", Department of Humanities and Social Sciences Indian Institute of Technology Guwahati, Perspectives on Global Development and Technology 14 (2015) 430-447.

[6] D.A. Mada, Sunday Mahai, "The Role of Agricultural Mechanization in the Economic Development for Small Scale Farms In Adamawa State", the International Journal Of Engineering And Science (IJES) Volume 2 Issue 11 Pages (91-96)2013 ISSN (e): 2319–1805.

[7] Dr. C.N.Sakhale, Prof. S.N.Wagmare and Rashmi S.Chimote, Priyadarshini College of Engineering, Nagpur, MH- India .A Review Paper on "Multi Purpose Farm Vehicle". International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056 Volume: 03 Issue: 09 Sep-2016 p-ISSN: 2395-0072.

[8] Prof. M.V.Achutha, Sharath Chandra and Nataraj. G.K, Mysuru, India. "Concept Design and Analysis of Multipurpose Farm Equipment." International Journal of Innovative Research in Advanced Engineering (IJIRAE) ISSN: 2349-2763 Issue 02, Volume 3 (February 2016).

[9] Kshirsagar Prashant , Kuldip Ghotane, Pritesh Kadam, Omkar Arekar, Ketan Insulkar RMCET, Ambav (Devrukh), Ratnagiri Maharashtra, India."Modelling and Analysis of Multifunctional Agricultural Vehicle." International Journal of Research in Advent Technology, Vol.4, No.1, January 2016 E-ISSN: 23219637.

The Influence of Gate Location in an Injection Moulded Top Module PCB Housing

ANIL KUMAR P R[1], T VENKATE GOWDA[2], NIHAL J KASHYAP[3],
UMA MAHESHWARI [4], HEMANTH BHAT[5], DARSHAN GOWDA N[6]

Department of Mechanical Engineering, Sapthagiri College of engineering
#14/5 Chikkasandara, Hesaraghatta main road, Bangalore- 57 India

[1]anilrampr@gmail.com
[2]venkatesh4u@gmail.com
[3]nihalkashyap546@gmail.com
[4]mahimaheshwari2712@gmail.com
[5]hemanthbhat123@gmail.com
[6]darshangowdadg1997@gmail.com

Abstract - It is necessary to provide a flow-way in injection moulding to connect the nozzle to the each impression; this flow-way is termed as feed system, normally feed system consisting of sprue, runner and gate. Gate is the small area between the runner and the part cavity, In design of injection mould gate location is the most critical factors in achieving dimensionally accurate part and resulting in high productivity of the product, since it influences the manner in which the plastic flow into the mould cavity. Gate location can have a drastic effect on a part that could result in incorrect parts. The analysis was carried out to study the location of gate which reduces filling time and improves the part quality considering base part as an example, this case study is done by mould flow analysis tool, to ensure the concepts mentioned above.

Key words: Injection moulding, feed system, gate location, filling time.

I. INTRODUCTION

In the injection moulding processes, gate location is very important design parameter which is in the relation with polymer capability, part shape and dimension, mould structure and mould condition, the selection of gate location influences the manner in which plastic flows in to the mould cavity , therefore, has great effect on the polymer molecule orientation and war page of injection moulding part after cooled, irrational gate location would leads to short shot, war page, shrinkage, weld and melt lines, air traps and other quality defects, even possibly directly result in wastrel. In a word, rational gate location has a significant effect on the part quality and proper working on mould. The component used for the study, top module PCB housing in electrical assembly. Its function is to fasten all the circuits' connection.

As this also has to be flexible, tough and cheap to manufacture, the material selected is POLYBUTYLENE TEREPHTHALATE (PBT 30%GF). The following sketch (fig-1) shows a 3D model of the part.

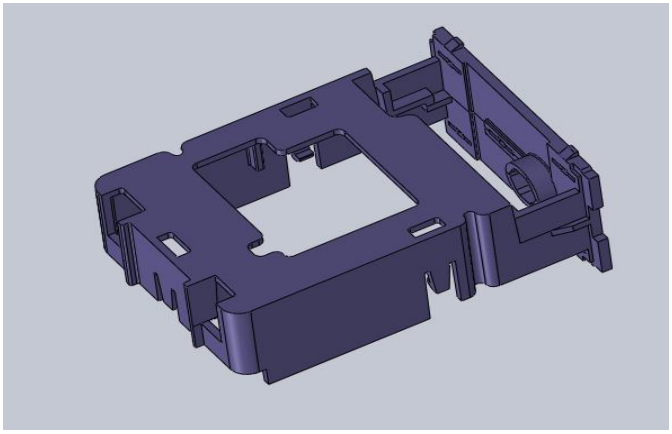


Fig. 1 3D Model of the Component

Like all thermoplastic injection moulding resins, Polybutylene Terephthalate (pbt 30%gf) has its own special characteristics. These characteristics not only affect the properties of the finished moulded pieces, but they also determine optimum moulding conditions. Available as either a photopolymer or a copolymer, Polybutylene Terephthalate is offered in a broad range of grades and types. The Inherent Chemical Properties are: Low Density, High-Temperature, Resistance Weathering (Ultraviolet Resistance), and Stress-Crack Resistance.

Other Properties-

1. High toughness and impact strength
2. Excellent dimensional stability
3. Hardness and rigidity
4. Heat resistance

TABLE I
PROPERTIES OF ACRYLONITRITE BUTADIENE STYRENE:

Property	Unit	Value
1.Specific Gravity	-	1.0 - 1.2
2.Thermal conductivity	w/mk	0.25
3.Melting point	°C	230
4.Shrinkage	%	0.4-0.6
5.Density	gm/cc	1.06-1.12

II. ANALYSIS

The main aim is to study the influence or effect of the position of gates in an injection moulded component. Here the only variables are the position and the number of gates in the design. The study uses constant values of all other parameters such as injection pressure and temperature, mould temperature, melt temperature, type of material, injection moulding machine, etc. Even the type of gate considered is a pin point gate of identical dimensions.

TABLE II
THE SET PARAMETERS ARE:

Melt temperature	250 °C
Mould temperature	80 °C
Injection locations	1
Max. Machine injection pressure	2.06 MN/mm²
Clamping force during moulding	40(ton)

Mould flow analysis software used to analyze plastic flow characteristics during moulding operations. They are very useful aids used in the design of plastic mould tools. They are capable of analysing a wide variety of characteristics including fill time, packing analysis, better gate location, gate area, pressure and temperature, warpage, weld lines, air traps, etc. There are many types of analysis available in Mould flow software. Not all of them deal with the influence of gate positions.

Only the relevant analysis was performed and below is the different types of analysis for which results have been provided in this study.

1. Fill Time Analysis: Fill analysis predicts the thermoplastic polymer flow inside the mould in the filling phase. A Fill analysis calculates a flow front that grows through the part incrementally from the injection location.

2. Pressure Drop: Shows the difference in pressure of the melt as it flows through the cavity. It also indicates the pressure required by the melt to flow through any given region.

3. Temperature Flow Front: Temperature at flow front shows the temperature of the polymer when the flow front reaches a specified point, in the centre of the plastic cross-section. The flow front temperature should not drop more than 20°C during the filling phase.

4. Air Traps: An air trap is where melt traps and compresses a bubble of air or gas between two or more converging flow fronts, or between the flow front and the cavity wall.

5. Weld Lines: A weld line is a weakness or visible flaw created when two or more flow paths meet during the filling process. They are not harmful if the difference in temperature is no too large.

The first step of the analysis is to determine which region of the Basetta tu base cover is most practical to place the gates. The image below (Fig-2) shows the component with respect to the most suitable areas for placing the gate. The green area is the best but it is at the centre and the region is not well defined. The gate mark should not occur on the surface so we select in the parting line area.

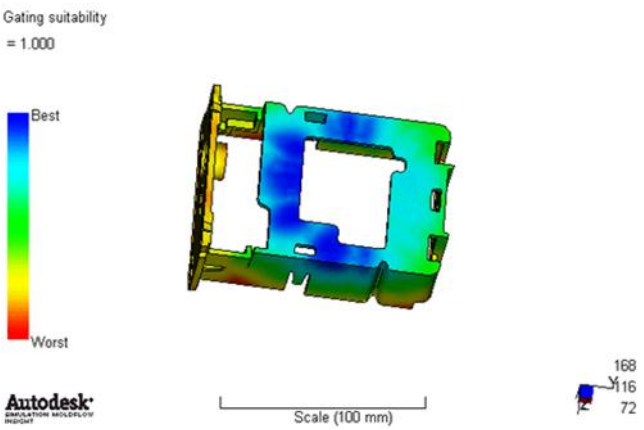


Fig. 2 Best gate location

III. ITERATIONS

The position and number of gates have been changed many times and three of the iterations have been shown here. The iterations has a single gate, the images below show the positions of the gates on the part and on the parting line for the respective iterations.

1st Iteration-

No. of gates 1, Best gate location by software (mould flow).

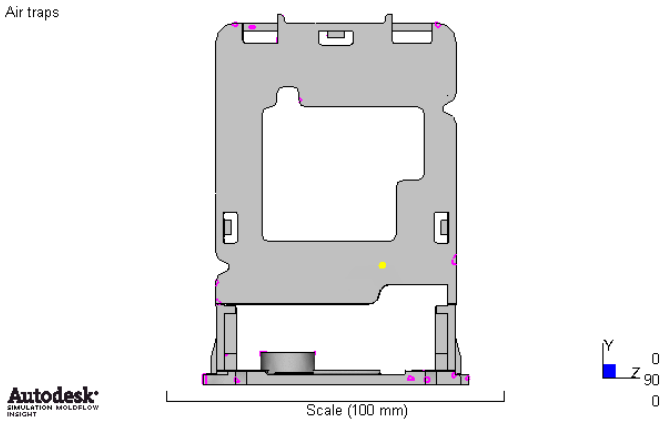


Fig. 3.1 (a) Air trap

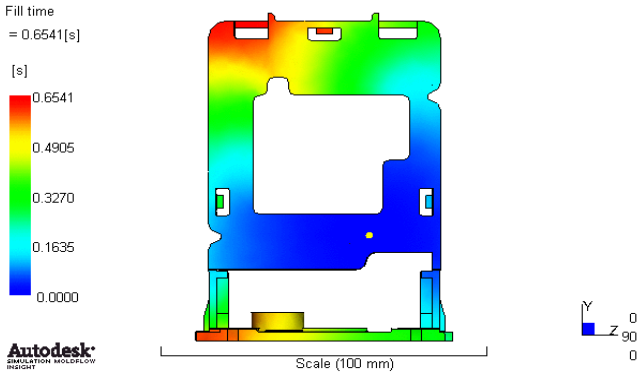


Fig. 3.1 (b) Fill time

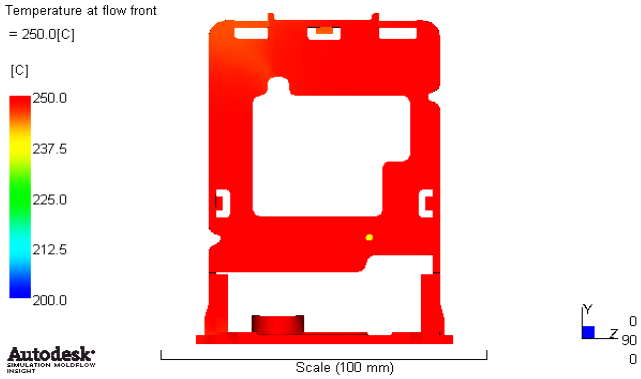


Fig. 3.1 (c) Temperature at flow front

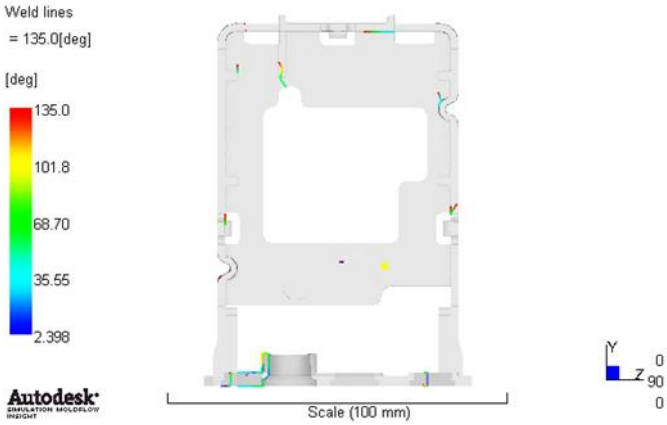


Fig. 3.1 (d) Weld lines

Results*:*

- Air traps are less.
- Time required to fill the mould is 0.654 sec.
- Temperature at flow front is 250 ^{0}C.
- Weld lines are less.

2nd Iteration-

No. of gates 1, front face of the component

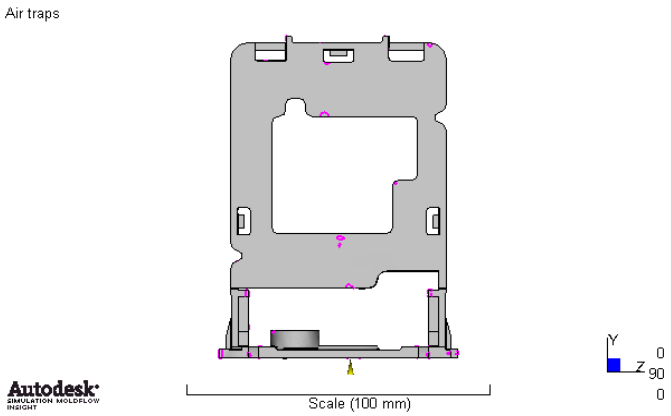


Fig. 3.2 (a) Air trap

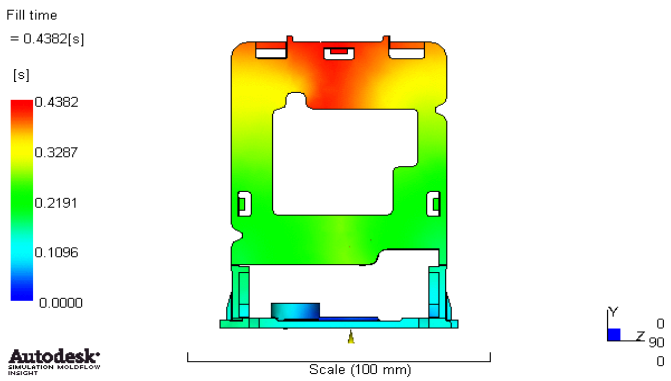


Fig. 3.2 (b) Fill time

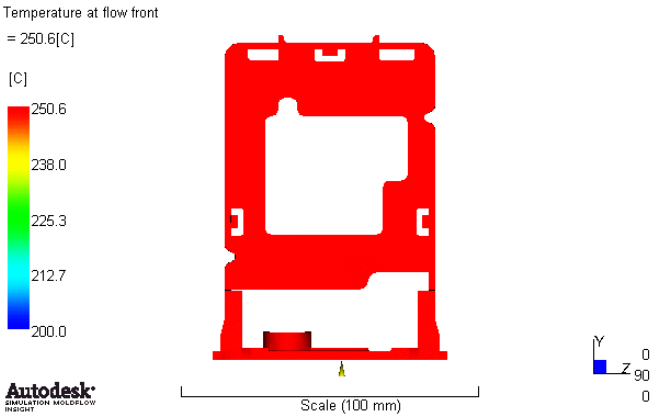


Fig. 3.2 (c) Temperature at flow front

Fig. 3.2 (d) Weld lines

Results:

- Air traps are less.
- Time required to fill the mould is 0.438 sec.
- Temperature at flow front is 250.6 ^{0}C.
- Weld lines are less.

3rd Iteration-

No. of gates: 2, Front face of the component

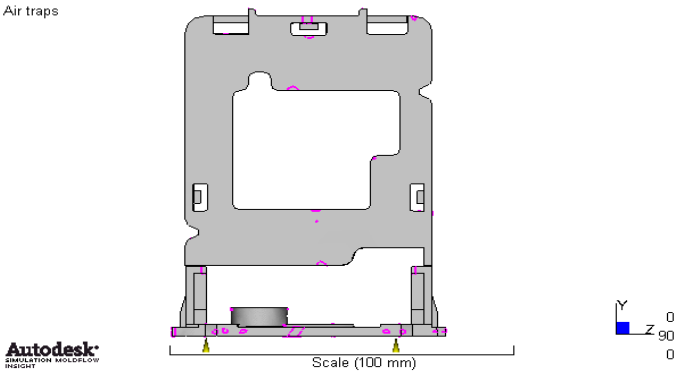


Fig. 3.3 (a) Air trap

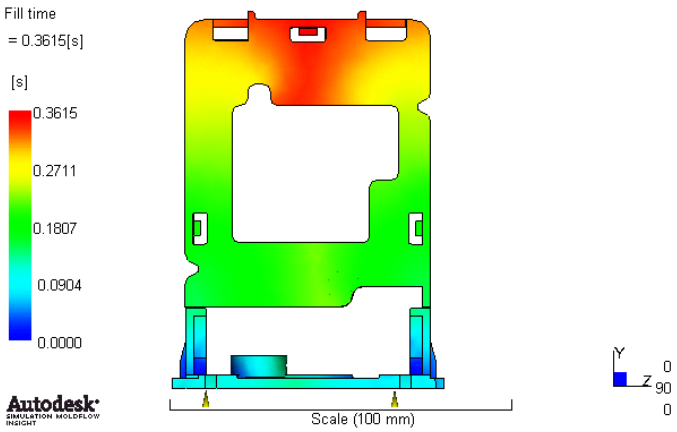


Fig. 3.3 (b) Fill time

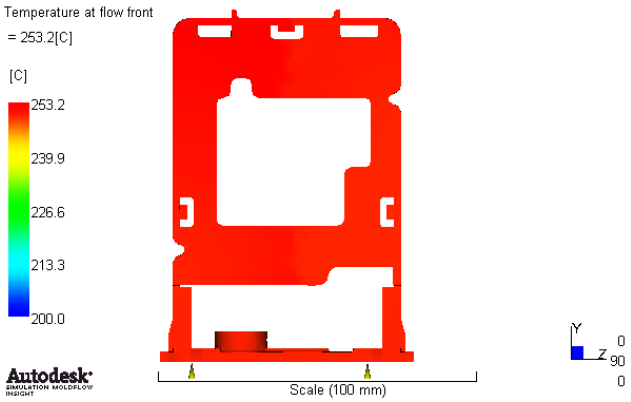


Fig. 3.3 (c) Temperature at flow front

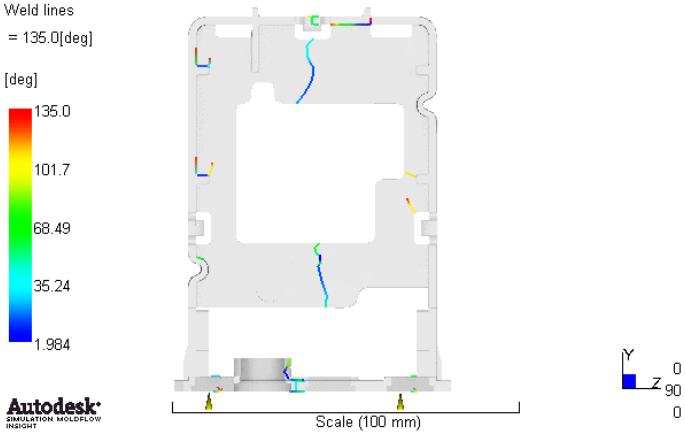


Fig. 3.3 (d) Weld lines

Results:

- Air traps are less.
- Time required to fill the mould is 0.361.
- Temperature at flow front is 253.2^{0}C.
- Weld lines are more.

TABLE III
COMPARISION OF EXPERIMENTAL RESULTS

Iteration	Air Traps	Fill time	Temp. At flow front	Weld lines
1st	Less	0.654sec	250^0C	Less
2nd	Low	0.438sec	250.6^0C	Less
3rd	More	0.361sec	253.2^0C	more

IV. RESULTS

- Best location of the gate obtained from the analysis and based on the component complexity. The 2nd iteration gate location is finalized after conducting the analysis.
- The fill time observed is 2.518sec, which is used in machine parameter setting.
- The temperature near the weld line is nearly same as melt temperature, which results weld lines to fuse.
- Most of the air traps are located at the parting surface and bosses, which can be removed by providing suitable air vents in the mould.
-

V. CONCLUSION

In the course of analysing the component, gates were considered at different positions and the experiment was carried out. The results of the numerous analyses were compared each other and the best location of the gate is considered. The gate position of the third iteration has poor flow and temperature characteristics while the first iteration is not satisfactory in many aspects. The second iteration achieved better results in the analysis with having very few problems compared to other. Thus it is safe to say that iteration two offers the best results in positioning of the gate.

VI. ACKNOWLEDGEMENT

We would like to express our sincere gratitude to the Management, Principal Sapthagiri College of Engineering Bengaluru for the facilities provided and their support. Also we would like to thank the Head of department Mechanical Engineering and faculties for their encouragement and support.

VII. REFERENCES

[1] P. Kennedy, Flow Analysis of Injection Moulds, Hanser- Gardner, 1995.

[2] C.L. Tucker III, Computer modeling for polymer processing, Hanser Publishers, Munich, Vienna, New York, 1989.

[3] Runner and gating design handbook – Tools for successful injection moulding. - John. P. Beaumont - Hanser Verlag, Technology and Engineering.

[4] A Guide to Injection Moulding of Plastics by Prabodh C Bolur, McGraw-Hill publication.

[5] P.K. Bharti, M. I. Khan, Recent methods for optimization of plastic injection molding- a retrospective and literature review, P.K. Bharti et. al. / International Journal of Engineering Science and Technology Vol. 2(9), 2010, 4540-4554.

[6] Effect of varying gate size on the air traps in injection moulding – Arjun Kapila, Kanwarjeet singh ,Gaurav Arora and Narayan Agrawal , Department of Tool Engineering Delhi Institute Vol.5, No.1(FEB 2015)

[7] Influence of Feeding System in Injection Moulding on Lower Washer of a Bearing – Vikash B J, Chandra Kumar R ,Department of mechanical engineering , RV college of engineering ,Vol.2, Issue 08 August 2017

Voice Activated XY Plotter for Specially Abled

CHANDAN P*[1], MOHAN S[2], KIRAN S[3], JAIRAJ B[4],R.G. DESHPANDE[5]

Department of Mechanical Engineering, Sapthagiri College of Engineering
#14/5 Chikkasandra, Hesaraghatta Main Road, Bangalore- 57 India.

[1]ananuchandan@gmail.com
[2]mohansrshet@gmail.com
[3]kiransatish36@gmail.com
[4]iamjairaj0011@gmail.com
[5]deshpande@sapthagiri.edu.in

Abstract **-XY plotters are used to print by moving a pen or other writing device across the surface of a piece of paper. XY Plotter is an embedded system that works based on the principle of Computer Numerical Control. The XY plotter has a two axis control and a special mechanism to raise and lower the pen. Each axis is powered and driven by using an Arduino compactable driver . which is used to recording or plotting two dimensional data on a rectangular coordinate system. For this we use softwares like Arduino IDE software and G code converter.**

Keywords – Arduino uno, XY plotter ,G code

I. INTRODUCTION

XY plotters are used to print by moving a pen or other writing device across the surface of a piece of paper. It is an embedded system that works based on the principle of Computer Numerical Control. It basically works with two stepper motors and a servo motor, wherein the robot plots the input given from the user from a mic onto the drawing board or examination paper using Arduino microcontroller. To Design and fabricate voice activated X-Y Plotter for specially challenged. To facilitate people especially the ones who cannot write or the one's who face a lot of problem finding substitutes during examinations and other places where they need to fill a form or a piece of paper. This can be overcome by a voice activated X-Y plotter. To build a mechanical prototype of a plotter machine which is able to write text and draw images on a given solid surface. To develop plotter which works more efficiently, which is used to record or plot two dimensional data on a rectangular coordinate system.

II. METHODOLOGY

- Selection of material.
- Design of components.
- Part manufacturing and fabrication.
- Assembly of parts.
- Coding and Testing.
- Continuous error modification.
- Output is obtained.

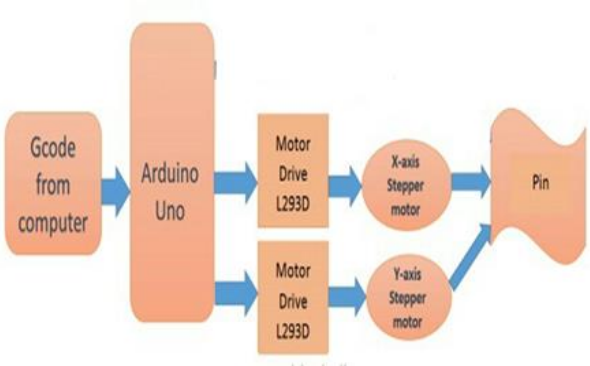


Fig.1 Flowchart

A voice activated x y plotter is a device which take human voice has an input and convert it into a machine language which can be read by microcontroller and commends a motor to write on paper. Primarily microphone detects and encode the human voice into machine language. Then this is sent to computer application called Inkscape which types the vocabulary which microphone is detected with the help of 'Gctrl' application text is converted into g-code and m-code, which used to control CNC. This codes are sent to Arduino which actuates the stepper motor in controlled manner in order to create control of alphabets on sheet.

We use electrical energy as a energy source to actuator the shaft with the help of motors. We use cartesian co-ordinate system to define the movement of pen. We use normal ball bearing for smooth rotation of shaft and slider bearing for linear movement of pen holding apparatus. Jumper wires as communication bus between motor and Arduino.

III. HARDWARE

Arduino Uno

Arduino Uno is microcontroller based on ATmega328P Atmel AVR family microcontroller (MCU). It is an open source software and hardware design and manufacture a single of microcontroller.It contains 14 digital input/output pins and 6 analog input can be sampled using on chip ADC .Arduino Uno can be programmed by using open sources.

Fig.2 Arduino Uno

Stepper Motor

The stepper motor used in the project is NEMA 17 2 phase 4 wire 1.8 degree step size with torque of 4.2kg/cm. The stepper rotational motion can be converted into the movement of the pen with respect to the X, Y and Z axis directions. It is a brushless motor distributes full rotation in several equal steps. They are basically used to convert rotational motion into linear motion. The stepper motors, each of which are placed on X axis and Y axis serve the purpose.

Fig.3Stepper Motor

IV. SOFTWARE

Inkscape

Inkscape is a free and open-source vector graphics editor used to create vector images, mainly in Scalable Vector Graphics format. Other formats can be imported and exported. Inkscape can provide us with primitive vector shapes and text.

Fig. 4 Inkscape

V. DESIGN OF XY PLOTTER

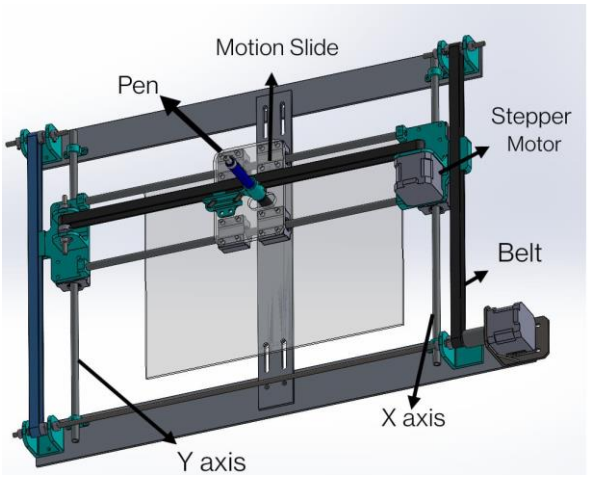


Fig. 5 Isometric view of plotter

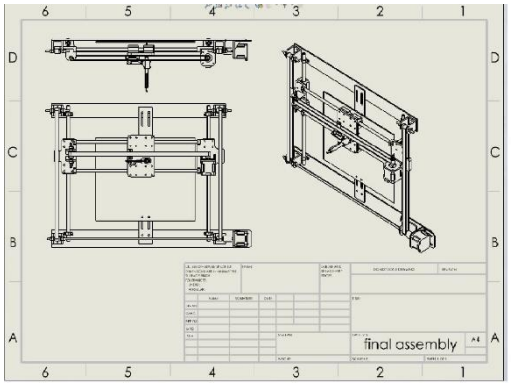


Fig. 6 Final 2D Draft

VI. RESULT AND DISCUSSION

Result and Discussion Based on the performance conducted on the machine it was found out that after uploading the input on the inkscape software .

Fig 7. Input to Ardunio

The input given to the machine is

Fig 8 Output obtained

The figure /text obtained on the sheet from the pen fitted to the machine. The output obtained from the machine.Therefore after machines performance was found out to be satisfactorily producing the required output .Hence it can be implemented in public places as well as in examination centres.

VII. CONCLUSION

The Arduino based XY drawing Robot using atmega 328 microcontroller is used in the arduino board which is used to draw fast and efficient texts or drawings as per the input taken from the user. The input is fed into the input port of the micro controller after passing through inkspace. Stepper motors are used to set the position of the pen to the origin and a servo mechanism is used to lift and lower the pen which then imprints the output on the paper. This project serves to provide a good platform for future development and this project demonstrates our understanding and the application of mechanical engineering knowledge into solving every day's problem faced by specially abled and other peole for the benefit of mankind.

ACKNOWLEDGMENT

I would like to express my gratitude to our Project guide, **Prof. Dr R G Deshpande**, Associate Professor, Sapthagiri College of Engineering Bengaluru, for his constant support and guidance throughout this work. I place on record, my sincere thanks to **Dr P Mahadevaswamy,** HOD, Mechanical engineering, for his constant assistance and backing that motivated me for the successful completion of this work.

REFERENCES

[1] SudharshanAdiga, Prajwal Shetty ,C Sunanda " *Mini CNC Drawing machine for PCB printing*"(2020)

[2]Sheetal N Patil,Prashanth G Patil "*Implementation of Arduino Uno based 2D plotter*"(2019)

[3]Pratik Kamble, Dr. SuchitraKhoje, Prof. JyotiLele, "*Implementation of Paper PCB using Conductive Ink 2D Plotter*", Fourth International Conference on Computing Communication Control and Automation (ICCUBEA), 2018.

http://ieeexplore.ieee.org/document/867781

[4]Madekar, kajal j. " *Automatic mini CNC machine for PCB drawing and drilling.*" (2016).

https://www.irjet.net->IRJET-V312194.Pdf

[5]Linggarjati, jimmy, and Ronda Hedwig. "*manually interchangeable heads of homemade computer numerical control (CNC) machine*." internetworking Indonesia journal 1.1 (2013).

PEDAL OPERATED REVERSE OSMOSIS WATER PURIFICATION

1)ANANDA ,2)ANIL KUMAR .R,3)DHANUSH.U,4)DIVAKAR .R ,5] MADHU KUMAR .Y.C
Department of mechanical engineering ,Sapthagiri college of engineering
#14/5 Chikkasandra, Hesaraghatta main road ,Banglore-57 india
1]anandaaaa29@gmail.com
2]divakar112698@gmail.com
3]dhanuanu1947@gmail.com
4]anilkumar049369@gmail.com
5]Madhukumar@sapthagiri.edu.in

I .ABSTRACT— **Reverse osmosis is a separation process that uses pressure to force a solvent through a membrane that retains the solute on one side and allows the pure solvent to pass to the other side, meaning it allows the passage of solvent but not of solute. In reverse osmosis, the idea is to use the membrane to act like an extremely fine filter to create drinkable water from salty water. Reverse osmosis (RO) is a membrane-technology filtration method that removes many types of large molecules and ions from solutions by applying pressure to the solution when it is on one side of a selective membrane. The result is that the solute is retained on the pressurized side of the membrane and the pure solvent is allowed to pass to the other side. To be "selective," this membrane should not allow large molecules or ions through the pores (holes), but should allow smaller components of the solution (such as the solvent) to pass freely**

II .INTRODUCTION

The process of osmosis through semipermeable membranes was first observed in 1748 by Jean-Antoine Nollet. For the following 200 years, osmosis was only a phenomenon observed in the laboratory. In 1949, the University of California at Los Angeles (UCLA) first investigated desalination of seawater using semipermeable membranes. Researchers from both UCLA and the University of Florida successfully produced fresh water from seawater in the mid-1950s, but the flux was too low to be commercially viable until the discovery by Loeb and Sourirajan of techniques for making asymmetric membranes characterized by an effectively thin "skin" layer supported atop a highly porous and much thicker substrate region of the membrane. By the end of 2001, about 15,200 desalination plants were in operation or in the planning stages worldwide

III .OBJECTIVE

Pedal powered water purification by RO method meets the needs of the people without requiring any electrical energy

This filteration system could be brought into remote areas and emergency conditions likes flood, famine earthquakes etc.

The aims of the project may be summarized as follows:

To design and construct a reverse osmosis unit, powered by pedalling and capable of producing drinkable water from brackish borehole feed for rural households or small communities.

To motivate peoples about renewable energy resources by physical energy using from human .

To select desalination membranes which will deliver the maximum amount of potable water at the prevailing operating conditions.

Provision of safe and potable drinking water in adequate quantity and within minimum distance to all at all time and to bring about an improvement in the general quality of life in the rural area.

Initiate conservation, recharge and sustainability measures with regard to drinking water in the rural area.

rification kit which requires minimum maintenance and is cost efficient

IV. LITRATURE REVIEW

- pedal power water purification and design was focused on process of conception, invention, visualization, calculation etc.

- he also made a force analysis to check performance criteria.
- The physical parameter of design was determined by the appropriate calculation and the practical consideration with some reasonable assumption.
- It is discovered that the design is simple, cheap, efficient and affordable as could be seen from the readily available materials used.
- It also use the Bernoulli's principle for the flow calculation with the help of peristaltic pump.

- Has studied on the design and he used peristaltic pump with silicone tubing.
- This tubing was visually better suited for our project having no kinds to reduce flow, easy to clean and flexible enough to create suction between rollers.
- Sidecar is added to the bicycle for the two tanks setup one of dirty water & other of clean water tank for utilization around the home.
- Filtered water we get through this design

V .METHODOLOGY

To develop this mechanism we have used bicycle and centrifugal pump, chain sprocket

In this purification process mainly the Bernoulli's principal is used which state that and increase in speed of a fluid occurs simultaneously with a decrease in pressure or decrease fluids potential energy

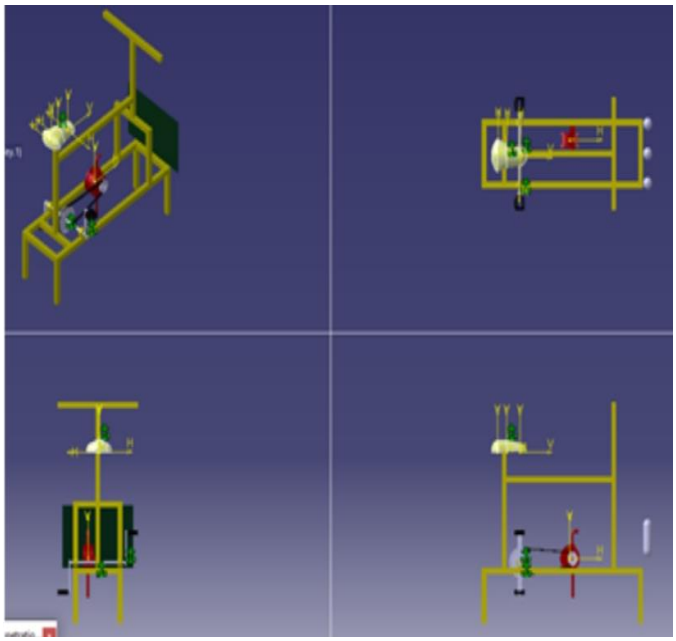
The main The experimental analysis of this project started with a detailed study of various mechanisms that could be used in this project and their practical applications. Since this project involves the effective utilization of energy derived .

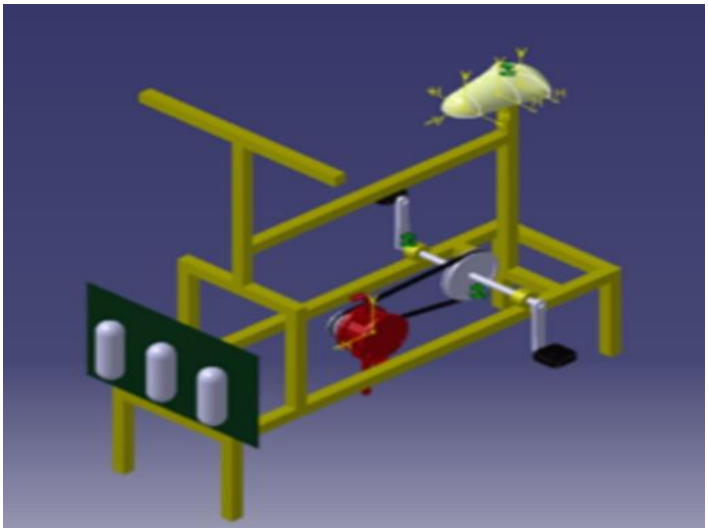
The design aspects may not actually` coincide with the requirements for the fabrication and practical applications. Hence, the method of Reverse Engineering was adopted in this project.

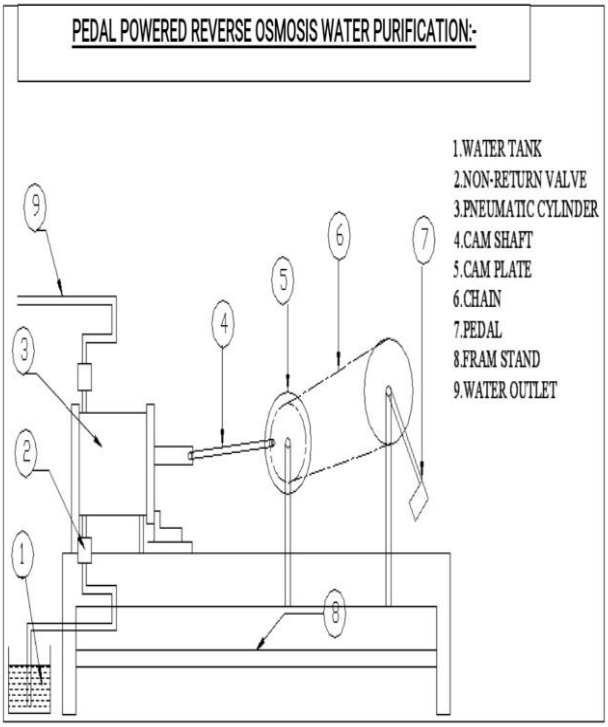
As per this method the tower was first fabricated based on the requirements with standard parts and designing using catia software and keeping in mind various safety precautions and availability of components.

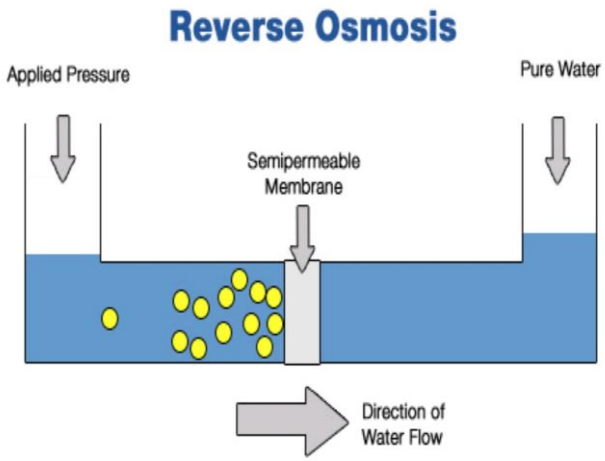
Testing and then the basic designing of the parts followed this setup of the entire deign in to three different stages used to purified the water

VI .DESIGN









VII .WORKING

The pedaling operation done by manually with the help of man and this power is transferred to the Cam mechanism. This Cam and cam shaft is used to activate the pneumatic cylinder. The pneumatic cylinder forward stroke is suction the water and return stroke will deliver the water.

The membranes used for reverse osmosis have a dense barrier layer in the polymer matrix where most separation occurs. In most cases the membrane is designed to allow only water to pass through this dense layer while preventing the passage of solutes (such as salt ions). This process requires that a high pressure be exerted on the high concentration side of the membrane, usually 30-250 psi for fresh and brackish water, and 600-1000 psi for seawater. Reverse osmosis (RO) is used to reduce dissolved solids from feed waters. Municipalities and industrial facilities are able to use RO permeate as a consistently pure drinking water supply and to transform drinking water to high purity water for industrial use at microelectronics, food and beverage, power, pharmaceutical facilities, and can be used for removing bacteria, pyrogens, and organic contaminants.

RO systems are also now extensively used by marine aquarium enthusiasts, as the domestic water supply contains substances that are extremely toxic to most species of saltwater fish. In the production of bottled mineral water, the water passes through a RO water processor to remove pollutants and microorganisms, including the smallest microbe known, archaeobacteria. In the United States, house hold drinking water purification systems, including a reverse osmosis step, are commonly used for improving water for drinking and cooking.

VIII .ACKNOWLEDGMENT

I am extremely grateful to Dr. P Mahadevaswamy, HOD Department of Mechanical engineering Sapthagiri college of engineering, Bangalore for his valuable support on the completion of this paper. I like to thank my Project guide Mr . MADHU KUMAR .Y.C sir for supporting me for this benificial concern and helping me achieve this
Finally,thank my whole team members for their support.

XI . REFERENCES

JOURNAL

1] Dhruv dugger “bicycle operated pump filter” publication , vol .3 no 3, e-ISSN: 2278-0149(2014)

2] Vishal garg , neelesh Khandare . gautam yadav “ design and experiment setup of pedal operated water pump” publisher IJERT –VOL 2 Ussue 1 , e-issn:2278-0181(2013)

BOOKS

1] “Fluid mechanics and hydraulics machine” by Dr . r . k Basal , laxmi publications(p) ltd,

2] “a textbook of fluid mechanics” by Rajput , S. Chand & Company ltd.

Design and Development of Water Pumping and Power Generation by Swing Action

ARUN KUMAR R[1], ANUP P[2], DHANUSH M[3], KUSHAL V[3], NITIN S RAM[5]
Department of Mechanical Engineering, Sapthagiri College of engineering
#14/5 Chikkasandra, Hesaraghatta main road, Bangalore- 57 India
[1]Arunkumar@sapthagiri.edu.in
[2] gotoanup94@gmail.com
[3]dhanushm0206@gmail.com
[4]kushalvenkatesh146@gmail.com
[5] nitinsram8951@gmail.com

***Abstract* - This project work describes about lifting the water for the irrigation purpose & generating the power.Serbian inventor Veljko Milkovic has invented, patented and developed series of such machines based on two-stage oscillator for producing energy. The operation of the machine is based on forced oscillation of the pendulum, since the axis of the pendulum affects one of the arms of the two-armed lever by a force which varies periodically. Part of the total oscillation energy of the pendulum-lever system is changed into work for operating a pump, a press, rotor of an electric generator or some other user system. In day to day life there is a much more use of swing cradle by children, in the swing cradle energy is created through swing action that energy can be used for lifting the water in village area as well as in gardens. To lift the water, system used is double acting reciprocating pump. The use of swing cradle reduces the cost of centrifugal pump installation.**

INTRODUCTION

New and technically original idea - hand water pump with a pendulum - provides alleviation of work, because it is enough to move the pendulum occasionally with a little finger to pump the water, instead of large swings**.** Using the minimum of human strength in comparison to present classic hand water pumps enables efficient application in irrigation of smaller lots, for water-wells and extinguishing fires even by old people and children, which was proved by a large number of interested future consumers during the presentations. Hand water pump with a pendulum is a realization of a new, original, and even unbelievable, by very simple solution for pumping water. Work is alleviated because easier, long-lasting and effortless use of the hand water pump has been fitness for drinking purpose. Work by [1] enabled. Input energy for starting the process of pumping, in form of occasional pushing of the pendulum, is much less than with typical hand pumps. Hand water pump with a pendulum for pumping water out from wells or reservoirs consists of a cylinder with a piston, lever system, a seesaw, a pendulum, a reservoir and output water pipe .To get the water running out of the pump, the pendulum needs to be out of balance. After that, based on gravitational potential, the piston starts oscillating and the continuous stream of water is coming out of the output pipe. The pendulum should be occasionally pushed, to maintain the amplitude i.e. the stream of water. The pump works well with all sizes of the pendulum, but mainly with the amplitude of 90°. The advantage of this invention compared to present hand pump solutions are: less force to start the pump, less water consumption, both arms can be used to fetch the waterThe invention is applicable on other devices that use lever mechanisms, such as a hand press etc.

MATERIALS & METHODS

According to power sources water lifts can be classified as manual, animal and power operated devices. The brief description of these devices is as under: Human Powered Devices Man has a limited physical power output, which may be in the range of 0.08 to 0.1 hp. This power can be used to lift water from shallow depths for irrigation**.**

The device consists of a basket made from the cheap materials like woven bamboo strips, leather, or iron sheet to which four ropes are attached. Two persons hold the basket facing towards each others, dip the basket in water

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Hand pumps are manually operated pumps they use human power and mechanical advantage to move fluids or air from one place to another.

They are widely used in every country in the world for a variety of industrial, marine, irrigation and leisure activities. There are many different types of hand pump available, mainly operating on a piston, diaphragm or rotary vane principle with a check valve on the entry and exit ports to the chamber operating in opposing directions. Most hand pumps have plungers or reciprocating pistons, and are positive displacement.

When the seating of the swing set moves forward & backward some torque is induced in the shaft by the holding bars of swing set. This torque displaces the larger sprocket which is pivoted over axis of shaft causing the angular displacement. This angular movement is converted to rotational motion of smaller sprocket by chain attachment. The sprocket rotates the spur gear arrangement which runs the dynamo, thus producing the electricity. The electricity thus produced is stored in a battery by using electric circuit

During the forward stroke & backward stroke of swing some torque is induced in shaft. The shaft is mounted between two bearings. At one end of the shaft a large sprocket is attached rigidly, this sprocket pivots over shaft axis when the shaft is displaced. The larger sprocket is attached to a smaller sprocket using chain. The shaft in which smaller sprocket is mounted is connected with the spur gear arrangement. With this arrangement power is generated in the dynamo and stored in the battery

Methodology:

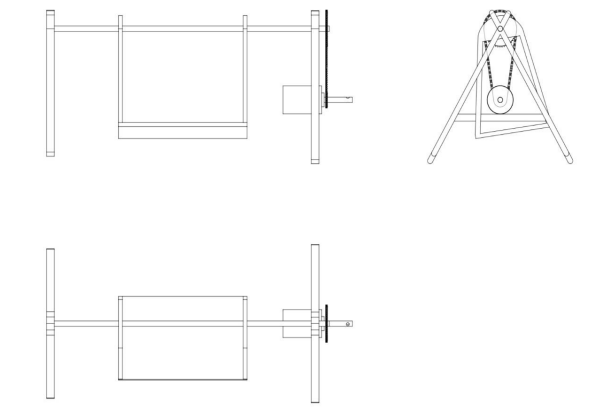
The vertical hold is fabricated holding the hinge axel to create the swing action to the chair held on this axel. So whenever this swing is used i.e. it swings. The horizontal beam is made to rotate clockwise & then anticlockwise this, to one end to his horizontal beam another horizontal beam is fixed at 90º to previous beam at central part. Thus whenever the swing, swings this another horizontal beam moves like a see saw. This motion is given to flexible kind of hikes. These hikes are made up of nylon and strakes. These hikes transfer this motion to a chain, either sides of said horizontal beam is converted with separate flexible hills i.e. in all two hikes are used and each of these flexible hikes a separate chain is connected this. The person is sitting condition the axel held within ball bearing at the sides are swinging the chair displaced from resting equilibrium position is to subjecting to the restoring force due to gravity that will accelerate it back towards the equilibrium position when released, the restoring force combined with the persons mass causes it to the oscillate about the equilibrium position, swing back and front.

This action is converted to the mechanism rotate the gear set which is coupled to the generator to generate electricity. Another arm which is fixed to the axel is activating the pump to operate connecting to the water tank to fill pressurized air into the each action. Now whenever a child enjoying this types of swing, these swings move horizontal hike like a see saw fashion style. This horizontal like thereby pulls and release flexible link those one connected to chains. These chains run over a free wheel and thereafter are connected to the fever using ring rubber.

This free wheel then transmits mechanical energy to the axis of shaft that further delivered this energy to flywheel that rotate the generator that is in direct physical contact with the flywheel thus electricity is produced which can be stored and later on.

In each release the same flexible link the mite then by chain is released and motion is not happened to axis using free wheel.

Body fabrication:



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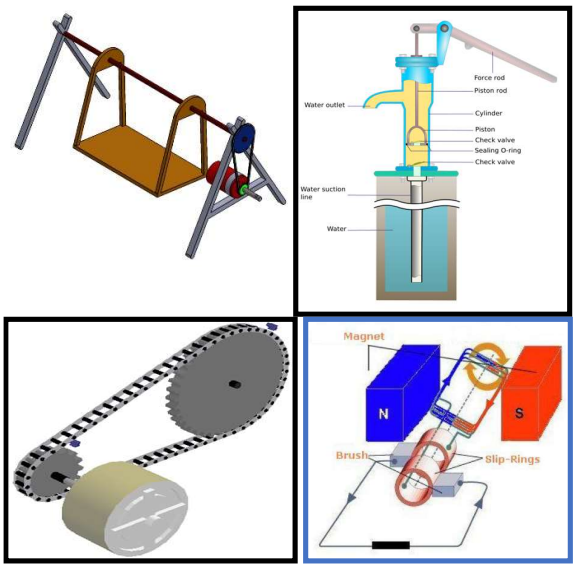
FABRICATIONS OF PARTS:



I. RESULTS & DISCUSSIONS

- A simple mechanism can be designed and developed to utilize the swing action.
- This device can efficiently transform swing action into useful electrical energy.
- The device can cater to the small scale power requirements.
- This device can be effectively be used as a pumping device in rural places for irrigation and other requirements.
- Such a device can reduce human efforts with a simple technology easy to operate and maintain.
- Such an innovative method can replace the conventional energy resources on small scale.

II. CONCLUSIONS

- The free energy of the machine based on oscillation swing action system, is defined in this study, as a difference between the resulting energy of the machine and the energy input from the environment in the same time interval. Existence of the free energy defined in this way is not in accordance with the energy conservation law, but it has been verified experimentally and it can be explained.
- The electricity procedure suing swing electricity generation is pollution free. Required manufacturing cost so it can be looked upon as a probable solution for partial fulfillment of energy demands. The future of swing electricity generation appears to be good not only regarding Indian context but the whole world as well possible to develop an affordable, safe and self-operating water purifier for people who are in need of drinking water

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- We would like to express our sincere gratitude to the Management, Principal Sapthagiri College of Engineering Bengaluru for the facilities provided and their support. Also we would like to thank the Head of department Mechanical Engineering and faculties for their encouragement and support.

REFERENCES

- www.electricityforum.com/electricity-generation.htm
- www.omafra.gov.on.ca/english/engineer/facts/03-047.htm
- www.powerauthority.on.ca
- www.epa.gov/landfill/docs/generating.pdf
- www.iseis.org/EIA/pdfstart.asp?no=06044
- www.nzqa.govt.nz/nqdocs/units/pdf/19325.pdf

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BLUETOOTH CONTROLLED 4 WHEEL STEERING MECHANISM WITH TRAY FOR MEDICINE AND SUPPLIES

KUSHAL DHAKAL[*1], ASHUTOSH JHA[#2], NISHANT SINGH[*3], ADARSH K. RAI[#4], SATISHKUMAR YD[*5]

Department of Mechanical Engineering, Sapthagiri College of engineering
#14/5 Chikkasandra, Hesaraghatta main road, Bangalore- 57 India

[1]kushaal.dhakal.3979@gmail.com
[2]ashutoshjha10349@gmail.com
[3]nishantsingh1401@gmail.com
[4]ads.rai.king@gmail.com
[5]satishkumaryd010@sapthagiri.edu.in

Abstract **- "4 Wheel Steering Mechanism" can be considered as one of the leading mechanisms for better control and quick response of steering in tight parking, low turning radius and fast lane change for vehicles. In addition, four-wheel steering mechanism reduces wear and tear of the wheel as it helps to overcome the problem of over steering as well as under steering. Demonstrating four-wheel steering system, the project aims to analyze the problem and challenges of four-wheel steering system. The project can also be used as mobile tray for isolation rooms in hospital considering low turning radius and tight spaces to provide food items and medicine supplies to patient without direct human contact showing the advantage of 4-wheel steering on small level.**

Keywords **– Steering, Mobile tray, Isolation rooms**

I. INTRODUCTION

Steering is the term applied to the collection of components, linkages, etc. which will allow a vessel (ship, boat) or vehicle (car, motorcycle and bicycles) to follow the desired course. Four-wheel steering, 4WS, also called rear-wheel steering or all-wheel steering, provides a means to actively steer the rear wheels during turning maneuvers. It should not be confused with four-wheel drive in which all four wheels of vehicle are powered. Four-wheel steering is a method developed in automobile industry for the effective turning of the vehicle, increase the maneuverability and reduce the drivers steering effort. In city driving conditions, the vehicle with higher track width and wheelbase face problems of turning as the space is confined the same problem is faced in low-speed cornering. The turning radius is reduced in the four-wheel steering of the vehicle which is effective in confined space, in this project turning radius is reduced without changing the dimension of the vehicles. In situations like vehicle parking, low speed cornering and driving in city conditions with heavy traffic in tight spaces, driving is very difficult due to vehicle's larger track width and wheelbase. When both the front and rear wheels steer toward the same direction, they are said to be in-phase and this produces a kind of sideways movement of the car at low speeds. When the front and rear wheels are steered in opposite direction, this is called anti-phase, counter-phase or opposite-phase and to produces a sharper, tighter turn.

Hence, there is a requirement of a mechanism which results in less turning radius and it can be achieved by implementing four-wheel steering.

II. LITERATURE SURVEY

We preferred many research papers, reference books related to this topic and review papers. By observing that a lot of information and ideas regarding our concept. Some of these papers are described below:

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1. Arun Singh and Abhishek Kumar at al. (2006) work on the stability of four-wheel-steering system. In this research they observed Automobile industry is widely used two-wheel steering system. But four-wheel steering system has many advantages which are very useful as compared to two-wheel steering system still 4WS has not widely used. In four-wheel steering system, all the four wheels are steered by driver to take a sharp turn for parking purpose or in a traffic situation. Four-wheel steering system is not a new technology but it has not gained more popularity than two-wheel steering system even though experimental results has told that four-wheel steering system is more suitable than two-wheel steering system. Because the turning radius of any four-wheel vehicle is decreased by the implementation of four-wheel steering system. Four-wheel steering system has excellent maneuverability, high stability and it is a solution to over steer/under steer. Due to four-wheel steering system, driver can easily control and steer the car and decrease the driver effort. In this project, we developed an effective four-wheel steering system which gives a better result at low and high speed. So, it increases maneuverability, stability and also used to decrease turning radius and driver effort. It also works in traffic and parking condition. There are the following results that we obtained from the experimental testing of model. Turning Radius is decrease by calculation 5.394m to 2.099M and by experimental 4.42m to 2.00 m.

2. Arvind at al. (2013) work on Optimizing the turning radius of a vehicle using symmetric four-wheel steering system. The main objective of this project is to decrease the turning radius of the vehicle using four wheels symmetric steering system (4WS). The system being analyzed here is a mechanical linkage between the front and the rear axle with a rack and pinion steering system at both the ends. This mechanical system is studied by kinematic analysis of the steering system geometry and the turning radius is calculated for a vehicle with and without this four-wheel symmetric steering. These measurements are compared to know the effect of the system on the vehicle in terms of the turning radius. From the kinematic analysis it is evident that the turning radius of the vehicle can be reduced up to 35% by using four-wheel symmetric steering system without crossing the practical limitations

III. MATERIALS & METHODS

The implementation of the project design can be divided in two parts.

- Hardware implementation
- Arduino implementation

Hardware implementation deals with the physical components used in the project. In this project working of four-wheel steering system with the help of rack and pinion mechanism to reduce the turning radius and increase the stability at the time of driving and turning is done. A steering motor is connected to the pinion and hence pinion drives the rack when the signal is given. In this model 2 rack and pinion mechanisms are used one in the front wheel axle whereas the other one is used in the rear wheel axle to achieve both front and rear wheel axle steering. The frame is designed based on the load to be carried in the scissor tray for the supplies and medicine.

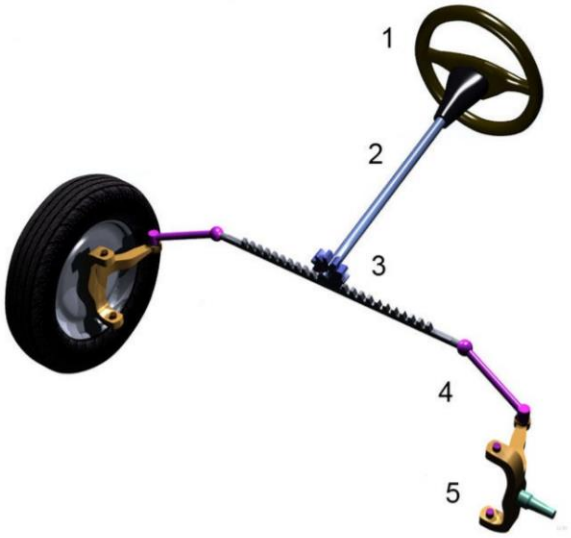

Fig: 1. Rack and pinion steering mechanism
1 Steering wheel; 2 Steering column; 3 Rack and pinion; 4 Tie rod; 5 Kingpin.

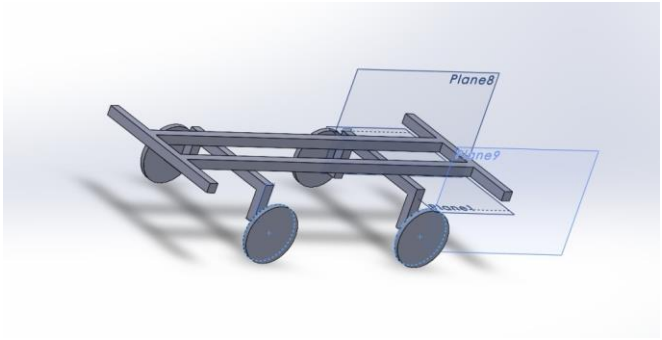

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Fig.2: conceptual design of frame

Fig.3: fabricated frame

Scissor tray is attached to the model to assist its work at isolation centre for different heights powered by driver motor controlled by the user. The motto of using scissor tray is to reduce spill out the liquid supplies while moving lower in height of the tray.

Fig.4: scissor tray

Arduino implementation deals with the contactless delivery of supplies helping the human/ medical staff to control the prototype remotely using Bluetooth signals that can be generated by Bluetooth module with the help of mobile phone.

Circuit:

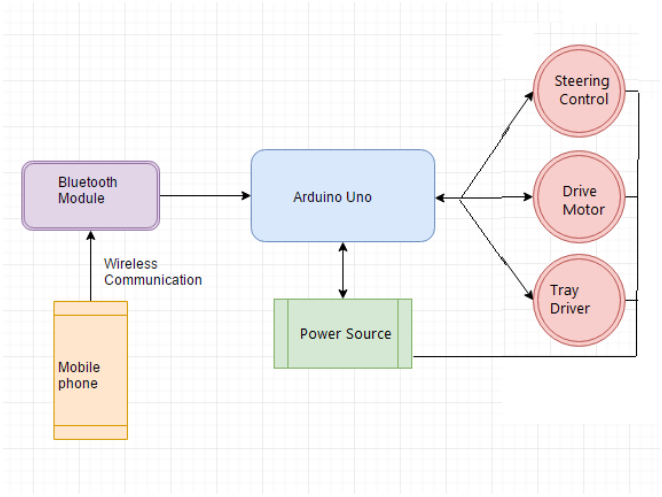

Fig.5: Arduino connected to various motors

Working:

Controlling of DC motors plays a very crucial role. Monitoring and controlling of speed of a DC motor by

using Android Smart phones have involved the Bluetooth technology, so and outer Bluetooth module HC05 is interfaced with the Arduino uno microcontroller unit for the wireless connection. The Bluetooth module obtains signal from the smartphone mobile android app. Therefore, according to the I/P signal, with the using of Arduino uno, MOSFET can be usually used to vary the voltage and current as well as the DC motor, which help in controlling speed of motor and direction of model.

Arduino is an open-source hardware and software company, project and user community that designs and manufactures single-board microcontrollers and microcontroller kits for building digital devices. It's hardware products are licensed under a CC-BY-SA license, while software is licensed under the GNU Lesser General Public License (LGPL) or the GNU General Public License (GPL) permitting the manufacture of Arduino boards and software distribution by anyone.

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IV. CONCLUSIONS

1) The four-wheel steering system is a relatively new technology that imposes cornering capability, steering response, straight-line stability, lane changing and low-speed maneuverability in cars, trucks and trailers.
2) The aim of 4WS system is a better stability during overtaking manoeuvres, reduction of vehicle oscillation around its vertical axis, reduced sensibility to lateral wind, neutral behaviour during cornering, improvement of active safety.
3) With these advantages and scissor tray operation theses could be used in isolated area with automating the full mechanism with the help of Arduino and connectivity devices like Bluetooth.
4) Even though it is advantageous over the conventional two-wheel steering system, 4WS is complex and expensive. Currently the cost of a vehicle with four-wheel steering is more than that for a vehicle with the conventional two-wheel steering.

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We would like to express our sincere gratitude to the Management and Principal of Sapthagiri College of Engineering, Bengaluru for the facilities provided. Also, we would like to thank our guide and Department of Mechanical Engineering for providing support and encouragement.

REFERENCES

[1] Design and Simulation of 4 Wheel Steering System [International Journal of Engineering and Innovative Technology (IJEIT) Volume 3, Issue 12, June 2014]
[2] Optimizing the turning radius of a vehicle using symmetric four-wheel steering system [International Journal of Scientific & Engineering Research, Volume 4, Issue 12, December-2013]
[3] Four-wheel steering system for Automobile [Nonvoter publications, International Journal of Innovations in engineering research and technology, volume 2, issue 4apr. -2015]
[4] Design and manufacturing of a system to measure the turning radius of Vehicle [International Journal of Engineering Science & Advanced Technology, Volume-4, Issue-6, 536-540]
[5] K. Lohith, Dr. S. R. Shankapal, & Mr. H. Monish Gowda "Development of Four-Wheel Steering System for a Car," SAS Tech Journal, vol. 12, pg. 90-97, Issue 1, April 2013
[6] V. B. Bhandari "Design of Machine Elements" McGraw Hill Education India Pvt. Ltd., vol. 3, 11th Edition, 2013
[7] Unknown, four-wheel steering report, http://www.scribd.com/doc/34677964/FourWheel-Steering-report, Retrieved on 13th Sep 2012.
[8] Unknown, four-wheel steering, http://www.wisegeek.com/what-is-four-wheelsteering.htm, Retrieved on 13th sep 2012
[9] stability of four-wheel-steering system [School of Science, Tianjin Polytechnic University, China b College of Mechanical Engineering, Tianjin University, China, Accepted 19 June 2006]
[10] Kumar P. Suresh, Joshi Swapnil, Kumari N. Prasanthi, "Design and Fabrication of Four-Wheel Steering System for Efficient Transportation Systems" International Journal of Innovative Technology and Exploring Engineering (IJITEE) ISSN: 2278-3075, Volume-8 Issue-10, August 2019.

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FABRICATION OF AUTOMATIC INFRASONIC FIRE EXTINGUISHER

PUNEETH S*[1], SUBHASH JADAV S[2], VISHWESH S[3], YASHWANTH GOWDA S[4], CHETAN B P[5]

Department of Mechanical Engineering, Sapthagiri College of engineering
#14/5 Chikkasandra, Hesaraghatta main road, Bangalore- 57 India

[1]prajwallucky7@gmail.com
[2]sushanthjadav7@gmail.com
[3]vishweshachari1399@gmail.com
[4]yashuyash004@gmail.com
[5]chetanbp@sapthagiri.edu.in

***Abstract* - Fire is an essential requirement for mankind, but it should be controlled from causing harm to the environment and also to the humanity itself. A fire extinguisher is an active fire protection device used to extinguish or control small fires, often in emergency situations. A conventional fire extinguisher uses compressed carbon dioxide as a propellant. This research work is aimed at providing a different way of extinguishing flames which completely eradicates the use of carbon dioxide or other chemicals, by using infrasonic sound which will not only help us save resources but also the environment and drastically reduce the health damage.**

Keywords – Fire extinguisher, Acoustic, Ecofriendly.

I. INTRODUCTION

The need of fire extinguishing techniques is vital as fire accidents are catastrophic in nature, which leads to unrecoverable loss. The current fire extinguishing system comes with various drawbacks. It is not ecofriendly. A Sonic fire extinguisher or an acoustic extinguisher uses infrasonic sound waves to extinguish a fire. It is capable of extinguishing small blazes of fire and low flames. Although they are small and portable they are yet to find a breakthrough in the field of industrialization. An acoustic extinguisher works by using sound waves—a type of pressure wave—to push oxygen away from the source of a flame and spread it over a larger surface area. These actions break the fire combustion triangle made up of heat, fuel, and oxygen, the three elements required for a fire to burn. The acoustic fire extinguisher puts out flames using low frequency bass (30 to 60Hz) without relying on water or chemicals. The acoustic fire extinguisher offers the cleanest and least destructive way to put out flames, because while fluids and chemicals are effective in putting out fires, they can also cause additional property damage and health risks.

The main objective of Project is to extinguish the flame in a clean and non-destructively way.

- To analyze the physics sound flame interactions
- To identify the frequency range that will be able to suppress an open flame.
- To produce a method to focus the sound waves on to the flames
- Developing a fire extinguisher that does not use chemicals or other propellants.

Work by [1] Myungjin Bae and EunYoung Yi (2016) shows that Sound fire extinguisher is developed based on principle of quenching fire by lowering its temperature with contacting vibration energy from low frequency sound under 100 Hz to and then blocking inflow of oxygen. [2] Dmitriy Plaks, Elizabeth Nelson (2005) their objective was to study the effects of acoustics on a flame in microgravity. This research was meant to provide a new approach to reducing and extinguishing a combustion reaction in space. [3] Bong Young Kim and Myungjin Bae (2019) in their study, they experimented to see if the Sound Fire Extinguisher could prevent conflagration by lowering the ambient temperature. Experimental results show that when the Sound Fire Extinguisher sound component of the same wind speed is supplied, the heated tableware is cooled by 10%–20% faster than the wind speed of 2 m/s. [4] Soongsil University (2019) In this paper, the characteristics of the sound beam formed by the special acoustic lens and the sound beam are verified through experiments. As a result of this experiment, the special

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sound lens of the sound extinguisher emits the resonant sound as the sound source of the plane sound source, so that the sound energy is concentrated and transmitted to the flame effectively.

II. MATERIALS & METHODS

Our acoustic fire extinguisher is designed to be portable so that it can be transported from one position to another with the help of a mobile device. The materials used are a subwoofer, frequency generator, 12V DC motor, Arduino Mega, Flame sensor module, Batteries and a collimator which is made of light weight material. In addition to this, the design is simple and compact.

Firstly the

1. SUBWOOFER: it is a loud speaker designed to reproduce low pitched audio frequencies know as bass and sub bass, lower in frequency than those which can be optimally generated by a woofer. A typical frequency range for a sub-woofer is out 20 to 200 hertz for customer products.

Subwoofers are made up of one or more woofers mounted in a loudspeaker enclosure—often made of wood—which is capable of withstanding air pressure while resisting deformation. Subwoofer enclosures come in a variety of designs, including bass reflex (with a port or passive radiator in the enclosure), infinite baffle, horn-loaded, and band pass designs, representing unique trade-offs with respect to efficiency, bandwidth, size and cost. Passive subwoofers have a subwoofer driver and enclosure and they are powered by an external amplifier. Active subwoofers include a built-in amplifier.

2. FREQUENCY GENERATOR: it is one of a class of electronic device that generates electronic signals with a set properties of amplitude, frequency and wave shape. These generated signals are used in extinguishing flames.

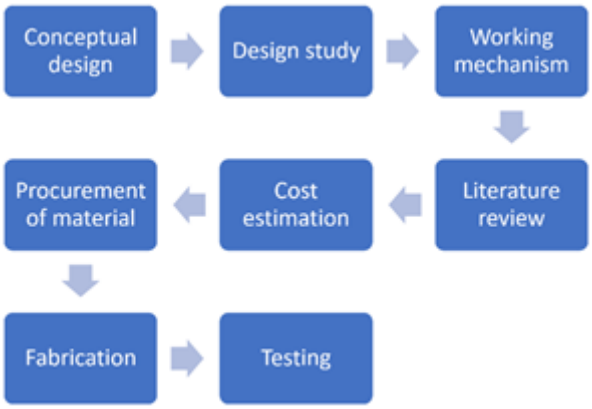
3. COLLIMATOR: it is a device used for changing the direction of waves i.e. it narrows the beam of waves. To narrow means either to cause the direction of motion to become more aligned in the specific direction.

In working, the flame sensor module senses the flames under its specific distance and indicates us, the fire extinguisher is conveyed to the particular location where the frequency generator generates the required frequency which is then passed onto the speaker which amplifies it and transmits it to the collimator which focuses the waves onto the flames and thereby extinguishing the flames.

4. BATTERIES: A battery is a device consisting of one or more electrochemical cells with external connections for powering electrical devices. When a battery is supplying electric power, its positive terminal is the cathode and its negative terminal is the anode. The electrons flow from negative terminal to positive terminal through the circuit.

5. ARDIUNO MEGA: This is an important component of the whole circuit, which is used to connect other electronic components.

Methodology:



- Selection of a suitable design which will be efficient in extinguishing the flames, which also serves the purpose of transporting.
- Analysing the proper working mechanism to operate the fire extinguisher.
- Research on materials which will be able to withstand the high temperature from the flames.
- Designing the model in a 3D software which satisfies the design parameters.
- Cost estimation of all the materials required for the completion of the project.
- Fabrication of the materials according to the design.
- Testing the model under suitable conditions and also under suitable precautions.
- Based on the testing results suitable changes are made to the project and the final model is obtained.

III. 3D MODEL:

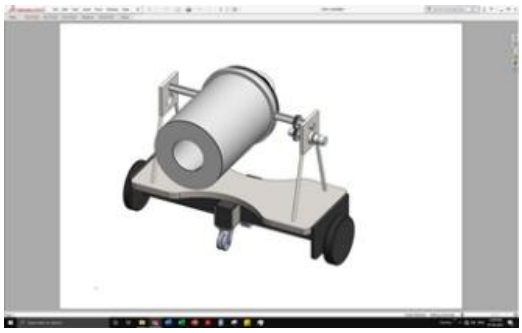


Fig. 1 3D Model (Isometric View)

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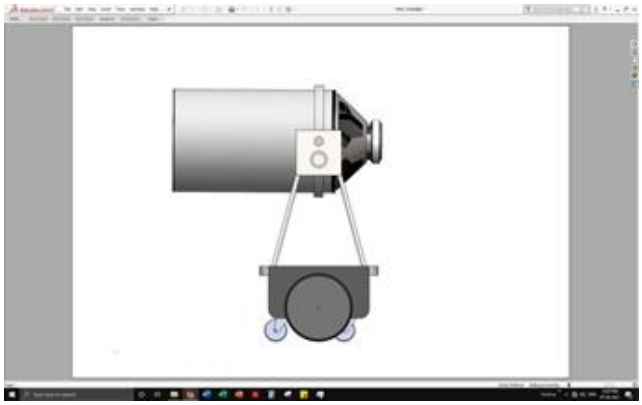

Fig. 2 3D Model (Left side View)

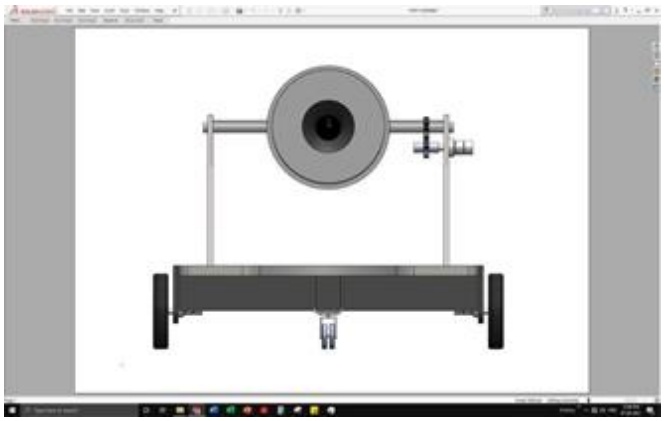

Fig. 3 3D Model (Front View)

IV. RESULTS & DISCUSSIONS

4.1 The effect of frequency on Pressure and sound :

Sound wave significantly effects on the fire extinguishing process. To evaluate the impact of sound waves on the fire, the fire was exposed to a range frequencies of sound waves from 0 Hz, 10 Hz, 30 Hz, 35 Hz, and 40Hz

The Sound travels in waves, which are simply variations of pressure in a medium. The energy from vibrating objects, such as speaker membranes, moves from particle to particle in the air in a repeating pattern of high- and low-pressure zones that is perceived as sound. It is found that the effective range was between 30 and 40 hertz, within the range of human hearing.

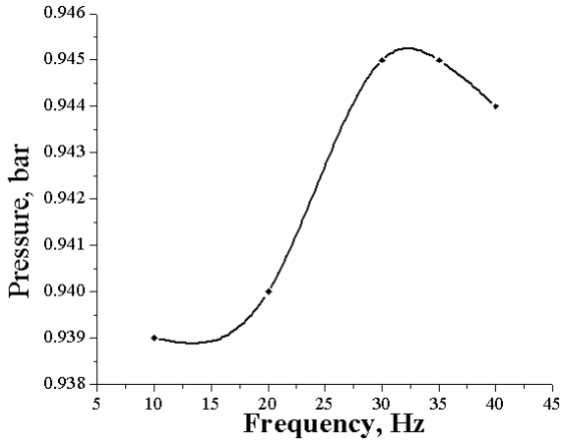

Fig. 4.1 Variation of Pressure with Frequency

4.2 Optimization of collimator:

In the present research an attempt has been made to investigate the effect of the geometry of the collimator to optimize the critical parameter such as pressure, sound and the acoustic velocity. Fig shows the variation of pressure, velocity and sound for varied length from 100 to 400 mm and varied diameter of 50 and 100mm.

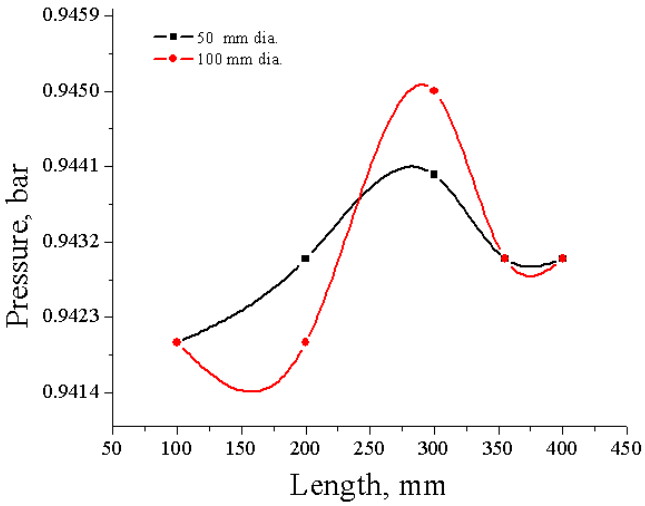

Fig 4.2 Effect of Vortex geometry on Pressure

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V. CONCLUSIONS

1. The idea of extinguishing fire with sound is a novel one, and has many possible applications in today's world.
2. In order to extinguish large area flames acoustically using the current setup, either a larger or more powerful (higher SPL output) speaker would need to be used. Directly increasing the output power of a speaker, will cause signal clipping; a distortion of the output signal. One might be able to use multiplex speakers to achieve extinction of larger flames.
3. Fire extinguisher is easy to operate.
4. Extinguishing the flame is achieved in the most eco-friendly method.
5. This device is capable of extinguishing class F and class c flames.

ACKNOWLEDGMENT

We would like to express our sincere thanks of gratitude to the Management, Principal Sapthagiri College of Engineering Bengaluru for the facilities provided and their support. Also we would like to thank the Head of department Mechanical Engineering and faculties for their encouragement and support. Further, I would like to thank our project co coordinator and also our guide for advising and supporting us throughout our project.

REFERENCES

[1] Myungjin Bae and EunYoung Yi: *The Journal of the Acoustical Society of America 140, 2958 (2016)*

[2] Dmitriy Plaks, Elizabeth Nelson, Nesha Hyatt, and James Espinosa Zade Coley, Cathy Tran, and Ben de Mayo. *The Journal of the Acoustical Society of America 118, 1945 (2005)*

[3] Bong Young Kim and Myungjin Bae, *the Journal of the Acoustical Society of America 145, 1896 (2019)*

[4] Bong Young Kim Commun. Eng., Soongsil Univ., 21-1, Garak-ro 23-gil, Songpa-gu, #203, Seoul 05669, South Korea, Myungjin Bae Commun. Eng., Soongsil Univ., Seoul, South Korea, *the Journal of the Acoustical Society of America 146, 3080 (2019)*

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MANLESS REMOTE CONTROLLED WEAPON SYSTEM

SANJEEV S*[1], PUNITH E[2], S M JAGANNATH[3], PRASHANTH[4], PRAMOD S V[5]

Department of Mechanical Engineering, Sapthagiri College of engineering
#14/5 Chikkasandra, Hesaraghatta main road, Bangalore- 57 India

[1]sanjeevgowda7213@gmail.com
[2]punith.e8@gmail.com
[3]jagannathsm3@gmail.com
[4]prashantpatil565@gmail.com
[5]pramod@sapthagiri.edu.in

Abstract **- Generally many hazardous, peril, unmanageable and various tasks are difficult to handle by human. Thus there's need for something, which could be physically present and handle the task. So, robot is way effective and useful option for such risky tasks. Nowadays in industries, medical, colleges, home appliances, restaurants, military and defence, robot plays important role and make the task easier and efficient. The most aim of Defence is to safeguard the border and to verify that no infiltrators or smuggler enters our country. Defence is deployed in very hard and sensitive areas at Border additionally as for internal security duty. Keeping see able the globe of responsibility given to Defence and availability of man power. sometimes it isn't in any respect possible to shield some vulnerable point round the clock, at that time it becomes imperative to develop an electronic system through which the weapon can been operated remotely or automatically. to beat this problem, we've designed a singular system i.e., remote controlled / auto firing device which can be sited at such places and is capable to fireside and also surveillance. The circuit is accustomed remotely controlled robot electronic gadgets are connected. The control is completed with none wire connection bY means of radio waves, like BLUETOOTH remote. The most focus of this project is to enable ease in operating different operation and provides emphasis on using BLUETOOTH waves. All operations in the project is controlled using Bluetooth application in android phone.**

Keywords – Robot, Bluetooth, Remote controlled

I. INTRODUCTION

Imagine the face of warfare with autonomous robotics: instead of our soldiers returning direct flag-draped caskets to heartbroken families, autonomous robots mobile machines which is able to make decisions, wish to fireplace upon a target, without human intervention can replace the human soldier in an increasing range of dangerous missions: from tunnelling through dark caves in search of terrorists, to securing urban streets rife with sniper fire, to patrolling the skies and waterways where there's little cover from attacks, to clearing roads and seas of improvised explosive devices (IEDs), to surveying damage from biochemical weapons, to guarding borders and buildings, to controlling potentially-hostile crowds, and when the infantry frontlines. These robots would be 'smart' enough to create decisions that only humans now can; and as conflicts increase in tempo and wish much quicker field of study and responses, robots have an explicit advantage over the limited and fallible cognitive capabilities that we homo have. Not only would robots expand the battle space over difficult, larger areas of terrain, but they also represent a significant force-multiplier—each effectively doing the work of the numerous human soldiers, while proof against sleep deprivation, fatigue, low morale, perceptual and communication challenges within the 'fog of war', and other performance-hindering conditions. But the presumptive case for deploying robots on the battlefield is over about saving human lives or superior efficiency and effectiveness, though saving lives and clearheaded action during frenetic conflicts are significant issues. This can be an era of automation where it's broadly defined as replacement of manual effort by mechanical power altogether degrees of automation. The operation remains a necessary a component of the system although with changing demands on physical input because the degree of mechanization is increased. Degrees of automation are of two types, viz. Full automation and Semi automation. In semi automation a mixture of manual effort and mechanical power is required whereas fully automation human participation is extremely negligible.

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II. MATERIALS & METHODS

Robot for military application is our project, which deals with remote operation with the help of a motorized arm. The circuit can be used to remotely controlled robot electronic gadgets connected to it. The control is done without any wire connection but be means of radio waves, like BLUETOOTH remote control. The focus of this project is to enable ease in operating different operation and gives emphasis on using BLUETOOTH waves. All operations controlled using mobile using android Bluetooth application

The construction of remote controlled video analyzing robot consists of a frame which is employed for mounting the components like D.C motor, Battery and equipment wheel. The front and back wheels are fitted within the base of the mount. The front wheel is attached using bolt and nut. The rear wheel is fitted with the assistance of shaft, bearings and bearing cap. The wheel (spur) is fixed during this shaft for front and backward movement of the vehicle.

The D.C motor is not to mention this back wheel gear arrangement with proper welding. Another D.C motor is let alone rack and pinion arrangement of the front wheel.

The ability for driving the motor is taken from the battery. The battery is charged through solar battery. The diode is employed during the charging of battery. The diode allows current only in forward direction. The lead acid D.C 12 Volt battery is employed for our project.

The receiver circuit is fixed inside the vehicle. The receiver having four relays. These relays output are attached to the D.C motor. The BLUETOOTH transmitter is kept outside the vehicle because of remote operation.

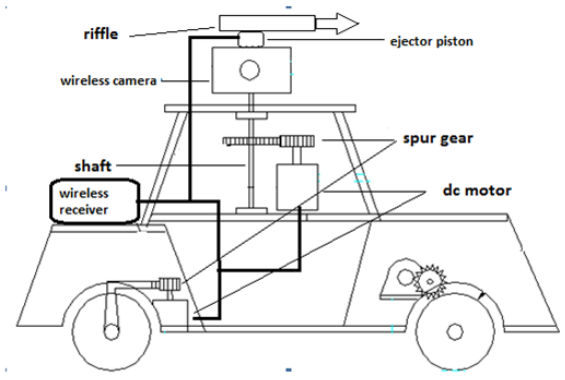

Fig.1 Sample model of rifle with stand

Methodology:

- Once connect the power supply to the system, controller peripherals, Timer, Sensor, Bluetooth module will get initialize and vehicle will be in stop condition.
- In receiver side controller always waiting commands from the control station.
- If commands received from the control station then controller will decide and take necessary steps as per the commands of the control station.
- Here control station means mobile it send commands to receiver.
- GUN is capable of rotating 360º, up and down movement using DC motor and Gun actuation is controlled by controlled station. Camera also used for viewing purpose,
- ROBOT is about to take FORWARD, REVERSE, LEFT, RIGHT and stop conditions.

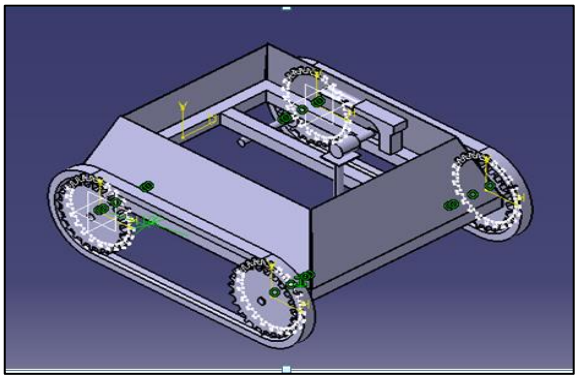

Fig.2 3D Isometric view of the model

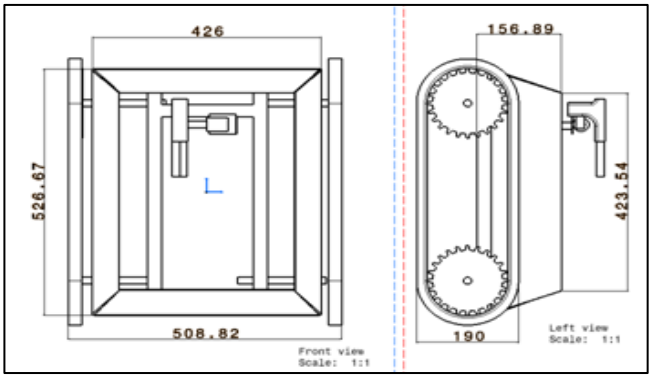

Fig.3 Basic design of model

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III. RESULTS& DISCUSSIONS

Performance test was carried out on that robot and was found that the total weight of the robot was around 12kilograms and moves at a speed of 15kmphr. The dimension is 15*28inch and carries a load of 15kilograms. The turret is capable of rotating 360 degrees with up and down movement. the robot is able to move in LEFT, RIGHT, FORWARD and REVERSE direction. The pellet gun acquires the target with the help of a camera and the shooting range is about 10metres.

IV. CONCLUSIONS

1. This capability would permit to send unmanned supply convoys, again minimizing human losses.
2. Another way to make military work safer is to send ground robots as pioneers instead of soldiers.
3. Cameras transmit images of live scene, and can act the vehicle accordingly
4. The military has recognized another advantage, too: more and more robots can do dangerous work that was previously undertaken by humans.
5. The military has recognized that automatic devices are far more efficient than the use of human soldiers, as there is a reduced risk of mistakes and the devices can also be equipped with powerful weapons.

ACKNOWLEDGMENT

We would like to express our sincere gratitude to the Management, Principal of Sapthagiri College of Engineering, Bengaluru for the facilities provided and their support. Also we would like to thank the Head of department Mechanical Engineering and faculties for their encouragement and support.

REFERENCES

[1] S. A. Joshi, Aparna Tondarkar: *Surveillance Robot for Military Application* 0.18535/ijecs/v7i5.10.

[2] Sahil Bhatnagar, Shivam Kumar Gola: *A Review on Rough Terrain and Defence Robot* 10.092016

[3] Dilip kumar, Tarunpreet: *Wireless multifunctional robot for military applications 10.1109/RAECS.2015.7453343*.

[4] Preamkumar Manoharan:*Unmanned multi-functional robot using zigbee adopter network for defence application* ISSN:2278-1323.

[5]Saliya Khar, Riza Souilman Utilization of Mobile Technology for Mobile Robot Controller DOI:10.1109/COS.20116079301.

[6] Bluetooth based android phone/ tablet controlled robot, http://www.robokits.co.in

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Design and Fabrication of Palm Leaf Plate Making Machine

VISHAL. M*[1], SHABEER. M[2], NARAYANA. M[3], MOHITH ANAND. D[4], MOHAN. A. E[5]

Department of Mechanical Engineering, Sapthagiri College of engineering
#14/5 Chikkasandra, Hesaraghatta main road, Bangalore- 57 India

[1]vsal336688@gmail.com
[2]smsbshabeer143@gmail.com
[3]narayanansati8867@gmail.com
[4]mohithanand07@gmail.com
[5]mohan@sapthagiri.edu.in

Abstract **- The disposable plates made up of plastics such as polythene, polypropylene, polystyrene, polycarbonate, polyvinyl chloride, etc. pose health risks due to the release of toxic chemicals; bisphenol A, melamine, vinyl chloride, and phthalates. The usage of disposable plasticware not only depletes fossil fuels but also causes microplastics pollution. Thus, thrust has been shifted to utilization of disposable plates made from plant leaves, which are renewable, biodegradable, and enriched with antioxidants and medicinal values. They are extensively used for serving food during marriages, religious festivals, community feasts, etc. The leaves from a vast variety of plants are used as dining plates, food wraps during steam cooking, grilling and frying of various dishes, and food packing material in India.**

Keywords – Disposable, Pollution, Medical values

I. INTRODUCTION

Palm leaf plates are made from complete organic materials which are leaves fallen from palm trees and collected. Currently no other alternative product in the world can match the properties of a palm leaf plate present in nature. Palm leaf plates are made from the naturally shed leaf sheaths of palm nut trees. The palm leaves are simply collected, Pressure washed, scrubbed, sun dried and then with the application of heat and pressure formed into appropriate shaped plates. Plates once used can be used as a good fertilizer which enhances plants growth, a good source of organic manure. The disposable plates and bowls are an alternative to plastic and paper plates. The products are natural, compostable and biodegradable yet look stylish. The demand is high within the country too. Compostable plates and bowls are the perfect solutions for emerging green businesses. The growing awareness about the adverse effect of plastic such as massive plastic pollution and its grave consequences on aquatic and aerial creatures after dumping this product into the sea are the major driving factors for the growth of the compostable tableware market. The increasing demand for safe, sustainable and environmentally friendly cutlery owing to the rising number of fast food restaurants and cafeterias is boosting the compostable tableware market.

II. MATERIALS & WORKING

The palm leaf making machine comprises a main body, square threaded screw, punch and die set and a heating coil. The main body provides housing for the punch and die set. The punch is attached to the screw rod which helps the punch to move in a vertical direction. A heating coil is provided at the bottom of the die to heat the leaf plate formed. The punch and die are designed so as to form the required shape of plate. The Palm Leaf Sheaths, which naturally fall from the trees, are collected from the Farms. These dry Palm Leaf Sheaths are soaked in water and thoroughly cleaned using brushes to eliminate the sand. The leaves are so arranged as to drain the water. The palm leaves are soaked in water for approximately 15 minutes and shade dried for 30 minutes. The dried palm leaf sheath is placed on the top surface of the die. Then the punch is lowered through the assistance of square threaded screws. As the punch moves down slowly, it presses the leaf sheath into the die cavity. The leaf sheath is left sandwiched between the punch and die for a certain

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period of time. The bottom surface of the die is connected to a heating coil. This coil heats the leaf sheath so that it maintains the shape produced by the punch and die (shape of plate) after it is removed from the punch and die set. The unwanted leaf sheath is separated from the whole leaf sheath so as to form a shape of plate. The punch is raised and the leaf plate formed is ejected carefully from the die cavity.

III. METHODOLOGY

- The fallen palm leaf sheaths are collected from the farm.
- The sheath is soaked in water for approx 15 minutes and left to dry.
- The dried sheath is placed on the machine to shape it. The punch and die set are designed to form the shape of a plate.
- The pressed leaf is held in that position for some time. During this time the leaf is heated at a moderate temperature.
- The punch is then raised slowly and the leaf is carefully ejected from the die.
- The palm leaf plates are packed and supplied for use.

IV. RESULTS AND DISCUSSION

Different temperatures (70°, 80°, 90°, 100°, and 110°C) were maintained for a particular operation at different periods of time. For a good quality product, following parameters have been found optimum: punch temperature, 110-115°C; die temperature, 35-40°C; time of operation, 60-90 s; and moisture content of raw leaf sheath, 14-17%.

Quality of areca leaf sheath varies with locations and seasons. In this study, locally available raw material, collected during July, has been used. Overheating of die-punch should be avoided for long-life and corrosion-free machines.

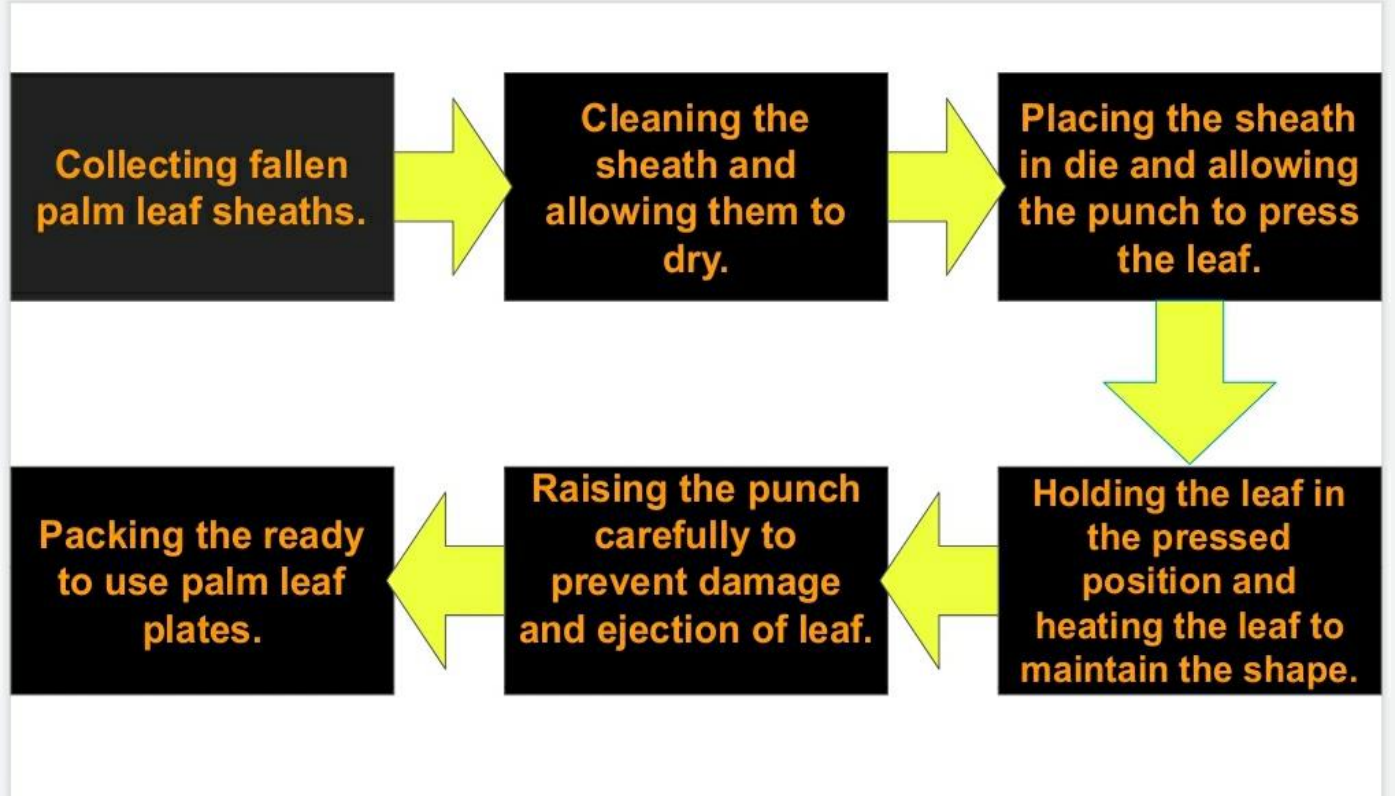
Optimum parameters required to produce a good quality product plate are as follows:

Holding time :- 1 minute

Temperature for punch :- 100-108°C

Temperature for die :- 35-40°C

Moisture content of leaf sheath :- 14-18%.



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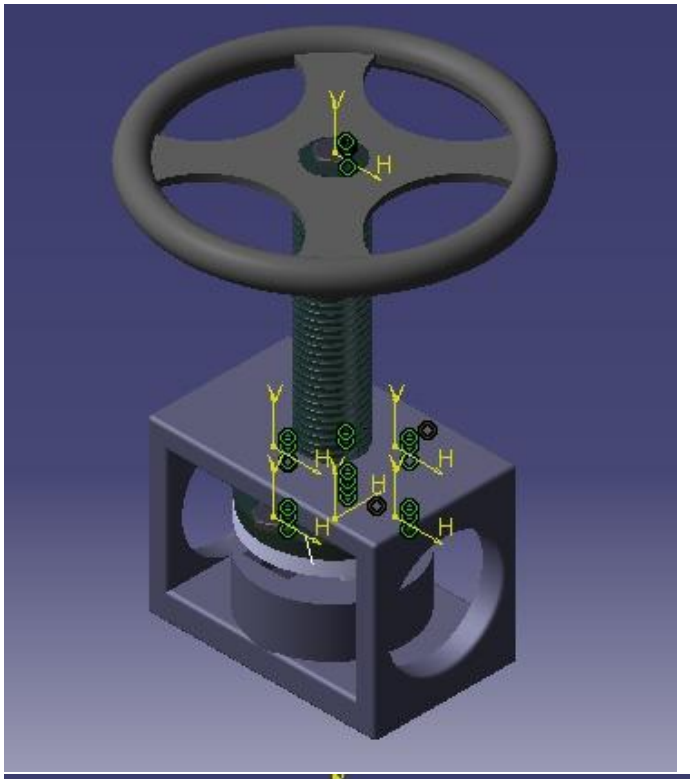
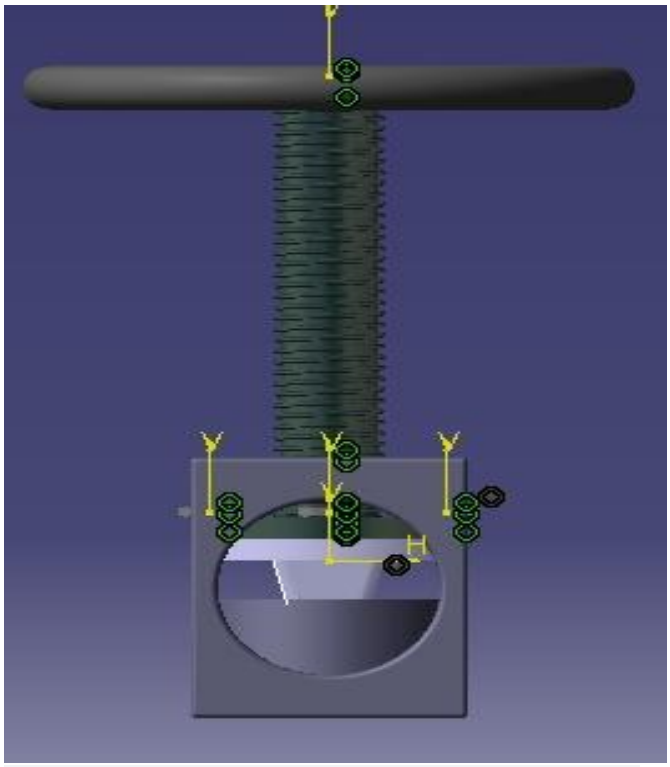
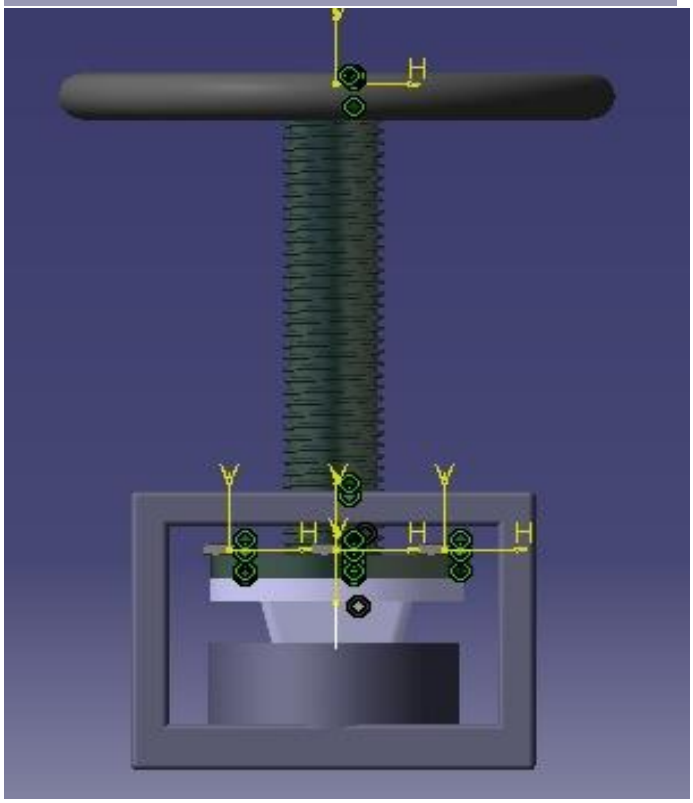
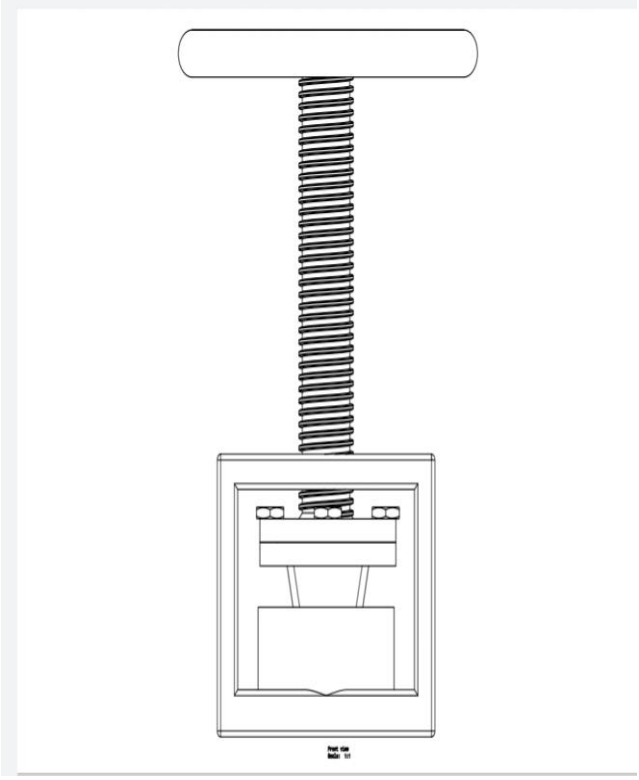
V. DESIGN OF PALM LEAF PLATE MAKING MACHINE









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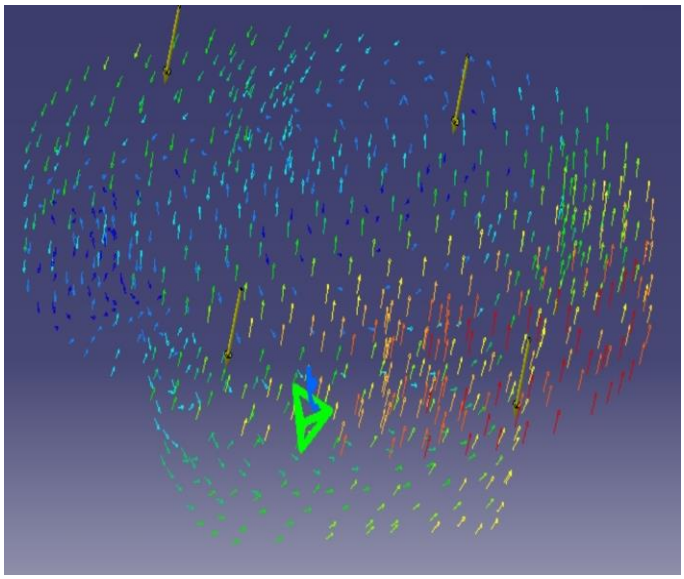
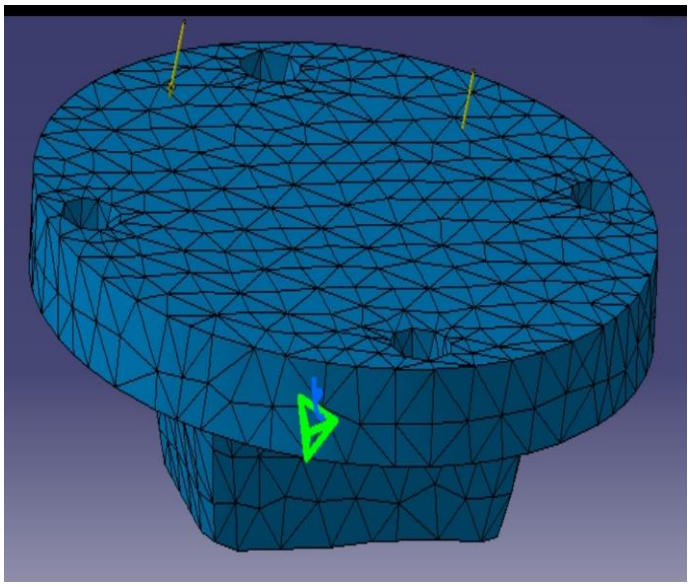
LIST OF COMPONENTS.

SL. NUMBER	PART	MATERIAL	QUANTITY
1.	Rotating wheel	MS	1
2.	Punch	Cast iron	1
3.	Die	Cast iron	1
4.	Bolt and nut	Steel	7
5.	Heating coil	Copper	1
6.	Hub	MS	1
7.	Washer	Rubber	7

To determine the behaviour of the machine, an analysis was made.





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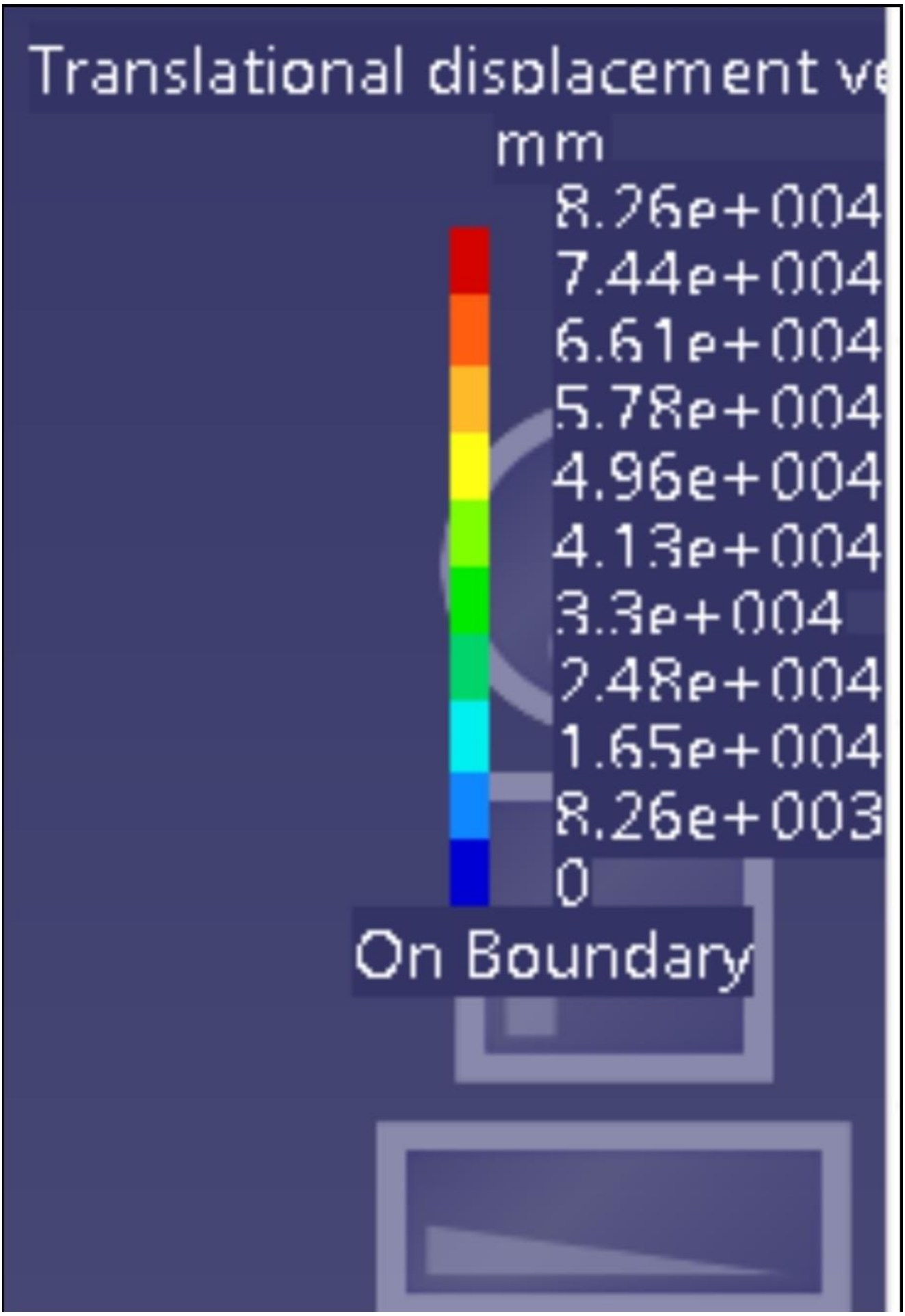

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VI. CONCLUSION

During the manufacturing of palm plates and bowls, no trees are being cut. Palm leaf plates are made from handpicked fallen leaves from palm trees. Without exposure to any chemicals or glues, palm leaf plates are made from our facility in India. Even used palm plates can be broken into small pieces and used as organic composites in the kitchen garden. Thus the palm leaf plates are organic. They are more solid, easier to recycle, and look wonderful, having a beautiful texture and elegant designs. However there are some drawbacks. Bottoms are not always completely flat – there may be a little curvature. In some cases they may have a slight vinegary scent (which dissipates if they're aired out before use). Edges can be a little rough.

Palm leaf plate making machines are very effective in terms of cost ,productivity, quality, versatility, space required, and ease of operation. This palm leaf plate making machine minimizes fatigue and can be operated in a seating position. Optimum parameters for a good quality product are as follows : punch temperature, 110-115°C; die temperature, 35-45°C; moisture content of raw sheath, 14-17%; and production time, 40-60 seconds. Single machine can be used for manufacturing a variety of products by interchanging a set of die-punch.

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We would like to express our sincere gratitude to the Management, Dr. H Ramakrishna, Principal of Sapthagiri College of Engineering, Bengaluru for the facilities provided and their support. Also we would like to thank Dr. P Mahadevaswamy the Head of department, Mechanical Engineering and faculties for their encouragement and support. We would also like to thank our guide Mr. Mohan A. E, Assistant Professor, Mechanical Engineering, for his support and coordination in completing this project.

REFERENCE

- Bavappa K V A, & Murthy K N, Potentialities of areca stem and leaves, Areca J, 10 (1960) 61-64.
- Menon S R K, Annamalai S J K, & Nayar N M, Areca leaf sheath-raw material for product development, in Proc PLACROSYM III.
- Narayana Murthy D, Utilization of some agricultural wastes, Indian For Bull No.207 (Forest Research Institute, Dehradun) 1957.
- Aaron HegdeS, John Deal (2014), "Areca Nut Farming in Southern India A Case Study" International Journal of Business and Social Science.
- Mohanraj K.S.; Vijayakumar P; Senthilkumar R; GokulKarthik A. (2017). Design and Analysis of Semi-Automatic Paper Cum Areca nut Plate Making Machine. International Research Journal of Engineering and Technology(IRJET) 4(5), 3546-3550
- Subramanian V & Govindarajan V S, Technology research on areca, Areca J, 13 (1962) 125-128

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Design and Fabrication of pesticide Sprayer and weed cutter

AJAY KUMAR V, GOWDA PRAJWAL SURESH, ASHITH RANJAN GOWDA, MANOJ LV, NATRAJ HN

Department of Mechanical Engineering, Sapthagiri College of engineering
#14/5 Chikkasandra, Hesaraghatta main road, Bangalore- 57 India
Ajaykumar21vijay@gmail.com

Abstract: The world's population is growing rapidly. Food production must be increased in order to meet their dietary needs, but this must come at a cost that is affordable to everyone. Agriculture was the main source of food for the population. All agricultural equipment is rarely modernized due to its low productivity. In India, farming is done by traditional means, in addition to the large-scale development of the industrial and service sectors compared to the agricultural sector. There will be a lot of field work in the agriculture sector, such as weeding, weeding, sowing, spraying, etc. Apart from this spraying operation, the farmers play a vital role in the agricultural process of protecting the crop. Traditionally, the spraying of pesticides and insecticides is carried out by farm workers carrying backpack sprayers that require more human effort. Attention is paid to these important problems and an attempt is made to develop equipment that will be of benefit to the farmer in spraying operations. As we know, there were different types of agricultural sprayers like backpa. Farmers face the problem of large area coverage in a short period of time. In this project work, we will manufacture a multiple operation fertilizer sprayer. And weed cutter this manufactured equipment will cover the maximum area.

Introduction : In India about 73% of population is directly or indirectly depends upon the farming. Hence it is said that India is an agricultural based country. But till now our farmers are doing farming in same traditional ways. They are doing seed sowing, fertilizers and pesticides spraying, cultivating by conventional methods. There is need of development in this sector and most commonly on fertilizers pesticides spraying technique, because it requires more efforts and time to spray by traditional way. Most Asian nations are at a developing stage and face the problem of a high population and, compared to developed nations, agricultural productivity is much lower. India is one of the nations facing the same problem. This is due to low farm level, poor farm availability of power and poor farm mechanization. [1-5]

Generally, farmers use the traditional way of spraying backpacks and spraying crops, making them time-consuming, costly and human fatigue is a major concern. Sprayers play an important role in spraying pesticides today in agriculture. Although sprayers vary as if they were motorized, hand operated. Pesticide spraying is an important process in agriculture. Nowadays, many types of pesticide sprayers are already on the market. For different types of pesticide sprayers, there are different shapes, sizes, method of carrying them, but the function is the same thing. The current idea for sprayers in our project is to use them efficiently. Reduce spraying work, human effort and sprinkling costs.

Objectives

• To cover maximum area in minimum time and at maximum rate.

• Work reliability under different working conditions.

• Decrease the cost of machine.

• Decrease labour cost by using the advanced spraying and weed cutting method.

• To use the Machine in small as well as in large crop area

• To utilize battery power sources for the purpose of pesticides sprayer.

• To reduce the discomfort occurs to the farmers during spraying and weed cutting .

• To eliminate environmental pollution by using natural energy source.

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Construction Details & Specification

- Manually operated spray pump has simple structure it consist of 1 wheel, piston pump, pump, nozzle, frame, tank, connecting rod, pipe, crank shaft, sprockets wheel, chain drive, etc
- Air compressor operated sprayer pump has consists pump, tank, nozzles, frame, etc
- There is trolley like structure containing two wheel at front side of frame.
- Freewheel is mounted on shaft connected to rear wheel drive. The free wheel is connected to crank shaft by chain drive. The crank shaft is then connected to piston pump with connecting rod.
- The piston pump is placed middle of frame which has reciprocating movement.
- The nozzle is mounted on upper side of the tank. Nozzle having flexible pipe which is move or turn any direction. We can also adjust the height of the flexible pipe. We use 2 nozzles in our sprayer. The whole assembly is connected to handle.
- The frame is made of carbon steel, which gives the desired strength and lightness. In this frame, a retractable link is attached to the top end. The electrical power from this battery is supplied to the electric motor by means of control switches, which control enables the entire device to be operated.

SPECIFICATION OF THE MACHINE

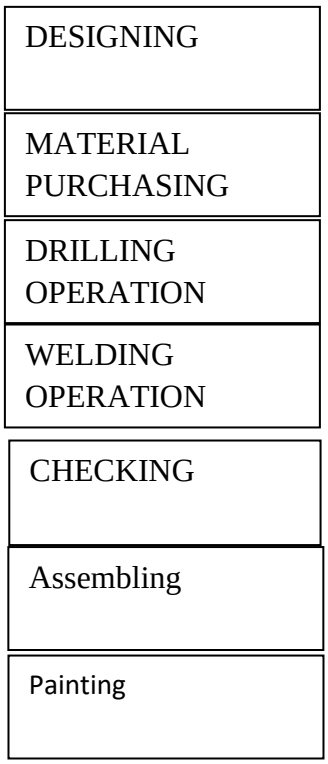
- Length of the machine : 48 inch
- Width of the machine : 18 inch
- Weight of the machine :15kg
- Width of the weed removed by the cutter (Cutter width) :6 inch
- Average speed of weed remover :150rpm
- Average travel speed of the machine :50rpm
- For one revolution of the handle, the depth of cut : 6mm
- Frame mild steel 1 inch square pipe

. SPECIFICATION OF DC MOTOR

- Dc gear motor 12 volt
- speed 60 rpm
- power 10 watts

- battery 12 volt
- lead acid battery
- wheel plastic

Methodology



Conclusion

The project focuses on the design and manufacture of spraying and weed cutting systems with a focus on light weight and portable nozzles. This project has an innovative method of minimizing manual stress. The main focus of our design is to reduce human effort and ease of operation in the case of spraying operations. We use past data and techniques to develop the multi operated agriculture machine. A new type of mechanism is being manufactured which is different from other machines; in addition to this mechanism, Such a multi operated machine for sprayer and weed cutter for agriculture will help to a large extent to improve spray area per acre and uniform spraying.

References

1) Smith, Harris Pearson and Wilkes, Lambert Henry. Farm Machinery and Equipment. McGraw-Hill Inc: 1976.

2) Stone, Archie A. and Gulvin, Harold E. Machines for Power Farming. John Wiley and Sons, Inc: 1967.

3) Pesticide History. Clemson. 2008-09-09. David Gordon Wilson. Technical Reviewers, Understanding Pedal Power. Volunteers in Technical Assistance (VITA), Y. Yorozu,

M. Hirano, K. Oka, and Y.Tagawa, "Electron spectroscopy studies on magneto-optical media and plastic substrate interface," IEEE Trans J.Magn. Japan, vol. 2, pp. 740-741.

4) Zakiuddin K.S., Modak J.P. 2010. Design and Development of the Human Energized Chaff Cutter. New York Science Journal.

5) P.B. Khope, J.P. Modak "Development and performance evaluation of a human powered flywheel motor operated forge cutter" ISSN 2277-8616.

6) .Abdul Shakoor khan and M Salim "Rice harvesting and threshing" PAK J FOOD SCI, 12(1-2): 45-52. P.B. Khope, J.P. Modak "Development and performance evaluation of a human powered flywheel motor operated forge cutter" ISSN 2277-8616.

7) P. Bhargavi, Dr.S.Jyothi.,2011 "Soil Classification Using Data Mining Techniques : A Comparative Study", Vol:2,ISSN:2231-5381(IJETT).

8) . B.Shivprasad, M. Ravishankara, B.Shoba.,2010 "Design And Implementation Of Seeding And Fertilizing Agriculture Robot" , Volume 1(3)190-213.

9) . Roshan V. Marode, P.Gajanan, and K.Swapnil ,OCT 2013 "Design & Implementation of Multiseed Sowing Machine", Vol : 2,No. 4, ISSN No.: 2278-0149, patented.

10) . A.Kannan, K. Esakkiraja , S. Thimmarayan, JAN 5014 "Design And Modification Of Multipurpose Sowing Machine" VOL:2 ,ISSN (ONLINE): 2321-3051

11) . D. Ramesh , H.P. Girishkumar,JULY 2014" Agriculture Seed Sowing Equipments: A Review" , ISSN N0.:2278- 7798,Volume3.

12) R. Joshua, V. Vasu and P. Vincent. (2010) "Solar Sprayer - An Agriculture Implement", "International Journal of Sustainable Agriculture 2 (1): pp. 16-19, ISSN 2079-2107"

13) M. A. Miller, B. L. Steward, M. L. Westphalen "Effects of multi−mode four−wheel steering on sprayer machine performance", American Society of Agricultural Engineers ISSN 0001−2351

14) R. D. Fox, R. C. Derksen. (2003) "Visual and image system measurement of spray deposits using water–sensitive paper" Applied Engineering in Agriculture Vol. 19(5): pp. 549–552. American Society of Agricultural Engineers ISSN 0883–8542.

15) Laukik P. Raut , Smit B. Jaiswal, Nitin Y. Mohite. (2013, Nov.) "Design, development and fabrication of agricultural pesticides sprayer with weeder",International Journal Of Applied Research and studies(iJARS), pp. 1-8, ISSN: 2278-9480.

16)] Mohd.Hudzari Haji Razali. (2012, May). "Sprayer Technology for Farm Mechanization Course",Technical Journal of Engineering and Applied Science(TJEAS), pp. 107-112, ISSN: 2051-0853.

17) Sandeep H. Poratkar and Dhanraj R. Raut. (2013, Mar.) "Development of Multinozzle Pesticides Sprayer Pump", International Journal of Modern Engineering Research (IJMER), Vol.3, Issue.2, pp-864-868, ISSN: 2249-6645.

DESIGN AND MANUFACTURING OF ELECTROMAGNETIC BRAKING SYSTEM

VINEET KUMAR[1], RANJAN KUMAR[2], TINTU TITUS[3], PRAVEEN SINGH[4], BASAVARAJ GANIGER[5]

Department of Mechanical Engineering, Sapthagiri College of engineering
#14/5 Chikkasandra, Hesaraghatta main road, Bangalore- 57, India

[1] vineet4321teeniv@gmail.com
[2] ranjan23k@pm.me
[3] tintutitus38@gmail.com
[4] basavarajganiger@sapthagiri.edu.in

Abstract **-The design of an electromagnetic braking system requires a multidisciplinary approach. Its performance is an outcome of usage of concepts from various fields' viz. mechanical, electrical, magnetic, and material engineering. This paper describes a new type of electromagnetic braking system for retarding the motion of a copper disc. The overuse of friction-type braking systems causes the temperature of the braking pads to rise, reducing the effectiveness of the system. An Electromagnetic Braking system uses Magnetic force to engage the brake, but the power required for braking is transmitted manually. The disc is connected to a shaft and the electromagnet is mounted on the frame. When electricity is applied to the coil a magnetic field is developed across the armature. The eddy-current is created by the relative motion between a magnet and a metal (or alloy) conductor. The current induces the reverse magnetic field and results in the deceleration of motion.**

Keywords: Electromagnetic Braking System, Copper Disc, Magnetic Force, Eddy Current

I. INTRODUCTION

A vehicle brake is used to slow down a vehicle by converting its kinetic energy into heat employed.

Electromagnetic Brake:

1) Electromagnetic brakes slow an object through electromagnetic induction, which creates resistance and in turn either heat or electricity.

4) Recent design innovations have led to the application of electromagnetic brakes to aircraft applications. In this application, a combination motor/generator is used first as a motor to spin the tires up to speed prior to touchdown, thus reducing wear on the tires, and then as a generator to provide regenerative braking.

II. METHODOLOGY

A. Electromagnetism:

Electromagnetism is one of the four fundamental interactions in nature. The other three are the strong interaction, the weak interaction and gravitation. Electromagnetism is the force that causes the interaction between electrically charged particles; the areas in which this happens are called electromagnetic fields.

B. Magnetic Effect of Current:

The term "Magnetic effect of current" means that "a current flowing in a wire produces a magnetic field around it". The magnetic effect of current was discovered by Oersted in 1820. Oersted found that a wire carrying a current was able to deflect a magnetic needle.

C. Factors Affecting Strength of an Electromagnet:

The strength of an electromagnet is:

1) Directly proportional to the number of turns in the coil.

2) Directly proportional to the current flowing in the coil.

3) Inversely proportional to the

D. Eddy Current:

Eddy currents are circular electric currents induced within conductors by a changing magnetic field in the conductor, due to Faraday's law of induction. Eddy currents flow in closed loops within conductors, in planes perpendicular to the magnetic field.

III. PARTS

A. AC Motor:

An AC motor is an electric motor driven by an alternating current (AC). The AC motor commonly consists of two basic parts, an outside stationary stator having coils supplied with alternating current to produce a rotating magnetic field, and an inside rotor attached to the output shaft producing a second rotating magnetic field.

B. Electromagnet:

An electromagnet is a type of magnet in which the magnetic field is produced by an electric current. The magnetic field disappears when the current is turned off. Electromagnets usually consist of a large number of closely spaced turns of wire that create the magnetic field. The wire turns are often wound around a magnetic core made from a ferromagnetic or ferromagnetic material such as iron; the magnetic core concentrates the magnetic flux and makes a more powerful magnet.

C. Copper Disc

1) The copper disc is made from the copper.

2)And the shaft is connected to the ac motor so that the disc is rotated as the same speed of the motor.

3) There are the two electro magnets are provided on the two other sides of the disc.

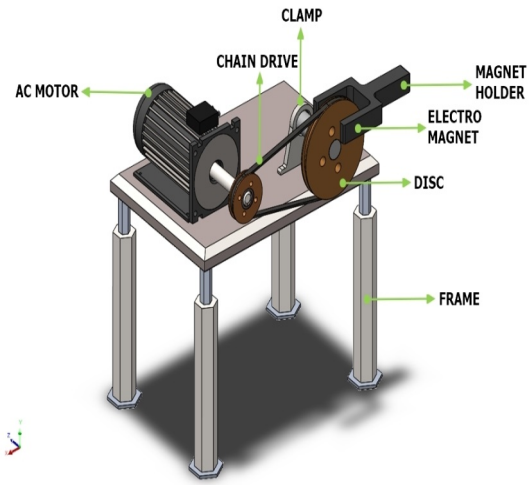


Fig.1 Design of Electromagnetic Braking System

D. Mild steel frame:

The mild steel frame is the base of the whole equipment.

E. Mild steel shaft

1) The shaft is the life line of the any equipment.

2) In this project there is the use the 30mm mild steel shaft for the mounting the disc and electric motor.

F. Deep groove ball bearing

1) Deep groove ball bearings are the most widely used bearing type and are particularly versatile.

2)They have low friction and are optimized for low noise and low vibration which enables high rotational speeds.

IV. OPERATIONS

A. Turning of Shaft:

Turning is the machining process in which a cutting tool, typically a non-rotary tool bit, describes a helical tool path by moving more or less linearly while the workpiece rotates

C. Welding:

Welding is a fabrication process that joins

materials, usually metals or thermoplastics, by causing coalescence. This is often done by melting the workpieces and adding a filler material to form a pool of molten material that cools to become a strong joint with pressure sometimes used in conjunction with heat, or by itself, to produce the weld.

D. Making of Electromagnet:

Magnetic fields are produced when all the electrons in a metal object are spinning in the same direction, either as a natural phenomenon, in an artificially created magnet, or when they are induced to do so by an electromagnetic field.

Material Required For Making of Electromagnet-

Iron nail, Copper wire, Battery or electricity supply, Wire strippers, Tape.

E. Fix Bearing Supports:

1) Bearing is use for smooth rotation of shaft on which disc is mounted.

2) Bearing fix at both side of disc on support which mount over the frame.

F. Coupling of Motor Shaft and Disc Shaft:

1) For coupling of motor shaft and disc shaft two clamps are used.

2) Both this clamp has same dimensions and hole for coupling.

G. Assembly of All Components:

1) At last the assembly of all parts is done on suitable space on frame.

2) Disc is mounting over shaft which in bearing support at both side.

3) Motor shaft and disc shaft is coupled by clamping method.

4) Then after electromagnet are mount at one side of disc but in opposite side.

5) For rotational motion of disc there is 2000 rpm motor mount with clamping.

6) For proper way for electricity process switch are provide.

V. TESTING

1) If the model is driven by the motor then the calculation will be as follows

Assuming,

Single phase AC motor.

Power = 12v/5A=60 watt

Speed= 0-8600 rpm(variable).

Motor Torque P = 2 πN T/ 60

8600 T = 0.066 N-m

VI. PERFORMANCE TESTING

$V = r \dot{\omega}$ (r=radius of wheel)

$= 0.9 \times 2\pi n/60$

V = 188.4 m/s

According to newton's law of motion

V= u + at

where the initial velocity of the wheel u=188.4 m/s and final velocity v=0

therefore $a = (0-188.4)/1 = -188.4$ m/s^2

$a = (0-188.4)/3 = -62.8$ m/s^2

2) If the model is powered manually then the calculation will be as follows

For constant speed at taking 200 rpm

$= 0.9 \times 2\ \pi n/60$

V= 18.8 m/s

According to newton's law of motion

V= u + at

where the initial velocity of the wheel u=188.4 m/s and final velocity v=0

therefore a= (0-18.8)/1 = -18.8 m/s^2

a= (0-18.8)/3 = -6.2 m/s^2

RESULT: Hence the deacceleration of the electromagnetic braking system by using manual method takes place according to the braking time.

VII. CONCLUSIONS

Electromagnetic braking system is found to be more reliable as compared to other braking systems. In oil braking system or air braking system even a small leakage may lead to complete failure of brakes. While in electromagnetic braking system as four disc plates, coils and firing circuits are attached individually on each wheel, even any coil fails the brake does not completely fails remaining three coil works properly.. Electromagnetic brakes have been used as supplementary retardation equipment in addition to the regular friction brakes on heavy vehicles. The frictions brakes can be used less frequently and therefore practically never reach high temperatures. The brake linings would last considerably longer before requiring maintenance and the potentially "brake fade" problem could be avoided.

The concept designed by us is just a prototype and needs to be developed more because of the above-mentioned disadvantages. These electromagnetic brakes can be used as an auxiliary braking system along with the friction braking system to avoid overheating and brake failure. ABS usage can be neglected by simply using a micro controlled electromagnetic disk brake system .These find vast applications in heavy vehicles where high heat dissipation is required. In rail coaches it can used in combination of disc brake to bring the trains moving in high speed.

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We would like to express our sincere gratitude to the Management, Principal, Sapthagiri College of Engineering Bengaluru for the facilities and their support provided. Also, we would like to thank the Head of Department Mechanical Engineering and faculties for their encouragement and support.

VIII. REFERENCES

[1] Ashutosh Kumar: A Comparative Study of Electromagnetic Braking System. International Journal of Engineering Research & Technology (IJERT), Volume 10, Issue 02, February 25, 2021.

[2] Chandan Kumar: ELECTROMAGNETIC BRAKING SYSTEM. JOURNAL OF CRITICAL REVIEWS (JCR), Volume 7, Issue 3, February, 2020.

[3] Janak S. Patil: Design and Analysis of Electromagnetic Disc Brake for Automobiles**.** Global Research and Development Journal for Engineering (GRDJE), Volume 2, Issue 3, February 2017.

[4] Rhythm Dhoot: Design & Theoretical Study of Electromagnetic Braking System. IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE), Volume 13, Issue 6, Ver. VI, PP 87-96, December, 2016.

[5] Smit Patel: Development of the Electromagnetic Brake. International Journal for Innovative Research in Science and Technology (IJIRST), Volume 1, Issue 12, May, 2015.

REGENERATIVE BRAKING WITH POWER MONITORING

SHIVASWAROOP S*[1], PUNITH H*[2], SHARATH R NAIK*[3], VARUN KUMAR B R*[4], TULSIDAS D*[5]

Department of Mechanical Engineering, Sapthagiri College of engineering
#14/5 Chikkasandra, Hesaraghatta main road, Bangalore- 57 India

[1]shivaswaroop43@gmail.com
[2]punith19799@gmail.com
[3]varunvirat189@gmail.com
[4]sharathnaik521@gmail.com
[5]tulsidasd@sapthagiri.edu.in

***Abstract* - We are slowly reaching the age of electric vehicles. The major issue behind the mass use of electric vehicles is the battery charging time and lack of charging stations. So here we propose a regenerative braking system. This system allows a vehicle to generate energy each time brakes are applied. The stronger the brakes, the more power is generated. We use friction lining arrangement in a brake drum. As a drum rotates the friction lining does not tough the drum as soon as brakes are applied, the friction lining touches the drum from inside and moves the motors connected to the lining in the same direction, thus generating electricity using motors as a dynamo. Thus, this system allows for charging car batteries each time brakes are applied, thus providing a regenerative braking system. It moves us another step ahead towards a pollution-free transportation system.**

Keywords – Flywheels, DC motor, Ultracapacitor

I. INTRODUCTION

As has been described by Matthew Brown, a huge amount of energy is wasted in the transportation industry. Today's focus on the environment had brought about the innovation of various fields. One of the most affected fields has been the automotive track. With the push to make technology more environmentally friendly, a lot of attention has been paid to electric vehicles. The high fossil fuel consumption in vehicles has prompted research in ways to improve the consumption rate. One of the technologies that have come out of this search for improvement is regenerative braking. The brake system in a traditional combustion engine is based on hydraulic braking technology. However, this technology has various downsides - mainly a large waste of energy. A moving car has an immense amount of kinetic energy. When the driver steps on the brakes, there is a lot of energy conversion going on. The kinetic energy of the car turns into heat energy as the car slows down. Because cars are so heavy, large amounts of heat energy are produced. Since the produced heat energy is not captured in a hydraulic braking system, there is a large amount of wasted energy that could be used for other vehicle-related tasks. On top of this, the heat causes the brakes of the car to wear down and become weaker and weaker. The use of regenerative braking systems in electric vehicles has been able to overcome many of the disadvantages of the traditional hydraulics braking system. In urban settings, regenerative braking recycles about half of the total brake energy. There are various other positives about technology. The benefits are becoming more and more beneficial to society than cars like the one in Fig. 1 are becoming more and more popular on the road.

II. LITERATURE REVIEW

In this paper [1] a test bench for testing of regenerative braking capability of a Brushless DC Motor is design and then fabricated. The project creates awareness for engineers towards energy efficiency and energy conservation. It

concludes that the regenerative braking systems are more efficient at higher speed and they cannot be used as the only brakes in a vehicle. The definite use of this technology described as in the project in the future automobiles can help us to a certain level to sustainable and bright future of the energy-efficient world as a part of the power that is lost can be regained by using the regenerative braking system.

In this paper [2] the advantages of regenerative braking systems over conventional braking systems have been mentioned. Regenerative braking systems can work at high-temperature ranges and are highly efficient when compared to conventional brakes. They are more effective at higher momentum. The more frequently a vehicle stops, the more it can benefit from this braking system. Large and heavy vehicles that movies at high speeds build up lots of kinetic energy, so they conserve energy more efficiently. It has a broad scope for further advancements and energy conservation.

In this paper [3] the techniques to increase the efficiency of the regenerative braking system are mentioned. The technique mentioned was to reduce the weight of the automobile which increases performance, using a super capacitor also improves the conversion rate of energy in the regenerative braking system, making the automobile compact also tends to increase the efficiency of the system.

In this paper [4] the Fabrication process on the Regenerative Braking System had been implemented as per the prescribed measures has been taken and the future enhancements should be processed on basis of the need of the study. The Implementation of the regenerative braking system is quite essential in automotive transportation with maximized performance in braking.

In this paper [5] the regenerative braking system used in the vehicles satisfies the purpose of saving a part of the energy lost during braking. Also, it can be operated at a high-temperature range and are efficient as compared to a conventional braking system. Regenerative braking systems 17 require further research to develop a better system that captures more energy and stops faster. All vehicles in motion can benefit from these systems by recapturing energy that would have been lost during the braking process. The use of more efficient systems could lead to huge savings in the economy of any country.

In this paper [6] the regenerative braking system used in the vehicles satisfies the purpose of saving a part of the energy lost during braking. The regenerative braking system is designed to partially recover the battery charge wasted in the braking of the vehicle. The energy is converted into heat by friction brake which is dissipated to the environment. This Energy is utilized to rotate the rotor of the generator converting the mechanical energy of wheels into a useful charge of battery. The regenerative braking system cannot be used as the main braking system of a vehicle as it cannot bring the vehicle to rest. Experimentation shows that a minimum of 11% battery energy can be recovered using the regenerative braking system which would otherwise be wasted to heat in friction brakes. Hence the distance traveled between two successive charging requirements can be increased to 10 to 15 % using this regenerative braking, when installed in actual vehicles.

In this paper [7] it is mentioned that Regenerative braking can save up to 5% to 8% of waste energy. The systems have been enhanced with advanced power electronic components such as 18 ultra-capacitors, DC-DC converters (Buck-Boost), and flywheels. Ultra-capacitors, which help improve the transient state of the car during start-up, provide a smoother charging characteristic of the battery and improve the overall performance of the electric vehicle system. Buck-boost converters help maintain power management in regenerative braking systems, such as boosting acceleration. Finally, flywheels are used to improve the power recovery process through automotive wheels.

III. COMPONENTS USED

1)FLYWHEEL

In this system, the translational energy of the vehicle is transferred into rotational energy in the flywheel, which stores the energy until it is needed to accelerate the vehicle. The benefit of using flywheel technology is that more of the forward inertial energy of the car can be engaged even during relatively short intervals of braking

and acceleration. In the case of the batteries, they are not able to accept charge at these rapid intervals, and thus more energy is lost to friction.

2)MOTOR

The role of the motor is important as a component of energy conversion in the brake system. Most motors are decorated on the front of an electric vehicle, this means that only the front wheel can produce regenerative braking force, rear wheels produce braking forces through mechanical friction. The output characteristics of the motor are as follows.

3)BATTERY

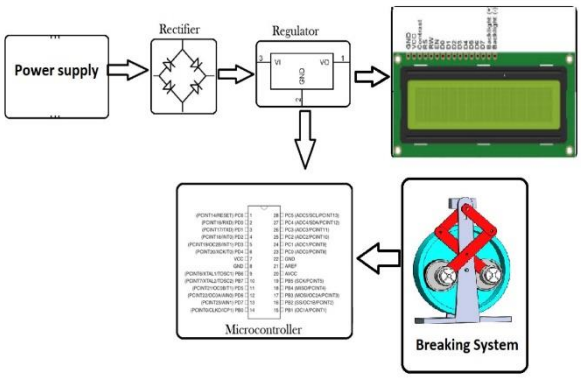
This system captures kinetic energy during deceleration, storing it in the battery so it can be used as electricity to power the electric motor. The idea behind regenerative braking is to capture that otherwise wasted kinetic energy and put it to use, converting it to electricity.

4)CAPACITOR

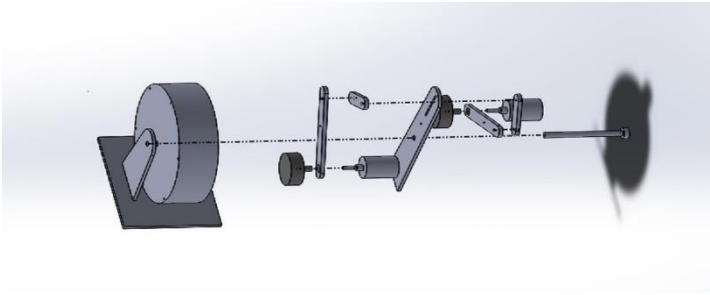
It was claimed that SC provides an efficient means of storing regenerative braking energy. Supercapacitors have been extensively studied as electrochemical devices that bridge the gap between conventional capacitors of low energy density, and fuel cells and batteries that suffer from low power density. Supercapacitors are used in applications requiring many rapid charge/discharge cycles, rather than long-term compact energy storage — in automobiles, buses, trains, cranes, and elevators, where they are used for regenerative braking, short-term energy storage, or burst-mode power delivery.

5)DYNAMOMETER

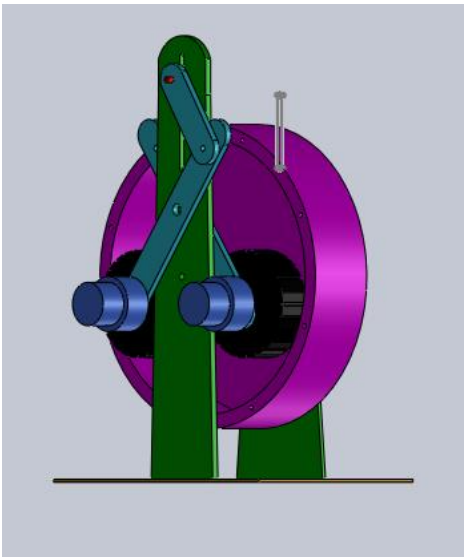
The dynamometer emulates road load conditions during testing, and regenerative braking can test their function while the vehicle is in deceleration condition. Performances of power requirements are illustrated and translated into a sequence diagram.



1)Block diagram



2)Product Assembly



3)3D Assembly

IV. RESULTS

Regenerative braking technology is one more positive step forward in Toyota's quest to realize the ultimate ecocar. By working in concert with previously developed electric motor technologies, its application helps Toyota's electric vehicles and hybrid vehicles (including the recently released Prius) to achieve extended ranges and to be friendlier to the environment than ever before. At the same time, this new technology remains unobtrusively in the background; drivers benefit from regenerative braking while enjoying the same firm braking feel found in conventionally equipped vehicles.

V. CONCLUSIONS

Driving is an extremely wasteful process. Large amounts of kinetic energy are turned into heat and gone from the car. Thankfully, a regenerative braking system makes use of this heat to regenerate the batteries of the electric vehicle. Despite the amount of research and development that has gone into regenerative braking, there is still significant room for improvement. Regenerative braking is still very limited and dependent on uncontrollable variables. Also, danger can arise if regenerative braking is applied to two-wheel-drive brake systems. However, regenerative braking does have various benefits. Proper implementation of the regenerative braking system extends driving range, improves the braking efficiency, reduces brake wear, and improves energy conservation.

VI. REFERENCES

[1]. Cody J, 2008, "Regenerative Braking Control for a BLDC Motor in Electric Vehicle Applications", Honours Paper in Bachelor of Engineering degree, University of South Australia, School of Electrical and Information Engineering.

[2]. Ford R. 2007, "Regenerative Braking Boosts Green Credentials, Railway gazette", http://www.railwaygazette.com/features view/article/2007/07/7577/regenerative_braking_boosts_green_credentials.htm, viewed: 23rd June 2008.

[3]. "Regen Braking" Q4D Sales Information Web Page, http://www.4qd.co.uk/fea/regen.html, viewed: 15th Aug 2008

[4]. 2002 Brown W., "AN857 Brushless DC Motor Control Made Easy." Microchip Technology Inc, available from http://www.microchip.com/stellent/idcplg?IdcService=SS_GET_PAGE&nodeId=1824&appnote=en012037, viewed: 15 August 2008.

[5]. Rashid M. H., 2004, "Power Electronics: Circuits, Devices and Applications" Prentice Hall, 3rd Edition

[6]. Emadi, A., 2005, "Handbook of Automotive Power Electronics and Motor Drives", CRC Taylor & Francis.

SMART IRRIGATION VEHICLE

JOEL S THOMAS[*1], HRITHIK RAJ SINGH[#2], KOLLA BHUVAN[*3], MANISH S GOWDA[#4], BASAVARAJU S[*5]

Department of Mechanical Engineering, Sapthagiri College of engineering
#14/5 Chikkasandra, Hesaraghatta main road, Bangalore- 57 India

[1]joelsthomas07@gmail.com
[2]kbhuvan1999@gmail.com
[3]hrithiksingh465@gmail.com
[4]manishsuresh1999@gmail.com
[5]basavarajus@sapthagiri.edu.in

Abstract **- "A Smart irrigation Vehicle" is an automated irrigation vehicle using Arduino microcontroller system which is cost effective and can be used in farm field or average home garden. The proposed system is developed to automatically water the plants when the soil moisture sensor has detected the soil is insufficient of water by using the Arduino as the centre core. The automated irrigation system is a fully functional prototype which consists of a soil moisture sensor; an LCD display to show the moisture percentage and pump status; a relay module which used to control the on and off switch of the water pump. When the soil moisture sensor sense the dry soil, it will show the moisture percentage on the LCD display, and the relay module will switch on the water pump automatically to start the watering process, or vice versa. Hardware testing is conducted to ensure the proposed system is fully functional.**

Keywords **– Bluetooth Controlled, Stores data using IOT**

I. INTRODUCTION

Embedded systems are finding increasing application not only in Domestic applications but also in areas of industrial automation, automobiles, power electronics, and defence and space equipments. Microcontrollers form the basic building blocks for many embedded systems. The project deals with the development of infrared remote controller of home appliances using ESP8266 micro controller, which is used to regulate the power flowing in the AC load using a remote controller sending signals to the micro controller ESP8266 as interrupts. The device is manufactured using Atmel's high -density non-volatile memory technology and is compatible with the industry standards MCS-51 instruction set. By combining a versatile 8-bit CPU with flash on a monolithic chip, the ESP8266 is a powerful micro controller which provides a highly flexible and cost effective solution to many embedded control applications. Other 3-channels are used for ON / OFF type control or for switching devices. The revolution of home networking is an emerging technology in this digital era. Like many other A.C drives gets to be automated with the embedded controllers for most of the devices for safety at residential areas or in industries. The project is an attempt to implementation of few consumer electronic products mostly at home. The objective of this project is to provide a combination of manual supervision and partial automation and is similar to manual set-up in most respects but it reduces the labour involved in terms of irrigation. Design is simple, easy to install, microcontroller-based circuit to monitor and record the values of temperature, soil moisture (Transistor circuit) that are continuously modified and controlled in order to optimize them to achieve maximum plant growth and yield. Also, the use of easily available components reduces the manufacturing. The design is quite flexible as the software can be changed any time. It can thus be made to the specific requirements of the user. This makes the proposed system to be economical, portable and a low maintenance solution for greenhouse applications, especially in rural areas and for small scale agriculturists.

II. MATERIALS & METHODS

The implementation of the project design can be divided in two parts.

- Hardware implementation
- Firmware implementation

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Hardware implementation deals in drawing the schematic on the plane paper according to the application, testing the schematic design over the breadboard using the various IC's to find if the design meets the objective, carrying out the PCB layout of the schematic tested on breadboard, finally preparing the board and testing the designed hardware. The firmware part deals in programming the microcontroller so that it can control the operation of the IC's used in the implementation. In the present work, we have used the proteus design software for PCB circuit design, the Keil Compiler development tool to write and compile the source code, which has been written in the C language. The Flash magic programmer has been used to write this compile code into the microcontroller. The project design and principle are explained using the block diagram and circuit diagram. The block diagram discusses about the required components of the design and working condition is explained using circuit diagram and system wiring diagram.

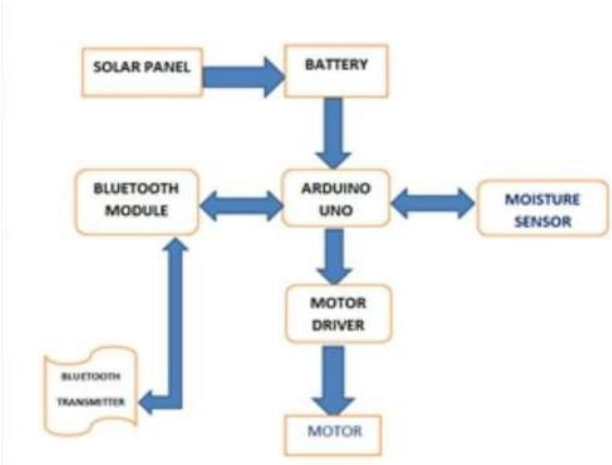

Fig.1 Block diagram

Circuit:

Using this sensor is quite easy. Connect the AO pin to any analog pin. If the sensor has a DO pin, it can connect it to any digital pin.

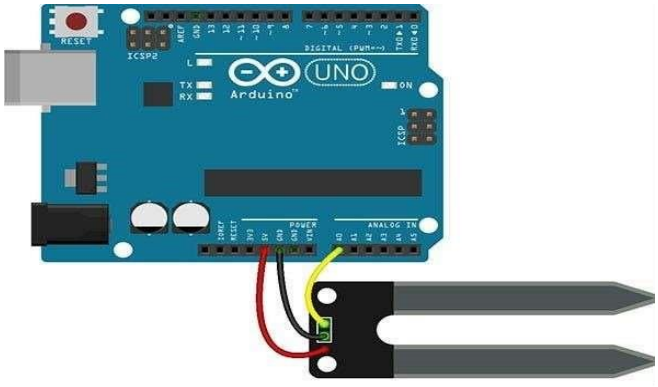

Fig.2 Arduino connected to moisture sensor

Working:

A battery powers the entire unit including the D.C. motors, pump, sensors and micro-controller. As soon as the sprayer is turned on the vehicle starts moving and spraying. The vehicle is controlled by wirelessly via Wi-Fi and pump sprayer on/off is controlled wirelessly, user can control vehicle motion like forward, left, right and stop wirelessly. *The vehicle receives a command to turn right* - In this case the relays which were initially in normally closed position get switched and the relay controlling the right motor and wheel goes to open condition, thus shutting off the right motor. Thus facilitating a right turn. *The vehicle receives a command to turn left* - In this case the relays which were initially in normally closed position get switched and the relay controlling the left motor and wheel goes to open condition, thus shutting off the left motor. Thus facilitating a left turn.

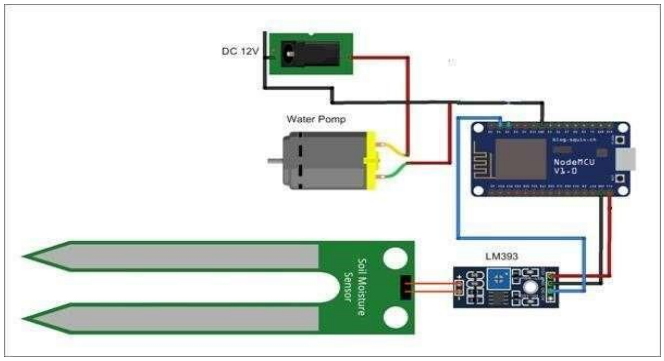

Fig.3 Connection circuit

This is controlled by a blynk app which is installed on the android mobile and using Wi-Fi from Nodemcu the

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mobile is connected to the system. The down and up keys are used to move moisture sensor inside and outside of the soil. When the moisture status is normal pump remain in off position and when the moisture sensor is dry the pump can be switched on by pressing the key.

III. CONCLUSIONS

1) Automation can help keep fertilizer on farm by effectively reducing runoff from the field retaining fertilizer on farm has both economic and environmental benefits.
2) Smaller amounts of water applied over a longer amount of time provide ideal growing conditions. Drip irrigation extends watering times for plants, and prevents soil erosion and nutrient runoff. Also, because the flow is continuous, water penetrates deeply into the soil to get well down into the root zone.
3) As the irrigator is not required to constantly monitor the progress of irrigation, the irrigator is available to perform other tasks uninterrupted.
4) Setting and moving sprinklers are not required. A timer delay as per environment can be added to the system for automatic watering.
5) The irrigator is not required to constantly check the progress of water down the base being irrigated. The irrigator is able to be away from the property, relax with the family and sleep through the night.
6) Automation of the irrigation system allows cut-off of water at the appropriate point in the bay. This is usually more accurate than manual checking because mistakes can occur if the operator is too late or too early in making a change of water flow.

ACKNOWLEDGEMENT

We would like to express our sincere gratitude to the Management and Principal of Sapthagiri College of Engineering, Bengaluru for the facilities provided. Also we would like to thank our guide and Department of Mechanical Engineering for providing support and encouragement.

REFERENCES

[1] Udupa (2015): The Arduino board and soil moisture sensor based irrigation system proves to be a real time response control system which monitors and wheel all the activities of irrigation system.
[2] Raj (2015): To provide an overview of some previous research and studies done in the direction of applying pattern recognition techniques in the agricultural domain.
[3] Chavan (2014): Zigbee-based agriculture monitoring system serves as a reliable and efficient system for monitoring agricultural parameters.
[4] Heldi et al (2014): The objective of the study is to develop a system for monitoring the temperature in the greenhouse by placing multiple temperature sensors at several observation positions.
[5] Anjum Awasthi (2013): The proposed system in this paper is designed by considering the requirement of a sugarcane crop for Indian climatic conditions.
[6] Jaichandran (2013): A prototype for automatic controlling and remote accessing of irrigation motor.
[7] Prisilla (2012): Water is one of nature's most important gifts to mankind, because of the increase in population food requirement for human being is also increasing.
[8] Cosmin (2012): This investigation demonstrates that there is an unquestionable growing tendency in the adoption of artificial intelligence in agriculture.
[9] Chetana (2012): The Automated Wireless Watering System is a user friendly system, which notifies the user about its status.
[10] Muhammad (2010): A simple approach to Irrigation control problem using Artificial Neural Network Controller.
[11] Kalyan (2011): The need for systems that make agriculture easier and more sustainable has increased within the past few years.

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Fabrication Of Solar Powered Load Carrying Vehicle

RAKESH K V[1],ROHIT M[2], SATISH KUMAR N[3],SUDHAKAR M[4], MAHESHA A M[5]

Department of Mechanical Engineering, Sapthagiri College of engineering
#14/5 Chikkasandra, Hesaraghatta main road, Bangalore- 57 India

[1]Rakeshkv7776@gmail.com
[2]Narayanasati8867@gmail.com
[3]Rohluffy@gmail.com
[4]sudhakar83100@gmail.com
[5]ammahesh@sapthagiri.edu.in

Abstract **-** Road transport has been dominated by petrol and diesel engines historically. Due to the environmental impacts and limited resources, both alternatives are unsustainable. The renewable energy directive, particularly identified as technology innovation, energy efficiency and renewable energy sources in the transport sector and it is considered as one of the most effective tools in reaching the targets in terms of sustainability and security of the supply. In this context, it is obvious that reaching the challenges depend on the rollout of Electric Vehicles (EV) as a sustainable transport and higher penetration of renewable energy sources. Here, a commercially marketable and simply designed electrical solar vehicle can replace fuel vehicles, controlling pollution and promoting wellness of the environment. It also creates awareness about the solar panel's future possibility and feasibility. Each part of the vehicle is designed and analyzed. This paper covers broad view on design and fabrication of a commercial renewable energy solar vehicle considering all the parameters within the limitations

Keywords -Renewable Energy, Electric Vehicles, Control pollution .

I. INTRODUCTION

Unlike vehicles with combustion engines, electric vehicles do not produce exhaust gases during operation. This alone makes electric vehicles more environment friendly than vehicles with conventional technology. However, the electrical energy for charging the vehicle does have to be produced from renewable sources. Electric drive motors run quieter than internal-combustion engines. The noise emissions from electric vehicles are very low. At high speeds, the rolling noise from the tires is the loudest sound. Electric vehicles produce no harmful emissions or greenhouse gases while driving. If the high-voltage battery is charged from renewable energy sources, an electric vehicle can be run CO2 -free. In the near future, if particularly badly congested town centres are turned into zero-emissions zones, we will only be able to drive through them with high-voltage vehicles. The electric drive motor is very robust and requires little maintenance. It is only subject to minor mechanical wear. Electric drive motors have a high degree of efficiency of up to 96% compared to internal-combustion engines that have an efficiency of 35– 40%. Electric drive motors have excellent torque and output characteristics. They develop maximum torque from standstill position. This allows an electric vehicle to accelerate considerably faster than a vehicle with an internal combustion engine producing the same output. The drive train design is simpler because vehicle components like the transmission, clutch, mufflers, particulate filters, fuel tank, starter, alternator and spark plugs are not required. When the vehicle is braked, the motor can also be used as an alternator that produces electricity and charges the battery (regenerative braking). The high voltage battery can be charged at home or by running. The energy is only supplied when the user needs it. Compared with conventional vehicles, the electric drive motor never runs when the vehicle stops at a red light. The electric drive motor is highly efficient particularly in lines and bumper-to-bumper traffic. Apart from the reduction gearbox on the electric drive motor, the electric vehicle does not require any lubricating oil. The paper is organized as day, for

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[1] solar vehicles and benefits of the technology by john Connors, ICCEP paper (2007) [2] K D Huang sc tzeng and M F Wu (2010) automotive application of solar energy [3] load carrying capacity evaluation of girder bridge using moving vehicles February (2021) engineering structure author Zhen Sun Yozo Fujino and Dionysius siringoringo

MATERIALS & METHODS

1.Solar panel: The term solar panel is used colloquially for a photo-voltaic (PV) module. A PV module is an assembly of photo-voltaic cells mounted in a framework for installation. Photo-voltaic cells use sunlight as a source of energy and generate direct current electricity. A collection of PV modules is called a PV Panel, and a system of Panels is an Array. Arrays of a photovoltaic system supply solar electricity to electrical equipment. Panel Size 1 ¼" — x I" Cost of the Panel Rs.700 - Rs.1,000/-. Weight of the Panel 1kg.Voltage 12 volt .Current 5 A. Power 12 watt.

2.Battery:A battery is a device consisting of one or more electrochemical cells with external connections for powering electrical devices such as flashlights, mobile phones, and electric cars. When a battery is supplying electric power, its positive terminal is the cathode and its negative terminal is the anode. The terminal marked negative is the source of electrons that will flow through an external electric circuit to the positive terminal. Weight of the battery 2 kg.Cost of the battery Rs.500 – 600.Output power 86.4 watt. Operating voltage 12 V .Current 7.2 A.

3.Chassis body : firstly the chassis is constructed M S (Mild Steel) is cut as per the required dimension using cutting machine. Then the pipe are welded to a square tube of dimension 24mm And thickness 2mm round hollow tube are since They are light weight.

4.Steering System : Mechanical linkage type arrangement is to used as steering system. Our steering geometry is having 99% Ackerman and also gives 60 degree lock to lock turn of steering wheel which is very suitable for the vehicle as it allows quick turn with small input

5. DC Motor : we will be using brushless dc motor. A dc motors speed can be controlled either over a wide range using a variable supplyVoltage or by changing the strength of current in its field windings. DC motor used in the project is 12 volts 30rpm .

Methodology:

- Fabrication of solar powered load carrying vehicle is constructed.
- The important of solar powered load carrying vehicles making the shift to the source of energy is cost effective.
- The main feature of this solar is to combine PV energy and human energy distinct importance has been given to pv solar energy as the main power source.
- Designing the model which satisfies the desired requirements.
- The list of components required are made and bill of the materials are collected.
- The assembled parts along with electronic components are tested in various terrains. various properties like load, voltage, speed of the vehicle etc are tested.
- Based on testing results, required changes are made and final product is obtained.

- ***Body Fabrication*:**

- A basic sketch has to drawn to furnish on software.
- Required design is done on the software and converted into draft.
- Material selection and procurement are done.
- Fabrication of body is done based on the final design.
- Required connections are done correctly.
- After completion of the assembly, testing is done and solar would also be harvested and converted to power in an efficient and clean manner .

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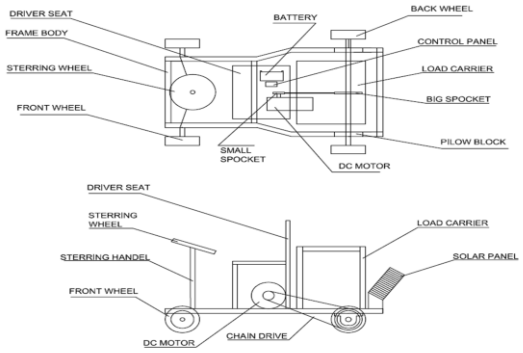

Fg.1 Basic Fabrication of Solar Powered Load Carrying Vehicle

II. RESULTS & DISCUSSIONS

The machines generally utilize environmentally friendly renewable energy which has no greenhouse potential. Because the systems merely require auxiliary energy for the operation of dc motor and utilize significantly less power Solar machines have few moving parts and a long life if designed correctly. The electricity grid is also relieved, since. Furthermore, noise emissions are significantly lower since machines work on electric motor. This project covers a broad view on the fabrication of commercial renewable energy load carrying solar vehicle considering all parameters within the limitation.

III. CONCLUSIONS

We are going to make the solar powered load carrying vehicle run on electrical and solar energy which would prove to be beneficial to the environment by producing no emissions and this vehicle would be powered by the electric motor. The solar panels on the contrary would be mounted on the top of load carrying vehicle. Solar energy would also be harvested and converted to power in an efficient manner.

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We would like to express our sincere gratitude to the Management, Principal Sapthagiri College of Engineering Bangalore for the facilities provided and their support. Also we would like to thank the Head of department Mechanical Engineering and faculties for their encouragement and support.

REFERENCES

[1] Solar fuels and industrial solar chemistry; January 2021 DOI: 10.1016/B978-0-12-819970-1.00005-0 In book: Concentrating Solar Power Technology (pp.677-724) ; Authors- Athanasios G. Konstandopoulos, Maria Syrigou and Kyriaki G. Sakellariou.

[2] SolarEnergy;January 2021 DOI: 10.1201/9781003151760-1 In book: Solar Technologies for the 21st Century (pp.1-18) ; Author- Anco S. Blazev

[3] Increasing the efficiency of solar panel by solar tracking system; December 2020; IOP Conference Series Materials Science and Engineering 993:012124; DOI: 10.1088/1757-899X/993/1/012124; Authors- A Imthiyas, S Prakash and N Vijay.

[4] Load-carrying vehicles; January 1987; Authors: Boughton.

[5] Load-carrying capacity evaluation of girder bridge using moving vehicle; February 2021; Engineering Structures 229:111645; DOI: 10.1016/j.engstruct.2020.111645; Authors: Zhen Sun, Yozo Fujino and Dionysius Siringoringo.

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Versatile Pneumatic Based Exoskeleton

SHETTY VARUN CHANDRASHEKAR[1], TEJAS MN[2], TEJAS V[3], VIJAY HP[4], P MAHADEVASWAMY[5]

Department of Mechanical Engineering, Sapthagiri College of engineering
#14/5 Chikkasandra, Hesaraghatta main road, Bangalore- 57 India

[1]vshetty210@gmail.com

[2]tejasmn08@gmail.com

[3]goodmantejas@gmail.com

[4]vijayh788@gmail.com

[5]hodmech@sapthagiri.edu.in

Abstract **– The Exoskeleton is a device that can be worn on the body like a suit. Sometimes, people who work at construction sites, suffer from back problem due to continuous carrying of loads on their back; People who have weak limbs need someone by their side to perform any activity. In order to prevent and tackle these problems, Low cost and Easy Maintenance Pneumatic based Exoskeleton is designed which has the capability to provide external skeletal structure to the wearer; To mimic the movements of the human body so as to help the wearer to exhibit body movements; To enable the wearer to lift loads beyond his capability and to demonstrate the pneumatic applications. The applications also finds in Medical Domain, helping people in rehabilitation and in Military domain – helping soldiers to carry weight for long duration with ease.**

Key words – Low cost, easy maintenance, mimicking body movements, External skeletal support

I INTRODUCTION

The Exoskeleton is a term which is classified under wearable robots that describes a robotic field which studies the interaction between the human body and robotics. It is a type of skeletal structure that surrounds the wearer. Exoskeleton wearable robots follow the principle of having the pivotal structures outside its user which allows the mechanical system to be used as a suit. In these systems, a Mechatronics structure is attached to different parts of the human body, and the wearer commands the mechanical system using physical signals (like electronic simulation produced by the orders of the brain, or by using a simple switch). The Exoskeleton suit can be made based on Hydraulics, Pneumatics, and Gear chain system powered by Motors. Each one has its own advantages and disadvantages. An artificial muscle is another type of pneumatic based Exoskeleton where instead of pneumatic cylinders, artificial muscles are used. Artificial muscles are nothing but an inflating tube placed inside a fixed length shell, when air supplied, the shell is made to contract which is used to lift weight. The above types can be classified as active Exoskeletons. Passive type Exoskeleton (there is no power supply for this type of exoskeleton) is also available. This type uses springs to help the wearer to lift weight and carry it for large amount of time with ease. The counter torque developed by the tension of the spring cancels the torque developed by the load which helps in carrying the load.

II LITERATURE REVIEW

Gopal Krishna U [1] reported work on a comprehensive design and fabrication of hand exoskeleton technologies for rehabilitation and assistive engineering by actuator technology. Michael Scott Liszka [2] worked on the design of exoskeleton for shoulder rehabilitation and process of design, kinematics, actuators, transmission and mechanical analysis. Roger Michcheal Pereira [3] suggested a low cost exoskeleton built with the help of pneumatic system which is portable to anywhere. Sheeba P.S [4] developed usage of flex and sensors in pneumatic systems instead of manual switch operated. There is a scope for next level advancement in exoskeleton technology. The present work focuses upon the designing an Exoskeleton Suit which has the feature of length adjustment and varying weight lifting ability of the suit.

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III METHODOLOGY

A. Components of the Device

1. Air Compressor – Max 150 PSI (Working pressure 110 to 130 PSI)
2. Pneumatic Cylinders – Bore Diameter – 32mm and Stroke Length – 200 mm & Bore Diameter – 32mm and stroke length – 125mm. Piston end mounting – Clevis Rod End.
3. Direction Control Valves – 3/2 Solenoid valve
4. Flow Control Valve – One Direction Flow Control Valve and Two Direction Flow Control Valve
5. Arduino – Arduino Uno; Accessories – Stepper Module, Red and Green Color Lights, Resistor & 24V Battery
6. Kinematic Links – Aluminum Extrusions & Stainless Steel square tubes and Sheets

B. Working of Pneumatic System of Exoskeleton

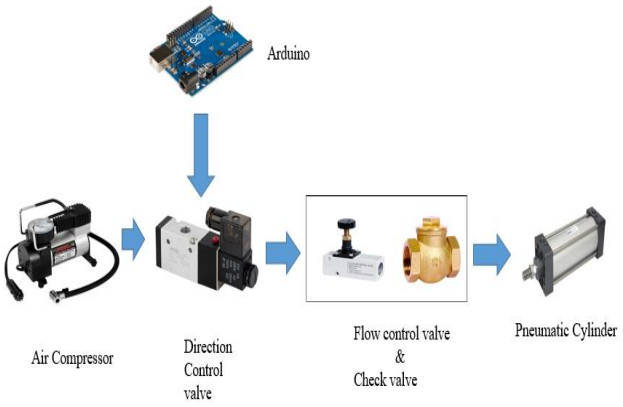

Fig. 1 – Schematic representation of working of Pneumatic System.

All the components related to Pneumatic System are connected through hose pipe is shown in Fig. 1. Air Compressor sucks the air from the atmosphere, compresses it to high pressure and stores it in the cylinder. Direction control valve is used to allow the compressed air to the Pneumatic Cylinder when required. 3/2 Solenoid Direction Control valve is used to control the flow rate of the compressed air, Flow control valve is used to allow the flow of compressed air in one direction. The compressed air stored in the cylinder is supplies to the pneumatic cylinder through Flow control Valve and Check Valve. The Solenoid valve is controlled via Arduino. When Arduino sends the signal to the solenoid valve, piston extension takes place.

C. Conceptual Design of Exoskeleton

Upper Limb Exoskeleton

The Kinematic Links are used to give external structural support. The device is to be operated using two switches, where each controls the either, one of the arm or one switch controlling only one arm. 3rd Switch can be used to control the movement of both the arms at the same time.

Lower Limb Exoskeleton

The Device is to be controlled through a switch. The process is to be completely automated. The Mechanism used here should be able to replicate the lower limbs movement while walking.

D. Designing of Exoskeleton

Upper Limb Exoskeleton

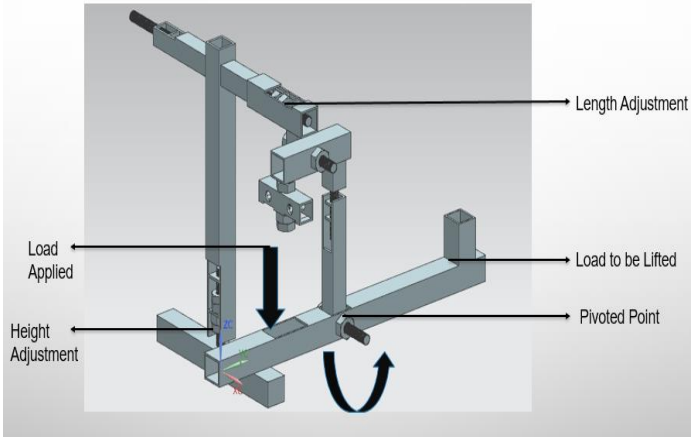

Fig. 2 – 3D Modelling of Upper Limb Exoskeleton

The 3D modelling of the Upper Limb Pneumatic based Exoskeleton was made in the software NX 11 is shown in Fig.2. The Mechanism used for the upper limb exoskeleton is Lever Mechanism, which include a rod having two ends with a pivoted point. The main attraction of this mechanism is that, by applying low amount of force, any amount of torque can be generated by adjusting the distance between the pivoted point and the point at which load is being applied. The elbow joint of our body acts as the pivoted point and a long rod is strapped to the arm. On the front end, the load to be lifted is placed and at the rear end, force generated by the Pneumatic Cylinder is applied. The extension of the piston results in generation of required torque to lift the load.

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Lower Limb Exoskeleton

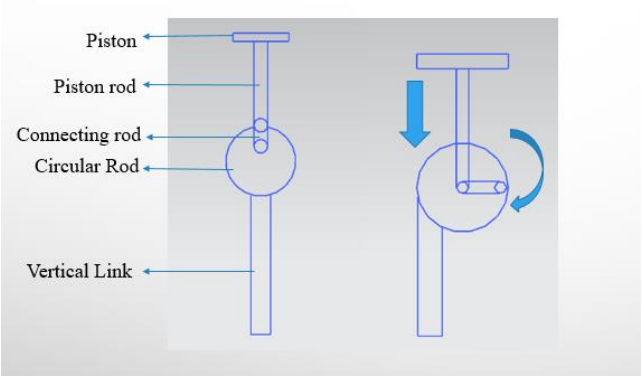

Fig. 3

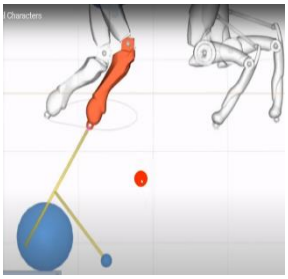

Fig. 4

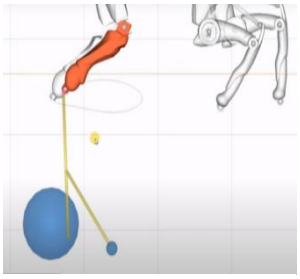

Fig. 5

The Lower Limb Exoskeleton is powered by pneumatics. The reciprocating movement produced by the piston movement of pneumatic cylinder is converted into circular motion as shown in Fig. 3. The Piston end is connected to a circular disc on one side and one the other side of the disc, a vertical link is attached. The vertical link traces the rotation of the circular disc. To replicate the walking pattern of the human being, an additional link is attached to the vertical such that a mechanism is formed whose end result is generating accurate relative movements of the link which is similar to that of walking pattern [5] as shown in Fig. 4 and Fig. 5.

E. Numerical Calculation

Calculation for determining the load that an Upper Limb Exoskeleton can lift is determined with the help of fIg. 6 which is showing the loading conditions.

Pressure produced by air Compressor, P = 120 PSI = 827371N/m^2

- Cylinder Bore Diameter = 32mm
- Force applied by Pneumatic cylinder = A*P = $(\frac{\pi*0.32*0.32}{4})$*827371 = 665.4115N/$m^2$
- Torque Produced = 665.115*0.165 = 109.744Nm

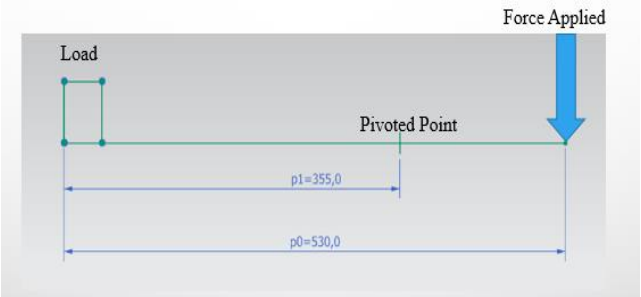

Fig. 6

- When Load, L = 30Kg
- Torque produced by the load to be lifted = 30*9.81*0.365 = 107.42Nm
- According to calculation, the total load that can be lifted by using one cylinder is 30Kg.
- By 2 cylinders = 30*2 = 60Kg

F. Controlling the Speed of Actuation

One of the major aspects is controlling the extension and retraction of the piston of pneumatic cylinder because, sudden actuation results in affecting to the body part. The extending of piston depends upon the load that need to be lifted. If small load is to be lifted and piston extension is rapid, there are chances of the load hitting the wearer face. When the retraction of the piston is rapid then the sudden jerk experienced by the arm is dangerous as it results in damaging the arm. Hence the following pneumatic circuit is used to control the actuation of the piston. Both Supply Air Throttling and Exhaust Air Throttling method is used. The Pneumatic part of the Exoskeleton is represented in the form of Pneumatic circuit diagram as shown in Fig. 7.

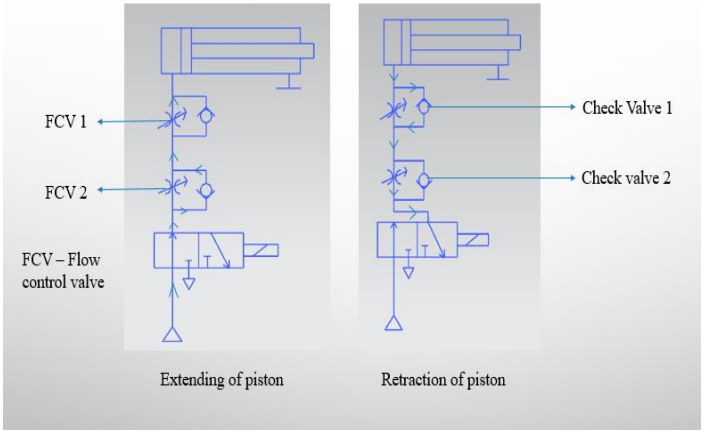

Fig. 7 – Pneumatic Circuit Diagram

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IVRESULT & DISCUSSION

As per Theoretical Calculation, the maximum load that can be lifted by using one cylinder is around 30Kg and by 2 cylinders, it is 60 kg. For increasing the lift capacity, we can use pneumatic Cylinder of bigger diameter or we can use Air Compressor of higher PSI. Since length adjustable feature is included, anybody can wear the suit.

CONCLUSION

The Pneumatic based Exoskeleton is a low cost device which is different from the present Exoskeleton, the design give the wearer the option of changing the distance between the pivoted point and the applied load point so as to increase the weight lifting ability and shoulder length adjustment feature enabling anyone to wear the Exoskeleton suit. The Suit provides an external skeletal structure for the wearer which also involves in helping the wearer to exhibit body movements produced by the Exoskeleton Suit.

REFERENCES

[1] Gopal Krishna U: Design and Fabrication of a Pneumatic Powered Exoskeleton suit for arms, IRJET volume 5 issue: 04, 2018.

[2]Michael Scott Liszka: Mechanical Design of a Robotic Arm Exoskeleton for Shoulder Rehabilitation, Department of Aerospace Engineering, university of Maryland, 2007.

[3]Roger Michcheal Pereira: Design and Fabrication of a Pneumatically Powered Human Exoskeleton Arm, Journal of Mechanical Engineering and Automation,7(3),85-88 2017.

[4]Sheeba P.S: Exoskeleton Arm with Pneumatic Muscle Actuation, International journal of Advanced Engineering and Innovative Technology, Vol 3(1),1-7,2016

[5]Stelian Coros and Robert W. Summer, Computational Design of Mechanical Characters.

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DESIGN AND FABRICATION OF AUTOMATED WHEEL CHAIR

GOUTHAM S B*[1], PAVAN B M[2], PAVAN KUMAR C[3], SHREMAI N S[4], CHETHAN B P[5]

Department of Mechanical Engineering, Sapthagiri College of engineering
#14/5 Chikkasandra, Hesaraghatta main road, Bangalore- 57 India

[1]gouthambasavaraj@gmail.com
[2]pavanpammu123@gmail.com
[3]pavancsy@gmail.com
[4]shremai517@gmail.com
[5]chethanbp@sapthagiri.edu.in

Abstract –**The aim of our project is to develop a wheel chair which is used when walking is difficult due to injury, physically challenged people or quadriplegic patients used to move from one place to another place with the help of beholder or by means of self operating. Automated Wheel chair is a mechanically controlled device designed to have a self-mobility. This reduces the human's effort to drive the wheel chair. It is based on the concept of head tilt movement which permits the operated w heels and various sensors used in the entire wheel chair to reduce errors, crash and breakdown. The major part of the project distinct on the proposed design theory and finalize by exploring the physical working model developed for the proposed design solution.**

Keywords -Self mobility, Wheel Chair & Movement.

I. INTRODUCTION

A wheelchair is a wheeled by self-mobility device designed specifically for disabled peoples. These type of robotic wheelchairs or robotic technologies have the potential to improve the lifestyle of people suffering from one or more disabilities Wheelchairs are used by that people for whom walking is impossible due to some physical problems [1]. There are lots of disabled people. old aged people, handicaps are increasing nowadays. A smart variety of support devices and apparatus has been forming to help improve their quality of lives. Some of the people not able to move from place to place as easily as normal people. In our project we present a mechanically controlled automated wheel chair to help the disabled peoples to move easily in a confined space. In this project there are three sections Mechanical, Electrical and Electronics. This wheelchair as in many variations self-operated, operated by the motor or with help of a person to push. The most concern in this project is low cost with acceptable performance instead of high velocity or high accuracy. The design consolidate several technologies to apply on the wheelchair. This design of small area automated wheel chair can cost at very low price. In those three sections Mechanical part consists of wheels, shafts, flanges, frame, gears. Electrical part consists of a permanent magnet DC motor of high torque, Battery and Electronic part consists of Arduino-UNO board, accelerometer, Ultrasonic sensor. This three sections will the most important parts of this project. These three sections is also key things in getting the best automatic wheel chair by using all the necessary things. The designing of the automated wheelchair is done using a software Unigraphics. After opposing the final design, mock up design is prepared to get the touch and feel of the wheelchair. The designing of automated wheelchair uses a head tilt movement operation for moving the wheelchair by using ultrasonic or infrared sensors. These devices will easy the lives of many quadriplegic patients, old aged peoples and handicaps, especially those with severe impairments, by increasing scope of mobility. The working and controlling of the wheelchair will be carried out using head movements and other characteristics of the system. Obstacle sensor is helpful for blind people. It helps to bar the wheelchair to move in a threat of any obstacles.

II. RESEARCH WORK ON AUTOMATED WHEELCHAIRS.

In nowadays, there are many approaches of navigation control in the existing wheel chair for example: joystick, speech, hand gesture, touch switch, eye movement, tongue movement and head movement etc. To provide a safe movement and to easily navigation control a lot of research work on a wheelchair has already done. Researches in automated wheelchair can be considered in

many departments such as robotics, artificial intelligence automation and with the advancement of technology. However, the materialistic automated wheelchair is not found easily. An automated wheel chair is driven by occasional movement control-based system. Joystick, hand gesture and other standard control interface are only suitable for the patients with healthy upper extremities. And control interface like Speech (talk), tongue movement are apposite for quadriplegic patients and this is not suitable for noisy environment for recognise the voice [3] [4]. In Eye movement control or eye blinking are not 100% efficient in a dim or bright environment [5][6]. In tongue movement, the control of tongue needs to be pierced, which leads uncomfortable to the patients [7][8]. Considering the restriction of the approaches discussed above, the most suitable control interface of wheel chair for quadriplegic patients is the head movement control. The head movement wheelchair has the suitable option to control the navigation through head movement.

In our proposed system, we combing some new features. The significant contributions of this research are listed below,

- The wheelchair can notice the head orientation and to navigate the wheelchair according to controlled by the controller (user).
- Wire connection is not required between the head movement detective sensor (accelerometer sensor) and wheelchair control unit, thus the controller will not fell-sick with a wire hanging on the head.

Can detect an accident and play sound to notify other adjacent people in the surroundings. In case of accident, it stops the entire system and notify the accident information to family member by sending SMS with location

III. MATERIALS & METHODOLOGY

A. 5V Power Supply Using 7805 Voltage Regulator

In most of our electronic products or projects we need a power supply for converting mains AC voltage to a regulated DC voltage. For making a power supply designing of each and every component is essential. Here I'm going to discuss the designing of regulated V Power supply.

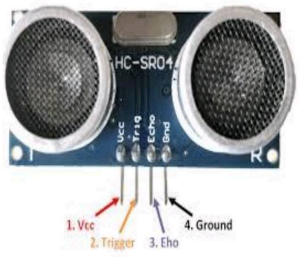
Components List: Step down transformer, Capacitors, voltage regulator, Diodes.

B. Liquid Crystal Display (LCD)

The LCD panel is used in this block interfaced with micro-controller through the output port. This is a 16 character x 2line LCD module, capable display numbers characters and graphics. The display contains two internal byte-wide registers, one for commands (RS=0) and the second for characters to be displayed (RS=1). It also contains a user. Programmed RAM area (the Character RAM) that can be programmed to generate any desired character that can be formed using a dot matrix. To distinguish between these two data areas, the hex command byte 80 will be used to signify that the display RAM address 00h is chosen.

C. ARDUINO-UNO

Arduino-uno is a microcontroller board based on theAT mega328P datasheet. It has 14 digital input / output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator (CSTCE16M0V53-R0), a USB connection, a power jack, an ICSP header and a reset button. IT contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. You can tinker with your Uno without worrying too much about doing something wrong, worst case scenario you can replace the chip for a few dollars and start again. UNO means one in Italian and was chosen to mark the release of Arduino software (IDE) 1.0. The Uno board and version 1.0 of Arduino software (IDE) were the reference version of Arduino boards, and the references model for the Arduino platform; for an extensive list of current, past or outdated boards see the Arduino index of boards.



Ultrasonic sensor

Arduino-Uno Board

D. ADXL335 Accelerometer sensor

Cameras and smartphones these days use an accelerometer consisting of an axis-based motion sensor. They can detect earthquakes as well. It's an electromechanical device measure acceleration forces. The force can be static or either dynamic. Acceleration, as well all know, is the measurement of the change in velocity upon a given time. A laptop hard drive also uses an accelerometer. Suppose when a laptop falls, the accelerometer detects and turns off the hard drive to prevent it from being damaged to prevent data loss. An accelerometer also helps the automotive industry in airbag technology, in detecting crash and inflating the airbag almost in milliseconds of time. It also helps in calculating the gravitational pull and checking the angle and tilt device. By this way, it also detects how the device is moving. Geolocation catching uses an accelerometer. Such as in google maps. It gives GPS the proper coordinates whenever the device moves during navigation. The rotation of a phone I.e., portrait or landscape is also identified by accelerometer. Or if you're moving uphill or coming downhill. In short, we can say it's a device that calculates changes in gravity acceleration. They help in calculating changes in vibration, tilt, and acceleration.

METHODOLOGY

A. Perception of head movement

To percept the head motion, we have used a three-axis accelerometer. The Sensor is placed at the top of the head and it is parallel to the ground surface level. When the head of the controller tilted towards various direction. The intention of the accelerometer sensor is also changed. Figure a shows head tilt towards back, wheelchair drive reverse in direction. Figure b shows head tilt towards front, wheelchair drive forward direction. Figure c shows head tilt towards right, wheelchair drives right direction. Figure d shows head tilt towards left; wheel chair drives left direction.

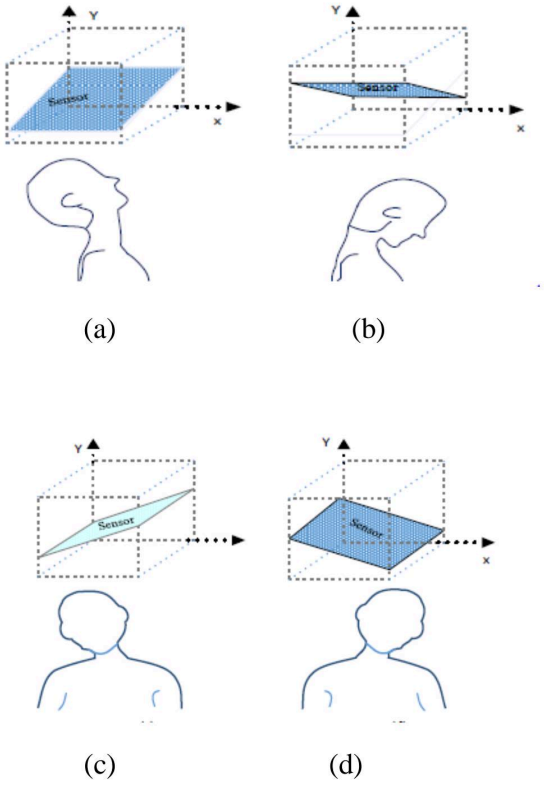


Fig.2 Head tilt movements.

B. Connection Between Head movement detective circuit and Wheelchair control circuit

There is no wire connection/ link between the movement of head control circuit and wheelchair control circuit. The two circuits share the data through the wireless connection between the two Bluetooth modules. Before connecting the Bluetooth modules one to each other, It should be configured to automatically pair with each other. After pairing of devices, the micro-controller of the head movement detection circuit can send any data to the microcontroller of the wheelchair circuit.

C. Reading the Location/ Map-Reading and SMS sending

The GSM modem is used for text messaging and Reading the location. The micro-controller communicates with GSM modem by some commands and Communication protocol.

D. Circuit diagram

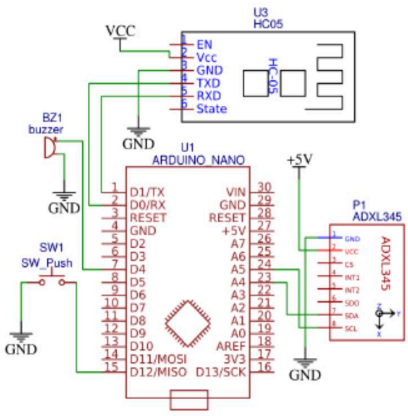


Fig.3 Circuit diagram of head movement detection

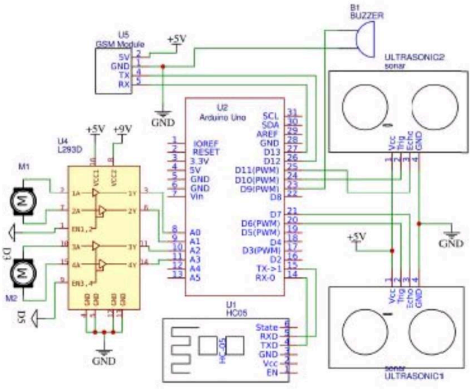


Fig.4 Circuit diagram of unit control of wheelchair

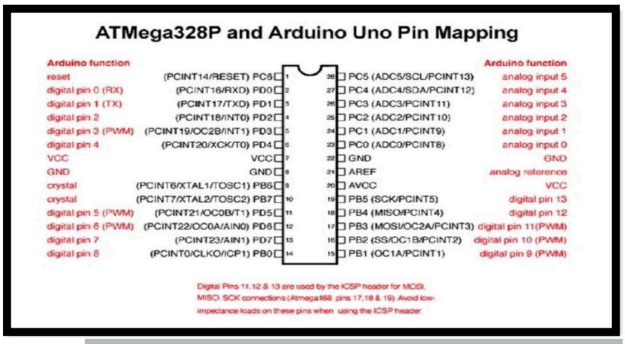
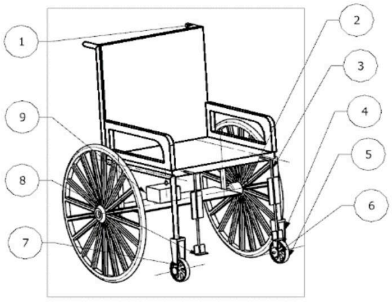


Fig.5 ATmega328/P and Arduino Uno Pin Mapping

Fig.6 3D model



PC NO	PART NAME	QTY
1	BODY 2	1
2	MOTOR	2
3	WHEEL 3	2
4	CASTER	2
5	WHEEL 2	2
6	SCREW	2
7	NUT	2
8	MODEL3	2
9	BATTERY	1

Fig.7 Parts of wheelchair

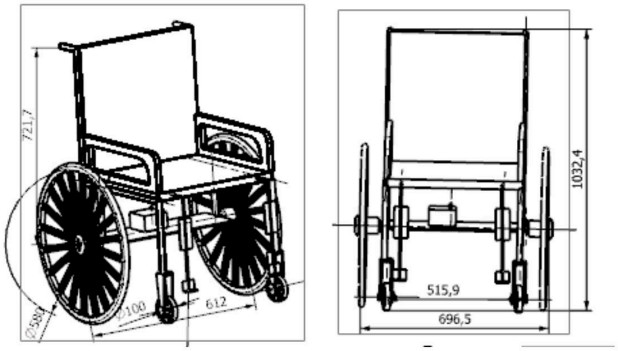


Fig.8 Basic design of wheelchair

ATmega328/P

The high-performance Microchip Pico Power 8-bit AVR RISC- based microcontroller combines 32KB ISP flash memory with read-while-write capabilities, 1024B EEPROM, 2KB SRAM, 23 general purpose I/O lines, 32 general purpose working registers, three flexible timer/counters with compare modes, internal and external interrupts, serial programmable USART, a byte-oriented 2-wire serial interface, SPI serial port, a 6-channel 10-bit A/D converter (8-channels in TQFP and QFN/MLF packages), programmable watchdog timer with internal oscillator, and five software selectable power saving modes. The device operates between 1.8-5.5 volts. By executing powerful instructions in a single clock cycle, the device achieves throughputs approaching 1 MIPS per MHz, balancing power consumption and processing speed.

IV. RESULTS & DISCUSSIONS

The prototype of the head tilt movement based wheelchair has been shown in fig 6-8. This Prototype has been tested by tilting the accelerometer present on a headgear and which will be worm by the user. The receiver circuit will give the necessary commands and controls the movement of wheelchair in forward, backward, left and right directions. We obtained the following results from the ADXL335 accelerometer which was used drive motors. shows the trials conducted and success rate.

DIRECTION	NO. OF TRIALS	SUCCESS	SUCCESS RATE
Forward	12	10	83.33%
Backward	12	11	91.67%
Left	12	10	83.33%
Right	12	11	91.67%
Overall result	48	42	97.5%

CONCLUSIONS

1. This automated wheelchair is valuable for the people who could not move from place to place-missing legs and arms, People with weakness or no upper body action and paralyzed children.
2. The automated wheel chair can be used to help quadriplegic patients to lead their life without extra assistance foe moving in flat surface.
3. The combined data of accelerometer and ultrasonic sensor ensures proper wheelchair locomotion for disabled peoples.
4. The tailored made threshold for users' convenience. Moreover, the low cost of the assembly parts of this wheelchair has enhanced its affordability.
5. In the future, we can use a machine-learning algorithm to detect the head movement for controlling the wheelchair more precisely.

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REFERENCES

[1] Pajkanović, Aleksandar, and Branko Dokić. "Wheelchair control by head motion." Serbian Journal of electrical engineering 10, no. 1 (2013): 135-151.

[2] Md. Eftekhar et. al. "A multi-controlled semi-autonomous wheelchair for old and physically challenged people", Proceedings of the 1st International Conference on Advances in Science, Engineering and Robotics Technology (ICASERT-2019), Dhaka, Bangladesh.

[3] Prathyusha, M., K. S. Roy, and Mahaboob Ali Shaik. "Voice and touch screen-based direction and speed control of wheel chair for physically challenged using arduino." International Journal of Engineering Trends and Technology (IJETT) 4, no. 4 (2013): 12421244.

[4] Nishimori, Masato, Takeshi Saitoh, and Ryosuke Konishi. "Voice controlled intelligent wheelchair." SICE, 2007 annual conference. IEEE, 2007.

[5] Wanluk, Nutthanan, et al. "Smart wheelchair based on eye tracking." Biomedical Engineering International Conference (BMEiCON), 2016 9th. IEEE, 2016.

[6] Jain, Monika, Shikhar Puri, and Shivali Unishree. "Eyeball motion-controlled wheelchair using IR sensors." World Acad. Sci. Eng. Technol. Int. J. Comput. Electr. Autom. Control Inf. Eng 9, no. 4 (2015): 906-909.

[7] Kim, Jeonghee, Hangue Park, Joy Bruce, Erica Sutton, Diane Rowles, Deborah Pucci, Jaimee Holbrook et al. "The tongue enables computer and wheelchair control for people with spinal cord injury." Science translational medicine 5, no. 213 (2013): 213ra166-213ra166.

[8] Huo, Xueliang, Jia Wang, and Maysam Ghovanloo. "Wireless control of powered wheelchairs with tongue motion using tongue drive assistive technology." In 2008 30th Annual International Conference of the IEEE Engineering in Medicine and Biology Society, pp. 41994202. IEEE, 2008.

"A Review on an Eco-friendly Water Purification Method Using Polystyrene Beads as Packed Media"

TEJA M [1], NITHIN H [2], M K GURUPRASAD [3], AMBIKA Y R [4], SHREYAS B V [5]

Department of Civil Engineering, Dayananda Sagar Academy of Technology and Management
22 Mile, B M Kaval, Udayapura, Kanakapura Road, Bangalore – 560082, India.
[1] tejagowda2031@gmail.com
[2] nithin15p0620@gmail.com
[3] guruprasadkubasad99@gmail.com
[4] ambikaa089@gmail.com
[5] shreyasbv2009@gmail.com

Abstract: **Water is the basis of all life. But, the quality of drinking water has been deteriorated due to various anthropogenic activities. There is a need for an efficient and eco-friendly water treatment method as the conventional methods are inconsistent and release excess of waste water. Polystyrene (Ps), a synthetic resin can be used as a packed media filter to purify water by ion-exchange method. The ion-exchange process using synthetic resin is the most effective method for the removal of selective ions from water. This method is widely used for the removal of nitrates, fluorides, iron and hardness of water. The advantage of using Polystyrene beads would be that they are light-weight, durable, easily operated and chemically inactive to the chemical agents present in the water samples. Also, water purification using Polystyrene beads proves to be an effective way to recycle the Polystyrene waste accumulated in the society. This paper presents a critical review on the use of Polystyrene as ion exchange resins for water treatment.**

Keywords: Polystyrene beads; Conventional methods; Ion exchange; Water purification.

I. INTRODUCTION

Water is of primal importance for the survival of human beings. The quality of water required for consumption is a subject of ongoing concern. Water from various sources contains different types of impurities and cannot be directly used by the public, before removing the impurities. Anthropogenic activities which pollute drinking water are use of chemical fertilizers in the agricultural practices, spills from industrial operations, percolation of sewage into water sources, urban runoff into the lakes, rivers and streams. Presence of impurities can cause various diseases such as cardiovascular problems, kidney stones, Methemoglobinemia, Cyanosis, Asphyxia, Hypercalcaemia, Hypermagnesemia, dental, skeletal disorders and so on.

The contaminants in the water can be removed by numerous treatment methods, such as chemical precipitation, Reverse Osmosis, filtration, aeration, adsorption, etc. But, the performance of these traditional methods has been found to decrease with the increase in the concentration of pollutants. Also, a large quantity of waste by-products is obtained during the purification process. In recent times, with the rise in the concern for the environmental and eco-friendly approach, alternatives such as synthetic resins, polymers and silica beads have been considered for water treatment. These alternatives are utilized as they can be recycled, reused and regenerated. They are used as a media to adsorb or exchange the pollutant ion. Hence, an adsorption ion exchange unit is one of the most feasible and an effective treatment method to purify potable water.

Polystyrene (PS) beads are polymers made of monomer styrene. They are used as an ion exchanger which exchange specific ions existing in the polymer with pollutant ions in water sample. Apart from being used for purifying water, they also have other applications in the production of plastics and in sorting out few elements. Some of the benefits of using Ps beads are that, they are cost effective, durable, easy to manage, recovered easily and can be reused, low energy costs and supply high resistance to different chemical contaminants in the effluent. Contemplating all the above points, the current review paper is focused on presenting Polystyrene beads as fixed media to treat both potable water and waste water effectively.

II. REVIEW OF LITERATURE

Ion exchange is a water treatment method where one or more pollutant ions in the water sample are extracted by exchange with another non-objectionable, or less objectionable ionic substance. Although, there are many ion exchangers present, researches have been carried out to use synthetic resin wastes to treat water, as accumulation of these wastes results in environmental degradation. Polystyrene beads are one of the synthetic resins used to purify water based on the principle of ion exchange. Following section highlights the use of Polystyrene beads in various forms (beads, grains and foam) and sizes (2mm, 4mm, 6mm) to treat both waste water and potable water.

A. Water Purification Using Synthetic Resin Waste

The researchers have investigated how plastics and polystyrene foam such as foam packaging can be used as a synthetic resin in combination with packed sand-gravel filters in columns system in order to extract total hardness (TH) present in the groundwater. This study was carried out in a school at Thailand by collecting groundwater sample from there. Polystyrene is a thermoplastic substance and is in solid state at room temperature. Thus, they need to be synthesized into active adsorbent cationic resin. The synthetic resins were produced by crushing waste polystyrene foam used for food packaging to a size of 0.2 – 0.3 cm^2. Then 5 g of raw material was transferred into a flask with 100 mL of 95% sulfuric acid and made to react under room temperature for the reaction period and then filtered using a funnel. Later, the slurry was washed with 250mL of distilled water for ten times, to remove the residual sulphuric acid from resin. The resin was then dried at 40°C for 30 min and was neutralized by stirring it with 500mL of 1M NaCl solution for 2hrs. This entire process aimed at converting the sulphonated polymer resin into its Na+ form. Also, the experiment was carried out using both fine sands and gravels as filter material in the packed column. The experimental study was carried by using 5 different columns packed with different thickness of filter. The columns were made from polyvinyl chloride plastic and the groundwater sample was pumped at a flowrate of 1 L/min for 1 h. This entire process aimed at converting the sulfonated polymer resin into its Na+ form. Also, both fine sands and gravels were used in the study as filter material in the packed column with the size range of 0.125-0.250 mm and diameter 4.0-8.9 mm. The experimental study was carried by using 5 different columns packed with different thickness of filter. The columns were made from polyvinyl chloride plastic and the groundwater sample was pumped at a flowrate of 1 L/min for 1 h. For experimental study, 5 different columns were used as shown above (fig.1). C was the control column which contained of packed sand and gravels, column 1 was an amalgamation of packed gravels-sand filters and 392.5 cm^3 foam resins, column 2 was a combination of foam resins up to a depth of 785 cm^3 with packed gravels-sand filters, column 3 was an amalgamation of packed gravel, sand filters and bubble plastic resins up to 392.5 cm^3 and column 4 was combination of bubble plastic resins up to a depth of 785 cm^3 with packed gravel and sand filters.

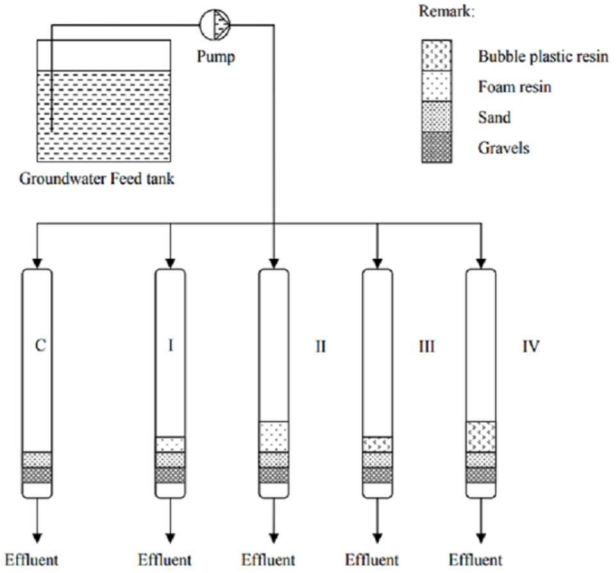


Fig.1: Line diagram of experimental setup (Nuangon, et,al., 2011)

It was observed that the TH of the water passed through the control column (absence of packed resin) on an average was 386.7 mg$CaCO_3$/L which was exceeding Thailand standards. But, column 1,2,3,4 were within the standards. Thus, we can conclude that the removal efficiency was more when packed resin was used for treatment of groundwater. **Nuangon, et,al., 2011 [9].**

B. Polystyrene Beads Used as Foam

Polystyrene foam filters were used to build a water treatment unit in Ukraine. The purpose of their research was to treat surface water and groundwater and achieve required drinking water standards. Polystyrene beads were processed with hot water or steam and Polystyrene foam was produced. Researchers designed an ascending filtration stream using Polystyrene foam as a filter to purify drinking water. Water sample was pumped into the bottom distribution system using the pipeline. The water sample was then passed through the layer of Ps foam filling and the treated water is collected at the top. The filtration cycle is completed with the

deterioration of pollutants in the water sample. Washing valves were installed on the pipeline supplying water sample to flush the washing water. In the flushing process, pure water was allowed to flow down from the upper part, expand and wash water filling. The collected flushing water was discharged into the sewer. After the completion of flushing, filtration process is restarted. Also, a two-stage water treatment unit was developed using Ps foam filters for the purpose of clarification and discoloration of water. At the first, water sample was disinfected using chlorine and then coagulant was added to water. Next, the sediments in the water was allowed to settle in flocculation chamber. Then, the water sample was passed through layers of Polystyrene foam filters. They recommended the use of air separators for the removal of iron. Water treatment unit developed with this material was energy saving and cost efficient compared to the existing technological schemes. They provided savings in terms of capital investment, operating costs and electricity. They also reduced water consumption for own needs and the amount of buildings and structures. **Orlov, et,al., 2016 [2].**

C. Polystyrene Used as Granules

They evaluated and compared the use of descending rapid filters using polystyrene granules as media with the combination of Sand and Anthracite filter. The comparison of the filters was on the basis of turbidity, conductivity, true and apparent colour, dissolved solids, pH, temperature, removal of cyanobacterium and residual aluminium under the similar working conditions of filtration. Polystyrene granules of diameter 0.68mm were filled up to a depth of 97cm. In the sand and anthracite filter, Sand particles of diameter 0.62mm and anthracite particles of diameter 0.85mm were filled up to a depth of 30cm and 80cm respectively.

The water quality observed from the Ps granules filter turned out to be equal to the water quality obtained by the combination of Anthracite and Sand filter. The length of the filter runs was shorter in Polystyrene filters when compared to the other filter. A lower bed porosity was presented as Ps granules are granular elements with virtually spherical grains and small grain size, which lead to the head loss of the PS filter quickly, thus ending the runs early. In addition, Polystyrene granules did not release noticeable quantity of styrene in water and can hence be used as a filter element. **Juliana, et,al., 2015 [4].**

D. Polystyrene Used as Beads

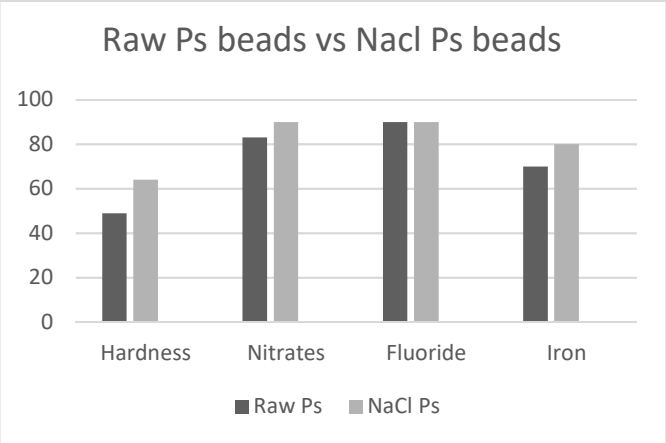
1) Pre-treatment using raw Ps beads: In order to overcome the emergency situations (Natural disasters, war or famine) and provide clean drinking water, Reed and Kapranis experimented with Polystyrene (Ps) beads to provide pre-treatment required for efficient application of disinfection. Lack of availability of chemicals for chemical flocculation and difficulty to transport gravels for sedimentation led to the use of Ps beads. They setup a vertical up flow type filter model filled with Polystyrene beads. Three experiments were carried out using two 300mm diameter PVC pipes to hold the media. One was to determine the efficiency of Polystyrene compared to Gravels, next to analyse the turbidity removal efficiency of 'S' shaped and bead shaped Polystyrene media and another to evaluate the effect of filter bed depth (1m and 0.75m) on the water treatment.

From the experiments performed, it was seen that the turbidity removal efficiency of Polystyrene (42%) was equivalent to that of gravel (41%). And, the efficiency of bead shaped media was better than the 'S' shaped media. The ideal condition for optimum removal efficiency for low turbidity water was seen to be using Ps beads of 4 mm diameter, a filtration rate of 0.75 m/h and a bed depth between 0.75 and 1.0 m. Also, they observed that there was no much difference in the removal efficiency due to alteration of filter bed depth. They also stated that the removal efficiency increases with the increase in the inlet turbidity and filters arranged in series are required for the treatment of high turbidity. Hence, the roughing filter using polystyrene proved to be an effective alternative as they were simple to construct, easy to operate and efficient in the removal of turbidity. **R A Reed, et,al., 1998 [10]**.

2) Water treatment using NaCl saturated beads: Experimental studies were conducted using polystyrene beads which were efficient in the removal of impurities from the water source. To determine the treatment efficiency of the Polystyrene beads Column studies were carried out. The groundwater was analysed to determine the characteristics of the water sample. Polystyrene beads of various sizes (2mm, 4mm, 6mm) were used as a packed media and water was passed at various flow rates (0.25, 0.5 and 0.75 L/min). Two columns were used. One was filled with Raw Polystyrene beads and the other with supersaturated NaCl Polystyrene beads. When the water was passed through, it was observed that the contaminants present in the water were removed through ion exchange process. As water passed through the packed media, pollutant ions in the water sample were exchanged with the loosely held sodium ions present on the surface of the beads.

From the experiments conducted, it was observed that impurities removal efficiency was more when beads of size 2mm were used at a flow rate of 0.25L/min. It was observed

that, the removal efficiency of hardness and other impurities was more with smaller resin beads, this was mainly due to an increase in surface area and film diffusion rate. Polystyrene beads when supersaturated with NaCl solution had more efficiency in removal of Hardness, turbidity, Nitrates, Iron and Fluorides from water source when compared to Raw Polystyrene beads. **Madhukar, et.al., 2015 [3].**



Graph 1: Performance of Raw Ps beads vs NaCl Ps beads

3) Water treatment using sulfonated beads: They investigated and compared the results obtained when polystyrene beads were sulfonated using 95% concentrated sulfuric acid and Raw Polystyrene beads to remove Iron and Hardness from the groundwater sample. Polystyrene beads of different sizes (2mm and 8mm) were sulfonated using 95% sulfuric acid. Raw Ps beads and Sulfonated Ps beads were filled in different column reactors and the water sample was passed through the packed media at different flow rates (100, 200, 300 and 400 L/min) and results were tabulated. The efficiency of the beads was evaluated based on the removal of Total Hardness, Iron, Nitrates and Fluorides.

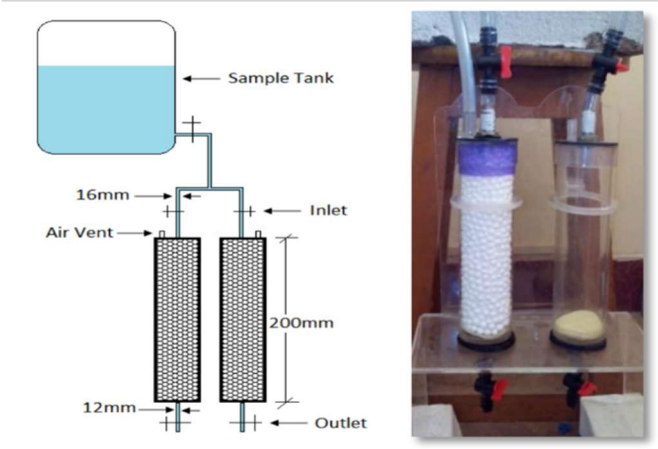


Fig2: Column studies using PS beads as packed media (Lavanya, et,al., 2014)

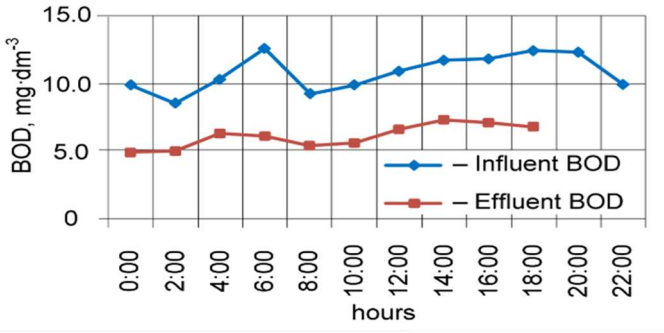
From the experiment, it was observed that the pollutant removal efficiency was high in Sulfonated Ps beads when compared to the Raw Ps beads. This was because sulfonation of the beads using 95% concentrated sulfuric acid resulted in increase of cation exchange capacity of the resin beads. Comparing the results of pollutant removal efficiency of various sized beads at different flow rates, they concluded that optimum efficiency was obtained by using Sulfonated Ps beads at a Flow rate of 100mL/min and Ps bead of size 2mm. The impurities in the purified water was below permissible limits which was required to comply with BIS standards. **Lavanya, et,al., 2014 [7].**

In this research paper, Authors explored the possibility of sulfonating Expanded Polystyrene (EPS) beads and use them for water purification. Sulfuric acid was used to sulfonate the Ps beads, so as to decrease the environmental degradation caused from the reaction and to enlarge its economy. 5 grams of Virgin polystyrene (VPS) and EPS waste were used for the research. VPS and EPS were dissolved in 1,2-dichloroethane (100mL) separately and these substrates were then assorted in a thermo - statted reaction vessel with a specified quantity of silica sulfuric acid. In the case of VPS, ratio of PS to sulfonating agent was 1:1.5 to 1:4 based on the moles of $ClSO_3H$ consumed per monomeric unit of polystyrene to synthesize silica sulfuric acid, duration was 60 – 720 min and temperature range was between 30 to 60^0C. In the case of EPS, PS to sulfonating agent ratio was 1:2, duration was 420 min and temperature range maintained at 60^0C. The Ion exchange capacity (IEC) was evaluated by equilibrating acid form resin with NaCl solution and measuring H^+ ions exchanged with sodium cation. Solutions of heavy metals, such as Zn and Cu, were prepared to assess the adsorption capacity of Ps beads.

It was seen that the advantage of using Silica sulfuric acid were that the sulfonate derivatives (H_2SO_4) were easily differentiated from the sulfonating agent by transferring of their suspension in 1, 2 – dichloroethane. They observed that with the increase in sulfonating agent, product cross-linking decreased which in turn increased the diffusion of ions and hence increasing the water purification capacity. They also stated that the sulfonation has to be increased by increasing reaction time, as increasing temperature for better sulfonation will result in the increase in difficulty to remove the sulfonated derivatives. The ion exchange capacity of VPS and EPS was 2.6 and 3.1 $mmolg^{-1}$. The pattern in the adsorption capacity was it decreased with the increase in metal concentrations. Also, they reported that the increased adsorption capacity in Cu^{2+} (Lesser diameter) compared to Zn^{2+} (Higher diameter) was because the adsorption depended

on charge density of cations and the diameter of hydrate cations. The performed experiment proved the usefulness of PS derivative wastes for the process of water treatment. **Wieslaw W. Sułkowski, et,al., 2009 [11].**

4) Waste water treatment unit using Ps beads: The researchers assessed the performance of the Expanded Polystyrene (EPS) filter developed for tertiary treatment of biologically purified effluents and compared its effectiveness with disc filter. The performance of EPS was evaluated based on parameters such as removal of Total Suspended solids (TSS), BOD and COD from the effluent and determination of frequency of backwashing compared to disc filters. They developed a two layered Polystyrene (Ps) bed up flow Biovis filter. The bottom layer was filled with 1 – 4mm dia Ps beads up to a depth of 900mm and the top layer was covered up to a depth of 400mm using 4 – 7mm dia Ps beads. The total Ps bed depth and volume was 1300m and 0.975m^3 respectively. The filtration unit plan dimensions were 1m x 0.75m. The effluents from the humus tank were let into the filtration unit from the bottom and was allowed to pass through the beads. The backwash process was linked to a level sensor. With the increase in the head loss, the set point in the stand pipe increased leading to the initiation of siphonic backwash when it reaches high set point. Once the head loss decreases and reaches low set point above the holding grid, the siphon was broken and backwash would be completed. They tested these filters at two sites of Thames Water Innovation serving a population of 3000-5000 each. In order to compare the efficiencies of the filters, the samples treated from the disc filters were used as an effluent at site 1 and the samples from the humus tank were used as an effluent at site 2.



Graph 2: Performance of Ps beads and Disc filters in removal of BOD (Fylypchuk V, et,al., 2017).

From the results, they observed that the treatment efficiency was higher in Biovis filters (BOD removal – 40%, TSS – 66%, COD – 28%) compared to the Disc filters (BOD removal – 21%, TSS – 52%, COD – 22%). They observed that the treated samples of disc filter were further treated at site 1 using Biovis filters. Biovis filters were capable to cope sufficiently with higher and lower loading of solids. The backwash initiation set point level was chosen to be 0.6m as it provided the optimum backwash frequency of 2 times per day. The advantages reported of using Ps beads were absence of backwashing pumps, high resistance to various chemical contaminants present in the effluent and low energy costs. The construction and operation were simple and robust compared to the disc filters. They concluded that the overall filter had good operability rating. **Fylypchuk V, et,al., 2017 [1]**.

III. SUMMARY AND GAP STUDIES

The above papers discussed the physicochemical characteristics of water pollution and their impact on the environment through the analysis of works of earlier authors. Also, water contamination was considered to affect the survival of mankind and degrade the existing environmental conditions. They argued that anthropogenic activities were the major factors of water pollution and hence it was necessary for water treatment. They also discussed the need for recycling Polystyrene waste which resulted in environmental degradation. The research papers confirmed that the PS can be used as a packed media for water purification. Polystyrene in water treatment resulted in the removal of various impurities as seen in Table 1.

Sl.no	Parameters	% Removal
1.	Total Hardness	64%
2.	Iron	80%
3.	Nitrates	90%
4.	Fluorides	90%
5.	Turbidity	42%
6.	BOD	40%
7.	COD	22%
8.	TSS	66%

Table 1: Performance Ps beads on various impurities

The papers also explained the need for further research using Polystyrene, such as, determination of the media exhaustion, optimum removal efficiency by using different combination

sizes of the beads and the concentration of the agents required to convert Polystyrene into ion exchange resins.

IV. CONCLUSIONS

Utilization of Polystyrene for the water treatment is considered to be an effective way to recycle polystyrene waste and reduce the environmental degradation caused due to the accumulation. It was also noticed that these beads were a good option as they did not release excess of styrene while treatment of water. Ps in different forms (Beads, granules and foam) used for wastewater and water treatment were effective in the removal of COD, TSS, BOD from wastewater and turbidity, nitrates, fluorides, iron and total hardness from surface water. This method could also be combined with other water treating methods as they alone were efficient in replacing sand + anthracite filters. Thus, these beads as a packed media could be used to develop a home-based water purification unit.

ACKNOWLEDGEMENT

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REFERENCES

[1] Fylypchuk V; Induchny S; Pearce P; FylypchukL; Martynov S: *Application of expanded polystyrene filter for Tertiary Treatment of Domestic Waste Effluent in The Uk*. Issue: 2017, No. 35 (X–XII): 41–47 ,2017 PL ISSN 1429–7426.

[2] Orlov V; Martynov S; Kunytskiy S: *Energy saving in water treatment technologies with polystyrene foam filters*. Issue 2016, No. 31 (X–XII): 119–122, 2016 PL ISSN 1429–7426.

[3] Madhukar M; Dr Sadashiva Murthy B M; Dr.Udayashankara T H: *Removal of ground water pollutants using polystyrene beads*. Issue: February 2015.

[4] Juliana M. Schöntag; Bruno S. Pizzolatti; Victor H. Jangada; Fernando H. de Souza; Maurício L. Sens: *Water quality produced by polystyrene granules as a media filter on rapid filters*. Received in revised form on 14 January 2015, Accepted on 1 February 2015.

[5] M.S. Mohy Eldin; M.A. Abu-Saied; T.M. Tamer; M.E. Youssef; A.I. Hashem & M.M. Sabet: *Development of polystyrene-based nanoparticle ion-exchange resin for water purification applications*. Desalination and water treatment-January 2015.

[6] Sharon O, Skipton Extension Water Quality Educator, Bruce I. Dvorak: *Drinking water treatment: water softening [ion exchange]*. Issue: September 2014.

[7] Lavanya R. S (M.Tech Scholar), Savitha Ulavi (Assistant professor), Dr. K. S Lokesh (Professor) Department of Environmental Engineering, Sri Jayachamarajendra College of Engineering, Mysore, Karnataka, INDIA: *Water softening and de-ironing of ground water using sulfonated polystyrene beads*. ISSN: 2278-0181 Vol. 3 Issue 6, June – 2014.

[8] M Madhukar, S.P Manjunath and Rohini V. Gopal: *Preliminary studies on removal of nitrate and hardness from ground water using polystyrene beads*. Water Science & Technology Water Supply - April 2014.

[9] Prapat Pentamwa , Wipasinun Thipthara and Suparat Nuangon, School of Environmental Health, Suranaree University of Technology, Nakornratchasima, 30000. Thailand: *Hardness removal from groundwater by synthetic resin from waste plastics*. 2011 International Conference on Environmental and Computer Science.

[10] R.A. Reed and Y. Kapranis, WEDC: *Roughing filtration with polystyrene beads*. 24th WEDC conference, Islamabad, Pakistan, 1998.

[11] Wieslaw W. Sułkowski, Krzysztof Nowak, Anna Sułkowska, Agnieszka Wolińska, Wioletta M. Bajdur, Danuta Pentak, and Barbara Mikuła: *Study of the sulfonation of expanded polystyrene waste and of properties of the products obtained*. 29th November 2009.

INVESTIGATIONS ON THE INFLUENCE OF TRAFFIC ON ROAD ECONOMICS USING HDM-IV – A CASE STUDY

HanamantHunashikatti, Vijay Devar, Dr. G Sreelakshmi

ABSTRACT

Traffic is growing at a very large rate in our country, especially in the metropolitan cities like Bangalore, Delhi, Chennai, and Kolkata. As we already know, highway transportation and economic growth are two parameters which are very closely linked with each other, there is a need for us to keep improving the capacity of the roads with respect to the growth of traffic or manage the traffic in a better way. It is estimated that in Bangalore, about 625new vehicles gets registered every day. So, there is a need for investigating the effect of traffic volume and composition on the Road user cost. In the paper the authorsare trying to evaluate the effect of traffic on the Road user cost with reference to alternative improvements on Mysore road, to evaluate the influence of road geometrics and traffic using HDM-IV.

1.0 INTRODUCTION

Economic growth increases mobility and with it, the traffic. The nation'seffort to boost prosperity and create jobs is therefore leading to undesirable side effects. It is seen in the growing congestion on Indian roads, especially in peak hours and heavily urbanized regions. By virtue of economic activities the companies perform, they influence the traffic flow directly Bangalore is the fastest growing major metropolitan city in India, and is also the country's fourth largest fast moving consumer goods market [1]. Bangalore is well known as a hub for India's information technology sector Bangalore's 52,346 crore economy (Net District Income) makes it one of the major economic centers in India, with the value of city's exports totaling 43,221 crore,with an economic growth of 10.3%. Once called as the pensioners paradise has turned to an unlivable place due to heavy traffic and lack of mass transport facilities. . A 2010study done by the author found Indian cities as extremely congested — the average bus speed is 10-12 km/h in many large cities. There is a need to support this growth with improvements in the infrastructure to help achieve better economic growth.

A research article found Indian cities as extremely congested — the average bus speed is 6–10 km/h in many large cities. Because of the congestion in Indian roads the fuel efficiency of the vehicles is also very low. This increases the overall fuel consumption per equivalent kilometer travelled, besides resulting in heavy pollution since the engines run very inefficiently at such low speeds. Pollutants from poor road network and resultant poor fuel efficiencies include hydrocarbons, NO_x, SO_x, methane, carbon monoxide and carbon dioxide - all of which cause health problems, adverse climate effects and related environmental damage.

Transport performs a key role in achieving fast economic growth. Road Transport is the dominant consumer of the petroleum products. The usage is high due to the alarming increase in travel demand and growth of vehicles. The vehicle riders have to overcome congestion and delay on roads. There is considerable loss of fuel due to idling of vehicles at the traffic

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intersections which results in increase of operating cost and wastage of precious fuel.

Based on the research done earlier [2] it is very clear that the road transportation has the maximum effect on the land use patter and other parameters. One of the literature also showed that an investment of 1% in road infrastructure will create 5% of jobs [9].

1.2 ECONOMIC EVALUATION

Economic evaluation is the methods of determining the value of a good, service, activity, policy, program or project. This can help guide decisions toward optimality, which refers to maximum social benefit. Economic evaluation involves quantifying incremental economic impacts to determine net benefits or net value. There are many methods available for the economic evaluationwhich include (i) Rate of return methods - Benefit cost (B/C) ratio method and First year rate of return method (ii) Discounting cash flow (DCF) method - Net present value (NPV) method and Internal rate of return (IRR) method [1].

1.2.1 Importance of Economic Evaluation

Economic evaluation acts as a tool which helps us in comparing different schemes with respects to the benefits that we can get from them. It also helps in ranking the schemes in case if the resource available is scarce. Economic evaluation helps in phasing the road programme over a period of time depending upon the availability of the resources. A certain kind of widening will always be beneficial but if the widening is justifiable in the near future can be know from economic evaluation [2], [3]. This also helps in evaluating alternate strategies such as stage construction of full construction, alternative specifications such as whether to go for flexible pavement or rigid pavement can also be evaluated.

1.2.2 Total transportation cost

In the earlier days only the cost of construction of the facility was taken into consideration while evaluating the pavement but the present day scenario is calling for the consideration of VOC of the improvement into consideration as it also forms the major part of total road user cost. [4], [5].

There are mainly three types of costs that are involved, i.e. the cost of construction of the facility initially, periodic cost maintenance of the facility over its design life, and the road user cost. In this the total construction cost and maintenance cost together are known as “Highway costs”

1. Cost of construction of the facility includes
   a. Survey, investigation and design costs
   b. Land acquisition costs
   c. Construction costs
   d. Physical contingencies
   e. Supervision, quality control and administration charges
2. Cost of maintenance of the facility
   a. Ordinary repairs, such as pot-hole filling, patch repairs, dressing earthwork etc.
   b. Periodic repairs, such as renewals and resurfacings.
   c. Operational expenses, such as traffic signals, traffic aid posts, lighting, prizing etc.
   d. Supervision and administrative charges.
3. Road user cost
   a. Vehicle operational cost
   b. Time cost
   c. Accident cost

1.2.3 Factors affecting road user cost

1. Vehicle operation cost
   a. Vehicle factors
      i. Age
      ii. Make
      iii. Horse power
      iv. Load carried
      v. Condition of vehicle
      vi. Level of maintenance input
      vii. Type of fuel used
      viii. Type of tires used
   b. Roadway factors
      i. Roughness of surface
      ii. Type of surface
      iii. Horizontal curvature
      iv. Vertical profile
      v. Pavement width
      vi. Type and condition of shoulders
      vii. Number of junctions per km
   c. Traffic factors
      i.Speed of travel
      ii.Traffic volume and composition
   d. Environmental factors
      i. Altitude
      ii. Rainfall
      iii. Temperature
2. Time cost
   a. Value of occupation time
   b. Value of goods in transit
   c. Value of time of commercial vehicles
3. Accident cost
   a. Cost of human fatal accident
   b. Loss due to injury
   c. Cost of hospitalization.

1.2.3 Benefits from the improvement

The benefits that can be obtained for the improvement can be divided in to two one is the benefits to the road users and other is social benefits. Road user benefits include savings in the road user cost savings in travel time savings in the accident cost, and social benefits include change in the land value, improvement in agriculture, health, trade and mining etc., [6], [7], [8].

1.4 Need for the study

Road user cost study in India carried out, has brought out some eye- opening conclusions about the economic losses on account of the drop in speed The fuel consumption can increase as high as 56 percent if speed of a truck fall from about 45 kmph to 20 kmph. It is concluded that road improvement, will save 1/5 of fuel bill of the country, apart from substantial saving of accidents etc. and total economic return on cost of road improvement would be as high as 50 - 60 percent in one year alone.

1.5Objective of the paper

1. Evaluate the vehicular characteristics along the selected stretch.
2. Evaluate the effect of traffic on the road economics
3. Study the effect of alternate strategies for improvement.
4. Arrive at the best solution based on technical and economic feasibility using HDM 4.

1.6METHODOLOGY

1.6.1 Road inventory

All the necessary data needed for the software for evaluation relating the road inventory such as length, width etc were taken, imposed speed limit on the stretch and altitude of the area were considered for the evaluation along with this traffic data is also required in terms of composition of the total volume. The inventory of the road is presented in the Table 1.

Table 1: Road inventory data

Section	Length (km)	Carriageway Width (m)	Speed limit (kmph)	Altitude (m)
RV college of engineering – Bangalore university	2.1	10.5	LCV=60,HCM=40	860
Bangalore university-Arcade mall	0.4	10.5	LCV=60,HCM=40	860
Archademall- pipeline road	2.2	10.5	LCV=60,HCM=40	860
Depanjalinagar-satellite bus stop	0.66	10.5	LCV=60,HCM=40	860
Satellite bus stop- Gopalan mall	1.4	10.5	LCV=60,HCM=40	860
Gopalan mall- Mosque	0.5	10.5	LCV=60,HCM=40	860
Mosque-Mysore circle	0.2	10.5	LCV=60,HCM=40	860

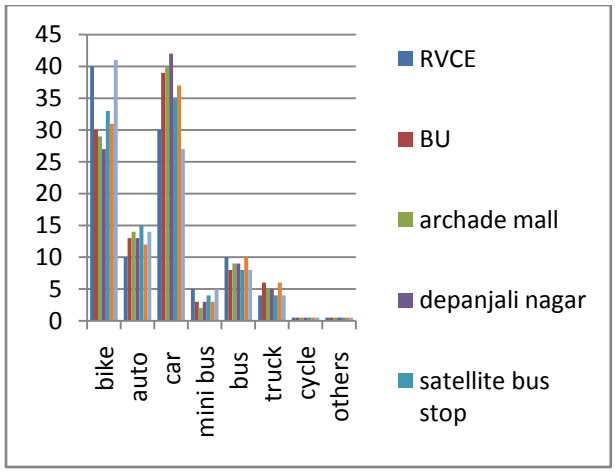
1.6.2 Volume count

The selected road stretch is a 4 lane divided carriage way, but in some places the width of the road was reduced but we cannot take all the varying lengths of the pavement into account so we have selected the common width of the pavement as 10.5m, and the speed limit and other parameters are also taken in to consideration as per the imposition.

The selected road stretch was divided in to sevensubsections and the traffic study was conducted from 6am to 9pm and the analysis of the data was done as per IRC-106:1990 and the traffic composition details are as presented in the Table 2.

Table 2: Composition of traffic along the study stretch

Section	% Composition(PCU)								
	2-wh	3-wh	4-wh	Mini bus	Bus	Truck	Cycle	Others	Total (PCU)
RVCE	40(17614)	10(4404)	30(13211)	5(2202)	10(4402)	4(1761)	0.5(220)	0.5(221)	44035
BU	30(14199)	13(6152)	39(18459)	3(1420)	8(3786)	6(2839)	0.5(236)	0.5(237)	47329
Archade mall	29(12550)	14(6059)	40(17311)	2(865)	9(3895)	5(2164)	0.5(216)	0.5(217)	43279
Depanjalinagar-	27(26205)	13(12617)	42(40793)	3(2911)	9(8735)	5(4853)	0.5(485)	0.5(485)	97055
Satellite bus stop	33(28089)	15(12768)	35(29792)	4(3405)	8(6809)	4(3404)	0.5(425)	0.5(426)	85120
Gopalan mall-	31(29580)	12(11450)	37(35306)	3(2862)	10(9542)	6(5725)	0.5(477)	0.5(478)	95422
Mysore circle	41(47331)	14(16162)	27(31169)	5(5772)	8(9235)	4(4617)	0.5(577)	0.5(578)	115442



1.7DATA ANALYSIS AND RESULTS

Analysis of the data was done with HDM-IV software version 1.3.8.The data other than traffic and road inventory were kept at the minimum value to exclusively study the effect of traffic and road geometrics with all the other parameters kept minimum or ideal. The analysis of the data was done for a period of 20 years and the discount rate was assumed to be 10% [9]. The alternatives selected for the analysis were 1m widening and 3m widening.

Data assumed

Analysis period=20years
Roughness (IRI) =0.5m/km
Texture depth=0.5mm
Skid resistance=0.4
Distress=nil
Deflection=0.5

Table 3: results of analysis

Section	Benefits for 1m widening(million dollars)	Benefits for 3m widening (million dollars)
RVCE	34.28	4.62
BU	11.01	-1.61
Archade mall	49.66	5.26
Depanjalinagar-	64.27	-31.28
Satellite bus stop	35.08	-16.87
Gopalan mall-	127.78	-62.92
Mysore circle	49.79	-23.92

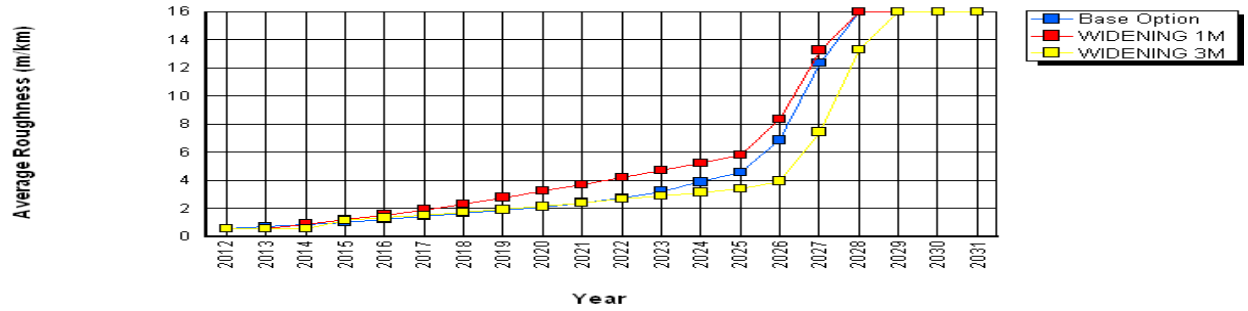


Fig 1: Variation of roughness over the design period under different improvements

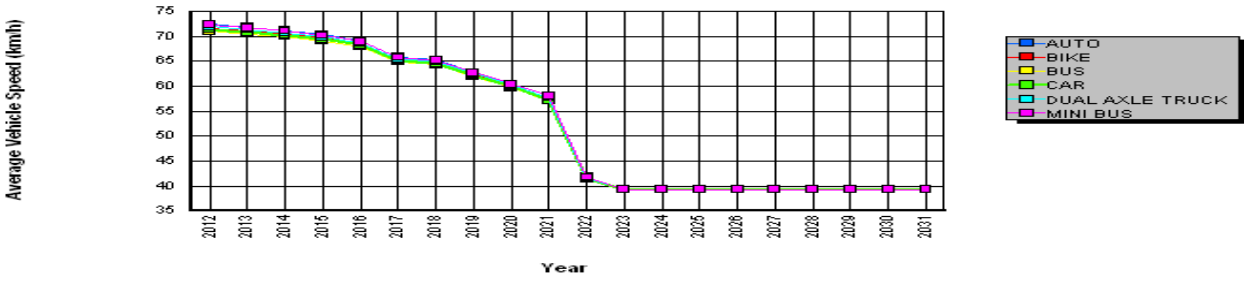


Fig 2: Variation of speed with base case

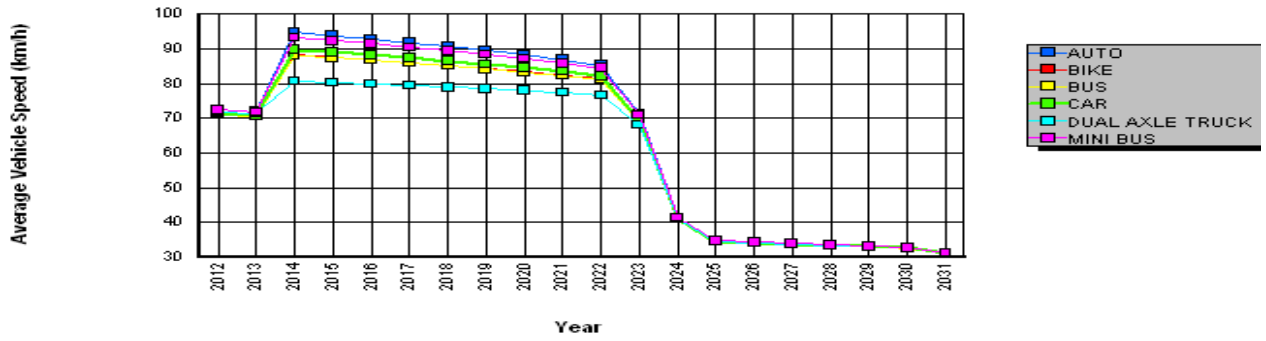


Fig3: Variation of speed with 1m widening

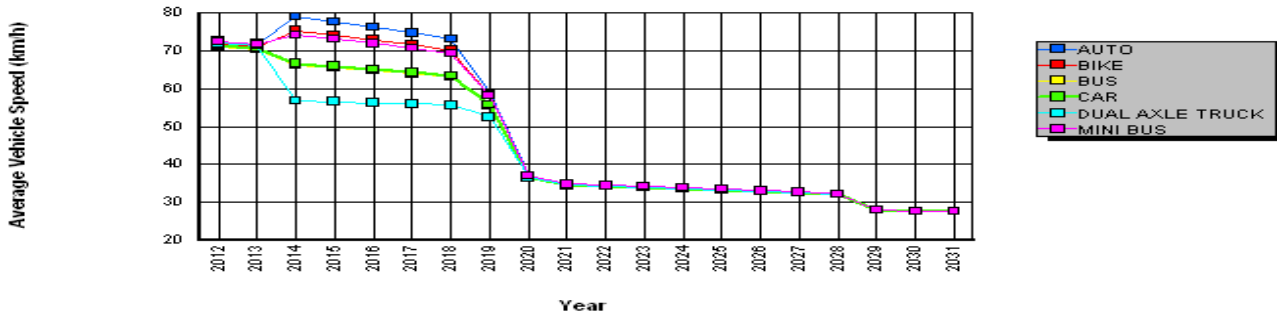


Fig4: Variation of speed with 3m widening

1.8 CONCLUSIONS

The results of the analysis show that the traffic volume alone has a huge impact on the Road user cost and keeping the road user cost alone into consideration also it is very much justifiable that the widening is needed and the benefits could have been even higher if periodic maintenance was undertaken. The benefits are in the amount of crores of rupees per year, if we are not undertaking an improvement the benefits which we would have got otherwise we are turning them into losses. The method that is suggested in the IRC method of economic evaluation does not take in to account the deterioration of the pavement throughout the course of time which is important as and when the pavement gets deteriorated the vehicle operation cost goes on increasing this will result in unrealistic values.

The negative values in table 3 indicate that, suggested improvement is not justifiable at present stage. The reason may be because of the short stretches selected, the cost of construction has proved to be more than the benefits.

References

1. Kadiyali L.R., **Road User Cost Study, Objectives and methodology,** Indian highways, New Delhi, 1979.
2. Swaminathan C.G. and L.L.Kadiyali, **Road User Cost study-** Vol 44-1, journal of Indian roads congress, new Dehli, 1983.
3. **Road User Cost Study**, final report, Central Road Research Institute, New Delhi, 1982.
4. **Manual of Economic Analysis for Highway Projects**, Indian Roads Congress, New Delhi, 1995.
5. **Study for updating Road user Cost Data**, prepared for the min. of Surface

Transportation, L.R. Kadiyali and associates, New Delhi 1992.

6. Reddy, T.S., et al, **Updation of Road user Cost and Revised Software for Evaluation of Highway Projects**, Paper No. 493, Vol 64-2, journal of the Indian Roads congress, New Delhi, 2003.
7. **Report of the study Group on Road Safety**, Ministry of Transport, Govt of India, New Delhi, 1972.
8. Srinivasan N.S., Miss D.V.Hingorani and B.M.Sharma, **Economic cost of Road Accidents**, Journal of the Indian Roads Congress, Vol.36-2, New Delhi, 1975.
9. **Life-Cycle Evaluation of Flexible Pavement Preventive Maintenance**, Samuel Labi and Kumares C. Sinha, *Journal of Transportation Engineering*, Vol. 131, No. 10, October 1, 2005.
10. **HDM-4 Pavement Deterioration Models for Indian National Highway Network**, S. S. Jain, Sanjiv Aggarwal and M. Parida, *Journal of Transportation Engineering*, Vol. 131, No. 8, August 1, 2005

Interlocking stabilized mud blocks with partial replacement of cement and lime

1st Ravikiran L
Department of Civil Engineering
MITMysore
Mandya, India
kiranravi1021@gmail.com

2nd Surabhi KP
Department of Civil Engineering
MITMysore
Mandya, India
surabhiprakash27@gmail.com

3rd Venugopal MK
Department of Civil Engineering
MITMysore
Mandya, India
venugopalgowda1999@gmail.com

***Abstract*-In the present study an effort has been made to meet the economic requirements, to study the effect of altering important variables of stabilizers, to determine the most effective stabilizer for the available soil, to make construction activities easier and quick, interlocking stabilized mud blocks using materials like soil, granite fines, lime and cement and m sand. The present study also suggests that incorporation of granite fines in building blocks as a replacement to fine aggregates and compare favorably with that of conventional used building materials and suggest using granite fines at optimum percentage of replacement of fine aggregates will not only save large quantity of natural sand but will also reduce the pollution created due to the disposal of this granite fines.**

Keywords-Stabilization, Lime, Compressive strength, interlocking, cement, granite fines, Stabilized Mud Block (SMB).

I. INTRODUCTION

Earth is the oldest material used by man. People have used their native ingenuity to develop forms for the utilization of earth ranging from the extremely simple to highly complex methodologies. They have used the material in response to varying resources, social needs and site conditions. With the individual revolution, people had access to machines, easily available fossil fuels and a range of newly developed materials. New technologies became popular and earth construction skills were lost or regulated to the vernacular builder. Impetus was given to earth architecture in the post-world war II era due to economic and energy saving concerns.

However, as western nations worked their way to prosperity, the use of earth was eclipsed by a desire for modernity. Earth has always been the most widely used material for building in India and is apart of its culture. Traditionally, mud construction varies enormously with topography, climatic condition and needs of different regions. The common methods used for earth construction are cob, wattle and daub, rammed earth, and adobe. Approximately 55% of homes in India still use raw earth for walls. Earth is now thought of as a poor man's material because of disadvantages such as high maintenance and low durability.

II. INTERLOCKING BLOCKS

Typically, the construction process and masonry can be tedious, time consuming, and expensive. To overcome the hardships and issues encountered during construction, varied methods of construction is being considered and developed. Simultaneously, materials and equipment used for construction are also being fabricated to enhance the quality of construction and furthermore minimize the time and cost**.** Interlocking blocks is one such advancement in the construction industry.

Interlocking blocks are the enhanced form of conventional clay bricks. Each brick is constructively designed to lock itself to the other bricks around without the use of mortar. The self-locking is achieved using shear-key and lock mechanism. Based on the design, the shape of shear-key will vary and a complimentary lock is provided on the opposite side of brick. Load transfer is achieved by shear transfer and gravity.

Fig .1 Showing the Inter Locking Blocks

III. Role of stabilizers

Stabilization is a process of mixing admixtures with soil to improve its volume stability, strength, permeability and durability. Stabilization is considered to be an important step in the manufacture of CSEBs, and is aimed at improving the performance of a soil as a construction material. Amongst the variety of soil stabilizers used, cement has been the most popular stabilizer in the manufacture of CSEBs.

Lime has been used in stabilizing clayey soils, and has been found to impart long-term strength gain. As lime is known to impart strength in the long term, its utilization in some proportion as a replacement to cement may be beneficial. This paper reports the attempts made to understand the role of lime in combination with cement as a stabilizer in improving the long-term properties of CSEBs, optimize the use of stabilizers and maximize the strength of the blocks. Any effort to optimize the quantity of stabilizers used in combination would help in reducing the cost of the blocks. This work is thus aimed at contributing towards improvising the existing technology of manufacture of unfired earth blocks. This would be a good contribution towards sustainable development.

IV. BENEFITS OF INTER-LOCKING BRICKS

A. *Does not require plaster work*

Plastering can be time consuming and costly in case of conventional wall construction. Plastering of walls can be completely eliminated by using fairfaced bricks of your choice available in the market. If required the walls can be given a smooth finish by applying a thin layer of paint.

Fig 2. Shows No Plasterwork required

B. *Unskilled / Fewer Labours*

In case of Conventional brick laying, skilled labour is required for checking water level, spirit level and various other operations. Therefore a layman or an unskilled labour may find it difficult to learn the conventional methods of construction. Whereas interlocking bricks construction enables an unskilled labour to easily follow up on the construction procedure. It also provides various opportunities for an entrepreneur.

C. *Minimizes cost*

Since there is no use of mortar in the construction process, the cost of buying cement, sand, mortar and stone dust can be neglected. Also the cost for transportation can also be immensely reduced along with the cost on skilled labour. It does not require plasterwork, minor bar bending work, lesser cement and fewer laborers hence contributing to the overall cost reduction of the construction project.

V. MATERIALS USED

Fig-3Showing Materials required for manufacturing of Inter Locking SMB

VI. METHODOLOGY ADOPTED

The process of manufacture of interlocking stabilized mud blocks involves the following five steps:

A. *Soil preparation*

The procurement of raw materials such as soil, cement, lime, granite fines, M sand etc.

B. Mixing of Stabilizers and Moisture

In this the adding of lime mix and water for the soil prepared.

C. Block Preparation

The stabilized mud blocks are prepared in the construction site.

D. Stacking of Blocks

It is the process of proper arrangement of blocks in a orderly manner.

E. *Curing of Blocks*

It involves the curing of blocks for 28 days by gentle sprinkling of water.

VII. RESULTS AND DECISSION

TYPE -1: Lime, Cement, M -Sand, Soil.

Sl No	Materials	Proportions	Avg. compressive strength in N/mm^2		
			7 days	14 days	28 days
1	Lime	5%	2.45	2.97	3.01
2	Cement	10%			
3	M-Sand	25%			
4	Soil	50%			

Table I

TYPE -2: Lime, Granite Fines, Cement, M-Sand, Soil.

Sl No	Materials	Proportions	Avg. compressive strength in N/mm^2		
			7 days	14 days	28 days
1	Lime	5%	2.75	3.10	3.25
2	Granite Fines	5%			
3	Cement	10%			
4	M-Sand	30%			
5	Soil	50%			

Table II

VIII. CONCLUSIONS

Based on detailed Project work carried out, we have drawn the following conclusions:

i. From the table I by using M-sand 25% the average compressive strength obtained is 3.01 N/mm^2 for 28 days.

ii. Hence from the table II using additional granite fines 5% and reducing the M-sand by 5 % we got the average compressive strength as 3.25 N/mm^2 for 28 days.

iii. So by comparing both the results we have concluded that the granite fines have slightly more strength compare to the Type-1 Mix.

iv. The Interlocking SMB made using granite fines is cost effective and have good strength. Plastering process can be avoided on interior and exterior of buildings.

REFERENCES

[1] Lokeshwari M.A., K.S. Jagadish, "Eco-Friendly use of Granite Fines Waste in Building", International Conference on Solid Waste Management, 5IconSWM 2015.

[2] STUDIES ON STABILIZED MUD BLOCK AS A CONSTRUCTION MATERIAL Vinu Prakash**, Amal Raj *, Aravind S*, Basil Mathew*, Sumith V R * ** (Asst. Professor, Department of Geology, Mar Athanasius College of Engineering, Kothamangalam *(Civil Engineering VIII Semester Students, Mar Athanasius College of Engineering, Kothamangalam.

[3] Role of lime with cement in long-term strength of Compressed Stabilized Earth Blocks H.B. Nagaraj a,⇑ , M.V. Sravan a , T.G. Arun a , K.S. Jagadish b a Department of Civil Engineering, BMS College of Engineering, Bull Temple Road, Bangalore 560019, India bDepartment of Civil Engineering, Indian Institute of Science, Bangalore 560012, India Received 20 December 2013; accepted 3 March 2014.

[4] Experimental Study on Behavior of Stabilized Mud Blocks Using Fly ash and Quarry Dust 1Anil Kumar S, 2Chandra S, 3 Sharath. M Y, 4Theertharama N, 5Vasipalli vamsikrishnareddy 1 PG Student, Dept. of Civil Engg., AIT, Chikkamagluru, Karnataka, India 2Assistant Professor, Dept. of Civil Engg.,MIT, Kadakola Mysore, Karnataka, India 3, 4&5PG Students, Dept. of Civil Engg., AIT, Chikkamagluru, Karnataka, India.

[5] Vinu Prakash and the team studied on the title "STUDIES ON STABILIZED MUD BLOCK AS A CONSTRUCTION MATERIAL"-ISSN: 2349-2763 Issue 01, Volume 3 (January 2016).

[6] Kamble Ambarish and team studied on the title "EFFECT OF GRANITE FINES ON STRENGTH OF HOLLOW CONCRETE BLOCKS" - E-ISSN 0976-3945.

[7] Alankrit Chokhani and team made a studied on the title "Properties of Fly Ash Blocks Made from Adobe Mould."- (June 2018) 99(2):321–326.

[8] T. Devadas had studied on the title "Experimental study on replacement of fine aggregate in concrete with dissimilar curing conditions"- Case Studies in Construction Materials 11 (2019) e00245.

BUILDING ASSESSMENT TOOLS-COMPARISION OF GRIHA AND LEED (CASE STUDY)

KAVYA H P[1], DEEPAK A[2], ARUN KUMAR B Y[3]

[1]*Assistant Professor, Department of Civil Engineering, Sapthagiri College of engineering*
#14/5 Chikkasandra, Hesaraghatta main road, Bangalore- 57 India

[1] kavyahp@sapthagiri.edu.in
[2]deepakanjanappa@gmail.com
[3]arunkumar4695@gmail.com

Abstract **– The Green building trend increasing rapidly world wide in recent decades. The idea of green rating of buildings has taken roots in India. This is in line with the global trend in which the rating tools set benchmark for green measures for constructing and using buildings to make them sustainable and to make the building energy efficient. This research paper derives about the tools employed to execute this comparative analysis -GRIHA and LEED rating system by considering a case study. Buildings that need less energy, buildings that breathe, thus was the vision that created GRIHA. LEED represents the U.S Green Building Council's effort to provide a national standard for what constitutes a green building. An extensive analysis of case study pertaining to implementation of applications of rating tools is done in this paper where, future projects can analyze the different parameters to compare between the green building tools. Case study is considered in order to compare the two differetnt rating tools which will provide enhanced certification.**

Keywords – Green Building , GRIHA, LEED, Rating system, Case study

I. INTRODUCTION

Construction industry that has a wide range of technologies in building methodology and its procedures. Due to urbanization and industrialization, concerned towards environment is becoming less in order to construct a buildings of required design without following green concepts that saves our industry and provides a friendly environment through out the life span of the building. Idendifying the importance of sustaintability in construction sectors, leads to provide a good green structures that benefits life of environment. Green building concept not only for environment, it also as energy saving parameter and also provides cost effective construction. In this regard our work aims at identifying and analysing the comparision between the two rating tools for various constraints in green building rating system that can be adopt to provide certification.

Various research authors studied the rating system parameters that are included in construction sectors. Study by[2] Shivaji(2017) gives the observation that we can compare the rating systems based on the points belongs to process of construction.[3] Bhat.R, J.E.M Macwan, D.Bhat (2013)by the study they provided constraints and various building assessment tools that are considered in green rating system.[4] Gayathri sacin vyas (2016), has done a study on different design aspects of green building attributes that will be providing design criteria in this paper.[5]Indian green building council manual(2015) is refered in order to study the standards regarding the certification for the green building.[6] Iliyas(2015)analysed the different aspects of comparision for both GRIHA and LEED. The case study has been selected based on the green building concepts that are providing major criteria to obtained the ratings. Shairu Gems Diamonds is selected for the study of rating tools that are in green system of building. This research provides the differencing among the rating systems in which the building can undergo green certification.

II. GREEN BUILDING CONCEPT

The word "green" determines the environmental friendly aspects that provide better life regarding future benefits by using eco-advantages materials for the requirement. Green Building concept defines the parameters that are considered to get green structure as it should be "energy efficient that decreases the usage of energy, reduction in the impact of building on human health and also environment by proper site planning, using locally available materials, construction operation and its maintenance. The process of green building construction involves various steps to follow to in order to complete the green structure. Major techniques to adopt in green

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construction is to ensure the green design process to establish the firm goals to reach environmental aspects like energy efficiency, conservation of water, material procurement and resource management, waste recycling that is to reuse the construction waste to manage for other productivity. This includes initially higher cost but leads to higher rate of return on assets and other benefits.

III. GREEN RATING SYSTEM

Rating system involves evaluation of various aspects that are considered during the green building construction. It involves the measure of environmental performance of a building throughout its life cycle. Usually the green building evaluation is done as per standard criteria parameters related to design, construction and operational procedures of a green building. Few green building tools considered for the evaluation. This paper provides a information about two green assessment tool explained below.

GRIHA

The national green building rating system, Green Rating for Integrated Habitat Assessment was developed by TERI after a thorough study and understanding of the current internationally accepted green building rating systems and the prevailing building practices in India. The rating system was developed by the Centre for Research on Sustainable Building Science (CRSBS), TERI. CRCBS has been set up in TERI to facilitate development and mainstreaming of sustainable buildings, to improve performance levels of existing buildings, and raise awareness on sustainable buildings. The primary objective of the rating system is to help design green buildings and, in turn, help evaluate the 'greenness 'of buildings. The rating system follows best practices along with national/international codes that are applicable to the green design of buildings.

OPERATIONALIZATION OF GRIHA- THE NATIONAL RATING SYSTEM

A NAC (National Advisory Council) has been constituted by the MNRE and is convened by the Advisor of the Ministry. It comprises eminent architects, senior government officials from the Central Ministry, the BEE, the Central Public Works Department, and select state nodal agencies; representatives from the IT sector, real estate sector and developers; and representatives from ADARSH (GRIHA secretariat) and TERI. NAC is chaired by the Secretary, MNRE , and co-chaired by the Dr R K Pachauri, Director –General , TERI.

activities and to assign the people for their respective goal achievement in the firm to allocate the work that is to be done. By adopting green building concept we have certain benefits to achieve like cost minimization by reduced

Certification of GRIHA has some important steps to follow in green structures-"registration, submission of drawings and other documents as required to council, assessment/review as per GRIHA, feedback to project team, site visit and due diligence check post construction, evaluation of project by evaluator, award of rating", so that the project can obtained with green ratings as per the process of evaluation.

Table 1. Certification level of GRIHA rating system

% Points scored	Rating
50-60	One star
61-70	Two stars
71-80	Three stars
81-90	Four stars
91-100	Five stars

This process of providing the rating system followed by different categories of criteria which carries indivisual points based on the documents submitted by the building operators organization.

LEED

Rating tool under U S Green Building Council, Leadership in Energy and Environmental Design developed in 1998. This rating tool is widely used in green building rating system. LEED based on various environmental and building criterions that has to be satisfied by the building parameters to obtain the rating. The LEED was adapted by Indian Green building Council and provides the rating procedures as per Indian building consequences. This latest version of the rating system is called the LEED 2011 for India-New Construction and Major Renovations, or 'LEED 2011 for India-NC. Since the CII-Godrej GBC achieved the prestigious LEED rating for its own centre at Hyderabad in 2003.

Tab 2.Credit Point thresholds for different levels of certification

Certified	40-49 points
Silver	50-59 points
Gold	60-79 points
Platinum	80 points and above

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LEED certification process undergoes various steps so that each building willing to get certified has to provide the documents which is required to council of green rating. The process includes-online project registration, project team submits the preliminary documents to LEED committee, review by third party assessor, submission of final documents to committee, site visits by LEED team, final review and award of rating, acceptance of rating by the project team, leed presents plaque & certification indicating certification level.0158

IV. CASE STUDY

The research paper includes analysis of green rating systems that are rated for a green building Shairu Gems Diamonds, Surat, Gujarat. The building is rated with LEED gold ratings by satisfying all the criterions related to LEED rating system council. Project defines its environmental aspects and also energy saving materials that are efficient to energy, by procuring locally available materials for construction activities carried out in the project.

V. METHODOLOGY

By analyzing various aspects of green certification, studying its application into the building research has made with information regarding case study. The building is analysed the parameters of GRIHA and LEED criterions with respect to the points awarded for the particular category of work that is done in the building.

GRIHA- Green building rating tool that gives more importance for the various criterions percentage that are adopted to certification as follows[1]: Sustainable site planning (21.2%),health&wellbeing(11.5%),Buildingplanning&construction(11.6%),Energy end use(36.5%), energy renewable(7.7%), recycle(6.7%), recharge &reuse of water(4.8%).

LEED- This tools gives major role of green certifications in the aspects of percentage as follows[1]:Sustainablesites(23.63%),Waterefficiency(9.1%),Materials&Resources(12.73%),Energyand Atmosphere(31.82%), Indoor Environmental Quality(13.63%), Innovation in Design(5.45%), Regional Priority(3.64%).

By analyzing all the above parameters of the building that has to be present in documents for its certification this study gives the best rating rating pertaining to the case study that is selected. Since the shairu gems building already rated with leed certification this will provide the comparision of GRIHA rating system tool.

VI. COMPARATIVE ANALYSIS FOR THE CASE STUDY

GRIHA: Referring to the Fig.1 it is evident that the maximum weightage is provided to the energy efficiency criterion whereas there is no weightage given to transportation. It also considers various other criteria such as sustainable site, transportation, materials and indoor environmental quality.

LEED-India: From the Fig.1 we can analyse, maximum weightage is given to energy efficiency and there is very less or no weightage given to health and well-being. LEED India has given weightage to regional priority which makes it unique from the other two building assessment tools. It also considers other aspects such as sustainable site, transportation, materials and and indoor environmental quality.

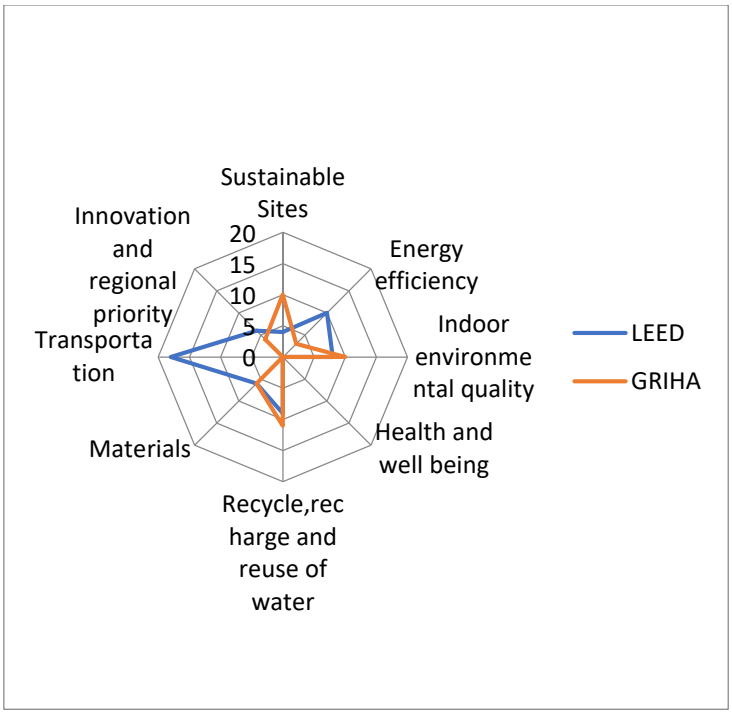

Fig.1 Pictorial representation of weightage given to different criteria by different rating tools

As per the above study, the building considered for this research provides with all the aspects of green rating system.

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- LEED-India has given the maximum weightage for the energy efficiency criterion than compared to GRIHA and IGBC.
- GRIHA has provided maximum weightage to sustainable site criterion as compared to LEED- India and IGBC.
- LEED-India has given the maximum weightage to innovation and regional priority criterion when compared to GRIHA and IGBC.
- LEED-India provides the maximum weightage to alternative transportation criterion whereas GRIHA has not considered alternative transportation and IGBC has provided only limited weightage to alternative transportation
- GRIHA has provided the maximum weightage to material efficiency when compared to LEED–India and IGBC.
- IGBC has provided the maximum weightage to water efficiency compared to LEED–India and GRIHA.
- GRIHA has provided the maximum weightage to health and wellbeing. LEED – India has not considered health and wellbeing for evaluation.
- LEED–India has provided the maximum weightage to IEQ (Indoor Environmental Quality) when compared to GRIHA and IGBC.

VII. RESULTS AND DISCUSSIONS

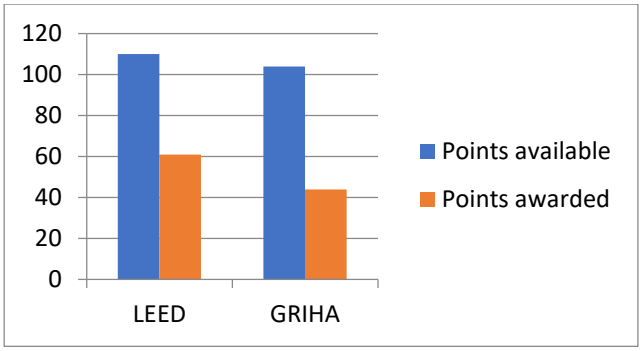

Fig.2 Graphical comparision of green rating points

Building Assessment tool	Points available	Points awarded
LEED	110	61
GRIHA	104	44

Tab 3-Comparasion of GRIHA and LEED points

From the above Fig.2 and Tab 3, a LEED Gold rated building was awarded 61 points out of 110 points. The same building when assessed with GRIHA failed to attempt an equivalent rating. When assessed with GRIHA the building achieved 44 points out of 104 points fetching a 2-star rating. It is clearly observed that the two building assessment tools considered for analysis seems to be inconsistent in some of the criteria.

VIII. CONCLUSION

The construction sector poses a major challenge to the environment. Globally, buildings are responsible for atleast 40% of energy use. An estimated 42% of the global water consumption and 50% of the global consumption of raw materials is consumed by buildings when taking into account the manufacture, construction, and operational period of buildings. In addition, building activities contribute an estimated 50% of the world's air pollution, 42% of its green house gases, 50% of all water pollution, 48% of all solid waste and 50% of all CFC's (Chlorofluorocarbons) to the environment. By considering a case study we could analyse the aspects of green building. There are many factors which has to be considered while constructing a green building. It is necessary to know how effective a particular project is in term of its sustainable development. This brief comparison would check the building on various points to give a fair idea of where it stands in being a green building. All the rating tools are good enough to possess the certification for the green building.

REFERENCES

[1] Laxman Jadhav et al:*Comparative study of LEED, BREEAM and GRIHA Rating System*, International Journal on Research & technology, Vol.8,2019.

[2] Shivaji, et al:*Assessment of GRIHA and LEED on the parameters of sustainable design and development of building*, International conference on research into design 2017, vol :2.

[3] Bhat.R, J.E.M Macwan, D.Bhat: *Sustainable Building Assessment Tool*, J.Inst.Eng.India Ser.12-Nov-2013. Pp:250-270.

[4]Gayathri Sachin Vyas et al.: *Identification of Green Building Attributes for the development of an Assessment tool:A case study in India*, Civil Engineering and Environmental systems, 33:4,313-334.

[5] *Indian Green Building Councils Green New Building rating system*, version 03, Abridged Reference guide, August 2015.

[6]Iliyas I S, et al: *Comparative study of LEED and GRIHA Rating system*,,Journal of Information, Knowledge and Research in Civil Engineering, vol-3, pg 168-174.

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ANALYSIS OF PROPERTIES OF SELF-COMPACTING CONCRETE UNDER VARIOUS TEST CONDITIONS

Pallavi G A[1], Geetha T S[2], Suma N G[3], Navya N[4]

Department of Civil Engineering, Sapthagiri College of engineering
#14/5 Chikkasandra, Hesaraghatta main road, Bangalore- 57 India

[1]pallaviga@sapthagiri.edu.in
[2]geethats@sapthagiri.edu.in
[3]sumang@sapthagiri.edu.in
[4]navyan@sapthagiri.edu.in

Abstract* – *Construction is one of the rapidly evolving industries all over the world. Out of all these materials concrete is the mainly and broadly used construction material in the world. The development of Self compacting concrete (SCC) has contributed to a mounting degree of architectural autonomy to carry out more complicated and sophisticated construction geometries, considering the various uses in structures SCC have been widely utilized in different countries. In this paper analysis of SCC is carried out under various test conditions and results shows that, in comparison with zero thermal cycles, there is a decrease in strength (compressive & tensile) values with increase in thermal cycles @ 150°C & 200°C for both 7 & 28 days cured SCC specimens of all 4 mix proportions.

Keywords – Concrete, Casting, Super plasticizer, furnace slag, Micro cement

Keywords – Concrete, Durability, Bacterial species

I. INTRODUCTION

Concrete is most common material used for all type construction due to its durability, concrete become inevitable. Construction is one of the rapidly evolving industries all over the world. There is constant need to adopt in this rapidly evolving industry. Construction materials play a crucial role in making construction activities more effective and efficient. Concrete has to compete with other construction materials such as steel, plastic and wood, when it comes to economy, productivity and quality.

However, there is a limit to the fluid behaviour of normal fresh concrete. Improper compaction of concrete may lead to creation of voids and affect the durability of concrete. Thus to have a proper compaction without affecting the strength and durability of concrete which compacts itself by its own weight is used.

To observe the actions of SCC compressive test were conceded out. Obtained result indicates this method could produce lucratively high quality of self-compacting concrete. it became evident that SCC provided many other additional benefits, irrespective of the skill of the construction worker. Self-Consolidating concrete and High Performance Concrete are the development made referring SCC which can pour easily in all directions under its self-weight. There will be no reduction in the uniformity of concrete and loss of coarse aggregates from the concrete while placing and flow.

The compulsion of this type of concrete was proposed by Okamura in 1986. Professor **Ozowa of Japan (*Ozowa et al., 1989)*** introduced the term ‘Self-compacting concrete’ (SCC) and then developed it at the University of Tokyo and after that it was developed by **Okamura and Ouchi *(Okamura and Ouchi, 2003).***

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The concept of SCC was to revolutionize concrete technology and open up new horizons in the concrete applications that were unthinkable before. SCC was very different from normal concrete and was characterized by its ability to flow freely under its own weight with the absence of segregation and bleeding or the requirement for compaction the development of SCC carried out by is referred to as Japanese Method.

Advantages Of Self-Compacting Concrete

- Saving the cost of workers and time.
- Compaction requirement.
- Sound Pollution is less.
- Where access to allow vibration is impossible.
- Complicated form works with very congested reinforcement.

Limitations

- Considering the provided cost of SCC the cost is more than work and quality of production of concrete two or three times greater. Such a high premium has some inadequate use of SCC function to universal construction. SCC is precised only to areas where in the majority desired. These include places where access to conventional vibration is not easy, or where there are crammed reinforcements.
- SCC should be of easy flow but should avoid Segregation or bleeding which is a key complexity in the growth of SCC. Cement mortar should have enough viscosity to make sure of flow including maintenance of settling of bigger aggregates.

- A concept of merging the SCC with normal concrete inside the member of identical structure to reduce the construction cost. This concept is frequently applicable to bulky elements, where packed reinforcements occur only in inadequate areas of structural member. These could include foundation and post-tensioned elements.

An SCC mix must follow the mentioned requirements:

- Non Segregation- When the concrete flows the coarse aggregates should stay without segregation.
- Non Bleeding- No rise of water in the mix to its top.
- Vibration- No vibration is required during placement.
- Flow spreads- 18 inch dia or greater should be achieved.

Properties may change due to temperatures ranging from 100°C to 300°C. At early stages of heating the evaporable water from concrete is gone over in the range of 20°C to 110°C. As the cement paste is exposed to increasing temperature, the effects that can takes place are, explosion of evaporable water (100˚C), and at this temperature level concrete is normally considered healthy. At early stages internal vapour, decomposition, and interface cracking cause diminish in the strength of concrete structure. Cement paste shrinkage will take place due to dehydration because of elevated temperatures. Expansion of cement paste occurs due to temperatures vary from room temperature to 150°C and it shrinks by increase in temperature from 150° to 300°C. From 300˚C, micro crakes are induced and parts of concrete structure get a pink color. Above 300˚C there is rejecting in mechanical distinctiveness.

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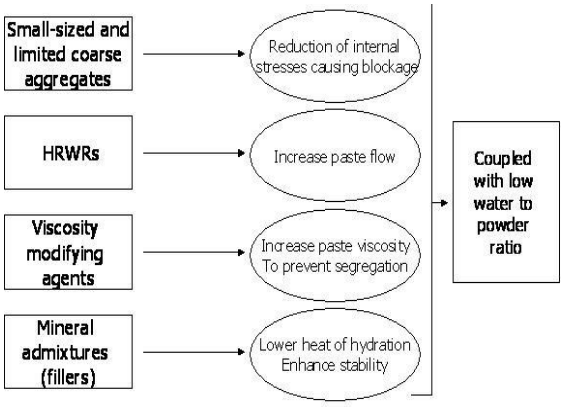

Fig 1: Basic Principles of SCC

II-Basic Principles and Requirements Of SCC

In SCC as it fills the voids and pores in the congested structural reinforced members the level of concrete is maintained straight. In reference with composition the materials present on concrete are same as normal concrete with presence of admixtures (fly ash, Micro cement, GGBS, Glenium B233, etc.) in altered proportions. Superplasticizers, which is also called as high water reducing agent. Mineral admixtures are used as an additional fine material, in addition with cement, and in some cases, they replace cement.

III-MEASUREMENTS OF PROPERTIES

The specimens are removed from the tank after the sufficient period of curing and make them dry for some time. The specimens of each mix are kept in oven and heated in altered temperatures i.e., 150°C and 200°C in an electric oven. In the experiment for first three hours the temperature is varied at a rate of 50°C per hour and for 200°C for first two hours it is varied at the rate of 50°C and for third hour it is varied at 100°C and the temperature should be constant up to 8 hours and 8 hours of cooling. For achieving steady thermal state, the temperature is maintained uniformly to 1 hour just before cooling. In the room temperature itself the specimens should allow to cool. .The weight of the each specimen should be taken to examine the SCC mechanical properties changes. Compressive strength, splitting tensile strength and mass loss were determined at the age of 7 days and 28 days.

III-A Compressive Strength

All the specimens i.e., cubes of size 150 mm of different mixes like Mix 1(100% cement), Mix2(70%C+15%Flyash+15%GGBS),Mix3(90%C +10%Allcofine)&Mix4(70%C+10%GGBS+10%Fly ash+10%Allcofine) were tested in an automated CTM as shown in Fig. 2 to 5. A formula is used for calculation of compressive strength

$C_s = P / A$

C_s=Compressive strength (N/mm²)

A= C/s area of cube (mm²)

P = Load (N)

Fig 2 Compressive strength of Mix 1

Fig 3 Compressive strength of Mix 2

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Fig 4 Compressive strength of Mix 3

Fig 5 Compressive strength of Mix 4

III-B-Split Tensile Strength

Splitting tensile strength test is a well-known indirect method used for determining the tensile strength of concrete. This test consists of applying compressive line loads along the opposite sides of a

concrete cylinder placed with its axis in a horizontal position, as shown in Fig 6. Because of practical loading in line a consistent tensile stress is introduced over the diameter which loading should be done at two third of it gained from the examining the flexibility. The tensile strength is calculated by a formula given below:

Ts= 2P/ πDL, Ts= Tensile strength (N/mm²)

P= Load (N)

D= Diameter of cylinder (mm)

L= Length of cylinder (mm)

Fig 6 Splitting tensile strength test

IV- Material Properties

IV-A Cement

Ordinary Portland cement is utilized for every concrete mixes of 43 grades. There should not be any lumps and should be bright in color. Cement tests is done as per *BIS: 8112-1989.* The table1 given represents physical properties.

Physical Property	**Value**	**Specifications *(BIS: 8112-1989)***
Fineness retained on 90-µm sieve (%)	1.0	10 mm
Standard Consistency (%)	30	-
Initial setting time (minutes)	65	30 min
Final setting time (minutes)	215	600 max
Specific gravity	3.12	3.15
Soundness(mm)	2.50	10 max

Table 1: Physical properties of Cement

IV-B Coarse Aggregates

Locally existing coarse aggregates having the highest size of 10 mm were used in the current work. Aggregates used are sieved through 10 mm sieve. Then washed to eliminate dust & dirt & dried to the saturated face dry surface condition. Indian

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Standard Specifications *BIS: 383-1970* is used to select the aggregates. The results of various tests conducted on coarse aggregates are tabulated in Tables 2 & Table 3, respectively.

Properties	Value
pH	8.0
Dissolved Solids(mg/l)	290
Suspended Solids	Nil
Chlorides (mg/l)	20
Sulphates (mg/l)	74
MPN Value/100ml	Nil

Table 2 : Properties of coarse aggregates

Sieve No. (mm)	Percentage Retained (%)	Percentage Passing (%)	Cumulative %age Retained
80	0.00	100	0.00
40	0.00	100	0.00
20	0 .00	100	0.00
12.50	18.5	81.5	18.5
10	29.68	51.82	48.18
4.75	31.88	19.94	80.06
Pan	19.90	0.04	99.96
Fineness modulus of coarse aggregates (10 mm) = (ΣC+500)/100 = (146.74+500)/ 100=6.46. (ΣC=146.74)			

Table 3: Sieve analysis of coarse aggregates

IV-C Water

Potable tap water was used for casting and for curing of concrete specimens conforming to the requirements of *BIS: 456-2000.* Properties of water are given in Table 4.

Characteristics	**Value**
Type	Crushed
Maximum size (mm)	10
Specific gravity	2.66
Water absorption (%)	0.90
Moisture content (%)	0.806
Fineness modulus	6.46

Table 4: Properties of water

IV-D GGBS

GGBS (Ground Granulated Blast Furnace Slag) is manufactured from blast furnace slag, a consequence from the production of iron. GGBS plays an important role in High performance concrete as binder.

Characteristics	**Value**
Colour	Off-white Powder
Bulk density(loose)	1000-1100 kg/m³
Bulk density(vibrated)	1200-1300 kg/m³
Relative density	2.85-2.95
Surface area	400-600 m²/kg

Table 5 Physical properties of GGBS

Chemical constituents	**% by Weight**
CaO	40
SiO2	35
Al2O3	10
MgO	8

Table 6: Chemical properties of GGBS

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II. EXPERIMENTAL METHODS & TESTS

This Stage discussed with the experimental procedure, methodology adopted for mix proportioning of various SCC mixes, procedure adopted for thermal cycles and micro structural behaviour of SCC.

For the mix proportions given in Table, necessary quantities of materials were weighed. While batching, mixing and casting the specimens precautions were taken. The mixing procedure adopted was as follows:

- Ordinary Portland Cement (OPC) having 43 grades was used for casting.
- The coarse aggregates and fine aggregates were then weighed with an accuracy of 0.5 grams and then mixed with condition of saturated surface dry condition.
- All the ingredients were then mixed together thoroughly, until a homogeneous mix obtained. The concrete mix was prepared with the help of mixer or can be done with hand mixing.

The fresh concrete was tested for its rheological properties. Once various criteria of self-compatibility were satisfied, final casting of the mix was done immediately. All the specimens were prepared in accordance with Indian Standard Specifications *IS: 516-1959.* After casting, test specimens were allowed to stay in the steel mould and left in the casting room for 25-30 hours at ambient condition. Specimens were demoulded after 30 hours with be concerned so that no ends were broken. After it is placed into the water-curing tank at the natural temperature for curing until the time for the experiment or as per condition for the test. The natural temperature for curing was 27 ± 1°C. Table 7 gives the various properties studied with sizes of specimens and the days of testing. Besides measuring the fresh properties (workability, temperature of concrete, and air content) hardened concretes were tested on various properties given in Table 7.

Property	Size of specimens	Days of testing
Compressive strength	150mm×150mm×150mm size cubes (*BIS 516-1959*)	7 days and 28 days
Splitting tensile strength	150mm×300mm size cylinder (*BIS 516-1968*)	7 days and 28 days

Table 7 : Various properties with size of specimens and days of testing

V-A Mixes

Totally 4 mixes were prepared were carried out by varying mineral admixtures such as Fly ash, GGBS and Micro cement.

- Mix 1: 100% Cement
- Mix 2: 70%Cement+15%GGBS+15%Fly ash
- Mix 3: 90%Cement+10% Micro cement
- Mix 4: 70%Cement+10% Fly ash+10%GGBS+10%Micro cement

V-B MIX DESIGN

Mix design is a progression of selecting appropriate ingredients for concrete and determining their proportions which would create, as inexpensively as probable, a concrete that satisfy the job requirements. The proportioning of the ingredients of concrete is an important phase of concrete technology as it ensures quality and economy. Since self-compactibility is largely affected by the description of materials and the mix proportions, it becomes necessary to evolve a procedure for mix design of SCC. *Nan Su (2001)* have proposed a mix proportioning system for SCC which is based on the Japanese concept. In this method the amount of

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aggregates required is determined, and the paste of binders is then crammed into the voids of aggregates to ensure that the concrete thus obtained has flowability, self-compacting ability and other required SCC properties. The amount of aggregates, binders and mixing water, as well as category and dosage of superplasticizer (SP) to be used are the major factors influencing the properties of SCC. The Mix Design procedure is as follows,

Step 1: Calculation of fine aggregate & coarse aggregate

The contents of Fine aggregate and coarse aggregate are calculated from equations 1 & 2,

$$W_{fa} = PF \times W_{fal} \times \left(\frac{S}{a}\right) \quad (1)$$

$$W_{ca} = PF \times W_{cal} \times \left(1 - \frac{s}{a}\right) \quad (2)$$

W_{ca}= Content of coarse aggregate in SCC (kg/m³)

W_{fa}= Content of fine aggregate in SCC (kg/m³)

W_{cal}= unit volume mass of loosely compacted coarse aggregates surface dry condition

W_{fal}= unit volume mass of loosely compacted fine aggregates surface dry condition

PF = Packing factor

$\frac{S}{a}$ = volume ratio of fine aggregates to sum of all aggregates

Step 2: Calculation of cement content

$$C = c\left(\frac{f'_c}{20}\right)$$

C= cement content

C= co-efficient factor

f'_c= designed compressive strength (psi)

Step 3: Calculation of mixing water content

$$W_{wc} = \left(\frac{W}{C}\right) C$$

W_{wc}= content of mixing water (kg/m³)

$\frac{w}{c}$= water/cement ratio

C= cement content

Step 4: Calculation of filler contents

$$V_{pf} = 1 - \left(\frac{C}{1000 \times G_c}\right) - \left(\frac{W_{fa}}{1000 \times G_{fa}}\right) - \left(\frac{W_{ca}}{1000 \times G_{ca}}\right) - \left(\frac{W_{wc}}{1000 \times G_w}\right) - V_a$$

V_{pf}= Volume of filler paste

G_c = Specific gravity of cement

W_{fa} = Bulk density of fine aggregates (kg/m³)

G_{fa} = Specific gravity of fine aggregates

W_{ca} = Bulk density of coarse aggregates (kg/m³)

G_{ca} = Specific gravity of coarse aggregates

W_{wc}=Bulk density of water

G_w = Specific gravity of water

V_a = % of Superplasticizer

Amount of filler required

$$W_f = \frac{V_{pf} \times 1000 \times G_f}{1 + \left(\frac{W}{p}\right) \times G_f}$$

Wf – mass of filler

Va – % of air content

w/p – water powder ratio

Gf – Sp. gravity of filler content

Step 5: Calculation of water required for SCC

$$W_W = \left(1 + \frac{W_f}{p}\right)\left(\frac{W}{C}\right)C + \left(\frac{W}{F}\right)W_f$$

W_W = Water content

P = total powder content (cement + filler)

Total water content W = W_W+ W_{wc}

Step 6: Mix Proportions

Total amount quantity of materials required per m³

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V Results and discussion

V-A-Compressive strength test

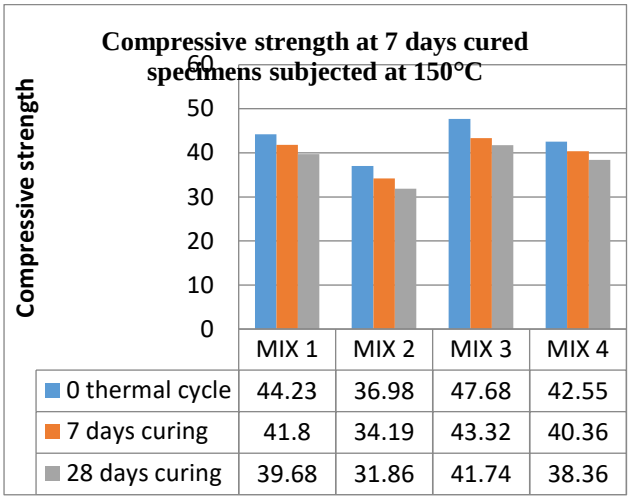

Fig 7: Graphical representation of Compressive strength at 7 days cured specimen subjected to temperature of 150°C

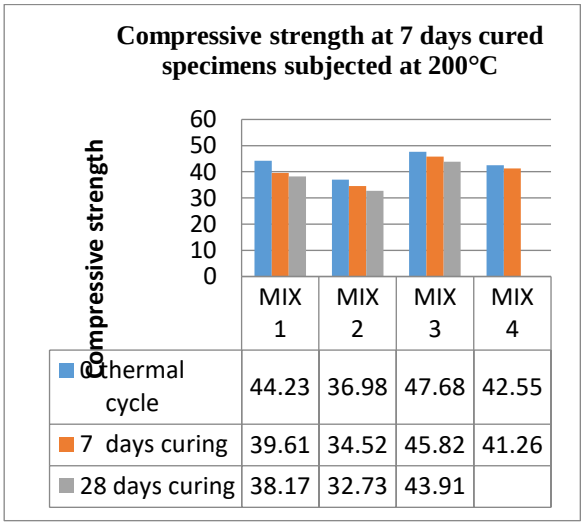

Fig 8: Graphical representation of Compressive strength at 7 days cured specimen subjected to temperature of 200°C

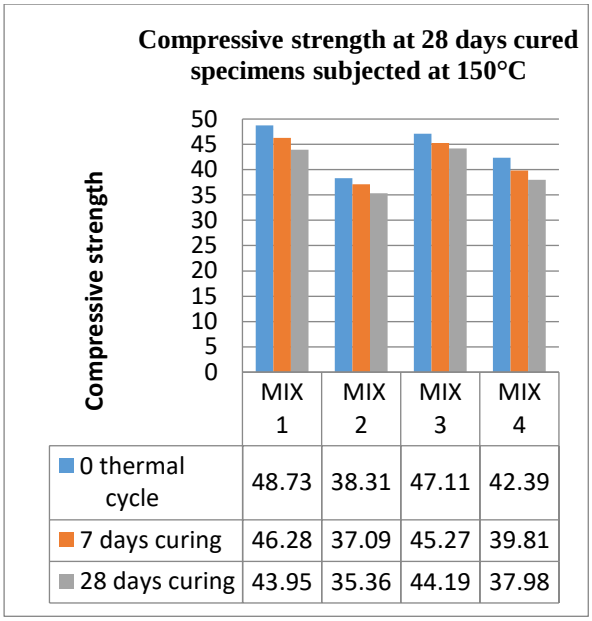

Fig 9 : Graphical representation of Compressive strength at 28 days cured specimen subjected to temperature of 150°C

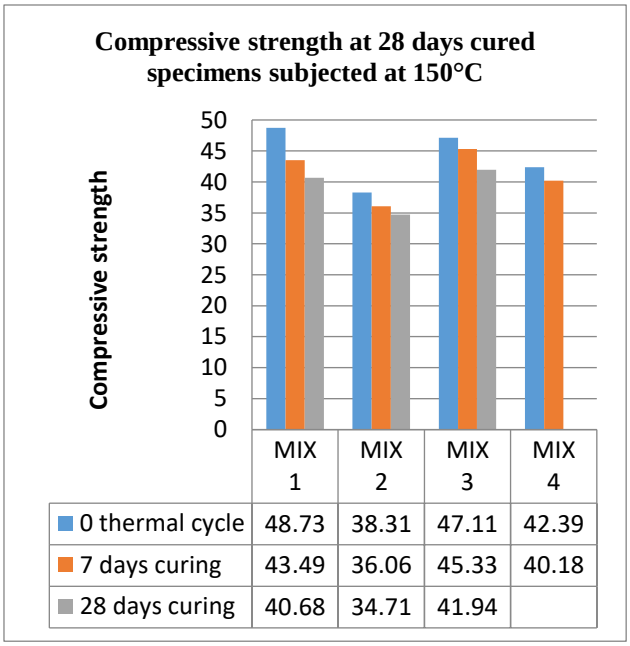

Fig 10 : Graphical representation of Compressive strength at 28 days cured specimen subjected to temperature of 200°C

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V-B Tensile strength test

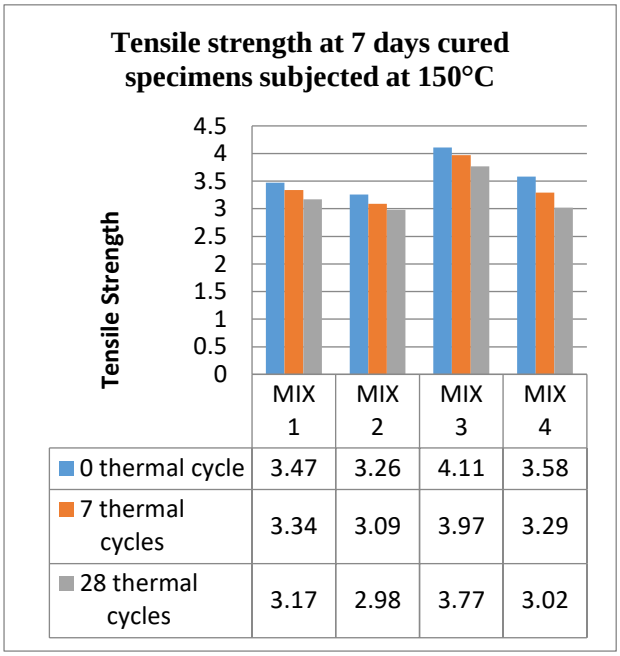

Fig 11: Graphical representation of Tensile strength at 7 days cured specimen subjected to temperature of 150°C

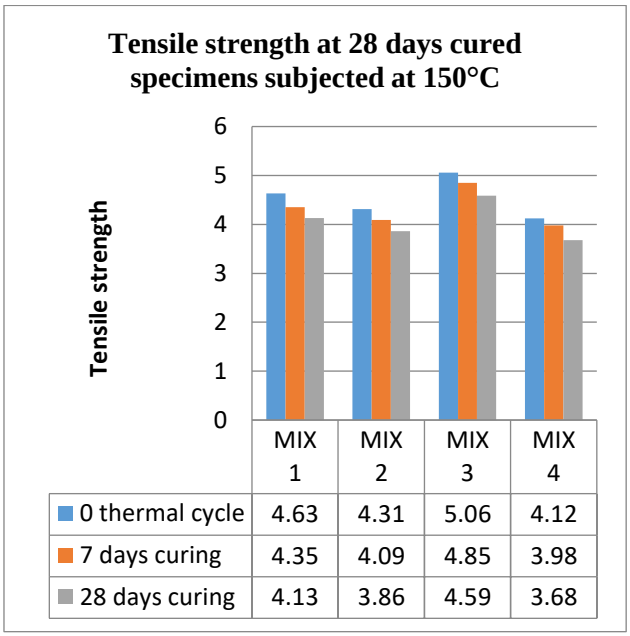

Fig 13: Graphical representation of Tensile strength at 28 days cured specimen subjected to temperature of 150°C

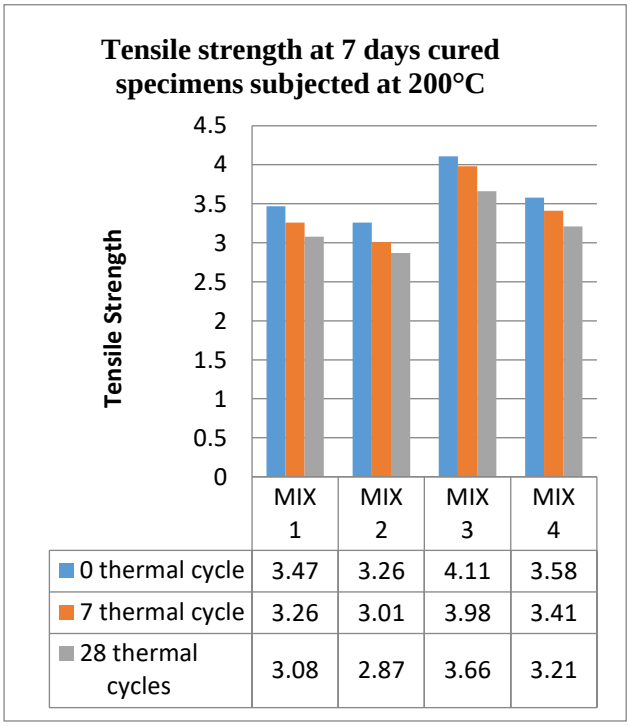

Fig 12 Graphical representation of Tensile strength at 7 days cured specimen subjected to temperature of 200°C

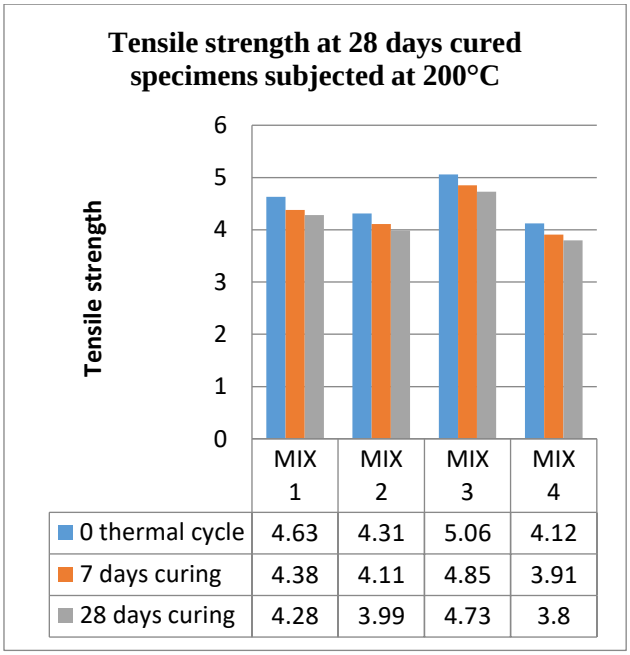

Fig 14 Graphical representation of Tensile strength at 28 days cured specimen subjected to temperature of 200°C

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VII. CONCLUSION

Conclusions can be given after experimental study as

- Nan-Su method is used for the mix Design which helps in reducing the trials and makes it simple to achieve SCC.
- All the Mix proportions developed satisfied the requirements of SCC specified by EFFNARC.
- It is observed that, in comparison with zero thermal cycles, there is a decrease in strength (compressive & tensile) values with increase in thermal cycles @ 150°C & 200°C for both 7 & 28 days cured SCC specimens of all 4 mix proportions.
- The SEM images for mix-1, specimens subjected to 7 & 28 thermal cycles @ 150°C & 200°C shows the presence of un hydrated cement particles.

- The SEM images for mix-2, @ 150°C & 200°C temperature for the specimens subjected to 7 thermal cycles shows scattered CSH gel, bright spot which indicates presence of un hydrated cement particles, the image also shows ball like structure which is fly ash in the concrete mix and In case of specimens subjected to 28 thermal cycles shows the excess formation of Ettringite with the reduction of CSH gel. Hence both compressive and tensile strength of the specimens reduced considerably.

- The SEM images for mix-3, specimens subjected to 7 & 28 thermal cycles @ 150°C & 200°C shows the presence of unhydrated cement particles together with CSH gel and sparsely distributed pores.

- The SEM images for mix-4, specimens subjected to 7 & 28 thermal cycles @ 150°C & 200°C shows the formation of dense CSH gel with very small amount of Ettringite and presence of pores.

REFRENCES

[1] Anand, N., Prince, A. G. (2011). The effect of elevated temperature on concrete materials-A literature review. International Journal of Civil and Structural Engineering, Vol-1, No.4, pp.928-938.

[2] Bilodeau, A., Malhotra, V.M. (2000). High volume fly ash system: Concrete solution for sustainable development. ACI Material Journal, Vol.-97,No.1, pp.41-48.

[3] EFNARC-2005. European guidelines for self-compacting concrete,specification, production and use.

[4] EFNARC Guidelines, "Requirements of Self Compacting Concrete", Published On 2002.

[5] Khayat, K.H. (1999). Workability, testing and performance of self-compacting concrete. ACI Material Journal, Vol.96, No.3, pp 346-353.

[6] Mehta, P.K (1999). Concrete technology for sustainable development. Concrete International, Vol.-21, No.11, pp.61-66.

[7] Nan Su, Kung-Chung Hsu, His-Wen Chai (2001) A simple mix design method for self-compacting concrete.

[8] Okamura, H., Ozawa, K. (1995). Mix design for self-compacting concrete. Concrete Library of Japanese Society of Civil Engineers, Vol.25, No.6, pp.107-120.

[9] Okamura, H., Ouchi, M. (2003). Self-compacting concrete. Journal of Advanced Concrete Technology, Vol.1, No.1, pp. 5-15.

[10] **Ozawa, K., Maekawa, K., Kunishima, M., Okamura, H. (1989).** Development of high performance concrete based on the durability design of concrete structures. Proceedings of the Second East-Asia Pacific Conference on Structural Engineering Construction (EASEC-2), Vol.1, No.1, pp.445-450.

[11] Ouchi, M., Nakamura, S., Osterberg, T.H., Hallberg, S., Lwin, M. (2006). Applications of self-compacting concrete in Japan, Europe and United States. Bridge Technology, pp.1-18.

[12] Shi, C., Yanzhong, W. (2005). Mixture proportioning and properties of self-consolidating light weight concrete containing glass powder. ACI materials Journal, Vol.102, No.5, pp. 355-363.

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STUDY ON STRENGTH OF SELF HEALING BACTERIAL CONCRETE

Suma N G[1], Navya N[2], Pallavi G A[3], Geetha T S[4],

Department of Civil Engineering, Sapthagiri College of engineering

#14/5 Chikkasandra, Hesaraghatta main road, Bangalore- 57 India

[1]sumang@sapthagiri.edu.i
[2]navyan@sapthagiri.edu.in
[3]pallaviga@sapthagiri.edu.in
[4]geethats@sapthagiri.edu.in

Abstract -

Durability of concrete is highly affected due to cracks and it leads corrosion of reinforcing bars. In concrete structures, repair of cracks usually involves applying a cement slurry or mortar which is bonded to the damage surface repairs can particularly be time consuming and expensive. In this study Bacterially induced calcium carbonate precipitation has been proposed as an alternative and environmental friendly crack repair technique. In our study bacterial species bacillus subtilis is used to improve the strength of concrete. Researchers have shown that the microbiologically induced endosperm forming bacteria is able heal cracks effectively.

Keywords – Concrete, Durability, Bacterial species

I. INTRODUCTION

Concrete is most common material used for all type construction due to its durability, concrete become inevitable. The only defect in use of concrete is that this is weak in tension Durability of concrete is highly affected due to cracks and it leads corrosion of reinforcing bars, so it is very essential to find suitable repair mechanism for regain the strength of concrete. In concrete structures, repair of cracks usually involves applying a cement slurry or mortar which is bonded to the damage surface repairs can particularly be time consuming and expensive. For crack repair, a variety of techniques are available like impregnation of cracks with epoxy-based fillers, latex binding agents such as acrylic polyvinyl acetate, butadiene styrene etc. But traditional repair system has a number of disadvantages aspects such as different thermal expansions coefficients compared to concrete and also have impact on environment and health therefore, bio-based calcite precipitation has been proposed as an alternative and sustainable, environmental friendly crack repair technique.

A method of strength improvement of cement–sand mortar by the microbiologically induced mineral precipitation was described **by P. Ghosh et al. (2005).** A thermophilic anaerobic microorganism is incorporated at different cell concentrations with the mixing water. The study showed that a 25% increase in 28-day compressive strength of cement mortar was achieved with the addition of about 10 cell/ml of mixing water. As synthetic polymers, used for concrete repair, may be harmful to the environment, the use of a biological repair technique was investigated by **K. Van Tittelboom et al. (2010)**. Uratolytic bacteria such as Bacillus sphaericus were able to precipitate CaCO3 in their micro-environment by conversion of urea into ammonium and carbonate. The bacterial degradation cubes absorbed more than three times less water than control cubes as a result of microbial calcite deposition. Microorganism is a unique living element and has the ability to precipitate minerals through the process of bio mineralization. The precipitation process occurred naturally and most of the precipitated products are very important compound composed of such as carbon, nitrogen, oxygen, sulphur, phosphorus and silica. So far, concrete incorporated with microorganism that

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able to precipitate calcium carbonate (calcite) was reported. However, little information on silica precipitation and its effect on concrete properties had been revealed. The concrete specimens were incorporated with Bacillus subtilis silica adsorbed in their cell wall by **H Afifudin et al. (2011)** -. Concrete specimens with five different concentrations of Bacillus subtilis cell with 104, 105, 106 and 107 cell/ml and control (without Bacillus subtilis) were cast. The effect of including Bacillus subtilis to the resistance to carbonation of the concrete specimen is found to be insignificant.

Cracks in concrete are the main reason for a decreased service life of concrete structures. It is therefore more advisable and economical to restrict the development of early age small cracks the moment they appear, than to repair them after they have developed to large cracks. A promising way is to pre-add healing agents to the concrete to heal early age cracks when they appear, i.e. the so-called self-healing approach was described **by J. wang etal**. (2012). The possibility to use silica gel or polyurethane as the carrier for protecting the bacteria was investigated. Experimental results show that silica gel immobilized bacteria exhibited a higher activity than polyurethane immobilized bacteria, and hence, more CaCO3 precipitated in silica gel (25% by mass) than in polyurethane (11% by mass) based on thermo gravimetric analysis. The results indicated that polyurethane has more potential to be used as a bacterial carrier for self-healing of concrete cracks**.** The relevant experiments were designed **by A. vahabi et al. (2013)** to determine the ability of indigenous bacterial strains isolated from limestone caves, mineral springs, and loamy soils to induce calcium carbonate precipitation. Among all isolates examined inefficient carbonate-precipitating soil bacterium was selected from among the isolates and identified by 16S r RNA gene sequences as Bacillus licheniformis AK01. Fourier transform infrared (FTIR) spectroscopy, X-ray diffraction (XRD) analyses, and scanning electron microscopy (SEM)/energy-dispersive X-ray spectroscopy (EDX) examinations were performed in order to confirm the presence of calcium carbonate in the precipitate and to determine which polymorphs were present. The kind of bacterial culture and medium composition had a profound impact on the resultant CaCO3crystal morphology. The bacterial cell walls significantly increased compressive strengths of concrete by 15%while also decreased porosity at 28 days of curing as described by **R. Pei et al. (2013)**. Assay for CaCO3 precipitation in vitro indicated that bacterial cell walls, but not dead cells, accelerated carbonation of Ca2+ ions in Ca(OH) solution. Since CaCO3 formed can fill up the void, decrease the porosity and increase the compressive strength in concrete, bacterial cell walls could act as a promising concrete admixture with benefits in enhancing mechanical performance and improving other carbonation-related properties. Alternative repair mechanism is currently being studied by **M.V.S. Rao et al. (2013)** i.e. a novel technique based on the application of bio mineralization of bacteria in concrete. The applicability of specifically calcite mineral precipitating bacteria for concrete repair and plugging of pores and cracks in concrete had been recently investigated and studies on the possibility of using specific bacteria as a sustainable and concrete -embedded self-healing agent was studied and results from ongoing studies were discussed. Overview of development of bioengineered concrete using bacterial strain Bacillus subtilisJC3 and its enhanced mechanical and durability characteristics was briefly described in this paper.

Shortcomings of conventional treatments have drawn the attention to alternative techniques for the improvement of the compressive strength. This paper reported by **V. Senthilkumar et al. (2014)** reports the effects of bacterial carbonate precipitation on the compressive strength of cement mortar specimens. The method of microbial mineral

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plugging in porous media was common in nature. Physical and biochemical properties ofCaCO3 precipitation induced by Enterococcus sp. microorganism into cement mortar specimen was studied and analysed. Significant environment concern related to its emission, disposal and reuse due to high alkalinity. **R. Siddique et al. (2014)** studied the effect of bacterial (Bacillus halodurans strainKG1) treated cement kiln dust on the compressive strength, water absorption and porosity (at7, 28 and 91 days) of concrete after reducing the alkalinity. **R. Andalib et al. (2014)** provided an insight into a new biotechnological method based on calcite precipitation for achieving high strength bio-concrete durability. It was very clear that mineral precipitation has the potential to enhance construction material resistance towards degradation procedures. The appropriate microbial cell concentration (30 10 cells/ml) was introduced onto different structural concrete grades (40, 45 and 50 MPa) by mixing water. A study carried out by **C. Stuckrath et al. (2014)** shows, the isolated and combined effect of two self healing agents for concrete, both based on calcium carbonate precipitation, was studied. Lightweight aggregates were impregnated with chemical and biological solution to be added as healing agents in concrete mixtures. The influence of two common chemical admixtures on the performance of the self-healing agents was also studied.The viability of encapsulated spores and the influence of microcapsules on mortar specimens were investigated by **J.Y. Wang et al. (2014)** firstly. Breakage of the microcapsules upon cracking was verified by Scanning Electron Microscopy. Self-healing capacity was evaluated by crack healing ratio and the water permeability. The results indicated that the healing ratio in the specimens with bio-microcapsules was higher (48%–80%) than in those without bacteria (18%–50%). A study carried out by **J.Y. Wang et al. (2014)** shows, bacterial spores were first encapsulated into hydrogels and then were incorporated into specimens to investigate their healing efficiency. The precipitation of CaCO3 by hydrogel-encapsulated spores was demonstrated by Thermos gravimetric analysis (TGA). Using Carbonate producing bacteria was a promising novel technique by**F. Nosouhian et al. (2015)** for the improvement of concrete characteristics. Durability of concrete in harsh environment such as sulphate exposure has been constantly an important issue.

M. Monishaa and Mrs.S. Nishanthi, conducted experimental study on self-healing concrete. They have used bacillus subtilis as self-healing bacteria.M20 grade concrete is prepared with different bacterial cell concentration of 10^4, 10^5 and 10^6 cell per millilitre of water and polyethylene fibre kept constant as 0.4 percent. They have observed 28days compressive strength of concrete have increased by 13.2% of cell concentration 10^5 cells/ml for all ages. **Dinesh, R. shanmugapriyan and S.T. Namitha Sheen**, have conducted experiment on bacterial concrete reduces the corrosion of reinforcement, increases the durability and strength of concrete. they concluded that application of the bacteria in a concrete it was found that the compressive strength and tensile strength of concrete increase with a decrease in permeability, water absorption and corrosion of the reinforcement compared to the conventional concrete. **SalahaldinAlsadey and Muhsensalem (2016)** have conducted experiment on influence of polypropylene fiber on strength of concrete. In this paper finding out the optimum quantity of polypropylene fibers required to achieve the maximum compressive strength for M25 grade concrete. They obtained tremendous increase in compressive strength of concrete by using 2% of polypropylene fiber. **HenkM.Jonkers and Erick Sehlangen (2008)** have conducted experiment on development of a bacteria basedself healing concrete. In this paper bacillus cohnii, bacillus halodurans and bacillus subtilis species were obtained from the german collection of the microorganism.

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They found to be addition of healing bacteria leads to the 10% increase of the compressive strength. Study by **B. Naveen and Sivakamasundari** on the effect of calcite precipitating bacteria on self-healing mechanism of the concrete they have found to be caco3 crystal precipitated inside the concrete is effective.

II. BACTERIAL CONDITION

There are various types of Bacteria's that can be used in the concrete such as B. Subtilis, B. Pasteurii, B. Cohnii, B. Licheniformis etc. We have selected Bacillus Subtilissincethis bacteria produces Calcium Carbonate and due to ease of availability from pharmacy department of AIKTC. A member of the genus Bacillus, B. subtilis is rod-shaped, and can form tough, protective endosperms, allowing it to tolerate extreme environmental conditions. B. subtilis is considered the best studied Gram-positive bacterium and a model organism to study bacterial chromosome replication and cell differentiation. It is one of the bacterial champions in secreted enzyme production and used on an industrial scale by biotechnology companies. The microphotograph of strains of Bacillus Subtilis is shown in fig. 1.

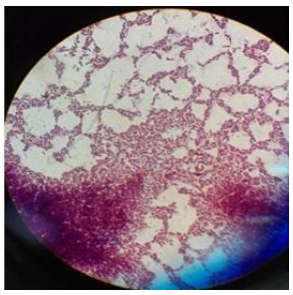

Fig 1: Microphotograph of strains of Bacillus Subtilis

III. CULTIVATION OF BACTERIA

The pure culture of bacteria i.e. Bacillus Subtilis is preserved on nutrient agar slants. It forms irregular dry white colonies on nutrient agar slants. Two colonies of the bacteria reinoculated into nutrient both of 350 ml in 500ml conical flask and incubated at the temperature of 37 degree Celsius and 150 rpm orbital shaker incubator. The medium composition used for growth of bacterial culture consists of Peptone, NaCl, yeast extract.

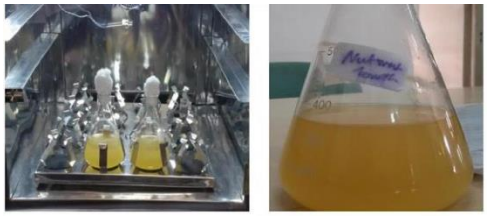

Fig 2: Bacterial solution in incubator.

III-A EXPERIMENTAL PROCEDURE FOR CULTURAL GROWTH OF BACTERIA

1. S. pasteurii PTCC 1645 (DSM 33, ATCC 11859; CCM 2056; NCIB 8841; NCTC4822) and B. subtilis PTCC 1715 (BGSC 1A747) prepared from the Persian type culture.
2. The bacteria were cultured in liquid medium according to the suppliers 'recommendations. The medium used to grow bacteria consisted of 5.0 g peptone, 3.0 g meat extract, per litre of distilled water; to which 1.5% agar was added to obtain a solid medium forth stock culture.
3. This medium was supplemented with 0.01 g MnSO4 · H2O to enhance sporulation and pH was adjusted to 7.0 using 1 N HCl.
4. The mixture was first sterilized by autoclaving for 20 min at 121°C, allowed to cool to room temperature (25°C).
5. According to supplier's recommendation for culturing of S. pasteurii strain, 10 mL filter-sterilized20% ureasolution through a sterile 0.22 µm filter (Jet Biofil) was added aseptically post autoclaving to100 ml cooled molten peptone/meat extract medium.
6. B. subtilis and. pasteurii cultures were obtained through activation of lyophilized bacteria whereas for all

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later experiments cultures were obtained through sub culturing.

7. Cultures were incubated at 30°C on a shaker incubator at 130 rpm for 72 h. Afterward, bacterial cells were harvested by centrifuging (5,000 r=min, 10 min) the 72 hold grown culture and the cells were washed twice in saline solution (NaCl, 8.5 g=L).

III-B SOURCES OF BACTERIA

Bacillus subtilis bacteria supplied by the developer of bacteria RETRON PROBIOTICS VIJAYAWADA

III-C SAFETY MEASURES FOR BACTERIAL SOLUTION

Bacteria are harmful for the health and it may lead to diseases. It is compulsory to use gloves while dealing with the bacterial solution. The flask must be heated before pouring the bacterial solution. The whole procedure must be done between the two candles so that the bacterium doesn't get contaminated by the interference of the other bacteria's present in the environment.

IV. MATERIALS & BASIC TESTING

IV-A CEMENT

Ordinary Portland cement of 53 Grade available in local market is used in the investigation. The cement used has been tested for various properties as per IS:4031-1988 and found to be confirming to various specifications of IS: 12269-1987.

Fig 3: Cement

Initial setting time and final setting time was noted down by taking 400gms of cement add 0.85P water (P= standard consistency), the gauging time is kept between 3-5minutes.The observation made are the initial setting time of given cement sample=1-hour 20 min and final setting time of given cement sample=10-hour 14 min.

Specific gravity test on cement was carried using following procedure

- let the weight of dry specific gravity bottle be W1.

• Fill the bottle with the water, let the weight be W2.

• Remove the water and fill the bottle with kerosene, let the weight beW3.

• Pour some of the kerosene out and introduce, weighed quantity of cement into

• The bottle Roll the bottle gently in inclined position until the no further air

• Bubble rise to surface. Fill the bottle to the top with kerosene and weigh it. Let The weight be W4.

Specific gravity of cement(S)=W5(W3-W1)/(W5+W3-W4)(W2-W1)

The observation of Specific gravity of cement was found to be 2.93

IV-B SAND

We had used the sand confirming the zone III according to IS- 383 as shown in fig-4

Fig 4: Sand

Basic test on sand was carried using Particle size distribution where Finess modulus is calculated and specific gravity of fine aggregate was calculated.

where

Fineness Modulus = (Total Cumulative Percentage of Passing)/100

Specific gravity = (W2-W1)/ (W2-W1) - (W3-W4)

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The observations are specific gravity 2.6, fineness modulus 2.71 and zone is II

VI-C COARSE AGGREGATE

The coarse aggregate is strongest and porous component of concrete. Presence of coarse aggregate reduces the drying shrinkage and other dimensional changes occurring on account of movement of moisture. In our investigation we had used the aggregate passing through 20mm IS-Sieve and retaining on 12.5mm sieve. The specific gravity of aggregate was found out to be 2.50.

Fig:5 Coarse Aggregate A

The specific gravity of aggregate is considered to be a measure of strength or quality of the material. Water absorption gives an idea of strength of rock stones. The specific gravity of aggregate was found to be 2.7 and water absorption was found to be 0.6%.

IV-D POLYPROPYLENE FIBER

Polypropylene is a polymer. Many no. of propylene monomers join with each in the synthesis of polypropylene. Polypropylene is a hard, stiff, strong and dimensionally stable materials that absorb very little water. It has good gas bearing properties and good chemical resistance against acid, greases and oils. it can be highly transparent and colourless but thicker section are usually opaque and off-white. It has a round cross section and mixed with a concrete at contents of 0.4% by volume or continuous network of fibrillated fibre to produce high fiber content composition

Fig6: Polypropylene Fiber

V. EXPERIMENTAL METHODS & TESTS

V-A Preparation of concrete Mix

In our investigation we have made M 20 grade of concrete as shown in fig 7. The mix ratio obtained after the mix design as per IS 456: was M20 (1:1.5:3). Further, we have poured the concrete in the cube Moulds and three different samples were made which are as follows

a. Conventional Concrete of grade M 20.
b. Concrete with 30 ml bacterial solution.
c. Concrete with 40 ml bacterial solution.

Fig7: Casting of concrete

V-B PH of concrete

In our investigation we find out the PH value of concrete by using the litmus paper as shown in fig 8. Once the concrete was completely mixed the litmus paper was touched to the concrete, the colour of the litmus paper changed to darkish green with reading between 7-8. Therefore, it gives the basis that bacterial solution will survive and further concreting work proceeded.

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Fig 8: Litmus paper indicating the pH value of Concrete

V-C Methods of mixing bacterial solution into concrete

There are different methods of mixing the bacterial solution in the concrete which are viz. Direct Mixing , Indirect Mixing, Injection method .In our investigation we have adopted the direct method in which, firstly the measuring jars were sterilized in oven for a temperature of about 1000c0for 5 min. After 5 min once it gets slightly cooled, the bacterial solution is poured form the flask in the measuring jar. The flask is firstly heated under the candle before pouring it into the jar, so that the bacterium doesn't get contaminated by the other bacteria's present in the environment. Once the bacterial solution is mixed in the water, the water is properly stirred and then it is used for immersion in the concrete.

V-D Casting of cubes and curing of different specimens of bacterial concrete

Once the concrete is completely mixed the concrete is poured in the cube, compactions been done by the vibration machine. Concrete cubes were removed from the Moulds after24 hrs. And they were put into the curing tank. Curing was done for 7, 14 and 28 days for all samples viz. Conventional, 30 ml and 40 ml.

V-E Experimental test on bacterial concrete

Various test are performed on bacterial concrete in order to get the results in various forms namely Slump cone test, Compressive strength test, Flexural strength test, Split tensile strength test.

VI. EXPERIMENTAL RESULT AND DISCUSSION

Various tests were conducted to know the characteristics of the concrete. The test was conducted to investigate the optimum dosage of bacterial solution under which cube attains its max strength.

*VI-A Workability Test*Slump cone test was performed to measure consistency or workability of fresh concrete and slump also gives an idea of W/C ratio needed for concrete to be used for different works. Concrete is said to be workable if it can be easily mixed, placed, compacted and finished. The observations made are Water cement ratio = 0.5 , Quantity of cement = 5 kg ,Quantity of Sand = 7.5 kg , Quantity of coarse aggregate = 15 kg , Slump height= 25mm.

Compressive strength of concrete cube was carried out after curing period 7,14 and 28 days. The results obtained are tabulated below with their respective graph of fig 9.

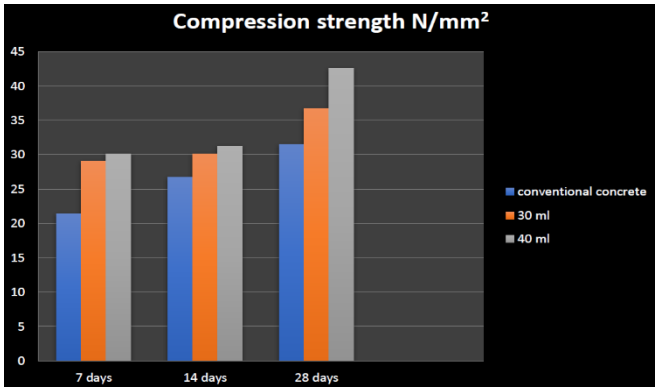
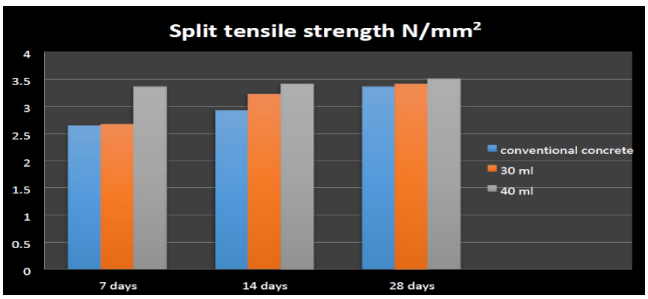


Fig 9: Compressive Strength Graph for 7, 14, 28 days

Split tensile strength of concrete cylinder was carried out after curing period of 7,14 and 28 days. The results so obtained are tabulated below with their respective graph of fig 10



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Flexural strength of concrete beam was carried out after curing period of 28 days the results obtained are tabulated below with their respective graphs of fig 11.

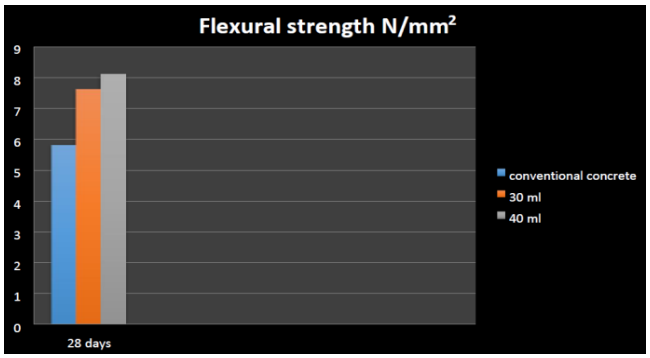

Fig 11: Flexural Strength for Curing Period of 28 Days

VII. CONCLUSION

Microbial concrete technology has proved to be better than many conventional technologies because of its eco-friendly nature, self-healing abilities and increase in durability of various building materials. The overall development of strength and durability of self-healing concrete by using bacillus subtilis bacteria and poly propylene fibre has investigated and compared with controlled concrete. The greatest improvement 10^7 cells/ml for all ages this showed that a 26.09% increase in 28days compressive strength, split tensile strength by 4.06% and flexural strength by 23.6% was achieved. The more $CaCO_3$ precipitations the better self-healing effect will be. Polypropylene fibre increased its mechanical property of the concrete. this process results in the precipitation of substantially higher amount of calcium carbonate inside the cracks to be healed. Optimum strength is obtained on 40ml concrete specimen. Bacillus subtilis strain can improve the characteristics of cement composites. Bacillus subtilis can be produced from the lab which is proved to be a safe and cost effective. Addition of bacillus bacteria improves the hydrated structure of cement mortar.

REFRENCES

[1]. S Dinesh, R. Shanmugapriyan & S.T. Namitha (2017) "Self Healing Concrete: A Review On Bacteria" Imperial journal of Interdisciplinary research (IJIR)

[2]. Salahuddin Alsadey & Muhsensalem "Influence of Polypropylene Fiber on strength of concrete" American journal of engineering research (AJER) 2016

[3].Self-healing cracked concrete: Bacterial approach, H.M jonkers & E. schlangen Delft University of technology, delft, The Netherlands

[4]. S. SunilPrathapreddy, M.V. Seshagiri Rao, P Aparna & Ch. Shashikala, "Performance of Standard grade bacterial (Bacillus Subtilis) concrete" Asian journal of Civil engineering (building & housing) Vol.11 NO.1(2010) pages 4355.

[5]. S. Soundarya & Dr. K. Nirmal Kumar "Study on the effect of Calcite,Precipitating bacteria on self-healing mechanism of concrete (Review paper)" International Journal of engineering Research & Management Technology.

[6]. M.Monisha & Mr. Nishanth (2017) "Experimental study on strength of selfhealing concrete" SSRG International journal of Civil engineering –(ICRTCETM2017).

[7]. Erik schangen 2008 "Development of a bacteria- based self-healing concrete" a review paper.

[8]. Meera C M and Subha V 2016 IOSR Journal of mechanical and civil engineering (IOSR-JMCE.

[9]. Asian journal of civil engineering (building and housing) s. Sunilpratapreddy and
m.v. Sheshigirirao, p. Aparna, 2010,

[10]. Rahman, M. Sam, N.F. Ariffin, M. Warid, H.S. Lee, M.A. Ismail, M.Samadi, Performance of epoxy resin as self-healing agent, Journal Technology 16 (2015)9–13.

[11]. Talaiekhozan, A. Keyvanfar, A. Shafaghat, R. Andalib, M.Z.A. Majid,M.A.Fulazzaky, A review of self-healing concrete research development, J.Environ.Treat. Tech. 2 (1) (2014) 1–11.

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PERFORMANCE EVALUATION OF CONCRETE WITH AND WITHOUT FLY ASH BY PARTIAL REPLACEMENT OF M-SAND WITH COPPER SLAG

NAVYA N[1], PALLAVI G A[2], GEETHA T S[3], SUMA N G[4]

Department of Civil Engineering, Sapthagiri College of engineering
#14/5 Chikkasandra, Hesaraghatta main road, Bangalore-57 India
[1]navyan@Sapthagiri.edu.in
[2]pallaviga@sapthagiri.edu.in
[3]geethats@sapthagiri.edu.in
[4]sumang@sapthagiri.edu.in

Abstract **- Many researches have already found it potential to use of copper slag as a concrete combination, as a result of copper slag has similar particle size characteristics seemingly to it of Sand.The present study mainly focuses on investigating the effect of using copper slag as a replacement of fine aggregate and the strength properties for M25 grade of concrete.The tests are to be conducted for various proportions of copper slag replacement with m-sand of 25%,50%,75%,100% in concrete the obtained results where compared with those of conventional concrete.Meanwhile test like specific gravity , sieve analysis , compression test , setting time .etc, are conducted for materials used in project and casted.Compressive strength are determined and compared. The block which comprises low cost and good compressive strength is suggested.**

Keywords – Concrete, Flyash, Copper Slag, M-sand

I. INTRODUCTION

Concrete is the man made material widely used for construction purposes. The usual ingredients in concrete are cement, fine aggregate, coarse aggregate, and water. With increasing scarcity of river sand and natural aggregate across the country, researches began cheaply available material as an alternative for natural sand. Utilization of industrial waste or secondary material has increased in construction field for the concrete production because it contributes to reducing the consumption of natural resources.In India, there is great demand of aggregates mainly from civil engineering industry for road and concrete constructions. But, now days it is very difficult problem for availability of fine aggregates. So researchers developed waste management strategies to apply for replacement of fine aggregates for specific need. Natural resources are depleting world- wide while at the same time the generated wastes from the industry are increasing substantially. The sustainable development for construction involves the use of nonconventional and innovative materials, and recycling of waste materials in order to compensate the lack of natural resources and to find alternative ways conserving the environment.

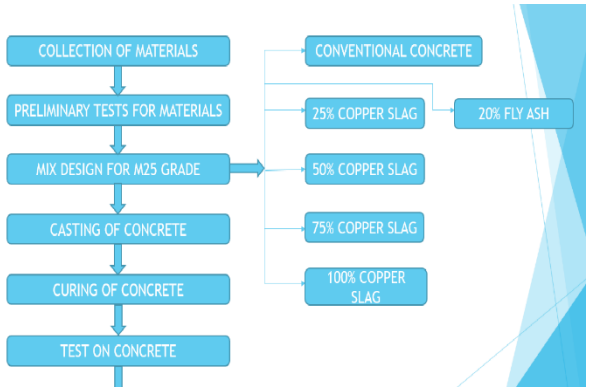
II. MATERIALS & METHODS

The properties of concrete both in fresh and hardened state depend largely on the properties of constituent materials used for its preparation. Detailed characterization tests were conducted in the laboratory to evaluate the required properties of the individual materials. The relative quantities of cement, aggregates, copper slag, fly ash and water together, controls the properties of concrete in the fresh state. The compacting factor was conducted to assess the workability.

III. MATERIALS USED

1. CEMENT.
2. FINE AGGREGATE.
3. COARSE AGGREGATE.
4. FLY ASH.
5. COPPER SLAG.
6. POTABLE WATER

IV. METHODOLOGY:



V. TESTS

The various tests to be done for finding the material properties are:

- Sieve analysis
- Normal consistency of cement
- Specific gravity of copper slag
- Fineness
- Initial setting time of cement
- Workability tests
- Test for Compressive strength
- Split tensile strength

VI. DETAILS OF TEST

1. TESTS ON CEMENT

Sl No	Properties	Test value	Test Method	Limitation As per IS 12269-2009
1	Specific gravity	Specific gravity of bottle (IS 4031 part-4)	3.16	<3.16
2	Finess of cement	Sieve test on 90µ sieve (4031 part- 5)	8.5 %	<10%
3	Initial setting Time	Vicat apparatus (IS 4031 part- 5)	35 min	>30
4	Final setting Time	Vicat apparatus (IS 4031 part- 5)	120 min	<600

2. TESTS ON COARSE AGGREGATE

Sl. No	Properties	Results
1	Specific gravity	2.73
2	Water absorption (%)	-
3	Loose Bulk density(kg/)	1690

3. TESTS ON FINE AGGREGATE

Sl. No	Properties	Results
1	Specific gravity	2.42
2	Water absorption in percentage	-
3	Bulk density (kg/m)	1908.14
4	Zone	2

4. FINENESS MODULUS OF COPPER SLAG

IS sieve no	Wt of sample W (gm)	%Wt retained (W/2000) x 100	Cumulative % C	% fine N=(100-C)
4.75	22	2.2	2.2	97.8
2.36	102	10.2	12.4	87.6
1.18	312	31.2	43.6	86.4
600µ	178	17.8	61.4	38.4
300µ	168	16.8	78.2	21.8
150µ	166	16.6	94.8	5.2
Pan	15	1.5	96.3	3.7

5. SPECIFIC GRAVITY OF COPPER SLAG

TRIALS	1
Empty weight of pycnometer (W_1)	606
Weight of pycnometer + 1/3 rd of copper slag(W_2)	1246
Weight of pycnometer+ $1/3^{rd.}$ of copper slag + water (W_3)	1970
Weight of pycnometer + water (W_4)	1506
Specific gravity	**3.63**

RESULT: The specific gravity of copper slag is **3.63**

6. DETAILS OF TEST SPECIMENS

Standard moulds were used for casting 150mm cube specimen, 150mm diameter and 300mm height cylinders. A total of 72 specimens were cast and the details are given **below**

FIG 1. TEST SPECIMEN

Serial No:	Specimen	Size(mm)	Numbers
1	Cube	150x150x150	48
2	Cylinder	150 x 300	24
		Total	72

7. MIX PROPORTION

Mix No	Water *l*	Cement kg/m^3	Coarse Aggregate kg/m^3	Fine Aggregate kg/m^3	W/C ratio
1	191.6	383.2	1161.50	631.21	0.5

Design mix = **1:1.64:3.03**

Quantity of materials required:

For one cube of size 15cm x 15cm x 15cm:

Cement	= 1.42 kg
Water	= 0.71 litre
Fine aggregate	= 2.34 kg
Coarse aggregate	= 4.32 kg

8. SPECIMEN IDENTIFICATION

Designation	Cement %	Sand %	Flyash %	Copper slag%
CM	100	100	0	0
F	90	100	10	0
C1	90	90	10	10
C2	90	80	10	20
C3	90	70	10	30
C4	90	60	10	40
C5	90	50	10	50
C6	90	40	10	60

VII. RESULTS & DISCUSSIONS

1. RESULTS OF SIEVE ANALYSIS

Discussions Grading of aggregate has an important affect on the workability and finishing characteristic of fresh concrete. As per IS 2386 (part 1)-1963, Fineness modulus of fine aggregate varies from 2.2 to 3.2 and for coarse aggregate 6 to 9. Uniformity coefficient of coarse and fine aggregate varies from 1 to 3 and should not be greater than 4. For the given sample the value of uniformity coefficient for coarse is 1.542, for copper slag is 2.166 and fine is 2.54 and the fineness modulus for coarse is 7.173 and fine is 3.061, which is within the specified limit.

Particulars	Coarse aggregate	Fine aggregate	Copper slag
Effective size D10	11	0.37	1.1
Uniformity coefficient	1.54	2.54	2.166
Coefficient of curvature	1.048	0.807	1.28
Fineness%	7.173	3.06	4.39
Zone	Zone 1	Zone 1	Zone 1

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2. RESULTS OF PHYSICAL PROPERTIES OF AGGREGATE

Discussions The bulk density depends on the particle size distribution and shape of the particle. The higher the bulk density, lower the void content to be filled by the aggregate. Here, the bulk density is higher in compact condition than in loose condition i.e, the voids are less in compact condition. And it can be understood from void ratio and porosity that voids are less in compact condition.

Particulars	Fine aggregate	Coarse aggregate
Bulk density (kg/m3)	1.451	1.594
Void ratio	0.644	0.878
Sp.gravity	2.386	2.994
Porosity (%)	39.18	46.75

3. SPECIFIC GRAVITY OF COPPER SLAG

Particulars	Values
Mass of pycnometer (M1) kg	0.634
Mass of pycnometer + sample (M2) kg	0.836
Mass of pycnometer + sample +water (M3) kg	1.6255
Mass of pycnometer + water (M4) kg	1.474
Specific Gravity	4

Discussions The specific gravity of copper slag is determined by using pycnometer and found to be 4 which is more compared to the fine aggregate.

4. FINENESS OF CEMENT

Sl no:	Weight of cement tested (g)	Weight of cement retained on sieve (g)	% weight of retained (%)	Fineness of Cement
1	100	3	3	3
2	100	3	3	

Discussions Fineness of cement will give large surface area of chemical reaction and thereby increasing the rate of heat evolution and rate of hydration. As per IS 4031-1988, the fineness of cement should not be exceed 10%.The obtained value is 3.%, which is less than specified value. Therefore it can be used for building construction.

5. TEST ON CEMENT-INITIAL AND FINAL SETTING TIME

Results

Initial setting time is 30 minutes and Final setting time is 600 minutes which is approximately 10 hrs.

Discussion

As per IS 4031 (part 5) the initial setting time of Portland cement should not be less than 30 minutes and final setting time is about 10 hours. The setting time is influenced by temperature, humidity and quantity of gypsum in cement. For the given sample the initial setting time was obtained as 30 minute and final setting time as 600 minute. Hence it can be used for transportation, placing, compaction and delaying the process of hydration or hardening of cement. The final setting time facilitates safe removal of scaffolding or form.

6. NORMAL CONSISTENCY OF CEMENT

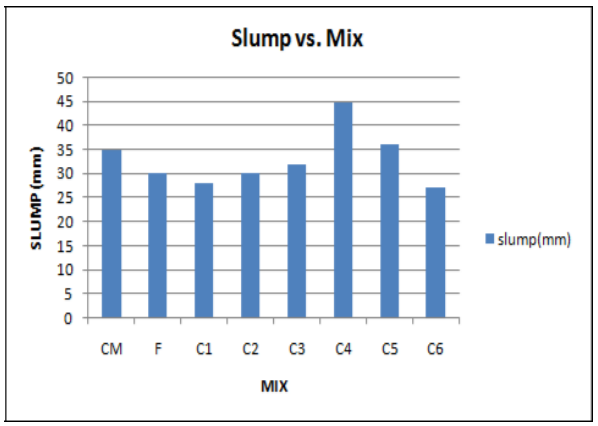
Result

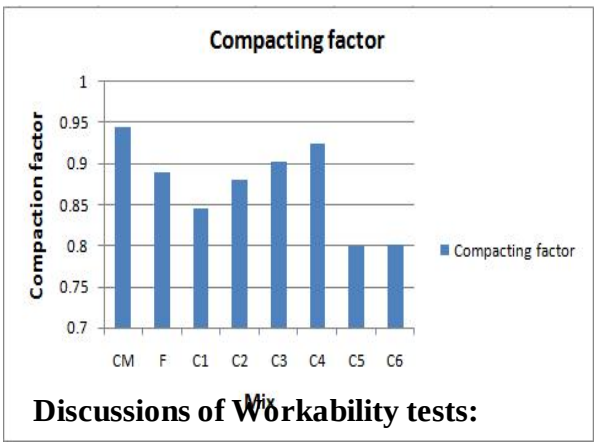
Normal consistency of cement is 32%.

Discussion

As per IS 4031 (part 4) 1988, the standard consistency is percentage of water by weight of cement that permits the plunger of 10mm diameter to penetrate upto a depth of 5mm-7mm about the bottom of mould. Its relative mobility of a freshly mixed cement paste or mortar or its ability to flow. Generally, the normal consistency of standard cement ranges from 26%-33%. In the experiment, the normal consistency of cement was obtained as 32%, which is within the specified limit. Hence this consistency can be used to determine water content for other tests like initial and final setting time, soundness and compressive strength.

7. FRESH CONCRETE TESTS-WORKABILITY TESTS

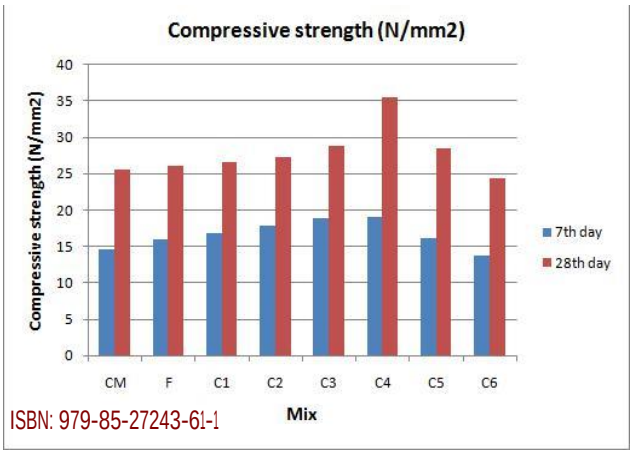


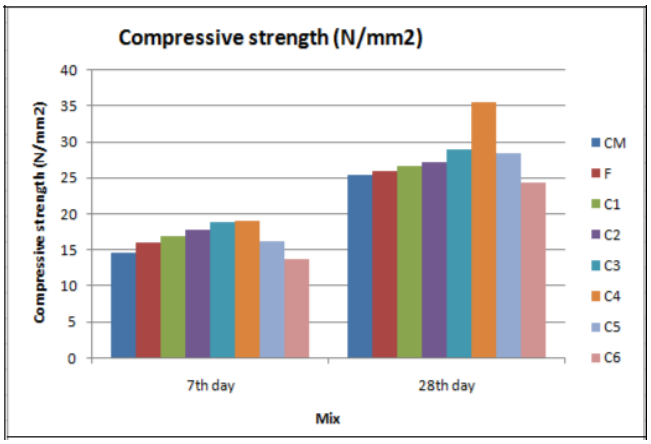


Discussions of Workability tests:

It is clear that the workability of concrete increases significantly with the increase of copper slag content in concrete mixes. This considerable increase in the workability with the increase of copper slag quantity is attributed to the low water absorption characteristics of copper slag and its glassy surface compared with fine aggregates. The glassy surface of copper slag increases the free water content in the mix hence increases the workability of concrete. The highest compaction factor is obtained at 40% replacement. The spherical shaped particles of fly ash act as miniature ball bearing with in the concrete mix and this leads to the improvement of workability of concrete or reduction of unit water content.

8. HARD CONCRETE TESTS

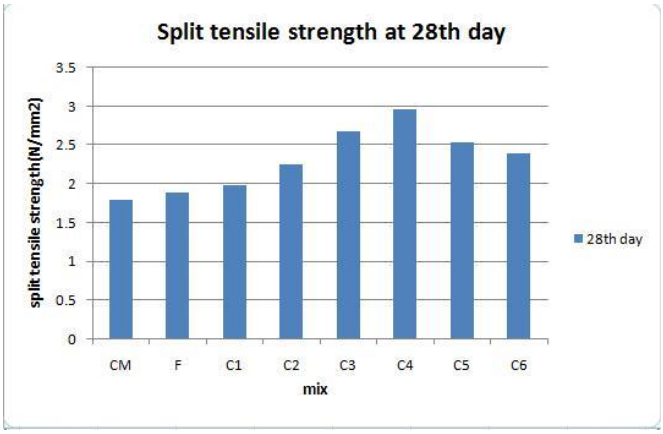




Discussions:

It can be seen that there is increase in strength with the increase in Copper Slag percentages. The highest compressive strength was achieved by 40% replacement of copper slag, which was found about 35.50 Mpa compared with 25.50 Mpa for the control mixture at 28th day. The compressive strength of concrete is increased as copper slag content increases up to 40%, beyond that compressive strength was significant decreases due to increases free water content in the mixes. This means that there is an increase in the strength of almost 40% compared to the control mix. However, mixtures with 60% replacement of copper slag gave the lowest compressive strength 24.32 Mpa. Concrete with 10% replacement of cement with fly ash shows good compressive strength for 28days. It is recommended that up to 40% of copper slag can be use as replacement of fine aggregates

9. SPLIT TENSILE STRENGTH



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Discussions:

The highest split tensile strength was achieved by 40% replacement of copper slag, which was found about 2.97 N/mm^2 compared with 1.8 N/mm^2 for the control mix. This means that there is an increase in the strength of almost 65% compared to the control mix at 28 days. The reduction in strength resulting from increasing copper slag is due to increased voids due to the fact that copper slag possesses fewer fine particles than fine aggregate. It could also be due to the increase of the free water because the copper slag absorbs less water than the fine aggregate.

VIII. CONCLUSIONS

By our project, we conclude that the strength of concrete increased by the replacement of sand by copper slag and cement by fly ash. Fly ash replaces Portland cement, save concrete materials costs. Here we using OPC of 53 grade, class F fly ash, well graded coarse and fine aggregate.

- 40% copper slag replacement showed maximum workability. The workability of concrete had been found to decrease after 40% in concrete.
- Among different mixes of concrete 40% showed maximum compressive strength at later ages. At later stages strength of concrete decreases due to segregation and bleeding.
- Maximum split tensile strength is obtained for C4 mix due to high toughness of Copper Slag.

Other uses are:

- Greater strength
- Decreased permeability
- Increased durability
- Reduced alkali silica reactivity
- Reduced heat of hydration
- Reduced efflorescence.

ACKNOWLEDGMENT

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IX. REFERENCES

[1] B. Jaivignesh, R. S. Gandhimathi,(2015) a study on *Experimental investigation on partial replacement of fine Aggregate by copper slag, Integrated Journal of Engineering Research and Technology, ISSN NO. 2348 – 6821.*

[2] Pranshu Saxena, AshishSimalti, (2015) *A study on Scope of replacing fine aggregate with copper slag in concrete, International Journal of Technical Research and Applications e-ISSN: 2320-8163, Volume 3, Issue 4, PP. 44-48.*

[3] Dr. A. Leema rose, P. Suganya,(2015) *a study on Performance of Copper Slag on Strength and Durability Properties as Partial Replacement of Fine Aggregate in Concrete, International Journal of Emerging Technology and Advanced Engineering (ISSN 2250-2459, ISO 9001:2008 Certified Journal, Volume 5, Issue 1).*

[4] T.G.S Kiran, and M.K.M.V Ratnam, (2014), *A study on Fly Ash as a Partial Replacement of Cement in Concrete and Durability Study of Fly Ash in Acidic (H2SO4) Environment, International Journal of Engineering Research and Development e-ISSN: 2278-067X, p-ISSN: 2278-800X, Volume 10, Issue 12.*

[5] Abraham, M.K., E. John and B. Paul (2014) *A Study on the Influence of Mineral Admixtures in Cementitious System Containing Chemical Admixtures, International Journal of Engineering Research and Development, 10, 76-82.*

[6] Aman Jatale, Kartiey Tiwari, Sahil Khandelwal (2013), *A study on Effects on Compressive Strength When Cement is Partially Replaced by Fly Ash, IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) e-ISSN: 2278-1684 Volume 5, Issue 4.*

[7] R RChavan& D B Kulkarni (2013) *A study on Performance of Copper Slag on Strength properties as Partial Replace of Fine Aggregate in Concrete Mix*

Design, International Journal of Advanced Engineering Research and Studies Vol.IV.

[8] Arivalagan. S (2013), *A Study on Experimental Study on the Flexural Behaviour of Reinforced Concrete Beams as Replacement of Copper Slag as Fine Aggregate", Journal of Civil Engineering and Urbanism Volume 3, Issue 4(176-182)*.

EXPERIMENTAL INVESTIGATION ON PROPERTIES OF PAPERCRETE OVER CONVENTIONAL CONCRETE

Geetha T S[1], Suma N G[2], Navya N[3], Pallavi G A[4]

Department of Civil Engineering, Sapthagiri College of engineering
#14/5 Chikkasandra, Hesaraghatta main road, Bangalore- 57 India
[1]geethats@sapthagiri.edu.in
[2]sumanng@sapthagiri.edu.in
[3]navyan@sapthagiri.edu.in
[4]pallaviga@sapthagiri.edu.in

Abstract— The major problem that the world is facing today is the environmental pollution. The majority of abandoned paper waste accumulating from the countries all over the world causes certain serious environmental problems. The present study focuses on utilizing the materials like waste paper and fly ash into cost effective building materials and re-cycle the wastepaper without any problem to the surrounding environment and the society .The investigation will be carried out to evaluate the strength and structural properties of fly-ash based papercrete moulds. Then the results will be compared with those of conventional moulds. The inference of the study could be that the papercrete materials are relatively low cost, light weight and more flexible.

Keywords— Papercrete, Strength, Light weight Material, Waste paper.

I. INTRODUCTION

1.1. General:

The world has been faced with environmental problems such as global warming, forest destruction and lack of resources. To solve these environmental problems, resources recycling have been performed.

Especially, paper is one of the most effective recycling resources to prevent global warming, forest destruction and etc. A name of papercrete was derived from its materials. Generally, it was made up of paper, cement and water. In order to resolve CO2 emission which made from construction sites because of cement this study is carried out. Papercrete is a new composite material using waste paper as a partial replacement of coarse aggregate. By using the waste paper, papercrete is not only reducing the amount of cement using but also making environmentally friendly building materials. This study aimed to evaluate the fundamental mechanical properties such as compressive, flexural and splitting tensile strength of papercrete containing waste papers as a partial replacement of coarse aggregate. Papercrete is a type of fibrous cement, made by shredding paper (old newspaper's...) into pulp in water and adding Portland cement. The thick mix can then be poured into moulds and cast like concrete, creating blocks, panels and innumerable other shapes. When cured and dried (above right), papercrete is strong, lightweight, insulating and has many properties which make it an ideal building material. It was discovered by ERIC PATTERSON and MIKE MCCAIN.

1.2 Objectives:

The major Objective of the project is replacing the costly and scarce conventional building blocks by innovative and alternative building blocks, which satisfies the following characteristics,

- Cost effective
- Environmental friendly
- Less weight
- Inflammable
- Less water absorption
- Easily available

1.3 Papercrete:

Papercrete is a tricky term as the name seems to imply a mix of paper and concrete, known as papercrete. But to be more accurate, only the Portland cement part of concrete is used in the mix. Papercrete may be mixed in many ways and different types of papercrete contain 50%-80% of waste paper. With the expected increase in literacy rate and growing economy, an increase in per capita consumption of paper is expected. The demand for upstream market of paper products like, tissue paper, tea bags, filter paper, lightweight, coated paper, medical grade coated paper etc., is shooting up. Due to this tremendous increase in use of paper, 1600 m3 papers are wasted in India per day. Even though the waste papers are recycled in paper industry is only 29%

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of waste paper is recycled. It is lower in comparison to the global average of 36%.

The basic constituents of Papercrete are:

- Paper: Usually waste paper such as used newsprint or cardboard.
- Aggregate: Coarse aggregate or fine aggregate such as sand may be used depending in the desired strength of the Papercrete.
- Cement: It is used as a binder and used to provide strength and rigidity to the Paper Crete.
- Water: Papercrete is a recent technology and its use is limited to experimental and recreation use.

II. MATERIALS & METHODS

2.1. Materials

Material for papercrete preparation has been mentioned below

A. Cement:

Cement is one of the binding materials used for this composite material. The cement is manufactured by using the silica, alumina, quick lime and small amount of gypsum and it is heated to form a clinker. Then the clinkers are crushed to obtain fine cement. There is a different type of cement are produced by varying the proportion of raw materials. Different types of cement available in Indian market are

- Ordinary Portland cement (OPC)
- Portland Pozzolana Cement (PPC)
- High-early-strength cement (quick setting cement)

  53 Grade Ordinary Portland cement is used as a binder in this project

B. Paper: Paper is a fibrous or cellulose compound obtained from wood, grass, etc... Paper is a natural polymer compound contains a large number of –OH group to form a matrix. The mixing of wet paper to cement form a cement matrix which gives the extra strength to the material.

C. Water: Water is one of the main ingredients for mixing of any raw materials. It gives the workability of materials. Water used is clean and clear and does not contain any other organic compounds. The pH of water is should be between 6-7

D. Fine aggregate: The sand used for the experimental program was locally available and Confirming to grading zone II. The sand was first sieved through 4.75 mm sieve to remove any particles greater than 4.75 mm and then was washed to remove the dust. The fine aggregates were tested per Indian Standard Specifications IS: 383-1970. As per Indian standard sand is divided into four zones based on the sieve analysis of sand as zone I is coarser and that falling in the zone IV is finer. The sand falling in zone IV shall not be used in reinforced concrete. The best suited one is sand falling into zone II.

E. Coarse aggregate: Locally available coarse aggregates having the maximum size of 20 mm and down used in the present work. The properties of the aggregate affect the water demand, workability and cohesion of concrete in plastic state and strength, density, durability and porosity of hardened concrete. The aggregates were tested per Indian Standard Specifications IS: 383-1970 part.

F. Fly ash: Fly ash normally produced from burning anthracite or bituminous coal falls in this category. This class of flyash exhibits pozzolanic property but rarely if any, self-hardening property.

2.2. Formation of Paper Pulp for Papercrete

a. As the collected papers cannot be used directly so first papers were converted into slurry form, known as pulp then is mixed with other ingredients.

b. Pins, threads and other materials attached to the collected paper were removed.

c. Then papers were torn into small pieces and all the torn pieces of papers were immersed in water.

d. The papers were kept in water for 3 to 4 days, and they soon degraded into a paste like foam.

e. After that period, the papers were taken out from water tank and shredded into little pieces by manually on large wire mesh. The shredded papers were converted into pulp.

f. The paper pulp had residual water in itself, and it was not good enough for mixing the ingredients. So the required amount of water was added at the time of mixing.

2.3. Fabrication of Moulds used in the Experimental Work

Cast iron moulds of the following sizes,

- Cubes of 150mm×150mm
- Cylinders of 150mm×300mm
- Beams of 100mm×150mm×1500mm

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III. RESULTS & DISCUSSIONS

1. Materials Results

Table.3.1.The results of various tests conducted on cement are tabulated.

Physical properties	Present study results
Specific gravity	3.15
Standard consistency (%)	30
Initial setting time (min)	50
Final setting time (hrs)	16
Compressive strength of cement mortar @ 3 days in MPa @ 7 days in MPa	 26.5 32.0

Table.3.2. The results of various tests conducted on coarse aggregate are tabulated.

Properties of the coarse aggregates	Present study values
Specific gravity	2.67
Water absorption	0.4%
Grain size distribution	well graded
Bulk density(KN/m³)	16.8

Table.3.3. The results of various tests conducted on fine aggregate are tabulated.

Properties of fine aggregate	Values
Specific gravity	2.64
Water absorption	1.4%
gradation	Zone II
Bulk density(KN/m3)	15.25

Table.3.4. Specific gravity results of fly ash

Property of the fly ash	Value
Specific gravity	2.616

Table.3.5. Determination of water absorption of papercrete

Sl no.	mix	(%) of paper added	Wet mass in kg (A)	Dry mass in kg (B)	Percentage of water absorbed	Average(%)
1	mix-1	10%	6.88	6.59	4.34	4.52
			6.85	6.54	4.7	
2	mix-2	20%	5.77	5.44	5.98	6.0
			5.81	5.48	6.02	

Table.3.6. Slump test with various water cement ratio of papercrete

Water cement ratio	Initial reading 'a' in cm	Final reading 'b' in cm	Slump (a-b) in cm
0.6	30	30	0
0.7	30	27	3
0.8	30	19	11

Table.3.7. Slump test with various water cement ratio of cement concrete

Water cement ratio	Initial reading 'a' in cm	Final reading 'b' in cm	Slump (a-b) in cm
0.3	30	30	0
0.4	30	17	13

2. Compressive Strength Results

28days Compressive strength of conventional concrete

Sl no	Weight of the cube (kg)	Load in KN	compressive strength in N/mm²	Average compressive strength in N/mm²
1	8.38	408	18.13	18.24
2	8.59	413	18.35	

28days Compressive strength of papercrete

Sl no	Percentage of paper (%)	Weight of the cube (kg)	Load in KN	compressive strength in N/mm²	Average compressive strength in N/mm²
1	10	1)6.88 2)6.85	170 168	7.55 7.46	7.505
2	20	1)5.77 2)5.81	110 114	4.88 5.06	4.97

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3. Split Tensile Strength Results

28days split tensile strength of conventional concrete

Sl no	Weight of the cylinder (kg)	Load in KN	Split tensile strength in N/mm²	Average Split tensile strength in N/mm²
1	15	310	4.42	4.58
2	14.54	335	4.74	

28days split tensile strength of papercrete

Sl no	Percentage of papercrete (%)	Weight of the cylinder (kg)	Load in KN	Split tensile strength in N/mm²	Average Split tensile strength in N/mm²
1	10	1)10.62 2)10.74	127 130	1.796 1.839	1.817
2	20	1)9.44 2)9.50	91 93	1.287 1.315	1.301

4. Flexural Strength Results

28days flexural strength of conventional concrete

Sl no	Weight of the beam (kg)	Load in KN	Flexural strength in N/mm²	Average Flexural strength in N/mm²
1	14.3		4	1.457	1.511
2	14.15		5	1.565	

28days flexural strength of Papercrete

Sl no	Percentage of paper (%)	Weight of beam (kg)	Load in KN	Flexural strength in N/mm²	Average Flexural strength in N/mm²
1	10	1)11.12 2)11.11	6 5	1.99 1.94	1.965
2	20	1)10.64 2)10.70	4 4	1.44 1.467	1.453

1. Comparision's of test Results

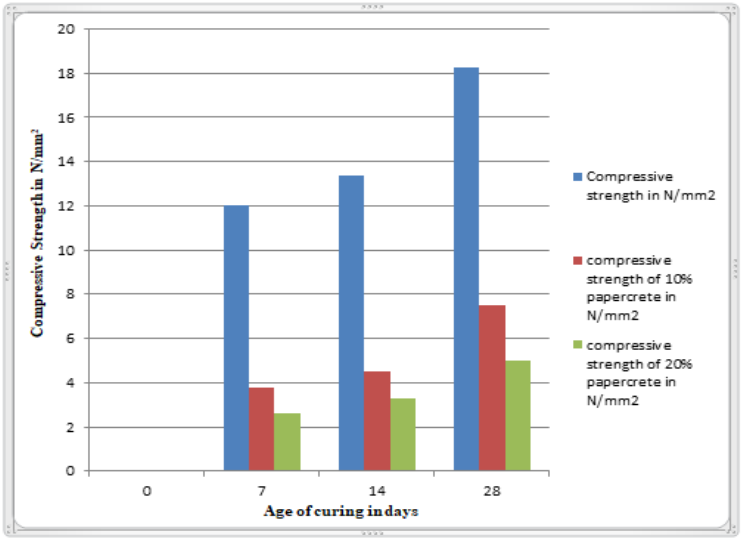

Fig. 3.1 Graph of Compression Test on Conventional Concrete and For 10% and 20% Papercrete

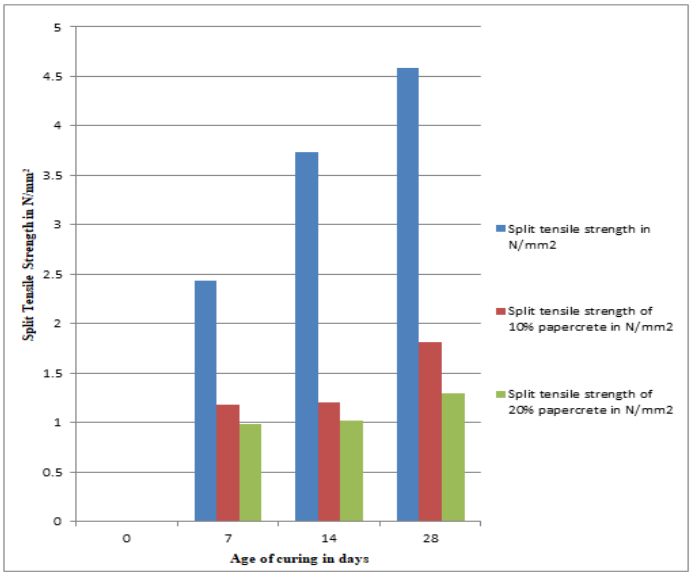

Fig.3.2 Graph of Split Tensile Test on Conventional Concrete and For 10% and 20% Papercrete

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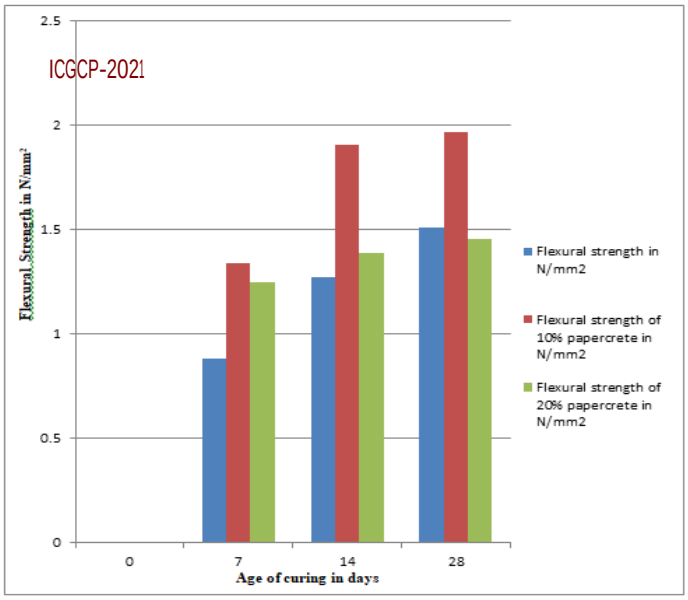

Fig.3.3 Graph of Flexural Test on Conventional Concrete and For 10% and 20% Papercrete

IV. CONCLUSIONS

1. As the percentage of paper mass is increased, the cube compressive strength decreased by 50% for 10% paper substitution and by 66% for 20% paper substitution and tensile strength decreased by 60% and 65% for 10% and 20% paper substitution respectively.
2. In flexural beam test, the flexural strength has increased by 25% and decreased by 10% for 10% and 20% paper substitution respectively.. This behaviour in tension is completely against split tensile test. Therefore this material quite fit to make pavement tiles, partitions boards, ceiling boards and other lightweight components of structures.
3. Increase in paper mass in concrete by 10% and 20%, increased water absorption by 4.5% and 6% respectively. This causes swelling of the mass and on drying, causes shrinkage which on repetition results in cracking. Thus either integral water proofer or water proof coating on this material is inevitable.
4. Its lighter than conventional moulds by 20% and 28% with 10% and 20% fraction of coarse aggregate was substituted by paper pulp and 10% of cement was replaced by fly ash .
5. Papercrete has a drawback of requiring more quantity of water at the time of mixing. Hence using admixture such as plasticizers or super plasticizers might reduce the amount of water needed.
6. The failure of papercrete is not sudden or a brittle failure, whereas it is gradual as it is compressible due to the presence of paper fibres which stretch before breaking.
7. Papercrete is suitable for making low cost homes with limited longevity and durability, as it is susceptible to changes in the surrounding environmental conditions.
8. It is also suitable for making community rooms, sale booths, storage rooms and dwellings for livestock.

V. REFERENCES

1. Myriam Marie Delcasse, Rahul V, Abhilash C, Pavan M K, Gangadhar. (March 2017) “Papercrete Bricks - An Alternative Sustainable Building Material” Myriam Marie Delcasse al. Int. Journal of Engineering Research and Application ISSN : 2248-9622, Vol. 7, Issue 3, (Part -6), pp.09-14.
2. KhonicaKeisham, Alva Pangambam, ChitraShijagurumayum. (March 2017) “A Review OnPapercrete”, International Journal of Engineering Technology, Management and Applied Sciences Volume 5 Issue 3, ISSN 2349-4476.
3. Prof.V. SoundaraRajan, R. Jagadeesh Kumar, L. Agnes Preethi, V. Mohanalakshmi, S.Kalpanadevi. “Experimental Investigation on Papercrete Bricks” IJSRD - International Journal for Scientific Research & Development| Vol. 5, Issue 02, 2017 | ISSN (online): 2321-0613.
4. K.Anandaraju, B.JoseRavindra Raj, R.VijayaSarathy. (June 2015) “Experimental Investigation of Papercrete Brick”, International Journal of Machine and Construction Engineering Volume 2 Issue 2 ISSN (Online): 2394 – 3025.
5. R.Selvaraj, R.Priyanka, M.Amirthavarshini, Dr.S.Prabavathy. (December 2015) “Evaluation Of Papercrete: An Innovative Building Material” International Journal of Engineering and Advanced Research Technology (IJEART) ISSN: 2454-9290, Volume-1, Issue-6.
6. Umarfarook H. Momin, Firoj Y. Sayyad (IRJET): “Highly compressed fly-ash based papercrete brick”
7. M .Manoj Kumar, G.UmaMaheshwari. (August 2017) “Papercrete”, International Journal of Science, Engineering and Technology Research (IJSETR) Volume 6, Issue 8, ISSN: 2278 -7798.

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A Comparative study on Water Quality Assessment of Chikkabanavara Lake in Bangalore City, Karnataka, India

Dhruvaraj M S[1], Pramod K R[2],Akshay J[3], ,Mahesh D[4]

Assistant professor's

Department of civil engineering

Sapthagiri college of engineering 14/5, Hesarghatta Main Rd, Chikkasandra, MEI Employees Housing Colony, Bengaluru, Karnataka 560057

[1]dhruvajms@sapthagiri.edu.in

[2]Pramodkr@sapthagiri.edu.in

[3]akshayj@sapthagiri.edu.in

[4]maheshd@sapthagiri.edu.in

Abstract - Lake water is the source of drinking and domestic use for rural and urban population of India. The aim of current comparative study was to assess water quality of Chikkabanavara Lake water, Bangalore. For this, lake water samples were collected from fifteen different locations on the basis of their importance were analyzed for the parameters like Temperature, Colour , Turbidity, , pH, Total Hardness, Calcium, Magnesium, Total Alkalinity, Nitrate, Chloride, Dissolved Oxygen (DO), Biological Oxygen Demand (BOD). . Findings suggest that lake water is not in the acceptable range for domestic usage, the Water Quality does not remain constant and it tends to change with time, more analysis can be conducted on the Lake after some time. Comparing previous data lake pollution rate is increasing constantly.

Keywords— —lake water, water quality, water pollution, physicochemical conditions

I. INTRODUCTION

Water quality refers to the chemical, physical, and biological characteristics of water based on the standards of its usage. A lake is an area filled with water, localized in a basin, surrounded by land, apart from any river or other outlet that serves to feed or drain the lake. The most common standards used to monitor and assess water quality convey the health of ecosystems, safety of human contact, and condition of drinking water. Water quality has a significant impact on water supply and oftentimes determines supply options. WQI is defined as a rating reflecting the composite influence of different water quality parameters. WQI is calculated from the point of view of the suitability of groundwater for human consumption. Rapid urbanization, especially in developing countries like India, has affected the availability and quality of groundwater due to its overexploitation and improper waste disposal, especially in urban areas. According to WHO organization, about 80% of all the diseases in human beings are caused by water.

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II. DETAILS OF THE STUDY AREA

Bangalore is located at a latitude of 12° 58′N and longitude of 77° 35′E at an altitude of 921 m above mean sea level (Lokeshwari and Chandrappa 2006). Bangalore spread over an area of 1000 km2 lies between latitudes 12°39′00″ to 131°3′00″N and longitudes 77°22′00″and 77°52′00″E and is heavily dependent on groundwater for its water requirements. This mega city situated on a N–S trending highland forms a divide between the rivers Arkavathi on the west and South Pennar on the east. Chikkabanavara Lake is located at a distance of 1.5 km north of Chikkabanavara railway station on the Bangalore-Tumkur railway line. The lake lies at 13°04'57.7"N 77°30'25.5"E. Chikkabanavara Lake spreads at about 100 acres on the outskirts of Bangalore.

Fig 1: The photo of Chikkabanavara Lake as captured from Google Maps

III. MATERIALS AND METHODS

Surface water samples for investigations were collected from fifteen different point in the lake sites selected which covered the critical area of the lake at 13°04'57.7"N 77°30'25.5"E.The grab samples were collected at 1 pm for on every Monday of week at 1 pm, sample was collected for period of August-December: 2020 and these were well preserved according as explained in the manual of Standard Operating Procedures of Sample storage, preservation and handling (IS:3025, 2003). Then they were later mixed together to get the composite samples. They were also labeled in order to prevent sample misidentification during analysis. The analysis of the following physicochemical

parameters and some heavy metals was carried out using standard methods. Colour , Turbidity, , pH, Total Hardness, Calcium, Magnesium, Total Alkalinity, Nitrate, Chloride, Dissolved Oxygen (DO) and Biological Oxygen Demand (BOD).

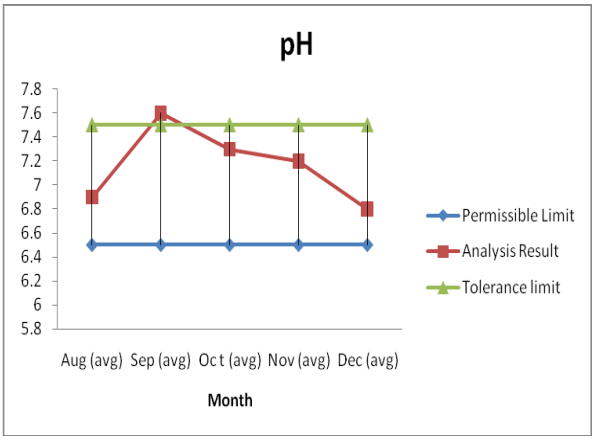
Analysis of the collected surface water samples was done in accordance with the procedures suggested in the Standard Analytical Procedure Manual for water samples which is based on IS:3025, 2003. Table 1 presents the methods of analyzing sampled different water parameter.

Table 1: Methods of Analysis

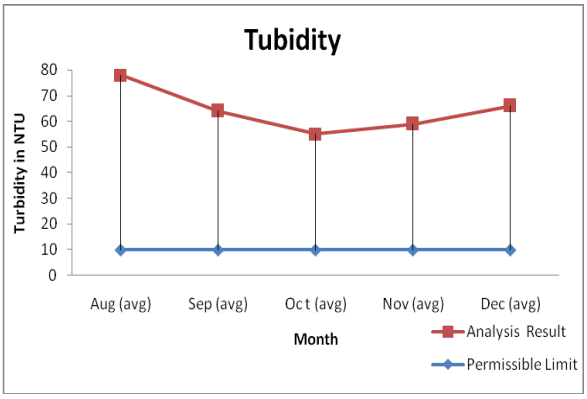
Sl. No	*Parameter*	*Method*	*Instru ment/ Equip*
1	Dissolved Oxygen	Mohr's method	DO Analyzer kit
2	Bio-chemical oxygen demand	Mohr's method	
3	Chloride	Titration with silver nitrate	Titration set up
4	Nitrates	Spectrophotometric abs.	Spectr ophoto meter
5	Total Hardness	Titration with EDTA	Titrati on set up
6	Calcium Hardness	Titration with EDTA	Titrati on set up
7	Magnesium Hardness	Titration with EDTA	Titrati on set up
8	pH	Electrometric	pH meter
9	Colour	observation	

IV. RESULTS AND DISCUSSIONS

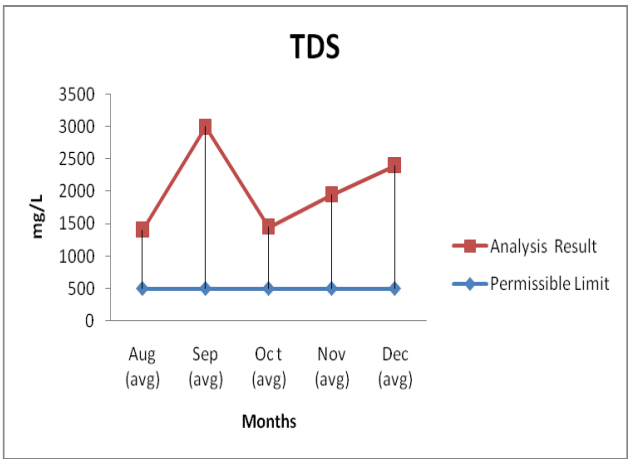
pH of water is important for the biotic compound. Most of the plant and animal species can survive in a narrow range of pH from slightly acidic to slightly alkaline condition



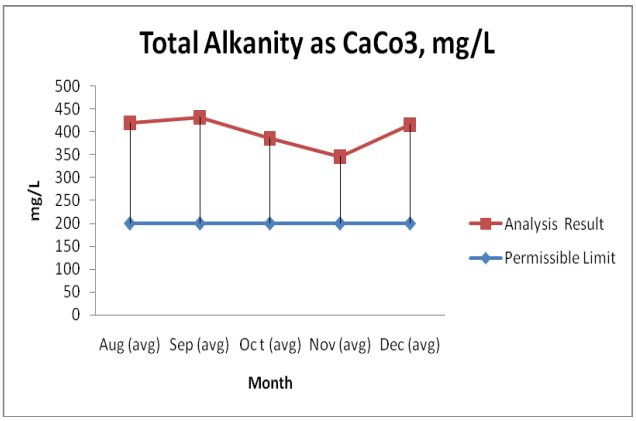
Turbidity of the lake water and the surrounding ground water ranged from 45 NTU up to 70 NTU which was higher than the permissible limit of 10 NTU



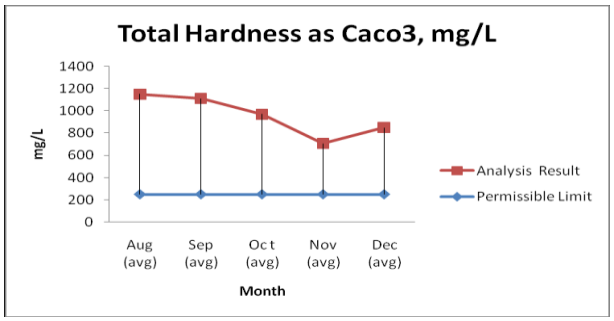
Total dissolved solids ranged from 950 to 2500 mg/L. This was excessive to the standard value of 500 mg/L and this affected the portability of water



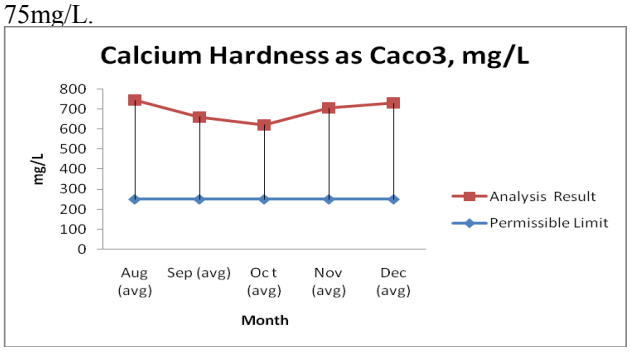
Total Alkalinity ranged from 140 to 230 mg/L. The Alkalinity value might have been due to the high pH in the water. The greater alkalinity values may be due to the large scale use of the banks of the lake as an open latrine and consequent washing of excreta in and near by the lake



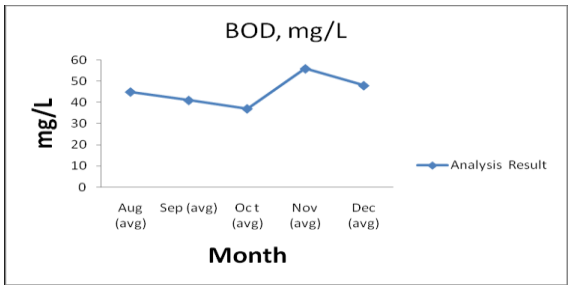
Total hardness ranged from 450 to 900 mg/L. These values were all above the permissible limit of 300 mg/L



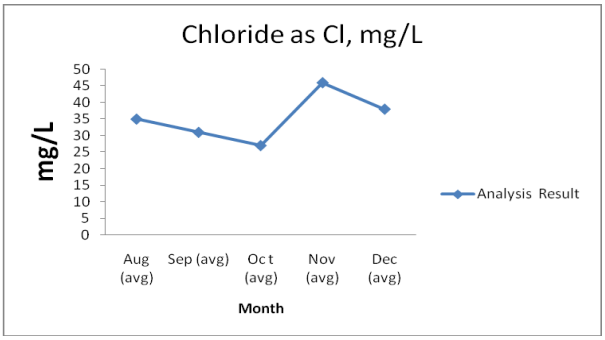
Calcium hardness is basically responsible for the hardness of water. The hardness values ranged from 370 to 500 mg/L which were all higher than the standard value of 75mg/L.



Bio Chemical Oxygen Demand was recorded in the range of 30 to 50 mg/L. This was only obtained for the waste water samples (Surface water)



Chloride ranged from 20 to 40mg/L. Chlorides in urban areas are the indicators of large amount of non-point source pollution by pesticides, grease, oil, metals and other toxic materials



Nitrates when present in excess can affect the water by creating conditions that will make it difficult for aquatic insects to survive. When they are present in a large number they tend to increase eutrophication. The result presented show that Nitrates are present in excess so the water will need to be treated for nitrates before it can be used for irrigation

CONCLUSION

Comparing Water Quality analyse data and found that water quality in river does not remain constant and it tends to change with time, day by day lake stars to loss its self-purification capacity and lake ecosystem also get disturbed and also there should be some rules set that will help prevent the pollution of the lake as discussed in the path towards ecological restoration.

REFERENCES

[1] Sona Pawara, Shruti Gujar, Siddhi Nalam,Saurabh Mirajkar, Vaishali Nagmoti, 2017, Remote Monitoring of Waters Quality from Reservoirs, 2nd International Conference for Convergence in Technology (I2CT).

[2] Devendra Dohare, Shriram Deshpande, Atul Kotiya (2014) Analysis of Ground Water Quality Parameters: A Review, Research Journal of Engineering Sciences, Vol. 3(5), 26-31.

[3] SS Sagar, RP Chavan ,CL Patil, DN Shinde, SS Kekane, 2015, Physico-chemical parameters for testing of water- A review, International Journal of Chemical Studies, 3(4): 24-28.

[4] Dr.C.Nagamani, Dr.C.SaraswathiDevi, A Shalini, 2015,Physico-chemical analysis of water samples, International Journal of Scientific & Engineering Research, Volume 6, Issue 1, pp-2149-2155.

[5] Rajkumar V. Raikar , Sneha, M. K, Water quality analysis of Bhadravathi taluk using GIS – a case study, International Journal Of Environmental Sciences, Volume 2, No 4, 2012,pp-2443-2453.

[6] Basavaraja, Simpi, Murthy KNS, and N. Patel Anil. "Analysis of water quality using physico-chemical parameters Hosahalli tank in Shimoga district, Karnataka, India." Global Journal of Science Frontier, Research 1.3 (2011): 31-34.

[7] Chaubey, Soni, and Mohan Kumar Patil. "Correlation study and regression analysis of water quality assessment of Nagpur City, India." International Journal of Scientific and Research Publications 5 (2015): 753-757.

[8] Dohare, Devendra, Shriram Deshpande, and Atul Kotiya. "Analysis of ground water quality parameters: a Review." Research journal of Engineering Sciences 3.5 (2014): 26-31.

[9] Gorde S. P., and M. V. Jadhav. "Assessment of water quality parameters: a review." Journal of Engineering Research and Applications 3.6 (2013): 2029-2035.

[10] Khalid, Anwar, et al. "Qualitative and quantitative analysis of drinking water samples of different localities in Abbottabad district, Pakistan." International Journal of Physical Sciences6.33 (2011): 7480-7489.

[11] Khan, Ilham, et al. "Impact of city effluents on water quality of Indus River: assessment of temporal and spatial variations in the southern region of Khyber Pakhtunkhwa, Pakistan." Environmental monitoring and assessment 190.5 (2018): 267

[12] . Pawara, Sona, et al. "Remote monitoring of waters quality from reservoirs." Convergence in Technology (I2CT), 2017 2nd International Conference for. IEEE, 2017.

[13] Rani, H. B., Bahri, D., Neupane, P., Kothari, K., Gadgihalli, V., Dinakar, R. P. H., ... & Deginal, K. Water Quality Analysis: A Case Study In Byramangala Lake Water and Surrounding Ground Water, (2017).

[14] Sagar, S. S., et al. "Physico-chemical parameters for testing of water-A review." International Journal of Chemical Studies 3.4 (2015): 24-28.

[15] Ullah, H., et al. "Chemometric evaluation of heavy metals distribution in wastewater irrigated soil of peri-urban area." International Journal of Environmental Science and Technology: 1-12. 17. Vaishnavi, V., R. C. Varshitha, and M. Tejaswini. "Literature Survey on Smart Water Quality Monitoring System." 18. Zafar, Shabnam, et al. "Assessing impact of effluent discharge on irrigation water quality in southern region of Khyber Pakhtunkhwa, Pakistan." Environmental monitoring and assessment 189.4 (2017): 156.

PARTIAL REPLACEMENT OF BITUMEN WITH CANDLE WAX IN BITUMEN MIX GRADE

Pramod K R[1],Akshay J[2],Dhruvaraj M S[3],Mahesh D[4]

Assistant professor's

Department of civil engineering

Sapthagiri college of engineering 14/5, Hesarghatta Main Rd, Chikkasandra, MEI Employees Housing Colony, Bengaluru, Karnataka 560057

[1]Pramodkr@sapthagiri.edu.in

[2]akshayj@sapthagiri.edu.in

[3]dhruvajms@sapthagiri.edu.in

[4]maheshd@sapthagiri.edu.in

Abstract— Bitumen is obtained from the distillation of petroleum. It is basically a sticky type of black viscous liquid and is the semi-solid form of petroleum. It is found in natural deposits and sometime. The bitumen is used as a sort of binding agent throughout the world and its need is on increasing alarm. This study is basically based to modify bitumen by using candle wax, Various tests were being done in order to find out what will be the effect on the bitumen by adding smaller percentages of waxes. The modification was done and the results were being recorded with the Hot mix asphalt technologies. By adding waxes at various percentages like 1%,2%,3%,4% were being added to it at varying percentages with the bitumen. The results showed that by adding waxes on bitumen the viscosity is increased as the wax content is being decreased and by this the compaction temperature and their addition temperature was also decreased.

Keywords— Candle wax, Bitumen., Marshall Properties, Mix design, Replacement.

I. INTRODUCTION

Bitumen is defined as a viscous liquid that constitutes the mineral oil, which possess a variety of hydrocarbons which will have a high or increased molecular weight and these hydrocarbons contain small proportions of oxygen, nitrogen and also of Sulphur. Additionally, it also has hydrocarbon derivatives which are being soluble in carbon Di-Sulphide Bitumen is either black or it can be brown in Colors, according to its mode of derivation. It has good water proofing and adhesive that is the sticking properties. Candle wax is defined as a soft white material which is basically colorless in nature. It is being extracted from petroleum coal and then the mixing is being done. This mixing occurs having about 20 to 40 carbon atoms in it. The melting point of the wax is 37°C and the Boiling point is greater than 370°C. At room temperature it is generally hard in nature and when the temperature is being increased it starts to melt. The term wax was firstly use in bee wax. But due to new technologies, it was made significant on various important issues like wax being applied to solids as well as on liquids. Due to the recent development the volumes of the traffic and the heavy axle loads are being increasing tremendously, so the researchers try to make ways of improving the bitumen mixture by increasing their performance and for this the best way to do is by modification of the bitumen with the help of certain additives. When the bitumen is being manufactured from crude oil, in this process large amount of gases like benzene, Sulphur dioxide and also nitrogen oxide are being evolved out in the atmosphere and these can be little bit controlled in the industry, but when the process of transportation and the application process takes place, bitumen gets heated to high temperatures.

OBJECTIONS

- To study the properties of the bitumen when added with small quantities of candle wax.
- To analyse the effect on the softening properties of the bitumen.
- To investigate on the strength parameters of the bitumen with the addition of the modifiers.
- To study about whether the bituminous mix is sustainable or not.
- To study about the economic and financial aspects that is being generated by the bitumen and the various mixes.
- To evaluate about the effects on the environment.

II. METHOLOGY

- Collection of Material
- Selection of Material
- Test on Material
- Finalize of Material

III. BASIC TEST ON NATURAL AGGREGATES

Basic tests on natural aggregates

TESTING OF MATERIALS	SPECIFIC GRAVITY TEST	LOS ANGELES ABRASION TEST	IMPACT TEST	CRUSHING VALUE TEST	FLAK INESS TEST
Requirement as per specification IS 2386:1963(R2016)	2.5-3	30%	Max 27%	Max 30%	Max 30%
Obtained values of aggregates	2.76	26%	16.5%	24.21%	15%

TABLE 1 SHOWING NATURAL AGGREGATES TESTING VALUES

V. SHOWING BITUMEN TESTING VALUES

Basic tests on Bitumen

DESCRIPTION OF TEST	TEST RESULTS	REQUIREMENT AS PER IS: 73- 2006
Bitumen penetration test	34	30-40
Softening point test	48 ^{0}C	45-55 ^{0}C
Ductility test	77	75(MINIMUM)
Viscosity test	45MINS	40MINS
Specific Gravity test	1.034	0.99

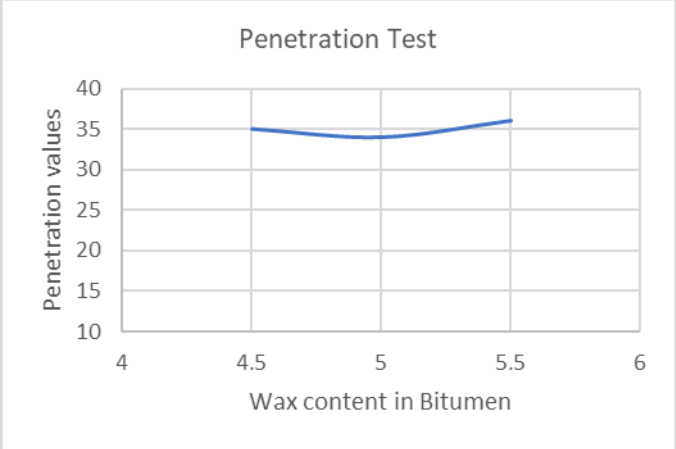
TABLE 2 SHOWING BITUMEN TESTING VALUES

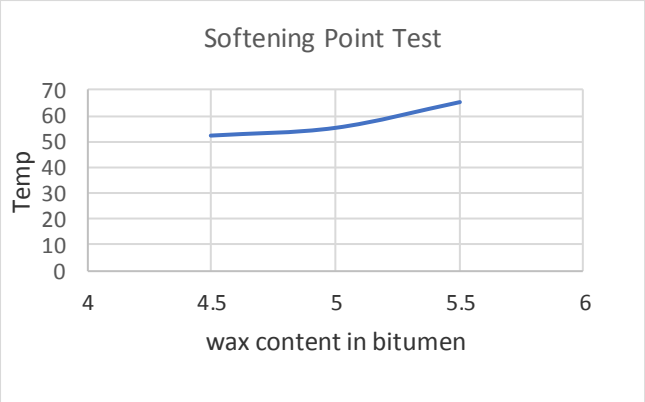
Basic tests on Bitumen replacement with wax

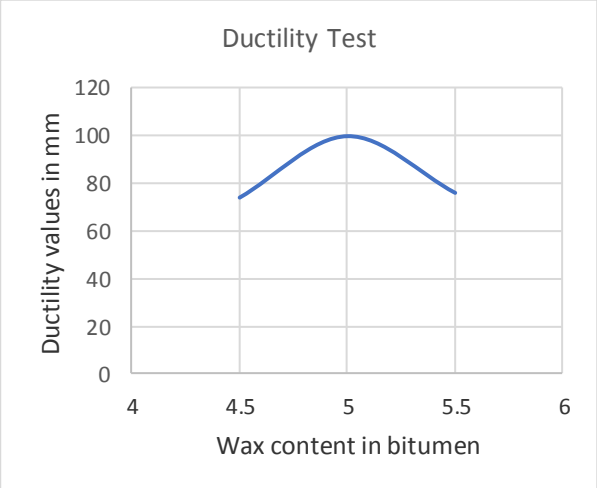
	Wax Content in Bitumen		
DESCRIPTION OF TEST	4.5%	5%	5.5%
Bitumen penetration test	35	34	36
Softening point test	52	55	65
Ductility test	76	100	74
Viscosity test	46	51	54

TABLE 3 SHOWING BITUMEN TESTING VALUES WITH REPLACEMENT OF CANDLE WAX

VI. GRAPHICAL REPRESENTATION OF VARYING WAX CONTENT IN BITUMEN WITH RESPECT TO VARIOUS TEST ON BITUMEN







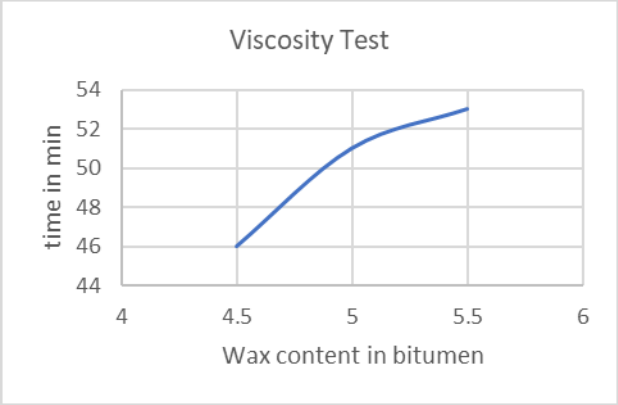


Figure 1 Showing graphical representation of varying wax content in bitumen with respect to various test on bitumen

VII. MARSHALL STABILITY TEST

Marshall Stability is conducted on compacted cylindrical specimens of bituminous mix of diameter of 101.6mm and thickness 63.5mm.The load is applied perpendicular to the axis of the cylindrical specimen through a testing head consisting of a pair of cylindrical segments, at a constant rate of deformation of 51mm per minute at the standard test temperature of 60 degree celcius.

The `Marshall Stability' of the bituminous mix specimen is defined as a maximum load carried in kg at the standard test temperature of 60 degree celcius when loaded under specified test conditions. The `flow value' is the total deformation that the Marshall test specimen undergoes at the maximum load, expressed in `mm' units.

VIII. SPECIMEN PREPARATION AND TESTING

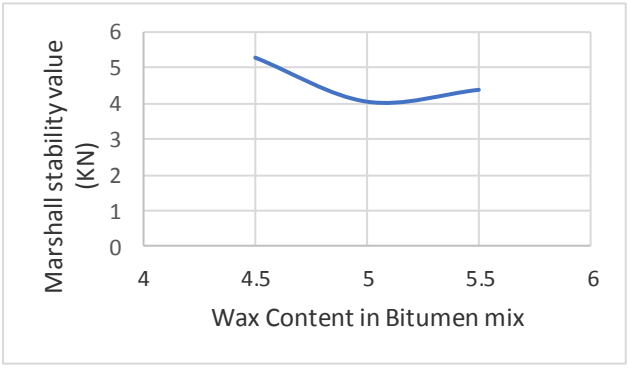
Approximately 1250gm of aggregates and filler is heated at a temperature of 175-190 degree Celsius. Bitumen is heated of 121-125 degree Celsius. The heated aggregate and bitumen are thoroughly mixed at a temperature of 154-160 degree Celsius. The mix is placed in a preheated mould and compacted by a rammer with 75 blows on either side at a temperature of 138 degree Celsius to 149 degree Celsius. The weight of mixed aggregates taken for the preparation of specimen maybe suitably altered to obtain a compacted thickness of 63.5+/- mm vary the bitumen content in the next trial by 0.5% and repeat the above procedure.

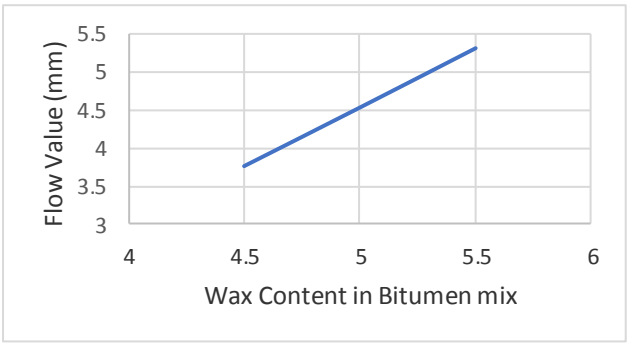
The load is applied at constant deformation rate of 51mm per minute and load and deformation rate of 51 mm per minute and load and deformation of the specimen at failure are noted. The max load value expressed In `kN' is recorded as the `Marshall stability' value of the specimen. The vertical deformation of the test specimen corresponding to the maximum load expressed in 'mm' units is recorded as the `flow values'.

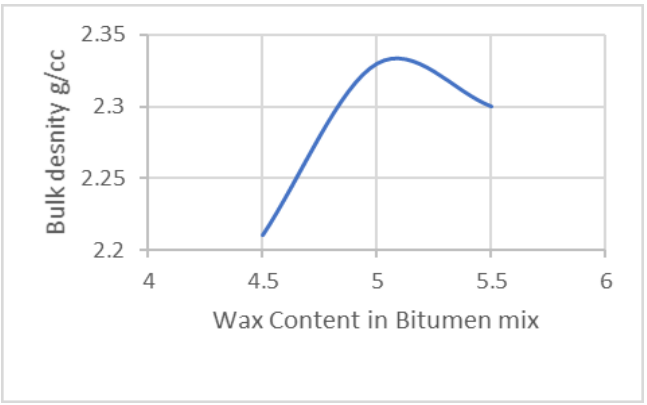
IX. DATA OF MARSHALL STABILITY TEST

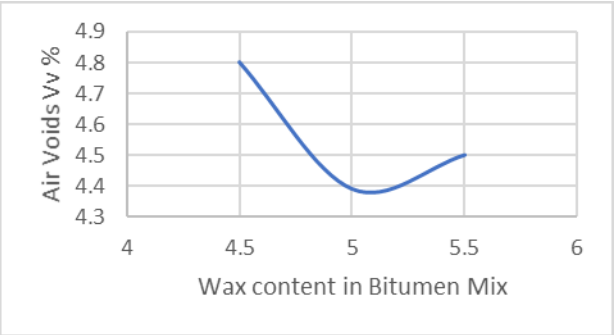
Candle Wax Content in Bitumen (%)	Marshall Stability Value (KN)	Flow Value (mm)	Bulk Density of the Mix (g/cc)	Total Air Voids V v %	Voids in Mineral Aggregate (VMA)	Voids Filled With Bitumen (VFB)
4.5	5.3	3.6	2.21	4.8	6.6	72.72
5	4.04	4.53	2.33	4.39	6.345	68.22
5.5	4.38	5.31	2.3	4.5	6.75	6.66

Table 4 Showing the Data of Marshall Stability Test









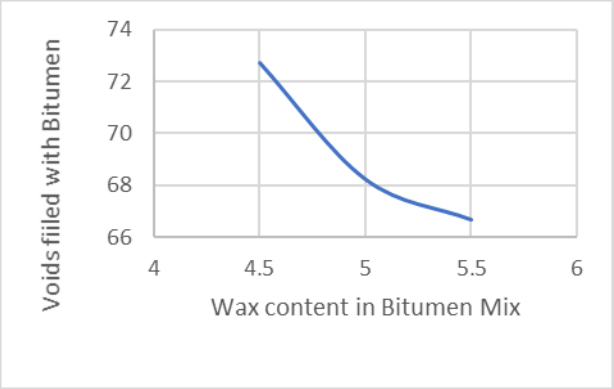


Figure 2 showing graphical representation of varying wax content in bitumen with respect to Marshall stability test

X .Results and Conclusion

- From desired results obtained from conducting experiment bitumen mix with 5% wax is best for pavement because all properties including resulting characteristics, shows best result at this quantity of wax and also it is good from economics point of view.
- The addition of wax exactly 5% will produce ductility in bitumen that will not flush or bleed when subjected to incremental changes in temperature, thus performing better than the unmodified bitumen.
- The Bituminous mix with 5% of wax shows considerable improvement in various mechanical properties.
- Natural wax in straight run bitumen today is low in content and of a type which should not be particularly harmful for binder Properties.
- The most feared influence of wax in bitumen is the sudden decrease in viscosity due to the melting of wax , if should occur within a temperature range affecting the resistance to permanent deformation of binder and asphalt pavement.
- Result and experience concerning some negative effects of wax in bitumen are based mainly on a laboratory studies on bitumen and bitumen mixtures and very few studies concerning effects of waxy bitumen on pavement properties have reported.
- For blown bitumen and wax modified bitumen in Road construction, the effects on bitumen may vary considerably.

XI. REFERENCES:

- Vijaya Sarathy R, Jose Ravindra raj B, Dinesh Kumar S, Analysis Of Properties In Bitumen And Asphalt With Partial Replacement Of Rubber Tyres May, 2015.
- Tandel Foram, Patel Arsh and Patel Ankit, Utilization of Candle Wax in Bitumen Pavement, June 2016.
- S Minu , R L Lija, Effect of partial substitution of candle wax in Bitumen.
- P K Das and B Birgisson " Lo Temperature Cracking Performance of Wax added to Bitumen".
- Hassan Fazelli , Hamid Behbahani , Amir Ali " Different Temperature Properties of Bitumen by FT-Paraffin".
- R. Sathishkumar and Dr. S P Jeyapriya " Comparison of Strength Properties of Bitumen Mixed With Waste Materials as Modifier".

DETERMINATION OF MARSHALL PROPERTIES OF HOT MIXED ASPHALT MIXED WITH RECYCLED COARSE AGGREGATE

Akshay J
Assistant Professor, Civil engineering department, Sapthagiri college of engineering, 14/5, Chikkasandra, Hesarghatta main road, Bengaluru, Karnataka, India

Dhruvaraj M S
Assistant Professor, Civil engineering department, Sapthagiri college of engineering, 14/5, Chikkasandra, Hesarghatta main road, Bengaluru, Karnataka, India

Pramod K R
Assistant Professor, Civil engineering department, Sapthagiri college of engineering, 14/5, Chikkasandra,Hesarghatta main road, Bengaluru, Karnataka, India

Mahesh D
Assistant Professor, Civil engineering department, Sapthagiri college of engineering, 14/5, Chikkasandra, Hesarghatta main road, Bengaluru, Karnataka, India

Abstract
The migration of population towards the big cities generates rapid construction activities. These activities not only put pressure on natural resources but also produce construction, renovation and demolition waste. There is an urgent need to find out ways to handle this waste owing to growing environmental concerns. This can reduce pressure on natural resources as well. The incorporation of Recycled Coarse Aggregate (RCA) in Hot Mix Asphalt (HMA) could be a way to promote sustainable construction.

In this investigation, a laboratory characterization of HMA made with RCA from Construction and Demolition Waste (CDW) for base layers in road pavements was conducted. Percentages of 5%, 10%, 20% and 30% of RCA in place of natural aggregate was analyzed. Rothfuch's graphical method of aggregate gradation was used to grade the aggregates according to MoRTH specifications for DBM grade 2. The Marshall Mix design procedure was used to develop the mixes. The Marshall Stability and flow test provides the performance measure for the Marshall Mix design method. The Marshall properties (stability, flow value, percentage air voids, voids filled with mineral aggregates (VMA), voids filled with bitumen (VFB)) of the mixtures were studied. The results indicated that HMA made with RCA exhibited mechanical properties similar to those obtained for conventional mixtures and thus, the mixes are found to comply with IRC specifications.

Keywords: Construction waste, Hot mix asphalt, Marshall properties, Mix design, Recycle

Introduction
The demand for good-quality highway materials continues to increase whereas economical sources are becoming more limited. This demand may become more critical, especially with the policy (adopted by some state highway departments) of banning some aggregate types that have been frequently used in the past for producing paving mixtures.

Bituminous mixture is a combination of aggregate and binder. The aggregate acts as the structural skeleton of the pavement and bitumen acts as the glue of the mixture. The properties of the aggregate have direct and significant effect on the performance of the pavement. The utilization of industrial by-products and recycled materials in road construction as secondary and alternative materials has gained widespread acceptance and is becoming more important.

To date, several investigation have examined the use of this type of waste material in HMA. In this investigation, a laboratory characterization of HMA made with Recycled coarse aggregates (RCA) for base layers in road pavements was conducted. Percentages of 5%, 10%, 15% 20%, 25% and 30% of RCA in place of natural aggregate was analyzed. The results indicated that bituminous mix made with RCA exhibited mechanical properties similar to those obtained for conventional mixtures.

The Marshall Mix design procedure was used to develop the mixes. The Marshall Stability and flow test provides the performance prediction measure for the Marshall Mix design method. The stability portion of the test measures the maximum load supported by the test specimen at a loading

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rate of 60mm/min. The flow value is recorded in 0.25mm (0.01inch) increments at the same time when the maximum load is recorded. The proportion of aggregate directly affect the performance of bituminous mix depending on their shape, texture and strongly on the gradation.

The determination of aggregate proportion depends strongly on the number of aggregate types to be blended and the limits of the desired gradation. Rothfuch's graphical method of aggregate gradation is used for better results. The results indicated that the mixes comply with IRC specifications. The Marshall properties (stability, flow value, percentage air voids, voids filled with mineral aggregates (VMA), voids filled with bitumen (VFB)) of the mixtures were studied.

Objectives

1. To determine the gradation of Dense Graded Bituminous Macadam (DBM) (grade 2) using Rothfuch's method.
2. To determine the base properties of aggregates, Recycled coarse aggregates and bitumen.
3. To determine the optimum binder content of DBM.
4. To determine the varying Marshall properties on replacing natural aggregates with Recycled coarse aggregates

Methodology

BASIC TESTS ON NATURAL AGGREGATES AND RECYCLED COARSE AGGREGATES

Natural aggregates used are crushed granite aggregates of 40mm downsize.
The RCA aggregates bought were of 40mm downsize.
Mechanical properties of both natural aggregates and RCA aggregates were tested and the results are as follows:

Table 1: IRC standard value table

Test name	Standard value as per IRC code
Aggregate crushing value	Max 30 %
Aggregate impact value	Max 27 %
Los Angeles abrasion value	Max 35 %
Waterabsorption	2%
Specific gravity	2.5-3

Table 2: Basic test on aggregate

Sl.No	Test name	Natural coarse aggregates	RCA
1	Aggregate crushing value	25.21%	20.59%
2	Aggregate impact value	17.78%	38%
3	Los angeles abrasion value	26.4%	33.96%
4	Water absorption	0.675	4.81%
5	Specific gravity	2.76	2.73
6	Flakiness and elongation	15%, 17%	16%, 19%

BASIC TESTS ON BITUMEN

Bitumen of VG30 grade is used and its basic properties were tested and the results are as follows:

Table 3: Basic tests on bitumen

Sl no	Description of Tests	Test Results	Requirements
1	Penetration test	67	60-70
2	Specific Gravity	1.02	0.99(minimum)
3	Softening Point(◦C)	47	45-55
4	Ductility in cm	76.3cm	40(minimum)
5	Viscosity test	42mins	40(minimum)

GRADATION OF AGGREGATES

The aggregate gradation for Dense Bituminous Macadam mix Grading-2 mid limit gradation was chosen as per table 500-10, of MoRTH (4th revision) specifications.

Grain Size Analysis for proportioning of Materials

The Grain Size Analysis was carried out by combining three sizes of materials into A, B, C varieties and the results are tabulated

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Table 4: Gradation of aggregates as per MoRTHspecificatons

Sieve Size(mm)	% Passing Specified	Mid limit
37.5	100	100
26.5	90-100	95
19	71-95	83
13.2	56-80	68
4.75	38-54	46
2.36	28-42	35
0.30	7-21	14
0.075	2-8	5

Table 5: Sieve analysis results

IS Sieve Size (mm)	% Passing		
	A	B	C
37.5	100	100	100
26.5	95	100	100
19	-	78	100
13.2	-	68.5	100
4.75	-	-	56
2.36	-	-	37.3
0.3	-	-	22
0.075	-	-	3.2

Rothfuch's graphical method of aggregate gradation

Rothfuch's method can be adopted for design of mixes using two, three or more number of materials. Proportioning of materials by rothfuch's method is as fallows.

1. First sieve analysis of the different selected aggregate is to be carried out in the laboratory. The results of the grain size distribution tabulated giving the different sieve sizes and cumulative percentages passing each sieve, ranging from 0 to 100% .
2. On a plain graph paper , the cumulative percentages passing various sieves ranging from 0 to 100% are plotted to natural scale on the y-axis. The x-axis is to represent different particle scale to be plotted later. The point representing 100% passing located on the y-axis represents maximum size of the set of sieves used in the sieve analysis, through which 100% of all the selected material will pass.
3. A sloping straight line of a convenient slope is drawn from this 100% passing point on the y-axis, to a point corresponding to 0% passing laying on the x-axis. The smallest sieve size that will be made use of, will be near this point on the x-axis, before the 0% passing. This sloping line represents the balancing straight line of the gradation of the mixed aggregates.
4. Using the grain size distribution table, the cumulative percentage passing any particular sieve size is selected and a line is drawn parallel to the x-axis so that, the line intersect the sloping line at a point and that point of intersection, a line parallel to y-axis is drawn to intersect the x-axis is marked as the grain size representing the selected sieve size.
5. Now in the chart the grain size distribution curves of the selected materials to be mixed are plotted. For eg: three materials A,B and C available locally are to be mixed. The grain size distribution curves of these materials are plotted. The straight lines of A,B,C are obtained allowing only minimum of the areas equally on either side of the balancing lines. The opposite ends of the balancing straight lines of A and B are joined.
6. The points where these two lines meet the sloping lineindicate the proportions in which the materials A,B and C are to be mixed . These values may be read from the y-axis by projecting the points of intersection of the sloping line.

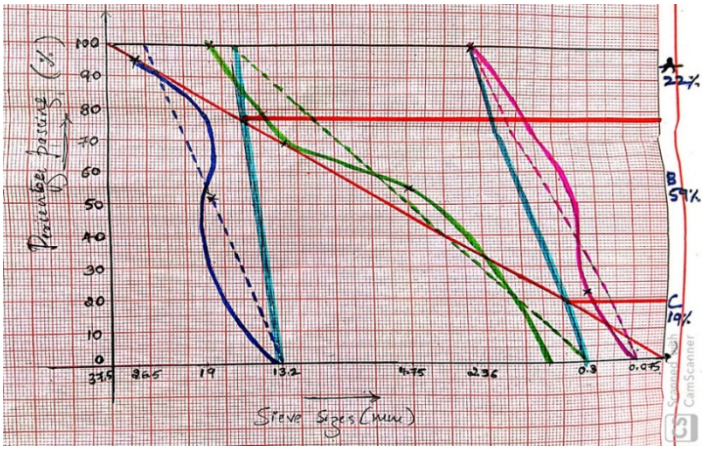

Figure 1: Rothfuch's graph as per obtained sieve analysis results

Table 6: Job mix formula table

IS Sieve Size (mm)	% Passing of materials			Obtained Gradation from Job Mix Formula obtained from graph (0.22A+0.59B+0.19C)	Specified Gradation according MoRTH DBM:GRADE-2
	A	B	C		
37.5	100	100	100	100	100
26.5	95	100	100	98.9	90-100
19	-	78	100	95.16	71-95
13.2	-	68.5	100	59.415	56-80
4.75	-	-	56	52.04	38-54
2.36	-	-	37.3	41	28-42
0.3	-	-	22	8.18	7-21
0.075	-	-	3.2	3.608	2-8

Material A = 22 % Material B = 59 % Material C = 19%

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MARSHALL STABILITY TEST

Marshall Stability is conducted on compacted cylindrical specimens of bituminous mix of diameter of 101.6mm and thickness 63.5mm.The load is applied perpendicular to the axis of the cylindrical specimen through a testing head consisting of a pair of cylindrical segments, at a constant rate of deformation of 51mm per minute at the standard test temperature of 60 degree celcius.

The `Marshall Stability' of the bituminous mix specimen is defined as a maximum load carried in kg at the standard test temperature of 60 degree celcius when loaded under specified test conditions. The `flow value' is the total deformation that the Marshall test specimen undergoes at the maximum load, expressed in `mm' units.

SPECIMEN PREPARATION AND TESTING:

Approximately 1250gm of aggregates and filler is heated at a temperature of 175-190 degree Celsius. Bitumen is heated of 121-125 degree Celsius. The heated aggregate and bitumen are thoroughly mixed at a temperature of 154-160 degree Celsius. The mix is placed in a preheated mould and compacted by a rammer with 75 blows on either side at a temperature of 138 degree Celsius to 149 degree Celsius. The weight of mixed aggregates taken for the preparation of specimen maybe suitably altered to obtain a compacted thickness of 63.5+/- mm vary the bitumen content in the next trial by 0.5% and repeat the above procedure.

The load is applied at constant deformation rate of 51mm per minute and load and deformation rate of 51 mm per minute and load and deformation of the specimen at failure are noted.The max load value expressed In `kN' is recorded as the `Marshall stability' value of the specimen.The vertical deformation of the test specimen corresponding to the maximum load expressed in 'mm' units is recorded as the `flow values'.

DETERMINATION OF OPTIMUM BINDER CONTENT (OBC):

Marshall Test specimens were prepared by adding 3.5, 4.0, 4.5, 5, 5.5and 6% of Bitumen. The compacted specimens were removed from moulds after 24 hours. The specimens were kept in thermostatically controlled water bath maintained at 60 degree Centigrade for 30 minutes. Graphs are plotted taking bitumen content (%) on X-axis and Marshall Stability value, flow value, bulk density, percentage of Air voids and percentage of voids filled with bitumen on Y-Axis.

Bitumen Content %	Marshal Stability (kN)	Flow Value (mm)	Bulk Density-G_b (g/cc)
3.5	10.53	1.86	2.154
4.0	11.03	2.10	2.155
4.5	11.77	3.06	2.188
5.0	13.39	3.56	2.205
5.5	11.89	4.10	2.184
6.0	10.90	4.40	2.086

The optimum Binder content for the mix is found by taking the average of following three bitumen contents from the graphs of the results:

1. Bitumen content corresponding to maximum stability.
2. Bitumen content corresponding to maximum unit weight.
3. Bitumen content corresponding to maximum 4% air voids.

Table 7: Marshall test results for determining OBC

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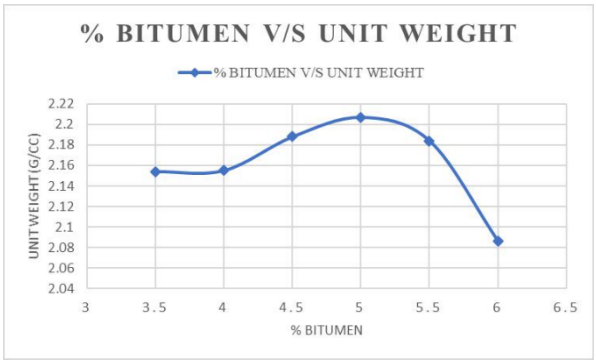
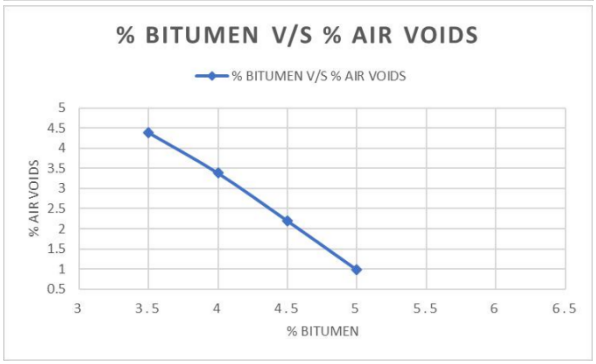
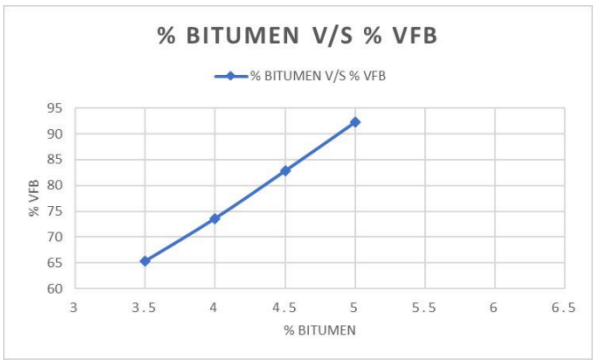






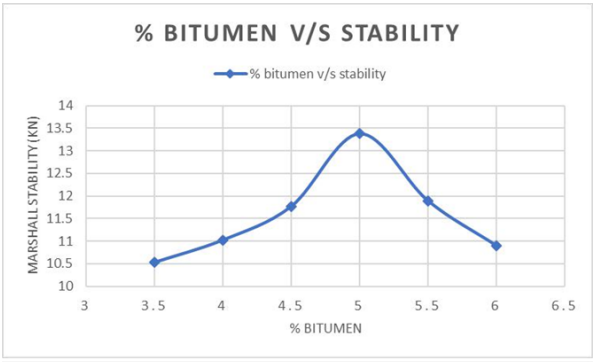
Bitumen Content %	Total Air Voids(V_v) %	Voids Filled with Mineral Aggregate-VMA %	Voids Filled with Bitumen-VFB %
3.5	4.38	12.615	65.279
4.0	3.38	12.791	73.575
4.5	2.2	12.788	82.796
5.0	0.99	12.75	92.235
5.5	-	12.94	-
6.0	-	14.11	-

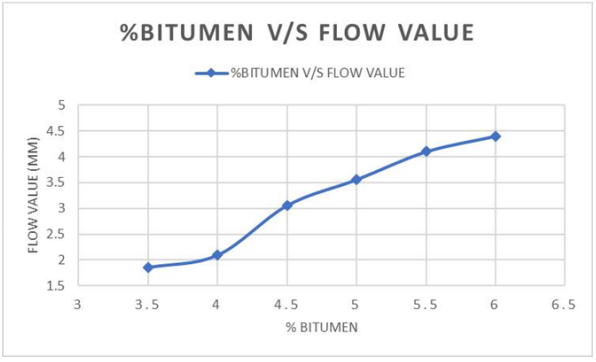
The optimum Binder content for the mix is found by taking the average of following three bitumen contents from the graphs of the results:

1. Bitumen content corresponding to maximum stability.
2. Bitumen content corresponding to maximum unit weight.
3. Bitumen content corresponding to maximum 4% air voids.

Hence the optimum Bitumen Content is (5.0+5.0+4.5) / (3) = **4.83%**

This percentage of binder (bitumen) was used for the remainder of the research to bind the aggregates. The Marshall properties of the mix at this binder content was also studied





MARSHALL PROPERTIES AT OPTIMUM BINDER CONTENT

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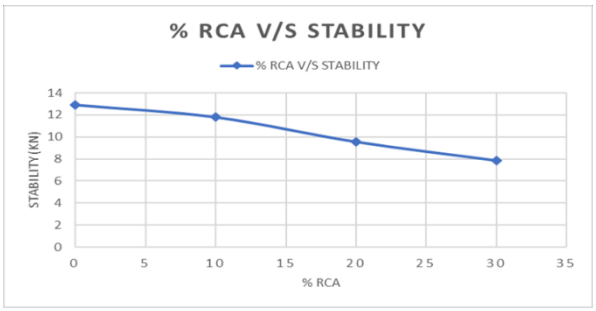
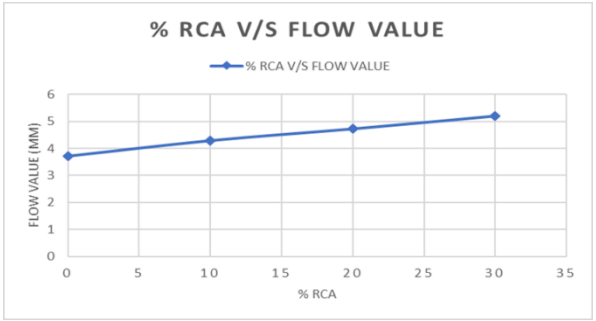
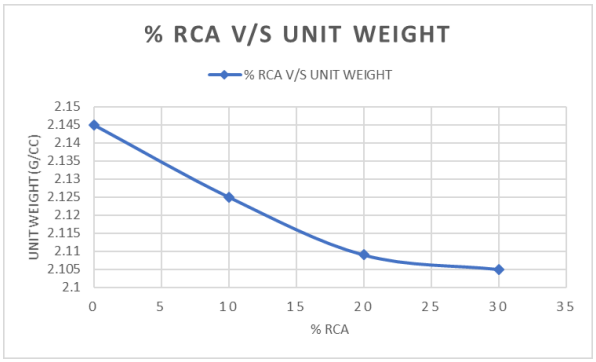


The Marshall properties of the bituminous mix at the determined binder content is found out and is tabulated as follows:





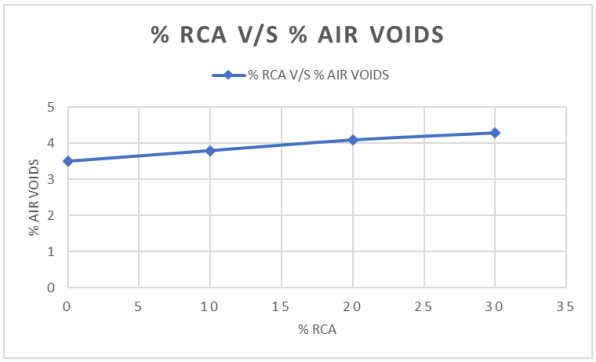


Table 8: Marshall Properties value at OBC

RCA %	Marshall Stability (kN)	Flow Value (mm)	Bulk Density G_b (g/cc)
0	12.93	3.73	2.145
10	11.814	4.3	2.125
20	9.575	4.73	2.109
30	7.876	5.2	2.105

VARIATION IN MARSHALL PROPERTIES AT VARYING PERCENTAGE REPLACEMENT OF NATURAL AGGREGATES BY RECYCLED COARSE AGGREGATES

The natural aggregates were replaced with RCA aggregates and the Marshall properties were tested so as to determine up to what percentage the RCA could be utilized in place of natural aggregates the results are as follows:

Table 9: Marshall Property variation

Marshall Properties	Results of DBM Grade-2 Mix	Requirements as per MoRTH Specifications
Optimum Binder Content,%	4.83	Min 4.5%
Stability(kg)	12.93 kN	9kN
Flow Value(mm)	3.73 mm	2 to 4 mm
Bulk Density(g/cm3)	2.145g/cc	-
Air Voids(Vv)	3.5	3 to 6
VMA%	21.87%	Min 12.5%
VFB(%)	68.1%	65 to 75%

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requirement as per the MoRTH specification Table 500-11.
2. The parameters such as stability, voids filled with bitumen and dry unit weight decreases with increase in % replacement of Natural aggregates by RCA in DBM mixes.
3. The parameters such as flow value, air voids and voids filled with mineral aggregates increases with increase in % replacement of Natural aggregates by RCA in DBM mixes.
4. Replacement of Natural aggregates by Recycled coarse aggregates up to 20% for DBM can be permitted without compromising the Specification requirements

Future scopes

1. The more the installation of Recycling plants for the construction and demolition waste can helps to reuse the waste in large extent easily.
2. The treating of RCA with bitumen emulsion can reduce the absorption of bitumen by RCA at the time of mixing.

Discussion

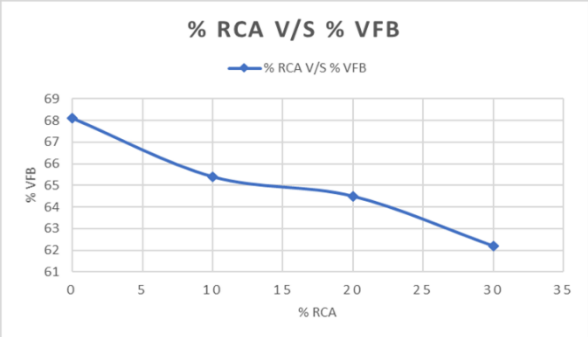
1. The Excess replacement of Natural aggregates by Recycled coarse aggregate reduces the load carrying capacity of the Dense bituminous Macadam layer. The mortar present over the RCA surface will effect the optimum binder content partially by absorbing bitumen.
2. The mortar present over the surface also effect the binding of bitumen and aggregate because of presence of water in mortar.
3. The RCA have already been undergone through stresses in their design life, hence affects to not replace Natural aggregate by larger percentage.

Conclusions

1. On the basis of the results of this project work the following conclusions can be drawn:
2. Results of physical properties of the aggregates used in this study were tested and are presented in table-2 and test results are satisfying the requirements as per Table 500-8 of MoRTH(IV revision) specifications.
3. The physical properties of the plain binder used for this study was tested and are presented in table-3 respectively and test results are satisfying the requirements as per IS: 73-2002 for plain Bitumen.

MARSHALL TEST PROPERTIES:

1. For Marshall Mix Design, optimum bitumen content was 4.83 % for a DBM mix and it was meeting the



References

[1] Highway engineering by S.K KHANNA, C.E.G JUSTO and A VEERARAGAVAN.
[2] Revised 5th edition 2019.
[3] Nem Chand & bros., Roorkee 247 667, India
[4] Principles and practice of highway engineering (Including Express ways and Airport Engineering)
[5] By Dr L.R KADIYALI, and N.B LAL
[6] Khanna publishers, New Delhi-6
[7] Ministry of Road Transport and Highways (4th revision)
[8] IS:2386 (part 4)-1963 "Crushing strength test, Abrasion test, Impact test" on aggregates
[9] IS: 2386 (Part 1)-1963 "Shape test" on aggregates.
[10] IS: 2386 (Part 3)-1963 "Specific gravity" on aggregates
[11] IS: 1203-1978 "Penetration Test" on bitumen
[12] IS: 1208-1978 "Ductility test" on bitumen
[13] IS: 1205-1978 "Softening point test" on bitumen
[14] IS: 1202-1978 "Specific gravity" on bitumen
[15] "Experimental testing of hot mix asphalt mixture made of recycled aggregate", Muhammad Masood Rafi (2011) submitted to PENNSYLVANA STATE UNIVERSITY on March 4,2016 (Waste management & research) wmr.sagepub.com
[16] "Stiffness of cold asphalt mixtures mixtures with recycled aggregate from construction and demolition waste", B.Gomez-Meijide(2015) Published in Construction and management materials (Higher Technical School of Civil Engineers,Department of Civil Engineering,University of Nottingham)
[17] Geo-technical and Geo-Environmental assessment of recycled construction demolition waste for road embankments. Nuno Cristelo(2016) Advance in transportation Geo-technics.
[18] Mechanical properties of hot-mix asphalt made with recycled concrete aggregates coated with bitumen emulsion. A.R.Prasandin(2011) (Higher Technical School of Civil Engineers,Department of Civil Engineering,University of Nottingham)

ISBN: 979-85-27243-61-1

[19] Recycled Construction and Demolition waste in cold asphalt mixtures: evolutionary properties.B.Gomez-Meijide (2011) ((Higher Technical School of Civil Engineers,Department of Civil Engineering,University of Nottingham)
[20] Effects of the use of Construction and Demolition waste aggregates in cold asphalt mixtures. B.Gomez-meijide(2012) (Published in Construction and Building Materials (Higher Technical School of Civil Engineers,Department of Civil Engineering,University of Nottingham,Spain) (NTEC)
[21] "Hot mix asphalt using c&d waste as coarse aggregates" I.Perez , A.R Pasandin;L.Medina (University of Coruna).
[22] Reuse of Construction and Demolition waste in the Netherlands for road constructions CH.F. Hendriks Delft University of technology, faculty of civil engineering and GeoSciences
[23] "Effects of recycled concrete aggregates of properties of asphalt concrete."
[24] SumedaParanavithana and Abbas Mohanjerani School of civilandchemicalengineering,RMITUniversity,.(Resources Conversation and Recycling Vol 48 no 1,PP 112)
[25] "Laboratory evaluation of hot-mix asphalt containing construction and demolition waste." A.R.Prasandin(2011) I.Perez
[26] "An Investigation of mechanical properties of recycled coarse aggregate concrete." (2016)DENG X.H(Associate professor,School of Civil and Architectural Engineering,Xian Technological Univesrsity) Archives of civil engineering.(VOL LXII ISSUE 4,Part 2)
[27] "Recycled aggregate in road construction following the Spanish general technical specifications for roads and bridge works" (pg-3): a case study M.Martin-Morales(2012) mariam@ugr.es .(Received 26 Oct 2011,Accepted 24 Apr 2012)
[28] "A comparative study of recycled aggregate from concrete and mixed debris as material for unbound road sub-base". J.R.Jimenez,F.Agrela,J.Ayuso,M Lopez. Vol 61,302,289-302 abril-junio)
[29] "Using blends of construction & demolition waste materials and recycled clay masonry brick in pavement". Ali Arisha(2016) Submitted in 3rd International Conference on Transportation Geotechnics(ICTG 2016),Volume 143
[30] "Experimental investigation of the effect of using different aggregate types on WMA mixtures".Mohammad FallahFafti(2016) (Received 28 april 2016,received in revised form 11sept 2016,Published in International Journal of Pavement Research and Technology 9(2016)
[31] "Construction and Demolition waste recycling plants revisited: Management issues". Serdar Ulubeyli(2017)

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Studies on Hardened Properties of M-20 Grade Concrete Using Recycled RMC Waste Coarse Aggregates

Dr. Kumar Raju B C
Dept. of Civil Engineering
Sapthagiri College of Engineering,
Bangalore, Karnataka
kumarrajubc@gmail.com

***Abstract* — Various combination of concrete are available in market but still achieving the desired strength with locally available materials has vast scope. The study investigates the strength determination of the composite concrete using supporting material like recycled waste from ready mixed concrete plant. In general the normal concrete is good in compression and exhibit lower tensile strength. The proposed concrete in combination with 50% recycled waste shows good tensile strength and other concrete properties.**

Keywords—Concrete, Compressive strength, recycled waste

I. INTRODUCTION

Ready Mix Concrete is a type of concrete that is manufactured in a factory or batching plants, according to a set proportions and then delivered to the work site by a truck mounted in transit mixers. This results in the precise mixture and specialty concrete mixtures to be developed and implemented on construction site. Ready mix concrete is advantageous when large quantities of concrete are to be mixed. Ready mix concrete is ideal for large jobs where space is limited Transit mixed concrete materials are batched at a central plant and are completely mixed in the transit. Frequently, concrete is partially mixed in the transit and is completely mixed at the job site [1]. This type of mixing allows the concrete to be mixed immediately before placing at the construction site as it keeps the water separate from the cement and aggregates. The problems of premature hardening and slump loss obtained due to delays in transportation or placement of central mixed concrete are avoided consequently by this method of mixing. Concreting in most of the construction sites is mechanized now-a-day's using hatching plants, truck mixers & concrete pumps and that is how RMC plants are popular today in the country. In the recent past Batching Plants are preferred in most of the construction sites for the production of concrete to improve overall operational efficiency [2]. Concrete for the projects can be sourced either from a nearby Commercial RMC Plant or from a plant installed at the Project site itself [3]. Later the truck mixers are used for transporting the concrete &concrete is placed/pumped in the site using stationary concrete pumps or truck mounted boom ups [4, 5].

II. MATERIALS USED

GENERATION OF WASTE Two types of waste were generated in the RMC plants is Sludge and Left over concrete (Hardened concrete lumps). In RMC plants, concrete generally ends up as waste due to the following two reasons: During the slump check of fresh concrete and after the truck returns from the construction site. The hardened concrete (inert) waste from RMC plants also occupies the landfills in greater capacity. Therefore, concrete recycling becomes a necessary strategy in order to preserve environment and effective utilization of resources. The waste hierarchy refers to the "3R's principle" reduce, reuse and recycle, which classify waste management strategies according to their desirability in terms of waste minimization. The aim of the waste hierarchy is to extract the maximum practical benefits from products and to generate the minimum amount of waste. Reuse and recycling is done in order to utilize the generated waste and to reduce landfill sites.

Recycling

The recycling of construction, demolition and excavation waste involves the processing of the material through one of the washing equipment installations and the subsequent production of sand and aggregate products. Waste recycling plans should be developed for construction and demolition projects, prior to beginning of a construction activity. The plans should identify the wastes that will be generated and designate handling, recycling and disposal methods accordingly. A Recycling Plant is the only solution to prevent dumping of residual concrete, in wet form. It also helps to recycle the residual concrete and aggregates & slurry water can be reused. We need to reduce (consumption), re-use & recycle to minimize the hazards related to pollution. The Recycling Plant is so far the best solution to ensure both maximum utilization of raw-material and control dumping of unused concrete, thus enabling us to optimally use our natural resources like sand, water, aggregates, etc.

Fig. 1. Recycled aggreagtes.

In the study propose a mix design of M-20 concrete using particular proportion of recycled aggregates. The strength of the concrete is determined by use of recycled coarse aggregates obtained from ready mix concrete (RMC) plant waste.

III. Methodology

The concrete samples with combination of recycled waste are used as supplements to study the behavior in terms of strength. The recycled waste is used proportionately varied from 50 % and 100 %. The concrete is designed for M20 characteristic strength, as recommended from earlier studies [6, 7], and then the normal concrete is compared with the proposed work. The significant factors for a concrete is the strength in compression and tension. So, the cubes were prepared as per mix design based on is IS: 10262:2009. Tests on trial mixes were conducted and mix proportion was finalized. Finally, a mix proportion that gives required 28 days' cube compressive strength with minimum cement content and required workability of 50 to 150mm is selected.

IV. Results

The cubes were casted for each of the concrete combination. Three sample for each 7daty 14days and 28days curing were casted tested for compressive strength and split tensile strength. The corresponding results are tabulated in table 1 and table 2.

TABLE I. Compressive strength

Sl No	Concrete Constituents	Compressive Strength		
		7days	***14days***	***28days***
1	50% recycled waste	14.20	16.014	24.57
2	50% recycled waste	24.57	33.57	39.42
3	100% recycled waste	5.925	21.763	25.17

From table 1, compressive strength of the samples determines that the combination of cement with RMC waste (50 %) shows better desired strength than other ones.

TABLE II. Split tensile strength

Sl No	Concrete Constituents	Compressive Strength		
		7days	***14days***	***28days***
1	50% recycled waste	2.59	3.25	3.64
2	50% recycled waste	2.95	3.39	3.9
3	100% recycled waste	2.56	2.47	2.97

From table 2, split tensile strength it was noted that, all the samples showed good results for 28 days curing with marginal differences with all the designs. From the study it is observed that 50 % of recycled waste proved to be best when comparing to other designs. The results indicate that the compressive strength increases with the increase in the percentage of recycled waste up to 50% beyond that it reduces. The results indicate that the split tensile strength increases may not vary much increase in the percentage recycled waste.

Conclusion

.The study was carried to find the strength properties of different constituents of recycled waste, which were replaced with course aggregates. From the results it is concluded that:

1. The recycled waste can be used as alternate for aggregates in future
2. The recycled waste posses cementitious property, so it can bind and provide good strength.

Acknowledgment

The authors thank the management of SCE and civil engineering department for providing the facilities to conduct the experiment and test the samples.

References

[1] Vieira LD, de Figueiredo AD, Moriggi T, John VM. Waste generation from the production of ready-mixed concrete. Waste Management. 2019 Jul 1;94:146-52..

[2] Kazaz A, Ulubeyli S, Er B, Arslan V, Atici M, Arslan A. Fresh ready-mixed concrete waste in construction projects: a planning approach. Organization, technology & management in construction: an international journal. 2015 Dec 1;7(2):1280-8..

[3] Basar HM, Aksoy ND. The effect of waste foundry sand (WFS) as partial replacement of sand on the mechanical, leaching and micro-structural characteristics of ready-mixed concrete. Construction and Building Materials. 2012 Oct 1;35:508-15..

[4] Vieira LD, de Figueiredo AD, John VM. Evaluation of the use of crushed returned concrete as recycled aggregate in ready-mix concrete plant. Journal of Building Engineering. 2020 Sep 1;31:101408..

[5] Xuan D, Poon CS, Zheng W. Management and sustainable utilization of processing wastes from ready-mixed concrete plants in construction: A review. Resources, Conservation and Recycling. 2018 Sep 1;136:238-47.

[6] Gebremichael NN, Karein SM, Karakouzian M, Jadidi K. Investigation of setting time and compressive strength of ready-mixed concrete blended with returned fresh concrete. Construction and Building Materials. 2019 Feb 10;197:428-35..

[7] Anastasiou E, Papachristoforou M, Anesiadis D, Zafeiridis K, Tsardaka EC. Investigation of the use of recycled concrete aggregates originating from a single ready-mix concrete plant. Applied Sciences. 2018 Nov;8(11):2149..

Experimental Investigation to Determine Infitration Rate in Soil Using Double-Ring Infitrometer

Dr. Kumar Raju B C
Dept. of Civil Engineering
Sapthagiri College of Engineering, VTU
Bangalore, Karnataka
kumarrajubc@gmail.com

Manoj K, Suprith S , Tejas T P, Tejesh R
UG Students
Dept. of Civil Engineering
Sapthagiri College of Engineering, VTU
Bangalore, Karnataka

Abstract: An attempt has been made in the present work to evaluate infiltration characteristics of soil at Bangalore near the water bodies using a Double ring infiltrometer. Experimentation work is carried out at three points in the Bangalore. This study aimed to determin the constant infiltration rates of that soil using the double ring infiltrometer and calculates the infiltration rate by using Horton's infiltration equation. The infiltration rate and incremental infiltration rate values are approximately equal, which shows the rate of infiltration is equal in both of the methods applied.

Keyword: Infiltration, double ring infiltrometer, Horton's infiltration equation

I . INTRODUCTION

Infiltration is the process by which water on the ground surface enters the soil, infiltration rate in soil science is a measure of the rate at which a particular soil is able to absorb the rainfall or irrigation, it is measured in inches per hour or millimetre per hour. The rate decreases as the soil becomes saturated, a soil that is in poor condition does not allow to enters the soil, and it flows down slope as runoff [1, 2]. A prolonged runoff can lead to poor water storage in the soil for plants to grow. It can also lead to soil erosion, which carries away sediments, organic matter and nutrients from the soil to the streams, lakes and rivers. Infiltration of water into the soil can be determined by a simple instrument called double ring infiltrometer.

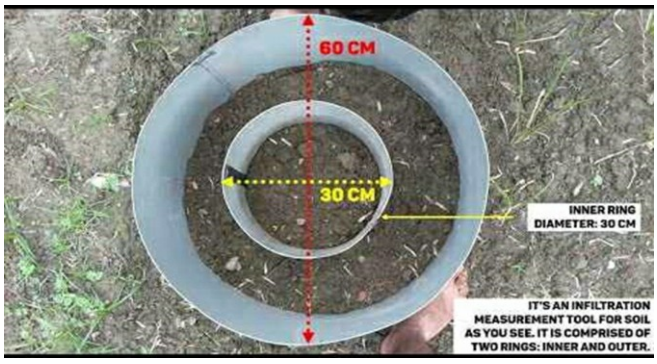
The double ring infiltration is suitable for almost any type of soil with the exception of clogging soils, stony soils or the soil of steep slopes. The outer ring causes almost vertical infiltration of water from the inner ring. When precipitation falls on the ground it starts to penetrate into the ground it helps into improve the increase in the water table. The first water wet soil surface and extra water gets infiltrate into the ground by gravitational force. The rate at which water gets infiltrate through soil surface called infiltration rate. The infiltration rate may depend on type of soil, rate of intensity of rainfall. Infiltration rate is not constant, the beginning infiltration is high after some time soil gets saturated the infiltration rate is decreased [3, 4]. Infiltration plays an important role on functioning of land activities, there are Two factors mainly affect the availability of ground water for crops and plants are impervious layer and ground water table. The study of infiltration comes in many hydrological problems like runoff estimation, soil moisture, budgeting and planning of Irrigation; infiltration plays a major role in hydrology [5].

II. STUDY AREA

Chikkabanavara is a town in Bengaluru, Karnataka, India. It is located in the Bangalore North Taluk of Bangalore urban district in Karnataka. The lake is located at a distance of 1.5km north of Chikkabanavara railway station on the Bangalore-Tumkur railway line.

III. METHODOLOGY

The two cylinders are digged inside the soil but the measurement is taken in the inner cylinder only the outer cylinder helps the water from the inner cylinder to flow vertically downwards and not laterally. The cylinders are of height 25cm which are been digged up to a height of 15cm inside the soil with the help of steel rod and hammer. Figure 1 shows the infiltrometer that has been used in this experiment with inner diameter 30cm and outer diameter 60cm



IV.INFILTRATION CALCULATION

By using Harton's equation

$$f_t = f_c+(f_o-f_c)e^{\wedge -kt}$$

Where,

F_o = initial reading

F_c = final reading

F_t = infiltration rate at any time

V .RESULTS ANDDISSCUSION

Table 1 and 2 shows the infiltration rate for the site. In the beginning the infiltration rate is high as the soil is in the dry state and slowly as the soil saturates it decreases and finally gets a constant value. This may be attributed to the fact that infiltration rate depends on soil characteristics. It is found

that for loamy soil the type of infiltration is slow-moderate, for sandy loam soil the type of infiltration is moderate whereas, for sandy soil we got moderate-rapid rate of infiltration [7].

Table 1: Infiltration reading obtained in the filed

Time in 'minutes'	Initial reading in 'cm'	Final reading in 'cm'	Infiltration rate in 'cm'
0-10	13	12	1.0
10-20	12	11	1.0
20-30	11	10.5	0.5
30-40	10.5	10.0	0.5
40-50	10.0	9.6	0.4
50-60	9.6	9.1	0.5
60-70	9.1	8.5	0.5
70-80	8.5	8.2	0.3

Table 2: Rate of infiltration

Time in 'min'	Rate of infiltration in cm/hr
20	11.2
40	10.12
60	9.28
80	8.34
TOTAL RATE OF INFILTRATION RATE 'CM/HR'	4.8

VI. CONCLUSION

As the measurements were taken in Sapthagiri campus field and water was spread for plants in regular interval. So, the infiltration to the soil got constant after a short time interval due to saturation of the soil. The infiltration rate and incremental infiltration rate values are approximately equal, which shows the rate of infiltration is equal in both of the methods applied. From work it was found that soil conditions effects infiltration rate. In filtration rates against time it is found that initial infiltration rates were high and decreased with time up to constant infiltration rate.

REFERENCES

[1] Gregory, J. H., Dukes, M. D., Miller, G. L., Jones, P. H.Analysis of double-ring infiltration techniques and development of a simpleautomatic water delivery system, 2005; 10.1094/ATS-2005-0531-01-MG

[2] SelimTarek, The Effect Of Land Use On Soil Infiltration Rate In A Heavy Clay Soil In Egypt, Lund 2011; VATTEN 67:161–166.

[3] Johnson, A. I., A Field Method for Measurement of Infiltration, U.S. Geological Survey Water-Supply Paper 1544-F, 1963, pp. 4–9.

[4] ASTM Standards, Standard Test Method for Infiltration Rate of Soils in Field Using Double-Ring Infiltrometer. D:3385 – 9403

[5] Mahmood S & Muhammad L, Surge Ring infiltrometer and its application to simulate infiltration. 2003; 367–379,

[6] Ahaneku I.E.,Infiltration Characteristics of Two Major Agricultural Soils in North Central Nigeria. 2011,; pp.166- 171.

[7] Srinivasan.K and Poongothai.S, Assessment of Infiltration rate of a Tank Irrigation Watershed of Wellington reservoir,Tamilnadu, India, 2013; Volume-02, Issue-07, pp-41-48

An Assessment of Ground Water Quality in and Around Peenya

Dr. Kumar Raju B C
Dept. of Civil Engineering
Sapthagiri College of Engineering, VTU
Bangalore, Karnataka
kumarrajubc@gmail.com

Manju M.S, Siddu Prasad.R
UG Students
Dept. of Civil Engineering
Sapthagiri College of Engineering, VTU
Bangalore, Karnataka

Abstract: Water is an essential natural resource for sustaining life and environment but over the last few decades the quality and availability of drinking water is reduced substantially due to various reasons. The study was carried to assess the ground water quality and its suitability for drinking purpose. The physico-chemical parameters were analyzed. The pH value in the study area peenya, Bangalore India, was varying from 7.0 to 7.5, total alkalinity between 58 to 68 mg/L. The study reveals that most of the parameters were exceeding the permissible limits.

KEY WORDS: Potable water, ground water, hardness, TDS.

I . INTRODUCTION

Water is one of our most precious resources. Lack of water is one of the principal causes of delayed development. Polluted water is one of the biggest killers responsible for up to 27000 deaths a day in the world s poorest countries. Of the limited volume of fresh water that is available to us, 97 percent (excluding permanently frozen water) is stored in underground. More than 1500 million people are using groundwater for drinking and domestic purposes. In arid areas, where rainfall is low or virtually non-existent, groundwater may be the only source of water for rural and urban population. Water is the earth's most distinctive constituent. It is a nature's gift to human race. It sets the stage for the evolution of life and is an essential constituent of all living beings. Water is widely used in agriculture, industries and for human consumption [1]. To continuous increase in water demands and near exhaustion of available surface waters, groundwater has become a major water source. Groundwater is the world's most extracted raw material withdrawal rates currently in the estimated range of 982 km^3/year. About 60 percent of groundwater withdrawn worldwide is used for agriculture; the rest is almost equally divided between the domestic and industrial sectors. In many nations, more than half of the groundwater withdrawn is for domestic water supplies and globally it provides 25 to 40 percent of the world's drinking water. Globally, about 38 percent of irrigated lands are equipped for irrigation with ground water [2].

II. STUDY AREA

The study is from I and II Stage of Peenya industrial area from the state of Karnataka that is situated between 13.0308 and 13.0151 latitude besides 77.5060 and 77.5225 longitude with a total geographical area of 191791 km2. The city is situated at an elevation of 874m above MSL.). As of 2001 India census, Peenya had a population of 42,386. Males constitute 52% of the population and females 48%. Peenya has an average literacy rate of 75%, higher than the national average of 59.5%: male literacy is 79%, and female literacy is 70%. In Peenya, 11% of the population is under 6 years of age.

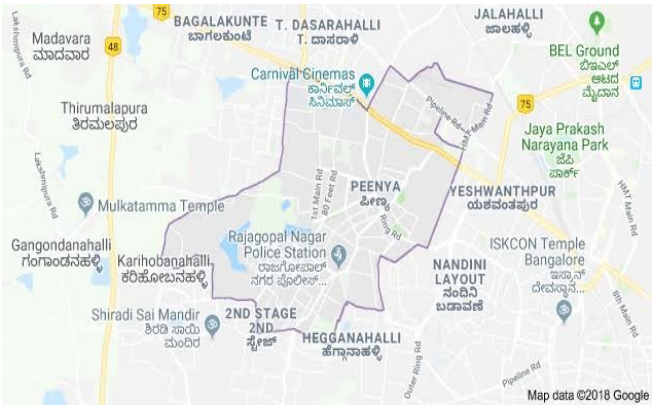


FIG:1 STUDY AREA

III. SAMPLE COLLECTION

The sample bottle was thoroughly cleaned and protected from any contamination during sample collection, preservation, and shipment to assure a high quality sample. Filtering equipment was rinsed thoroughly to remove any mineral deposits in hoses or support container vessels. The sample containers and hoses for organic analyses were acid-washed and rinsed several times with de-ionized water. Grab sampling has been adopted to collect groundwater samples. 40 groundwater samples were collected in polythene containers of 2 litres capacity for chemical analysis after pumping out sufficient quantity of water from the source such that, the sample collected served as a representative sample. The samples thus collected were transported to the laboratory condition [4,3].

IV. ANALYSIS

The groundwater quality was assessed by the analyzing chemical parameters such as pH, Electrical Conductivity, Total Dissolved Solids, Alkalinity, Chlorides, Total Hardness, Calcium Hardness, Nitrates, Sulphates, Iron and Fluorides. The analytical methods used to measure chemical parameters of groundwater samples collected from all the sampling stations are shown in the figure 2.The water samples were analyzed adopting standard methods in the Environmental Laboratory. The pH is a measure of the hydrogen ion

concentration of water. It is also chemical parameter being used in the assessment of borewell water quality. Bureau of Indian Standards (BIS) prescribes a pH range of 6.5-8.5 for drinking water [5]. In natural water, total dissolved solids consists mainly of inorganic salts such as carbonates, bicarbonates, sulphates, phosphate, and nitrate of calcium, magnesium, sodium, potassium, iron etc. and small amount of organic matter and dissolved gases.

Table 1: Physico-chemical Parameters

Sl.No	**Physico-chemical Parameters**	**Methods**
1	pH	Potentiometry (pH meter)
2	Conductivity	Conductivity probe
3	Alkalinity	Argentometry (Titration)

V . RESULTS AND DISCUSSION

During the study period of March 2021 to April 2021, totally 8 samples are collected on monthly basis and analyzed at monthly interval in the study area. To assess the groundwater quality of the study area, the groundwater samples collected were analysed for 12 chemical parameters. The chemical parameters were assessed within 48 hours of sample collection. The water samples were analysed adopting Standard Methods in the Environmental Laboratory, Department of Civil Engineering, Sapthagiri college of Engineering, Bangalore. The results of all the parameters for different groundwater samples collected from 8 bore wells are presented in the Table 2 to 4.

One of the purposes of the study is to understand the quality of groundwater in the Sub-Urban areas of Peenya City and pictorially represent it using by Water Quality Index (WQI), an effective tool for communicating the information on overall quality of water [6].

Table 2: ACIDITY

Sample details	Volume of sample in ml	Volume of sample in ml	Final reading in ml	Volume of 0.02NAOH	TOTAL acidity
B1	50	0	3	3	60
B2	50	3	6.2	3.2	64
B3	50	6.2	9.1	2.9	58

Table 3: ALKANITY

Sample details	Volume of sample in ml	Volume of sample in ml	Final reading in ml	Volume of 0.02 OF H2SO4	TOTAL alkanity
B1	50	0	2.9	2.9	58
B2	50	2.9	5.7	2.8	56
B3	50	5.7	9.1	3.4	68

Table 4: PH

B1	7.3
B2	7.16
B3	7.5

Table 5: DETERMINATION OF RESIDUAL CHLORINE

Sample details	Volume of sample in ml	Volume of sample in ml	Final reading in ml	Volume of 0.02 OFNa2S2O3	Residual chlorine in ml
B1	50	0	1.4	1.4	9.9
B2	50	1.4	3.2	1.8	12.7
B3	50	3.2	4.7	1.5	10.6

Table 6: TOTAL CALCULATION

SL/NO	Acidity in ml	Alkanity in ml	Residual chlorine in ml	Ph
B1	60	58	9.9	7.3
B2	64	56	12.7	7.16
B3	58	68	10.6	7.5

VI. CONCLUSION

Therefore compressive sewerage system for safe disposal of wastes should be developed to safeguard ground water quality in the study area. The bore well water is crystal clear, odorless and palatable and at few sample points are of the salty taste. The total hardness exceeds the permissible limit at many places in about 10 sampling station. The higher hardness is mainly due to disposal of municipal and sewage waste.

ACKNOWLDEGEMENTS

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REFERENCES

[1] Akshay R. T., Sonaje N. P. and Mujumdar M. M. (2011). Development of regression model for the Panchaganga River water quality in Kolhapur city. Engineering Research and Applications, 1(4), 1723-1730.

[2] Ambiga K. and AnnaDurai R. (2013). Assessment of groundwater pollution potential in and around Ranipet area, Vellore district, Tamilnadu. Int. J. Eng. Sci., 2(1) :263-268.

[3] BIS I. S. D. W. S. (2012). Bureau of Indian Standards. New Delhi, 2-3.

[4] Devi S. and Premkumar R. (2012). Physicochemical analysis of groundwater samples near industrial area, Cuddalore District, Tamilnadu, India. International journal of chemtech research, 4(1), 29-34.

[5] Rupal M., Tanushree B. and Sukalyan C. (2012). Quality characterization of groundwater using water quality index in Surat city, Gujarat, India. International Research Journal of Environment Sciences, 1(4), 14-23.

[6] World Health Organization. (1993). Guidelines for drinking-water quality. World Health Organization.

Urban Flood Estimation And Evaluation of Chikkabanavara, Bangalore

Dr. Kumar Raju B C
Dept. of Civil Engineering
Sapthagiri College of Engineering, VTU
Bangalore, Karnataka
kumarrajubc@gmail.com

Nithin H, Prajwal R, Harsha R , Prathapagowda H B
UG Students
Dept. of Civil Engineering
Sapthagiri College of Engineering, VTU
Bangalore, Karnataka

Abstract*—• To identify the locality under flood and To conduct survey of the existing drainage facility for the area and To design storm drainage for the designed flood frequencyand to compare the existing dimensions of the storm drainage .Suggestion for improvement of the drainage system and To study the design frequency flood for storm drainage forthat locality.

I . INTRODUCTION

Unplanned construction in low-lying areas, solid waste in urban drainage channels, and increased rainfall due to changing And climatic patterns are some of the identified common causes of urban flooding and estimation of urban runoff peak and volume is a fundamental step in determining the transferring capacity of urban drainage systems [1, 2].The main aim of is to estimate the flooding of the areas through rainfall data of that particular area of a certain period. Then design or upgradation of the drainage system by plotting rainfall duration, intensity curve. The performance of an urban drainage system in the study area is also investigated. In this Project, the capacity of the main canals in the study area is determined for peak runoff transferring for a design storm with 25 year return periods. Whereas, based on local observation and site study, localized and surface flooding can be observed in some urban areas [3, 4].

II. STUDY AREA

Chikkabanavara is a town in Bengaluru, Karnataka, India. It is located in the Bangalore North Taluk of Bangalore urban district in Karnataka. The lake is located at a distance of 1.5km north of Chikkabanavara railway station on the Bangalore-Tumkur railway line.

III. METHODOLOGY

Collection of field data required for design of sewerage system such as details of information outfalls, existing storm drains and others description of existing drainage facilities including size, shape, material, invert information age, condition etc. collection of plan indicating storm drainage system layout and collection of data regarding land use ,soil maps .And collection of data regarding flood histories and collection of data regarding utility of existing system and ward wise population as per census.

IV.RUNOFF ANALYSIS

Runoff of the Study Area is calculated using formula .

$$R=CIA\ m^3/sec$$

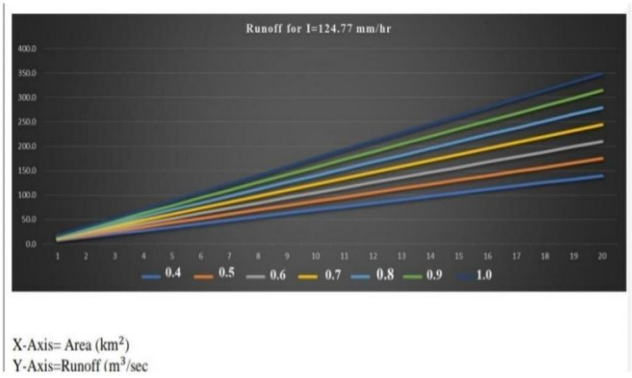
Where, R=Runoff in m^3/sec
C=Coefficient of runoff
I=Intensity of rainfall in mm
A=Area in km^2

Computation of discharge for varying catchment area assuming runoff coefficient C .The area of study is taken as $0.5km^2$, 1.0 km^2, 1.5 km^2,……..,10 km^2 and the Run-off coefficient is taken from 0.4 to 1.0. Where 0.4 refers to permeable, well vegetated areas like forest, flat land and 1.0 refers to areas with low infiltration, high runoff like pavement, steep gradient surfaces.

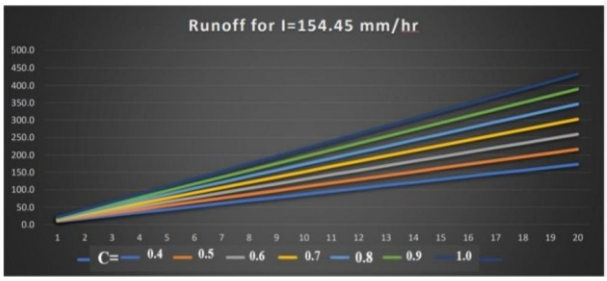
V .RETURN PERIOD ANALYSIS

Simply stated, a return period is an estimate of how long it will be between rainfall events of a given magnitude. For example, the return period for a 3-hour rainfall total of 4.25 inches in Bangalore City is 25 years [5, 6].

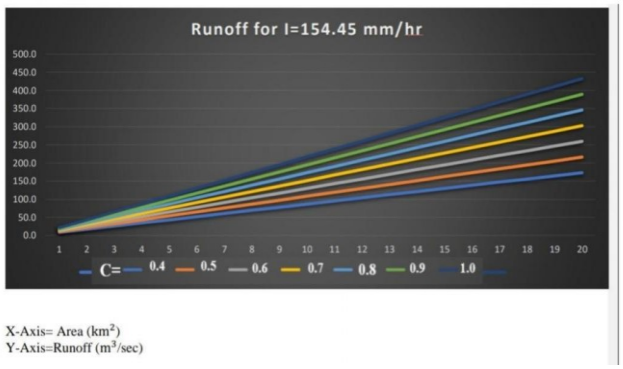
Runoff for Return Period (T)=10 Years ,I=124.77 mm/hr



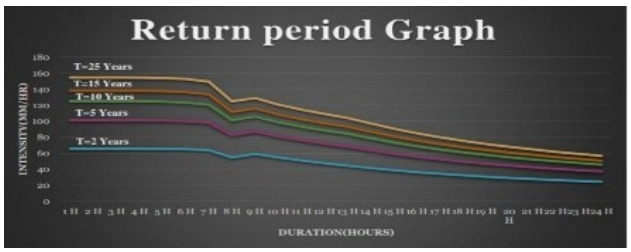
Runoff for Return Period (T)=25 Years ,I=154.45 mm/hr



Runoff for Return Period (T)=15 Years ,I=137.98 mm/hr



X-Axis= Area (km^2)
Y-Axis=Runoff (m^3/sec)



VI . RESULTS

1. Maximum runoff for 10 year return period with rainfall intensity i=124.77 mm is 394.4 m3/sec
2. Maximum runoff for 15 year return period with rainfall intensity i=137.98 mm is 386.3 m3/sec
3. Maximum runoff for 25 year return period with rainfall intensity i=154.45 mm is 432.5 m3/sec

VI. CONCLUSION

After this research many problems were discovered such as improper drainage design, insufficient water carrying capacity of the channels, poor maintenance and collection of solid waste in the drainage and blocking the path of water flow.The outcome of this project shall help to propose the layout for the new drainage in order to fulfill its requirements as a drainage, such as to drain off excess water from rain which causes flooding. All dimensions can be used for the construction as it is designed. Cleaning of the drainage channels frequently and proper maintenance has to be done. Therefore we conclude our major project by researching and knowing the major problems and thus understanding it.

REFERENCES

[1] Rabori AM, Ghazavi R. Urban Flood Estimation and Evaluation of the Performance of an Urban Drainage System in a Semi‐Arid Urban Area Using SWMM. Water Environment Research. 2018 Dec;90(12):2075-82.

[2] Freni G, La Loggia G, Notaro V. Uncertainty in urban flood damage assessment due to urban drainage modelling and depth-damage curve estimation. Water Science and Technology. 2010 Jun;61(12):2979-93.

[3] Chen Y, Zhou H, Zhang H, Du G, Zhou J. Urban flood risk warning under rapid urbanization. Environmental research. 2015 May 1;139:3-10.

[4] Jamali B, Bach PM, Deletic A. Rainwater harvesting for urban flood management–An integrated modelling framework. Water research. 2020 Mar 15;171:115372.

[5] Gupta K. Urban flood resilience planning and management and lessons for the future: a case study of Mumbai, India. Urban Water Journal. 2007 Sep 1;4(3):183-94.

[6] Ahamed SM, Agarwal S. Urban flood modeling and management using SWMM for new RR pet region, Vijayawada, India. InInternational Conference on Advances in Civil Engineering (ICACE-2019) 2019 Mar (Vol. 21, p. 23).

Corridor Modelling Of Selected Road Using Civil 3D Software

MANJUNATHA S AND ZEESHAN YOUSUF
UG std.: Dept. of Civil Engineering sapthagiri college of Engineering

AKSHAY J
Ass prf. Dept. of Civil Engineering, Sapthagiri college of Engineering

SANTHOSH MULWAD AND KIRAN
UG Std. Dept. of Civil Engineering,U Sapthagiri college of Engineering

Abstract - Roadway geometry design involves such tasks as creating the road alignment and plotting the alignment profile using bearings or coordinates (easting and northing), stations and elevations of points along the proposed route;calculation of sight distances, radii of horizontal curves, and lengths of vertical curves; computation of earthwork quantities, and numerous other analyses and calculations aimed at finding the optimum alignment while satisfying design standards and constraints. When performed manually, geometric design is very cumbersome, time-consuming and highly susceptible to very costly errors. Current trends are geared towards the use of computer programs for roadway geometry design. The programs offer amazing precision and save lotsof time and effort. This paper presents a complete geometric design of a typical highway using AutoCAD Civil 3D software. The aim of the project was to demonstrate how roadway geometric design can be performed in a very short time with much ease and precision. Theroad design procedure using AutoCAD Civil 3D has been presented. Manual geometric design of the same road was also performed, the results of which was compared favorably with that of AutoCAD Civil 3D.

Keywords—Geometric Design; AutoCAD Civil 3D.

I. INTRODUCTION

Highways are expected to guarantee users' comfort and safety, to permit efficient traffic operation, and at the same time attract the least possible cost in construction and maintenance. Highways are also expected to cause minimum damage to the environment and be aesthetically pleasing in their finished form. Geometric design is the means through which these demands are met. As the Nigerian Federal Ministry of Works (FMW) Highway Manual [1] puts it, "geometric design focuses on the specific measures that provide for efficient and appropriate operation of the road, as well as provide for all the specific details that make roads safe and compatible with social and environmental circumstances surrounding the road".

Geometric design of roads can be subdivided into three main parts: horizontal alignment, vertical alignment and cross section, which when combined provide a three-dimensional layout for a highway [2, 3].

Horizontal alignment of a highway defines its locationand orientation in plan-view. It comprises three geometric elements, including tangents (straight sections), circular curves and transition spirals between tangents and curves [2]

The vertical alignment (or roadway profile) is the longitudinal section of the road, comprising such geometric elements as crest and sag curves, and the gradients (straight grade lines) connecting them [1, 2]

The highway cross section shows the position and number of vehicle and bicycle lanes and sidewalks along with their cross slopes; shoulders, drainageditches, etc.

Highway geometry elements are expected to be selected, sized and positioned in a way that satisfies such design criteria as sight distance, vehicle stability, driver comfort, drainage, economy, and aesthetics. The design process involves some drafting and a number of analyses and calculations. The tasks which are usually performed by the design engineer include: creating the road alignment andplotting the road profile using coordinates (or bearings), stations and elevations; calculation of sightdistances, radii of horizontal curves, and lengths of vertical curves; computation of earthwork quantities, and numerous other analyses and calculations aimedat finding the optimum alignment while satisfying design standards and constraints.

Traditionally, these tasks are performed manually using drawing tools and mathematical techniques.When performed manually, geometric design is very cumbersome, time-consuming and highly susceptibleto very costly errors [4, 5] the traditional approach is also based mainly on a two-dimensional (2-D) analysis which does not guarantee a satisfactory design, reports Yasser et al. [6]

Current trends are geared towards the use of very sophisticated computer programs for roadwaygeometry design that offer amazing precision andsave lots of time and effort. Autodesk [7] summarizesthe importance of specialized road design software saying the tools help civil engineering professionals working on transportation projects to: explore preliminary design options and optimize projectperformance; determine optimal horizontal and vertical roadway geometry that are constrained by design criteria; engineer roadway geometry in the context of the existing environment more efficiently and effectively. The tools also enable engineers to work with a more realistic model of what truly existsat the project site thereby affording engineers the opportunity to consider safety requirements earlier in project development

. As Anaya and Shimon [4] put it, these computer applications can produce amazing visual graphics that enable the design engineer to view the road on screen from the perspective of the driver. They [4] further state that "without the use of three-dimensional modeling, highway planning experiences a significant difficulty. Cut and fill calculation tends to consume a significant amount of time… By using the object-oriented approach, theprocess of cut and fill calculation can be performed automatically and in an accurate manner".

There are ongoing efforts to complete the development of campus road network of the University of Ilorin, located in southwestern Nigerian town of Ilorin. One of the links in the road networkthat has been selected for development is the one leading to students' hostels from the University bus stop. This paper presents a complete geometric design of this road using AutoCAD Civil 3D software. The aim is to demonstrate how roadway geometric design can be performed in a very short time with much ease and precision so as to encourage civil engineering practitioners in the developing world to embrace the use of road design software. To provide a basis for comparison, manual design of thegeometry of the same road was also performed.

II. AUTODESK AUTOCAD CIVIL 3D

AutoCAD Civil 3D is a civil engineering design and documentation tool developed by Autodesk. AutoCAD Civil 3D software supports Building Information Modeling (that is, digital representation ofthe physical and functional characteristics of a facility). It is used for modeling, analysis and design of a variety of civil infrastructure project types, including roads and highways, land development, rail, airports, and water. AutoCAD Civil 3D helps civil infrastructure professionals improve project delivery, maintain more consistent data and processes, and respond faster to project changes, all within the familiar AutoCAD environment [8]

Autodesk [7] lists the features of AutoCAD Civil 3Das follows:

i. BIM tools for civil engineering design: AutoCAD Civil 3D supports Building Information Modeling (BIM) and helps reduce the time it takes to design, analyze, and implement changes.

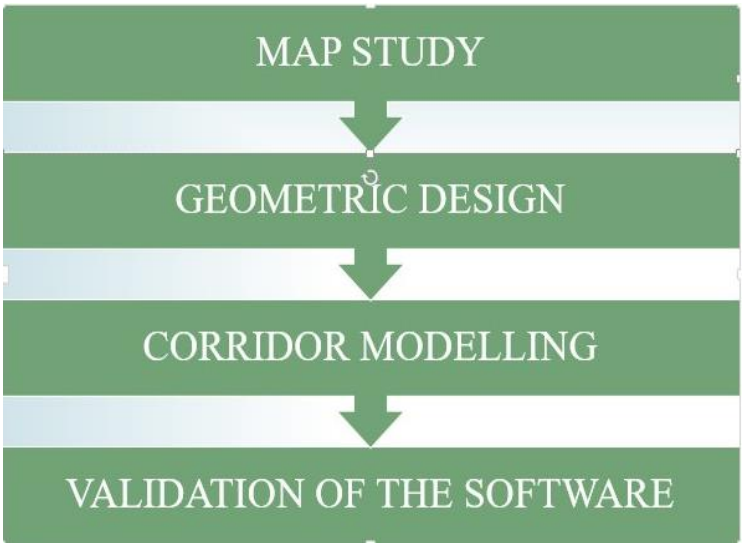
ii. Efficient civil design: AutoCAD Civil 3D performs faster design iterations with an intelligent, 3D model-based application that dynamically updates related civil design elements when changes are made. Itstreamlines time-consuming tasks for corridor design, parcel design, and pressure and gravity network design.

iii. It improves civil drafting and documentation. Connecting design and documentation helps boost productivity and deliver higher-quality designs and construction documentation. Changes to design elements are captured in documentation, minimizing manual updates.

iv. GPS surveying tools for faster processing.GPS surveying and data collection tools in AutoCAD Civil 3D can help you update your processes for improved project delivery.

v. Integrated storm water management and geospatial analysis. AutoCAD Civil 3D helps the designer to improve project delivery and make more informed decisions using visualization, simulation, and water analysis integrated with the design process for storm water management, geospatial analysis, and model analysis.

III. DESIGN METHODOLOGY



MAP STUDY

Map study gives a rough guidance of the routes to be further surveyed in the field. From the map (like Google map or Google clone drive) alternative routes can be selected in this study.

The probable alignment can be located on the map from the following details available on the map.

Avoiding valleys, ponds or lake.

Avoiding bend of river.

If road has to cross a row of hills, possibility of crossing through mountain pass.

For our project we have selected an area of stretch from janapriya apartments to chikkabanavara railway station which is around 700m.

Fig 1 study area

Survey Data Collection

The existing ground surface data are required for designing the geometry of highways. The survey information of the proposed route was obtained from the firm handling the development of the road. The survey information included Easting, Northing and elevations of points along the proposed route.

A. Design Criteria

The following design criteria based on the Nigerian Federal Ministry of Works Manual [1] were assigned to the horizontal geometry of the center line and also to the profile and cross section of the roadway:

i. Design speed = 80 km/h
ii. Super elevation rate = 4%
iii. Friction factor = 0.14
iv. ~~Minimum~~m Stopping Sight Distance = 130 m
v. Minimum Passing Sight Distance = 540 m
vi. Maximum grade = 7%
vii. Minimum K (rate of vertical curvature) for sagcurves = 30
viii. Minimum K (rate of vertical curvature) forcrest curves = 26.
ix. Roadway width = 12.8 m
x. Carriageway width = 7.3 m
xi. Shoulder width = 2.75 m

Import survey data (comprising easting, northing and levels and saved in Note Pad format) into the AutoCAD Civil 3D environment

- Create existing ground surface
- Create alignment by linking points on theexisting ground using polyline
- Apply the design criteria. In this project, the AASHTO design criteria was selected.
- Generate the existing ground profile.
- Create the formation level (finished) using the profile creation tools. Create the Assembly, which defines the cross-sectional component of the design. The assembly is constructed by connecting using the formula individual subassembly objects.
- Create the corridor, which is the resulting dynamic 3D model representation built from the combination of horizontal, vertical and cross-sectional design elements. Corridors may be used to calculate earthworks and quantity takeoffs, to performsight and visual analysis, to generate surfaces, and to extract information for construction purposes.
- Generate volume table report

B. Design of the Horizontal Alignment

Horizontal alignment design entails determining the minimum curve radius and curve length, and the computation of horizontal offsets from tangents to thecurve to facilitate locating the curve in the field. This section presents an overview of the horizontal alignment design procedure by means of AutoCAD Civil 3D and by manual method.

The survey data comprising easting, northing and elevations was imported into the civil 3D environment in notepad format. This automaticallygenerated the existing ground surface. Afterspecifying the design criteria that were to be placed on the alignment, the polyline construction tool from the toolbar was used to draw the layout of the road. The 'Geometry Editor' tool was used to draw thecircular and spiral curves and to extract the alignmentcurve report.

On the other hand, the easting and northing of the roadway center line was extracted from the survey data and plotted using Microsoft Excel with the easting as the abscissa and the northing as the ordinate. This plot produced the horizontal alignment of the proposed route. Using the design speed, super elevation rate and the friction factor specified in the design criteria, the minimum curve radius was calculated from the formula in equation 1

$$R = \frac{V^2}{127(e+\mu)} \quad (1)$$

Where R = minimum horizontal curve radius inmeters
V = design speed in km/he = super elevation rate. μ = friction factor

C. Design of the Vertical Alignment

The existing ground profile was generated using the 'Profile' tool from the toolbar, while the finished grades were created graphically using the profile creation tools. Profile geometry was determined by applying the design criteria of minimum K values for sag and crest vertical curves that satisfy the minimum requirements of stopping sight distance, comfort and appearance criteria.

Lengths of vertical curves were also calculated manually
Using the formula

$L = KA$Where L = minimum length of vertical curve in meters.
K = the rate of vertical curvature, defined as thelength of curve per percent algebraic difference in intersecting grades.
A = algebraic difference of grades in percent

D. Cut and Fill Calculation.

A feature within AutoCAD Civil 3D allows for the calculation of earthwork required on a project within afew seconds. After creating the ground surface and the proposed finished grade surface, AutoCAD Civil 3D makes it easy to create a comparison surface which highlights the elevation difference and computes the volume between the two surfaces. The process of calculating earthwork begins by clicking 'Surfaces' on the Modify tab. A volume report sheet can then be printed.

IV. DESIGN OUTPUT

This section presents the geometric design output from AutoCAD Civil 3D and from manual design.

A. Horizontal Alignment

The existing ground profile and the horizontal alignment produced by AutoCAD Civil 3D are presented. Also the horizontal alignment determined manually is presented in Figure 2. Comparison of Fig. 2 shows that the horizontal alignments produced by means of AutoCAD Civil 3D and manual design are similar.

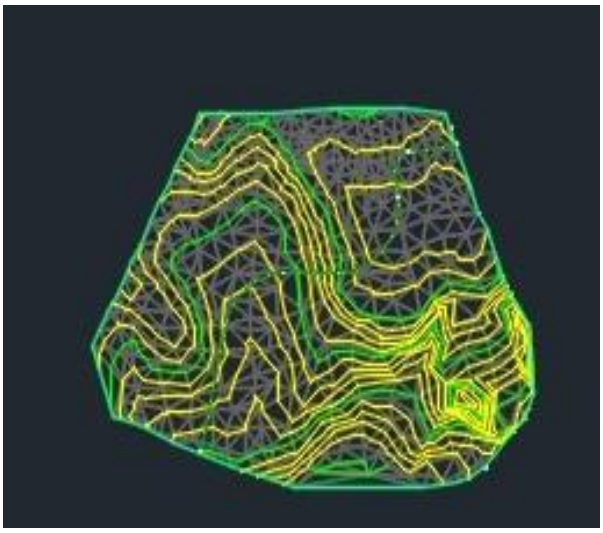


Fig 2 Horizontal Alignment

B. Vertical Alignment Design Output.

The vertical alignment design outputs by both AutoCAD Civil 3D and manual designs are presentedin Fig. 3 respectively. It is evident from these two figures that the profiles obtained by means of AutoCAD Civil 3D and manual methods are similar.

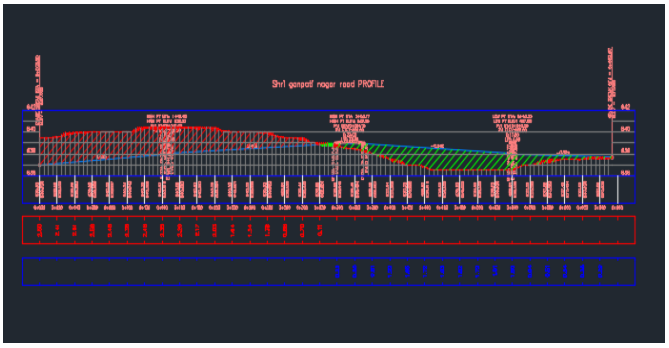


Fig 3 Vertical Alignment

Assemblies

Assemblies define the cross-sectional component ofthe design. They are built by connecting individual subassembly objects, thereby helping to simulate the geometry and material makeup of the road. Fig. 4 shows the roadway assembly.

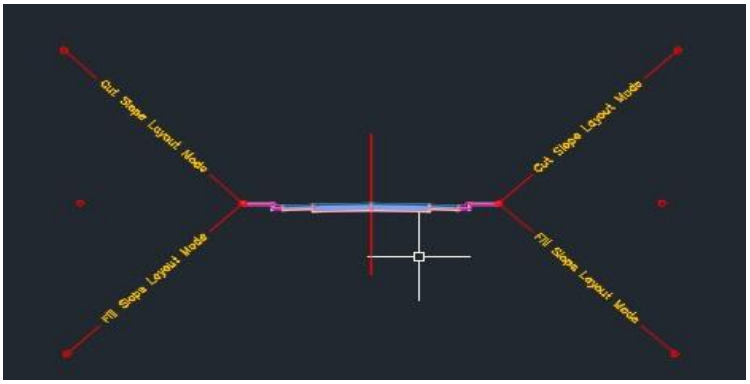


Fig. 4: Roadway Assembly

Corridors

A corridor is defined by at least one baseline and an assembly that is applied for a range of stations on that baseline. In many cases, corridors will have different assemblies at different stations, depending on the existing ground and other design requirements. It may be necessary to build a corridor model that is controlled by multiple baselines. To add and edit this type of complexity, you can use the Parameters tab of the Corridor Properties dialog box, where you can modify the associated baselines and assemblies, change assembly frequency and range, and update targets.

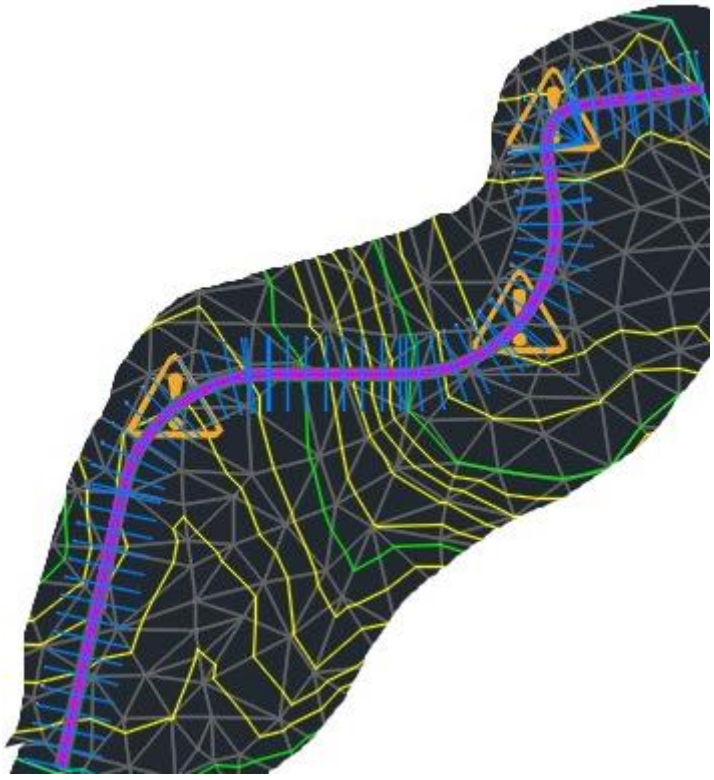


Fig 5 corridors

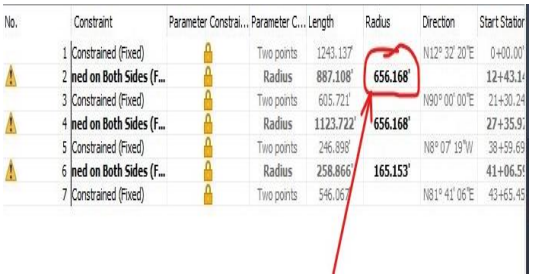
Validation of the software

CALCULATION OF SUPERELEVATION:

Step-1

AS per IRC 86:1983 code specification refer table 4.8

V=60 mph



No.	Constraint	Parameter Constrai...	Parameter C...	Length	Radius	Direction	Start Station
1	Constrained (Fixed)		Two points	1243.137'		N12° 32' 20"E	0+00.00'
2	ned on Both Sides (F...		Radius	887.108'	656.168'		12+43.14
3	Constrained (Fixed)		Two points	605.721'		N90° 00' 00"E	21+30.24
4	ned on Both Sides (F...		Radius	1123.722'	656.168'		27+35.97
5	Constrained (Fixed)		Two points	246.898'		N8° 07' 19"W	38+59.69
6	ned on Both Sides (F...		Radius	258.866'	165.153'		41+06.59
7	Constrained (Fixed)		Two points	546.067'		N81° 41' 06"E	43+65.45

R=656.168ft (from the software) =200m

e=v^2/225R

e=60^2/225*200

=0.08

The value 'e' is exceeded than 0.07, hence provide minimum super Elevation

Step -2

Check the coefficient of friction for the maximum value of e=0.07

At the full value of design speed.

F= [v^2/127R-0.07]

= [60^2/127*200-0.07]

=0.071

The calculated value of **F** is less than 0.15,

The super elevation of 0.07 is safe for the design sped.

CONCLUSION

Consequence of this observations made, investigations done, collection of traffic data, examination of the existing study area helps us to align the road which is feasible and sound in an effective way. By using total station makes survey easier and possible to truncate the time for the field survey. It eradicates manual errors like reading and recording co-ordinates. These co-ordinates enroll for map making and plotting contour and cross section in AutoCAD civil 3D. AutoCAD civil 3D helps to complete the design process in a relaxed and comfortable way within time and also it preserves lot of time and effort. This project introduces a complete geometric design of the village road using AutoCAD civil 3D.

REFERENCES

Federal Ministry of Works Highway Manual,"Geometric Design", Nigeria. Part 1, Vol. 1, 2013.

E.T. Demetrio's, "Highway Engineering", TheMcGraw-Hill Companies, Inc. New York, USA, 1999.

[1] Wikipedia "Geometric Design of Roads". Available from: https://en.wikipedia.org/wiki/Geometric_design_of_roads. Accessed February 2107.

[2] A. Anaya, and E. Shimon, "3D Model forHighway Alignment", International Journal ofScientific Engineering and Research (IJSER), Volume 4, Issue 3, March 2016.

[3] L. Chen-Fu and D.M. Levinson, "ROAD: Interactive Geometric Design Tool for Transportation Education and Training", Journal of Professional Issues in EngineeringEducation & Practice, Vol. 139, No. 2, pp. 116 – 122, April 2013.

[4] H. Yasser, M.E. Said, and A.O. Abd El Halim, "State-of-the-Art of Three- Dimensional Highway Geometric Design", Canadian Journal of Civil Engineering, Vol. 25, No. 3, pp. 500-511, 1998. Available from:http://www.nrcresearchpress.com/doi/pdf/10.1139/l97-111.

[5] Autodesk, "Highway Engineering and Road Design Software – InfraWorks", Available from: http://www.autodesk.com.au/products/infrawworks-family/vertical-apps/roadway- design/all/list-view. Accessed February 2107

[6] Autodesk, "Civil Engineering Design/AutoCAD Civil 3D", Available from: http://www.autodesk.com/products/autocad-civil-3d/features/all. Accessed February 2107.

[7] Excites Ltd., " AutoCAD Civil 3D 2017", Available from: http://www.excitech.co.uk/Products/AutoCAD -Civil-3D-2017. Accessed February 2107

"DETERMINATION OF COMPACTION CHARACTERICTICS OF A SOIL"

Dr G Srilakshmi [(1)] Ph.D,M.tech(Geotechnical Engg.)

Dinakar reddy[(2)] vyshak R[(3)], Taiba Taj[(4)],Usha K[(5)]

[1]*professor, department of civil engineering ,Visvesvaraya technological university, India*

[2]*undergraduate, department of civil engineering ,Visvesvaraya technological university,India*

[3] *undergraduate, department of civil engineering ,Visvesvaraya technological university,India*

[4] *undergraduate, department of civil engineering ,Visvesvaraya technological university,India*

[5] *undergraduate, department of civil engineering ,Visvesvaraya technological university,India*

Email ID: taibatajpinjar@gmail.com

Abstract-In geotechnical engineering, soil compaction is the process in which stress is applied to a soil densification as air displaced from the pores between the soil grains. Compaction is one of the important phenomena in soil mechanics. This is very much needed to improve engineering properties of soils. It increases density, strength and decreases voids, permeability, shrinkage, swelling etc. in this paper, the compaction characteristics determined by conducting standard proctor compaction test in the laboratory on different samples collected from different localities.

Keywords-soil, compaction, properties, strength, samples

INTRODUCTION

Soil compaction increases soil density, reduces porosity and leads to increased penetration resistance and degradation of soil structure. The degradation is enforced when tillage is used to break up compacted soils. Densification through soil compaction improves soil properties which plays an important role in the establishment and growth.

It increases soil strength and bearing capacity and reduces compressibility and permeability. The aspiration of compaction is to increases the strength of the soil. compaction can be accomplish by various ways like kneading, static, dynamic or impact & vibratory

MATERIAL & METHODOLOGY

The soil is collected from three different locality can be conducted in two ways

1. Standard proctor test
2. Modified proctor test

The fundamental of compaction were first time presented by RR. proctor in 1933, in his honor; the standard laboratory compaction test which is developed is commonly known as standard proctor test. The sample were collected and conducted standard proctor test for soil compaction.

According to proctor, the compaction of the soil mass is depended on the four major factor:-s

1. Soil type ,
2. Moisture content
3. Compactive effort
4. Dry density of the soil.

1. Standard proctor test

- Take sufficient quantity of representative soil ,air dry & pulverize it with a rubber mallet seive the soil through no:4 seive reject the coarser material.
- Take about 3kg of soil ; add a water to bring its water content to obtain to about 5% below the estimated optimum moisture content. (for coarse grained soil 4% initial water content and for fine grained soil 10% initial water content is preferable) then mix it thoroughly.

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- Clean the mould and measure its diameter and height weigh it without collar.
- Fit the collar and compact the moist soil in three equal layers by the rammer with evenly distributed blows to each layer. Use 25 blows for each layer.
- Remove the collar, trim the compacted soil even with the top of the mould with a straight edge. Clean outside of the mould and base plate and weigh it.
- Remove the soil from the mould, split it and take about 100gms sample for water content determination.
- Break the soil lumps, mix it with a remaining soil in the tray and add more water to increase the water content by 2 to 3% and repeat the compaction procedure for each increment of water until the mass of the compacted soil decreases.
- Calculate the water content for each trail and corresponding dry density
- Plot the compaction curve between water content as abscissa and dry density as ordinate.
- Note the water content against the peak of the curve as optimum moisture content and the corresponding dry density as max. dry density

Fig 1: conduction of compaction

RESULTS AND DISCUSSION

Bulk density = mass of the wet soil / volume of the mould

Dry density = bulk density / 1+water content

SL NO.	Wt. of compacted wet soil (gms)	Volume of the mould (cm^3)	Bulk density (g/cc)	Water content	Dry density (g/cc)
1	1726	981.74	1.74	6.67	1.64
2	2114	981.74	2.15	13.3	1.90
3	2160	981.74	2.2	16.1	1.89
4	2030	981.74	2.06	20	1.72

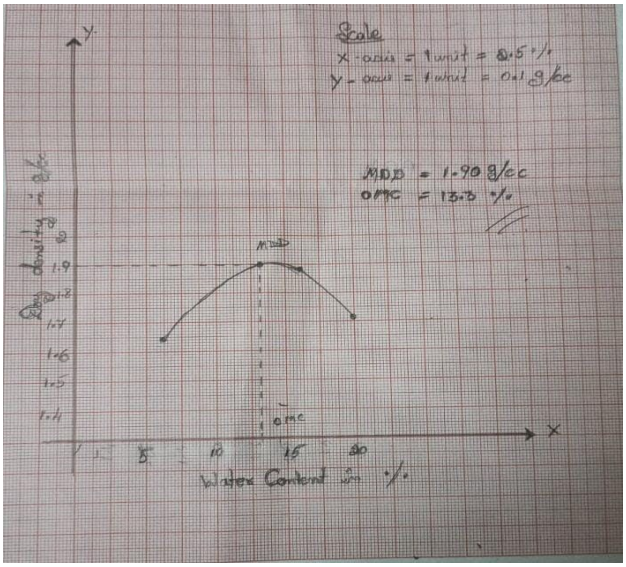
Bulk density = 1726/981.26

=1.74 g/cc

Dry density = 1.75/1+6.67/100

=1.64 g/cc

GRAPH



RESULTS

The optimum moisture content = 16.1 %

Max. dry density = 1.9 g/cm^3

REFERENCES

1. Seed, H. B., & Chan C. K. structure and strength characteristics of compacted clays. Jour Soil Mech.& Found. Div., ASCE, Vol. 85, No . SM5, proc. Paper 2216, oct 1959.

2. Lambe, T. W.the structure of compacted clay. Jour. Soil Mech. &found Div., ASCE, Vol. 84, No SM2, Proc. Paper 1654, May 1958.

ISBN: 979-85-27243-61-1

3. Lambe, T.W. the engineering behavior of compacted clay. Jour. Soil Mech.& found. Div., ASCE, vol. 84, No. SM2, p.1-35, 1958.

4. Groves, B.A. the influence of method of compaction on soil-cement strength properties. Research report, Univ .of california, berkeley, 1964

5. El- Rawi, N. M., haliburton T.A., & janes, R,L effect of compaction on strength of soil-cement. Jour. Soil Mech. & found. Div., ASCE, Vol. 93, No. SM6, proc. Paper 5578, Nov. 1967.

6. Whitehurts, E. A. stabilization of tennessee garvel & chert bases. HRB Bull. 108, 1955

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SELF HEALING CONCRETE (USING BACTERIA)

SHASHIDHAR A H[1], YASHIK A[2], AFTAAB AHAMED M[3], VINAY PATIL[4], KAVYA H P[5]

Department of Mechanical Engineering, Sapthagiri College of engineering
#14/5 Chikkasandra, Hesaraghatta main road, Bangalore- 57 India

[1]shashidhar3030@gmail.com
[2]yashikgd@gmail.com
[3]aftaab116@gmail.com
[4]vinaykumar874787@gmail.com
[5]kavyahp@sapthagiri.edu.in

Abstract **– Concrete undergoes crack formation is common parameter in construction of structure by concrete. To overcome this problem of crack propagation various studies and researches are carried out in the industry of concrete concrete testing aspects. One of the technique of crack reducing or crack filling procedure can be obtained by this study.Microbially induced carbonate precipitation has been tested over more than a decade as a technique to enhance concrete properties. Mainly bacteria following the pathways of urea decomposition, oxidation of organic acids, or nitrate reduction have been studied for this purpose. For bacteria mixed into fresh concrete, it is difficult to prove that they actively contribute to calcium carbonate precipitation and the effects on concrete strength are variable. Application of bacteria for surface consolidation has been shown to reduce water absorption and increase durability. Microbial self-healing of cracks in concrete shows promising results at the laboratory scale. However, their self-healing efficiency needs to be further proven in larger concrete elements, and under non-ideal conditions. The use of denitrifying cultures for concurrent self-healing and production of corrosion inhibiting nitrites is a promising new strategy**.

Keywords – Concrete, Self healing concept, Bacteria-Bacillus megaterium

I. INTRODUCTION

Concrete is the most widely used construction material and considered an artificial rock. However, due to the heterogeneity of the composition of its principle components the properties of the final product can widely vary. Crack formation is concrete is inevitable. Micro-cracks are formed first and then which leads to fine cracks with external loading. Once cracks form, in concrete it may reduce the life span of the concrete structures. Various repairing techniques are available to repair the cracks but they are highly expensive and time-consuming processes. A technique to repair the cracks in concrete by itself is considered more efficient and is called as self healing concrete. It is incorporated with a protective coating in the concrete as the crack forms and water penetrates the bacteria starts reacting with water and lime ($CaCo_3$) formation takes place which seals the cracks completely. A strain of bacillus species of bacteria is found to be used for self-healing. Urease positive bacterium - Bacillus megaterium, Bacillus pasteurii, Bacillus sp. CT-5, Bacillus subtilis, Bacillus aerius, S porosarcina pasteurii, AKKR5, Shewanella Species, Bacillus flexus etc. Bacteria used in this work - Bacillus pasteurii of 105 cells/ml of water. These bacteria based self-healing agent is believed to remain hibernated within the concrete for up to 200 years. The bacterial-spores start microbial activities when they come in contact with water and oxygen due to the development of cracks in concrete. Recently, the self-healing approaches have been exhibiting promising results in remediating the cracks in the earlier stages of formation of cracks.

II. MATERIALS

Cement – Cement is a binder material, Ordinary Portland Cement (OPC) of 53 grade was used. The physical and chemical properties of cement are as per IS: 12269 (1987).

Fig.1

Fine aggregate – M-sand passing through 4.75mm IS sieve and confirming to zone-1 of IS: 383 (1987a) was used. The specific gravity was found to be 2.3.

Fig.2

Coarse aggregates – It is crushed stones of maximum size 20mm and retained on 4.75mm IS sieves. The specific gravity was found to be 3.13.

Fig.3

Water – Potable water for conventional concrete. Bacterial water - consisting of 105 cells of Bacillus pasteurii / ml of water.

Ingredients	Cement	Fine aggregate	Coarse aggregate	Water
Quantity ($kg/m^{3)}$	340	657.5	1335.9	171.5
Ratio	1	1.92	3.95	0.55

[5]Tab.1

Bacteria- Cement and water have a very high pH value of around 13 when it mixed together. In such high pH environment most micro-organisms die. The bacteria which need to be added should fit such special norms i.e., it should be alkali resistant and it should also be able to withstand the harsh environmental conditions of the concrete.by referring to below figure of bacteria culturing process, it is found to be that Bacillus megaterium can precipitate maximum amount of calcite when compared to other urease positive bacteria, which results in more increase in compressive strength and higher efficiency of crack-healing[1]. Below figure shows the culturing process of bacteria which is required for this research.

Fig.4

Since the cell wall of the bacteria is negatively charged, the bacteria draw cations from the environment, including Ca2 +, to deposit on their cell surface. The Ca2 + -ions subsequently react with the CO3 2−-ions, leading to the precipitation of CaCO3 at the cell surface that serves as a nucleation site.

$$Ca2+ + Cell \; Cell\text{-}Ca2+ \; [2]$$

$$Cell\text{-}Ca2+ + CO3\ 2- \; Cell\text{-}CaCO3\downarrow [4]$$

III. METHODOLOGY

Bacteria strain selection: The healing agent selection criteria depended on the bacteria's alkali tolerance and the intended metabolic pathway for the Microbiologically Induced Calcium Carbonate Precipitation (MICP) reaction. Bacillus pseudofirmus and Diaphoro bacter nitro reduces were both ideal candidates. Both bacterial strains are capable of using oxygen or nitrate as electron acceptors, suggesting they have a higher viability in environments with minimal oxygen availability, provided nitrate is also present within the cementitious matrix. For this reason, the authors proposed testing these bacterial strains in concrete admixed with calcium nitrate, a commercial multi-functional admixture, to help sustain a continuous growth of bacteria that would maintain an active and stable calcite precipitation rate.

Encapsulation of Bacterial Healing Agents: The simplest and most effective methods to encapsulate bacteria involved the use of hydrogels, since they can act as a water reservoir to enable or sustain the MICP reaction. Thus, calcium alginate hydrogel beads were used in this study to encapsulate the bacterial cell suspension.[3]The simplest technique for producing alginate beads is extrusion dripping of the healing agent mixture into a calcium chloride gelling bath. The healing

agent mixture would be composed of the bacteria cells and nutrients, with a sterilized 1.3% alginate solution. A BUCHI Encapsulator B-390 was used to produce the calcium alginate beads. The culturing process of the Bacteria is completed and the bacteria have been encapsulated. This process is done at the microbiological laboratory in GKVK.

Concrete Mix Design: A water-cement ratio of 0.48 was selected, with a coarse aggregate to fine aggregate ratio of 60:40. The nominal maximum aggregate size was 20 mm for the coarse aggregate, and 4.76 mm for the fine aggregate, respectively. The calcium alginate beads were embedded at varying concentrations by weight of cement to determine the optimal dosage required for self-healing. A super plasticizer was added to increase the workability of the concrete mix. Lastly, calcium nitrate was added as an admixture at 2% by weight of cement as a supplemental nutrient for the bacterial strains.

Self-Healing Concrete Testing: The concrete samples were cast and cured in laboratory settings per ASTM C192 guidelines. Fresh concrete properties were measured with slump and air tests per ASTM C143 and ASTM C231, respectively. It is important to note that two different types of control specimens were used in this study. The first control group (Control NC) did not have alginate beads embedded, whereas the second control group (Control 3%C) did have alginate beads with nutrients but no bacteria cells.

IV. LABORATORY PROCEDURE

1. Mix design of M20 concrete using IS-codes: The concrete mix design as per IS:10262 (2009) and IS:456 (2000).

In order to obtain with the research about self healing, above procedure is carried out in laboratory with required testing materials and operators. For the materials and concrete undergoes various test has been conducted as follows- specific gravity, slump test compaction factor test, Fineness test executed in the laboratory with results as per standards.

Specific gravity: It is defined as the ratio between the mass of given volume of material and mass of an equal volume of water. One of the methods of determining the specific gravity is by the use of liquid such as water free ex-kerosene which doesn't react with cement. For this test a specific gravity bottle may be employed or a standard Le-chatelier flask may be used.

Fineness: The degree of fineness of cement is a measure of the mean size of grains in cement. The rate of hydration and hydrolysis, and consequent development of strength in cement mortar depends on the fineness of cement. The finer cement has quicker action with water and gains early strength though its ultimate strength remains unaffected.

Slump test: It is a measure indicating the consistency or workability of cement concrete. A concrete is said to be workable if it can be easily mixed, placed, compacted and finished. A workable concrete should not show any segregation or bleeding. Segregation is said to occur when coarse aggregate tries to separate out from the final material and the concentration of coarse aggregate at one place occurs.

Casting of cubes: A control concrete mixture and bacterial concrete mixture was designed as per IS:10262 (2009) and IS:456 (2000) to have a slump of 25-50 mm. For bacterial concrete mix, the cell concentration of 105 cells of Bacillus megaterium per ml of water to be used in the study. Since research is not concluded it will further taken into process.

Methodology that is followed is to cast normal concrete with required testing procedures and also bacterial concrete- self healing concrete by adding bacteria. Both the concrete cubes are casted and normal concrete test has been done as mentioned above. Below figures shows the mix proportioning of the concrete with standard water cement ratio required, for the proportion for fine aggregate and coarse aggregate.

Fig.5

The testing carried out for different curing periods like 7days, 14days and 28 days to achieve strength from the normal concrete.

Fig.6

Bacterial concrete is casted as per current study, in order to conduct the required tests for concrete as curing period is specified. Bacterial concrete that is self healing, the tests to be conducted as follows: compressive test and flexural test. These tests can be executed as usual in laboratory as per the required parameters.

Compression strength test- Compressive strength formula for any material is the load applied at the point of failure to the cross-section area of the face based the duration of testing that is: Load/Area.

Fig.7 Compression test of cubes of size 150mmX150mmX150mm for 7 days

Fig.8 Failure of the specimen

Flexural strength test- The Flexural test is carried on two point loading for Beans varying with different sizes used in the present study. The load which is required for the failure of the specimen is noted and the further calculations are carried out.

As the research is still under process few tests were to be conducted for the different curing periods. Above mentioned tests are conducted for both normal concrete and also for bacterial concrete for the curing period of 7days, 14 days and 28 days. After the completion of laboratory tests bacterial concrete is subjected to Electronic Microscope study to observe the process of self healing concept from the bacteria.

V. EXPECTED RESULTS

All the experimental tests results to be included with more strength parameter and also crack healing capacity of the bacterial concrete should be more than the normal conventional concrete.

When compressive strength is compared, it should obtain with the result of bacterial concrete is high when it is compared with normal concrete.

During the curing process the healing capacity of the bacterial concrete should increases with calcium content in the bacteria that is released to crack filling process.

Crack development and its healing is observed by undergoing different tests.

Bacterial concrete is undergoes with the electronic microscopic observation to study detail parameter of this research and its results.

VI. CONCLUSION

Cracks in the concrete is on going process that is un preventable to large extent. But by analysing this concept of bacteria having the capacity to heal that

cracks in the concrete develops better perspective in the field of concrete technologies.

The importance of this work is to introduce the urease positive bacteria (the bacteria which can precipitate calcium carbonate) such as Bacillus subtilis, bacillus pasterui, bacillus megaterium and to understand the healing procedure of cracks in concrete by them This study can provide with the results for different curing period and also strength parameters of the concrete for the specimens with and without bacteria. It also improves the idea that, use of such bacteria has positive effect on water absorption, sportivity and water permeability in concrete. Concrete studies is never ending concept where this present study can give idea of bacteria selection, laboratory tests that should be conducted and observation of crack healing capacity of the specimen that self-healing concrete structure.

VII. REFERNCES

[1] Ghosh, M. Biswas, BD. Chattopadhyay, S. Mandal: *Microbial activity on the microstructure of bacteria modified mortar*. CemConcr Comp (2009) 31(2).

[2] Ramakrishnan V, et.al: *South Dokata School of Mines and Technology, USA, Bacterial Concrete*, Proceedings of SPIE, Vol. 4234 pp. 168-176,Smart Materials.

[3] V. Achal, XL et.al: *Improved strength and durability of fly ash-amended concrete by microbial calcite precipitation.* EcolEng (2011) 37 (4).

[4] Ramchandran SKet.al: *South Dokata School of Mines and Technology,* USA Remediation of concrete using Microorganisms ACI Materials Journal, 98(2001) 3-9.

[5] Kusuma K et.al: *self healing concrete,* JSSATE, Banglore, India,(5)2018.

[6] Salma Banu Luhar,et.al: *A review paper on self healing concrete,* Journal of civil engineering research, 2015, 5(3): 53-58

[7] Elzbieta Stanaszek,et.al: *Bacterial concrete as sustainable building material,* Sustainability 2020, 12, 696.

[8] Henk M. Jonkers,et.al: *Development of a bacteria-based self healing concrete,* Tailor Made Concrete Structures, Taylor & Francis Group(2008).

GREEN AUDITING OF SAPTHAGIRI COLLEGE OF ENGINEERING

NISARGA J V, HARSHITHA R P, HARSHITHA K GOWDA, HARSHITHA R, GEETHA T S

Department of Civil Engineering, Sapthagiri College Of Engineering

#14/5 Chikkasandra, Hesaraghatta main road, Bangalore-57, India.

nisarga440@gmail.com
harshitharp1702@gmail.com
harshu.pari13@gmail.com
harshithar960@gmail.com
geethats@sapthagiri.edu.in

ABSTRACT- The environment where we live within is of utmost concern since it is directly related to the survival. Keeping our surrounding environment healthy is the responsibility of each and every individual. After Earth Summit Rio 1992, the concept of environmental audit was accepted by many countries. Green Audit is defined as an official examination of the effects an institute has on the environment. "Green Audit" aims to analyse environmental practices within and outside the institute, which will have an impact on the eco-friendly ambience and sustainable ecosystem. Green Audit gives awareness on the scope for improvement of environment and ecosystem of the campus. Thus, it is imperative that Sapthagiri College of Engineering, Bangalore evaluates its own status on environmental sustainability and contribute towards a sustainable future.

1. INTRODUCTION-

Green Audit is a tool of management system used methodologically for protection and conservation of the environment. It is also used for the sustenance of the environment. The audit suggests different standard parameters, methods and projects for environmental protection. It can be adopted by any industry, organization, and institute and even by housing complex. The green audit is useful to detect and monitor sources of environmental pollution. It is a systematic identification, quantification, recording, reporting and analysis of components of environmental diversity.

The green audit was first implemented in the United States in the early 1970s by some companies in commensuration with Clean Air and Clean Water Act. The United Nations Conference on Environment and Development (UNCED), also known as Earth Summit Rio-1992 held at Rio de Janerio inspired the countries on the globe to review their environmental stand to act effectively to save the earth with sustainable approach.

India is the first country in the world to make environmental audit compulsory (Arora 2017). The National Assessment and Accreditation Council, New Delhi (NAAC) has made it mandatory that all Higher Educational Institutes should submit an annual Green Audit Report.

1.1. OBJECTIVES

- To estimate the carbon emission of existing structures along the boundary line of the college and its built-up area.
- To find out the carbon emission of vehicles like bike, cars and other transportation vehicles in the campus.
- To find out the amount of oxygen emission by accounting trees, lawns and gardens present in the college premises.
- To find out the amount of alternative energy sources used in the college to reduces the amount of CO2 emitted.
- To provide remedial measures to attain carbon neutrality in the institution premises.

1.2. SCOPE OF GREEN AUDITING

Green Audit involves the inspection of a company to assess the total environmental impact of its activities, or of a particular product or a process. It indicates what type of carbon footprints organizations are leaving on the planet & also suggest ways to reduce it. Therefore, the scope of Green Audit can be listed as below

- Measuring key environmental parameter.
- Analyzing raw & test data
- Communicating with contractors, vendors, customers & regulators
- Examining policies, internal records, reports relating to environmental aspects. Accordingly, Green Audit mainly emphasize the following key areas
- Saving power
- Saving water
- Greening the workplace
- Driving Green

1.3. SCOPE OF CARBON FOOTPRINT AUDIT

- Due to burning of fossil fuels, huge quantities of greenhouse gases are emitted into the atmosphere causing greenhouse effects.
- The most common of greenhouse gases are CO2, water vapor, methane, ozone and nitrous oxide.
- Of all these, CO2 is the most prominent one comprising 402 ppm of atmosphere. So , reducing CO2 emission has become inevitable
- The amount of CO2 released into the atmosphere as a result of the activities of particular individual, organization or community is known as “carbon footprint”.
- Hence, it is necessary to know how much the organization is contributing towards sustainable environment.

1.4. C02 EMITTING SOURCES-

- Emission of CO2 through transport system
- CO2 emitted by generators
- CO2 emitted by culinary consumption(LPG)
- CO2 emitted by electricity consumption

2. METHODOLOGY-

The methodology consists of the following two phases:

a. Emission phase
b. Absorption phase

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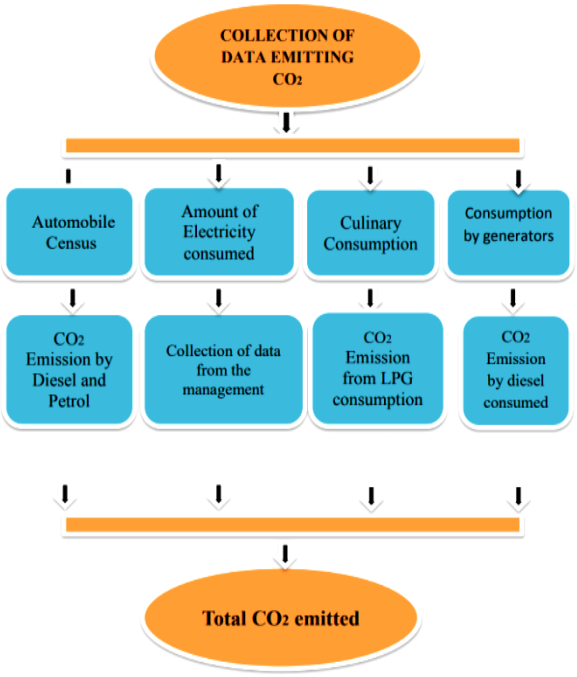
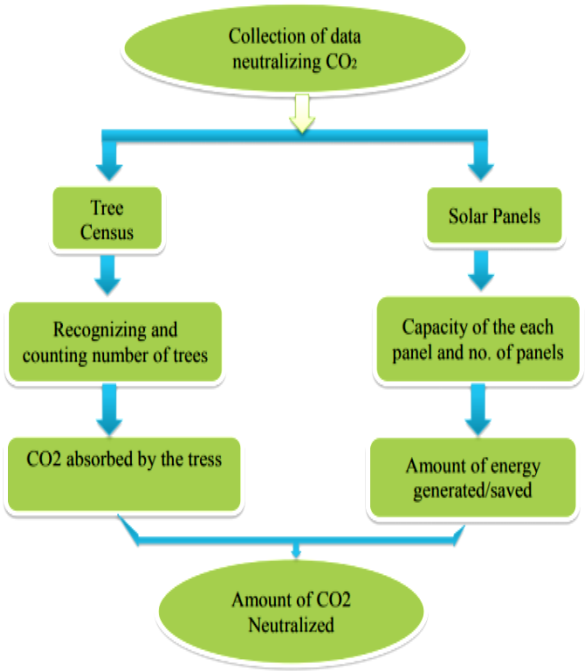
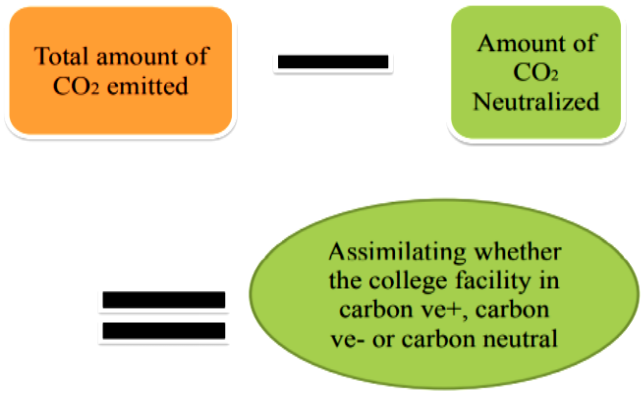
2.1.Emission phase: The following flowchart depicts the procedure for emission phase.



2.2. Absorption phase: The following flowchart depicts the procedure for absorption phase.



The results are obtained by considering the difference between the two phases as shown below.



3. RESULTS AND DISCUSSIONS

3.1. Emission of CO2 through transport system

Table.1.1 *Emission of Co2 by transport system*

Types of Automobiles	Type of fuel used	No of Automobiles	Mileage (km/hr)	Distance Travelled per day (km)	Distance Travelled per year (km
Bike	Petrol	284	40	24	4320
Car	Petrol	8	20	30	5400
Car	Diesel	22	20	30	5400
College bus	Diesel	6	20	50	9000

(continued)

Total Distance covered in km	Petrol/ Diesel Consumed /year (Ltr)	Emission of Co2/Ltr of petrol in kg	Emission of Co2/Ltr of diesel in Kg	Total Emission of Co2 in tons per year
1226880	27,264	2.31		62.979
43,200	3600	2.31		8.316
1,18,800	9900	-	2.68	26.53
54,000	4500	-	2.68	12.06

=283.076 tonnes

3.2. Emission of CO2 by generators

- **Data collection**:

1. No of generators used (diesel) = 2
2. Running time per day = 2 hours
3. Diesel consumed per month = 100 liter
4. Diesel consumed per year = 100*12 =1200 liter

- **Data analysis:**

1. CO2 produced per liter of diesel =2.6 kg
2. Total CO2 generated per year= 1200*2.6 = 3120 kg

= 3.120 tonnes

3.3. Emission of CO2 by culinary consumption(LPG)

- **Data collection:**

1. No of cylinders used in college (monthly) = 3

2. Capacity of each cylinders = 14 kg

- **Data analysis:**

1. CO2 generated per 14kg cylinders = 2.3 kg
2. CO2 generated by 3 cylinders =2.3*3 **=** 6.9 kg

= ***0.0069 tonnes.***

3.4. Emission of CO2 by electricity consumption

- **Data collection:**

1. Total electricity consumed (April 2019 to March 2020) = 2011.18 KWH

- **Data analysis:**

1. Electricity consumption (considering 30% of thermal consumption) = 603.354 KWH
2. One unit (1KWH) requires 0.538kg of coal
3. One kg coal emits 2.86 kg of CO2
4. Total CO2 emitted =603.354*0.538*2.86= 928.36 kg

=0.9283 tonnes

4. CONCLUSION

Total amount of CO2 emitted from college per year ***= 113.94tons.***

Among which the maximum emission is from automobiles, constituting a total emission of***109.885 tons*** of CO2.

5. REFERENCES-

- *International Journal of Advanced Research in Engineering and Management (IJAREM), 3(4), Arora.P (2017).*
- *National Environment Policy(2006), Government of India, Ministry of Environment and Forest.*

Plant latex mediated $SrAl_2O_4 : Dy^{3+}$ nanophosphor useful for LED application

K R ASHWINI[1], H B PREMKUMAR[2], G P DARSHAN[2], H NAGABHUSHANA[3], B DARUKAPRASAD[1]

[1]Department of Physics, BMS Institute of Technology and Management, VTU-affiliated, Bangalore 560 064, India
[2]Department of Physics, M S Ramaiah University, Bangalore 560 082, India
[3]*Center for Nano Research (CNR), Tumkur University, Tumkur 572 103, India*

Abstract **- Novel monoclinic SrAl2O4 : Dy3+ nanophosphor was synthesized by propellant chemistry technique using plant latex Euphorbia Milli extract as a surfactant. The synthesized sample was well characterized by Powder X-ray diffraction (PXRD), Scanning Electron Microscopy (SEM), UV-Visible spectroscopy and photoluminescence (PL) studies. The PXRD profile matched with the JCPDS No. 34–0379. SEM image shows particles of flakes structure with agglomeration. PL emission spectrum excited at λ_{Exc} = 350 nm, exhibit intense emission peak at 544nm. Photometric characterization indicated the suitability of $SrAl_2O_4$ nanophosphor for long blue phosphor. These results suggest that the prepared compound is a promising material for cost-effective light emitting diodes.**

Keywords – Combustion synthesis, Light Emitting diodes, Photoluminescence

I. INTRODUCTION

In the recent years, research on phosphor converted LED's have attracted extensively due to energy saving, high efficiency, eco-friendly nature and longer lifetime advantages [1]. Sources like incandescent and fluorescent lamps were lower luminous efficacy lighting sources due to very poor sensitive to human eyes [2]. To overcome from these problems, rare earth doped aluminates were drawn the attention for their unique applications in optical telecommunication, lasers, diagnostics, sensors, biological labels and luminescence [3]

Investigations of rare-earth doped inorganic systems as well as extension of their practical applications are of great scientific interest [4, 5]. In particular, the remarkable narrow band emission lines, large Stokes shift between excitation and emission of the trivalent rare-earth ions have been utilized to the maximum extent in the development of efficient phosphors. In general, luminescence observed in phosphor materials are attributed to the f–f or f–d transitions of rare earth ions. In addition, the luminescence intensity depends on the site symmetry and the nature of the host lattice. In recent years, activator doped Strontium aluminate oxide ($SrAl_2O_4$) have received great attention, because it has a wide range of application in structural, chemical, solid state lighting, catalysts and electrical industry [6,7].

The applications of doped aluminates phosphors in different fields have made them attractive to the researchers in present days. Based on their promising spectroscopic properties such materials have potential multimode utility in research as well as industrial ground viz. fabrication of light emitting diodes (LEDs), latent finger print detection, X-ray detection, solid state lighting, optical temperature sensing, biomedical detection and diagnostics, in vivo imaging, low power laser therapy, etc [8-11].

Herein, we report for the first-time combustion method to prepare $SrAl_2O_4$ phosphor using *E. Milli* extract as a surfactant. The luminescent properties of $SrAl_2O_4$ phosphors were studied carefully.

II MATERIALS & METHODS

All the chemicals used are of analytical grade and are used without further purification. The stoichiometric ratios of Strontium nitrate [Sr $(NO_3)_2.H_2O$], Aluminium nitrate [Al $(NO_3)_3.9H_2O$ (99.9%)] and $Dy(NO_3)_3.6H2O$ were used as oxidizers and E milli flower extract was used a fuel. The oxidizer to fuel ratio is calculated based on oxidizing (O) and fuel (F) valences of the reactants, keeping O/F ratio as unity [12]. Aqueous solution containing reactants is taken in a 300 ml cylindrical petri dish and is placed in a preheated muffle furnace. The reaction mixture undergoes thermal dehydration and auto-ignites with the liberation of various gases. The flame propagates throughout the reaction mixture causing decomposition of the reactants and subsequent formation of the desired

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product. The obtained product was calcined at 1200 °C for 2 h and used for further studies.

2.2. Characterization

Powder X-ray diffractometer (PXRD, Shimadzu 7000) is used to measure phase purity and crystallinity of NPs using a Cuk$_\alpha$ (1.541Å) radiation. Scanning electron microscopy(SEM) (Hitachi table top, Model TM 3000) was used to analyze the surface morphology. The photoluminescence (PL) measurement was performed on a Jobin Yvon Spectroflourimeter Fluorolog-3 equipped with 450 W Xenon lamp as an excitation source. The UV-Visible spectroscopy of the samples was recorded on Perkin Elmer (Lambda-35) spectrometer.

3. Results and discussion

Fig. 1(a) shows the PXRD patterns of $SrAl_2O_4:Dy^{3+}$ (1-5mol%) nanophosphor. The sharp and intense XRD diffraction peaks confirm the formation of monoclinic phase (JCPDS 34–0379) [13]. Further, it was evident that no other phases/impurities were detected. Broadening in the peak was utilized to determine the average crystallite size (D) using Debye - Scherrer's formula [12];

$$D = \frac{0.9\lambda}{\beta \cos\theta} \qquad \text{---------- (1)}$$

where λ ; the incident wavelength of Cuk$_\alpha$ - X-ray, θ ; the Bragg's angle and β; the FWHM in radian. The average value of D was found to be in the range 32 nm.

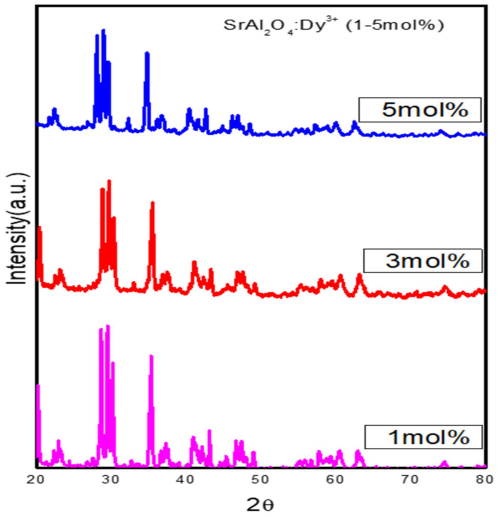

Fig.1.PXRD patterns of $SrAl_2O_4$: Dy^{3+}(1-5mol%) nanophosphor.

Fig. 2(a,b) show the SEM images of $SrAl_2O_4:Dy^{3+}$ nanophosphor, reveals that the surface morphology of product as fiber like structure and crystallites are together to form agglomerated particles.

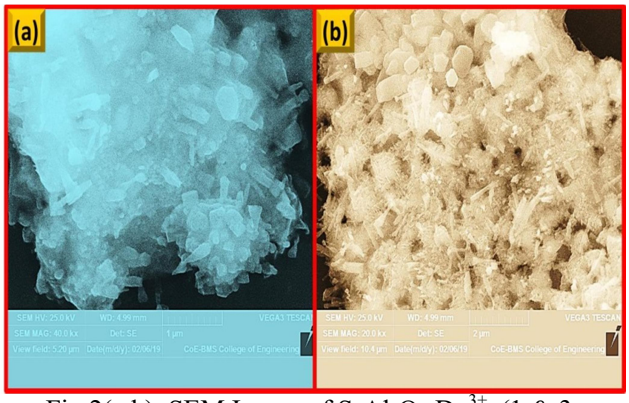

Fig.2(a,b). SEM Image of $SrAl_2O_4:Dy^{3+}$ (1 & 3 mol%)nanophosphor.

Fig.3.shows the emission spectrum of $SrAl_2O_4:Dy^{3+}$ (3 mol%)nanophosphor. The emission peaks are observed at 483nm and 577nm for the excitation wavelength of 350 nm. The spectra consist of emission bands in blue region.

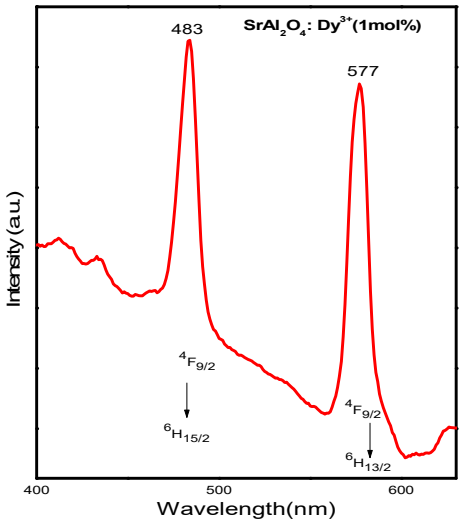

Fig.4(a). Emission spectrum of $SrAl_2O_4$: Dy^{3+}(3mol%)

4. Conclusions

The $SrAl_2O_4:Dy^{3+}$ nanophosphor was synthesized by solution combustion method using E milli as a fuel. The present method of synthesis was simple, direct and cost-effective method of synthesis, applicable on large industrial scale. The PXRD patterns exhibits samples were pure monoclinic phase with crystalline size of ~ 32The photometric characterization shows that samples exhibits white emission which is nearly same as the National Television System Committee (NTSC) standard values of pure white colour. The synthesized phosphor was promising white phosphor material which is applicable to solid state lighting and display devices when coupled blue LED.

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REFERENCES

[1]. Haitao Zhu, Renli Fu, Yahui Shi, Qinjiang He, He Wang, Xuhai Liu, Multi-colour light emission based on pixel-array phosphor layer in LEDs, J. Lumin., 221 (2020) 117057.

[2]. Ritesh Hemam, L. Robindro Singh, S. Dorendrajit Singh, R.N.Sharan, Preparation of CaB_4O_7 nanoparticles doped with different concentrations of Tb^{3+}: Photoluminescence and thermoluminescence/optically stimulated luminescence study, J. Lumin., 197 (2018) 399-405.

[3]. G.L. Bhagya lekshmi, Deepthi N, Rajendran, Luminescence dynamics of Eu^{3+} activated and co-activated defect spinel zinc titanate nanophosphor for applications in WLEDs, J. Alloys Compd., 850 (2021)156660.

[4]. Dong-Eun Lee, In-Cheol Sun Heebeom Koo, Ju Hee Ryu, Kwang meyung Kim, Ick Chan Kwon, Multifunctional nanoparticles for multimodal imaging and theragnosis, Chem. Soc. Rev., 41 (2012) 2656-2672.

[5]. N.H. Deepthi, G.P. Darshan, R.B. Basavaraj, B. Daruka Prasad, H. Nagabhushana, Large-scale controlled bio-inspired fabrication of 3D $CeO_2:Eu^{3+}$ hierarchical structures for evaluation of highly sensitive visualization of latent fingerprints, Sens. Actuators, B. 255 (2018) 3127-3147.

[6]. L.A. Diaz-Torres, J. Oliva, D. Chavez, C.R. Garcia, Enhancing the white light emission of $SrAl_2O_4:Ce^{3+}$ phosphors by co doping with Li^+ ions, Ceram. Int., 42 (2016) 16235-16241.

[7]. W. Shan, L. Wu, N. Tao, Y. Chen, D. Guo, Optimization method for green $SrAl_2O_4:Eu^{2+}$, Dy^{3+} phosphors synthesized via co-precipitation route assisted by microwave irradiation using orthogonal experimental design, Ceram. Int., 41 (2015) 15034-15040.

[8]. H. Zhang, Z. Xue, B. Lei, H. Dong, H. Zhang, S. Deng, M. Zheng, Y. Liu, Y. Xiao, A top-down method to fabricate $SrAl_2O_4:Eu^{2+}$, Dy^{3+} nanosheets from commercial blocky phosphors, Opt. Mater., 36 (2014) 1802-1807.

[9]. M. Dhanalakshmi, R.B. Basavaraj, G.P. Darshan, S.C. Sharma, H. Nagabhushana, Pivotal role of fluxes in $BaTiO_3:Eu^{3+}$ nano probes for visualization of latent fingerprints on multifaceted substrates and anti-counterfeiting applications, Microchem. J. 145 (2019) 226–234.

ISBN: 979-85-27243-61-1

[10]. A.Naveen Kumar, D.M.Jnaneshwara, H.Nagabhushana, S.C.Prashantha, M.Chandrasekhar, C.R.Ravikumar, M.R.Anil Kumar, N.Basavaraju, T.R.Shashi Shekhar, H.B. Premkumar, Enhanced photoluminescence, electrochemical and photocatalytic activity of combustion synthesized $La_{10}Si_6O_{27}:Dy^{3+}$ nanophosphors, J. Sci.: Adv. Mat. and Dev., https://doi.org/10.1016/j.jlumin.2012.04.030.

[11]. G.P. Darshan, H.B. Premkumar, H. Nagabhushana, S.C. Sharma, B. Daruka Prasad, S.C. Prashantha, Neodymium doped yttrium aluminate synthesis and optical properties – A blue light emitting nanophosphor and its use in advanced forensic analysis, Dyes and Pig., 134 (2016) 227-233.

[12]. B.S. Shashikala, H.B. Premkumar, G.P. Darshan, H. Nagabhushana, S.C. Sharma, S.C. Prashantha, Rational design of bi-functional RE3+ (RE = Tb, Ce) and alkali metals (M+ = Li, Na, K) co-doped CaAl2O4 nanophosphors for solid state lighting and advanced forensic applications, Mat. Res. Bull., 115 (2019) 88-97.

[13]. K.R. Ashwini, H.B. Premkumar, G.P. Darshan, R.B. Basavaraj, H. Nagabhushana, B. Daruka Prasad, Near UV-light excitable $SrAl_2O_4:Eu^{3+}$ nanophosphors for display device applications, J. Sci.: Adv. Mat. and Dev., 5 (2020) 111-118.

[14]. Taynara Basso Vidovix, Heloise Beatriz Quesada, Eduarda Freitas Diogo Januário, Rosângela Bergamasco, Angélica Marquetotti Salcedo Vieira, Green synthesis of copper oxide nanoparticles using Punica granatum leaf extract applied to the removal of methylene blue, Mater. Lett., 257 (2019) 126685.

[15]. Thuc-Huy Duong, Mehdi A. Beniddir, Grégory Genta-Jouve, Huu-Hung Nguyen, Dinh-Phuoc Nguyen, Thi-Anh-Tuyet Nguyen, Dinh-Hung Mac, Joël Boustie, Kim-Phi-Phung Nguyen, Warinthorn Chavasiri, Pierre Le Pogam, Further terpenoids from Euphorbia tirucalli, Fitoterapia,135 (2019) 44-51.

[16]. M. Gomathi, A. Prakasam, P.V. Rajkumar, S. Rajeshkumar, R. Chandrasekaran, P.M. Anbarasan, Green synthesis of silver nanoparticles using Gymnema sylvestre leaf extract and evaluation of its antibacterial activity, S. Afr. J. Chem. Eng., 32 (2020) 1-4.

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Photoluminescence Studies of Strong Red Emitting $CaAl_2O_4:Eu^{3+}$ Nanophosphor for Display Applications

B. S. Shashikala[1, 2], H. B. Premkumar[3*], G. P. Darshan[3], H. Nagabhushana[4]

[1]Department of Physics, Sapthagiri College of Engineering, Bangalore -560 057, India

[2]Visvesvaraya Technological University, Regional Center Bangalore -560 091, India

[1 3]Department of Physics, M. S. Ramaiah University of applied Sciences, Bangalore -560 054, India

[4]Prof. C.N.R. Rao Centre for Advanced Materials, Tumakuru University, Tumakuru–572 103, India

Abstract: Novel $CaAl_2O_4:Eu^{3+}$(1-9 mol%) Nano phosphors were fabricated by ultrasonic Sonochemical method where bio sacrificial fresh lemon juice is used as a fuel. The monoclinic phase in all samples is revealed by PXRD profiles. Morphologies of the NPs were mainly dependent on Eu^{3+}, lemon juice, Sonication time, pH and sonication power. The Photoluminescence measurements exhibit sharp peaks at ~ 577, 588, 615, 654 & 702 nm, related to $^5D_0 \rightarrow ^7F_J$ transitions respectively. CIE chromaticity diagram shows orange to red region of the phosphor. The dipole-dipole interaction between the activator ions leads to concentration quenching. These findings confirm that the prepared Nano phosphor might find an application in White Light Emitting Diodes and Display materials.

Keywords: ***Bio-inspired; Sonochemical route; Photoluminescence; LED.***

INTRODUCTION

The combination of Nanoscience and nanotechnology, particularly the emergence of engineered nanoparticles results in most promising development of devices in variety of fields like photonic materials, field emission displays, Nano electronics, biomedical, biological and chemical probes, light emitting and laser diodes [1-2]. Luminescent materials exhibit various applications and drag the attention of research community, due to their noticeable doping capability, thermal stability, spectroscopic, physical, chemical and structural properties [3]. White light emitting diodes (WLED's) are replaced by incandescent and fluorescent lamps for higher energy efficiency, small size, short decay time and environmental protection [4-5]. Hence, Nano phosphors are effectively excited near UV light and emit in visible range plays an important role [6]. Among different kinds of host materials, aluminates ($CaAl_2O_4$) have received a kind of interest due to its easy preparation, wide band gap, low cost and excellent physical and chemical stability [7].

The rare earth ions when incorporated with such host matrix give excellent luminescence results. In these, Eu^{3+} dopant ions were of high luminescence efficiency and proper CIE coordinates, further one of the most suitable sources corresponds to the red color of visible light spectra with a transition from ($^5D_0 \rightarrow {}^7F_2$). [8] $CaAl_2O_4:Eu^{3+}$ has more advantages for display applications, due to their higher stability, high quantum yield and higher emission intensity. Until today many synthesing methods like solgel, combustion, hydrothermal, co-precipitation, solvothermal, hydrothermal etc., [9].

The ultrasound method is used in preparing wide range of nano phosphors, including metals / sulphates /alloys/ aluminates / carbides/fluorides etc. This method also develops an interest for the synthesis of Nano phosphors because of its high potential uses like, controllable and fast reaction rate, smaller size distributions, high homogeneity, uniform mixing, less synthesis time, and least energy requirement and can be scalable to industrial needs. [10], this method is simple to operate and maintain also it is a convenient yet comparatively inexpensive tool. In this method the prepared solution was subjected to ultrasound irradiation, the micro bubbles (cavities) created in the solution was implosively collapsed by sound waves with which very high temperature and high cooling rates can be achieved which leads to the synthesis of many nanostructure materials including metals, alloys, oxides, sulphides and nanostructure supported catalysts.

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Considering these points, in this work, $CaAl_2O_4:Eu^{3+}$ (1-9mol %) and Nano phosphors were synthesized by ultrasonic Sonochemical method using fresh lemon juice as bio surfactant. The morphology and phase purity of the synthesized phosphors were verified by PXRD, SEM, respectively. Photoluminescence behaviour (PL) and photometric properties are studied extensively for lighting and display applications.

MATERIALS & METHODS

Aluminum nitrate [$Al(NO_3)_3.9H_2O$(99.9%)], Calcium nitrate [$Ca(NO_3)_2.4H_2O$ (99.9%)],Europium oxide(Eu_2O_3, Merck Ltd.) are used as oxidizers and taken in proper stoichiometric ratios with a fresh lemon juice as biosurfactant. The purchased fresh lemon were peeled and squeezed to obtain the pulp then the solid pulp will be removed by filtering with muslin cloth. Filtered lemon juice was diluted in 1:4 ratios and then 30 ml of the solution was used as a surfctant.

For the preparation of europium doped $CaAl_2O_4$ by ultrasonication method, initially the conversion of Eu_2O_3 to Europium nitrate was done by dissolving stoichiometrically measured amount of Eu_2O_3 in 1:1 HNO_3 kept on sand bath at 80 ^{0}C, where excess of nitric acid was evaporated to leaving a transparent europium nitrate solution. The stoichiometrically measured Calcium nitrate (2.3379 g), Aluminum nitrate (7.5028 g) and Europium nitrate were dissolved in 10 ml of distilled water. The diluted lemon juice (~ 30 ml) was added to above solution and mixed well using a magnetic stirrer for about 10 - 15 min then introduced ultrasound horn into the solution with frequency of ~20 kHz, power of ~300 W and the solution is irradiating with ultrasound waves for sonication time of 1 hr at 32 ^{o}C. The resultant solution was then kept in an oven for a day to get a gel like sample fallowed by calcined at 900 ^{o}C for 3 hr. The same procedure was included for different concentrations of Eu^{3+}.

RESULTS& DISCUSSIONS

The PXRD patterns of prepared $CaAl_2O_4:Eu^{3+}$ (1-9 mol %) nanophosphor was shown in Fig.1. The sharp and broad diffraction peaks of the pattern corresponding to monoclinic phase with the standard $CaAl_2O_4$ JCPDS (172155). Further, broad diffraction peaks were associated with strain or crystallite size present in the sample. The crystallite size (D) of the prepared nanoparticles was calculated using Scherer's formula.

$$D = \frac{0.9\,\lambda}{\beta \cos\theta} \qquad \text{---------- (1)}$$

Where λ is the radiation wavelength of Cukα - X-rays used, β is the full width at half maximum in radian, θ is the diffraction peak angle, D the average crystallite size and ε is strain present in the sample, the average crystallite sizes are depicted in Table 1.

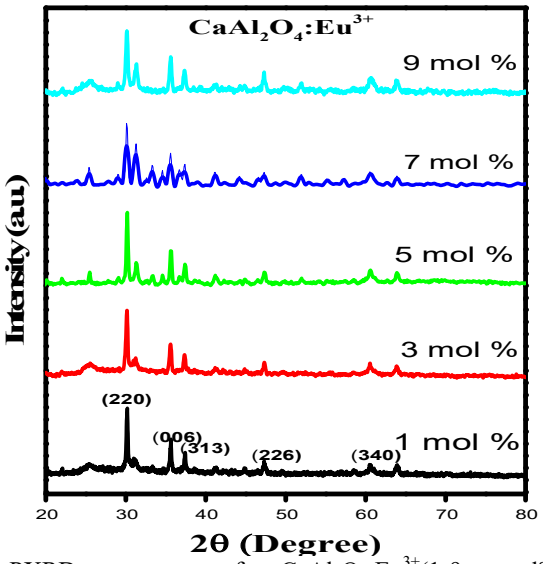

Fig.1:PXRD pattern of $CaAl_2O_4:Eu^{3+}$(1-9 mol%) nanophosphor.

Table 1: Estimated crystallite size of $CaAl_2O_4:Eu^{3+}$ (1-9 mol %) nanophosphor

$CaAl_2O_4:Eu^{3+}$ (mol %)	Crystallite size(nm) [D-S method]
1	27
3	19
5	22
7	25
9	30

The PL excitation spectrum of $CaAl_2O_4:Eu^{3+}$ (7 mol %) NPs monitored at ~615 nm emission wavelength, as in Fig 2(a).The spectra exhibit several peaks centered at ~ 367, 393, and 463 nm, are attributed to $^7F_0 \rightarrow {}^5G_3$, $^7F_0 \rightarrow {}^5D_2$ and $^7F_0 \rightarrow {}^5L_6$ transitions of Eu^{3+} ions, respectively.

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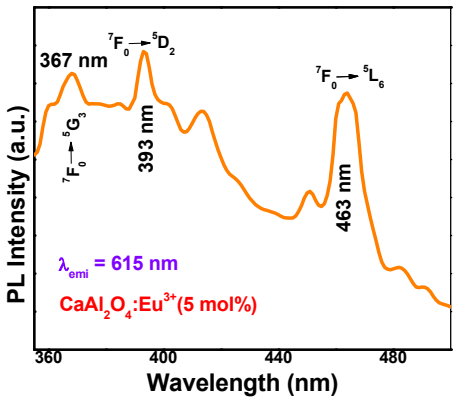


Fig.2(a) : PL emission spectra of $CaAl_2O_4:Eu^{3+}$ (7 mol%) nanophosphor

The photoluminescence emission spectrum of $CaAl_2O_4:Eu^{3+}$(1-9 mol%) nanophosphor is shown in Fig.(b) recorded upon 463 nm excitation exhibit sharp peaks at ~ 588, 615, 654 and 702 nm, owing to $^5D_0 \rightarrow {}^7F_1$, $^5D_0 \rightarrow {}^7F_2$, $^5D_0 \rightarrow {}^7F_3$ and $^5D_0 \rightarrow {}^7F_4$ transitions of Eu^{3+} ions. The most intense peak at 615 nm due to $^5D_0 \rightarrow {}^7F_2$ transition corresponds to electric dipole of Eu^{3+} ions was most hypersensitive and intense in the host matrix. The transition corresponding to $^5D_0 \rightarrow {}^7F_1$ at 588 nm is contributed to magnetic dipole of Eu^{3+} ions were insensitive to symmetry.

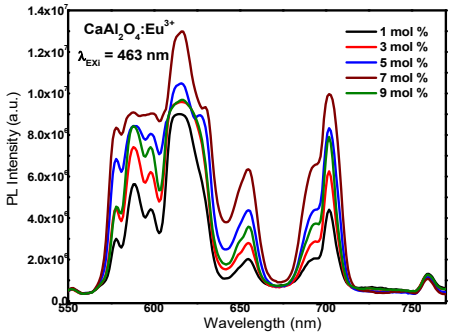


Fig.2(b) : PL emission spectra of $CaAl_2O_4:Eu^{3+}$ (1-9 mol%) nanophosphor

The PL emission intensity with various concentrations of Eu^{3+} ions was verified and It was found that PL intensity increases up to 7 mol % and later diminishes due to the concentration quenching effect so that there is an increased non-radiative relaxation between two closest Eu^{3+} ions. Change in the local environment of host matrix, may vary the intensity at 615 nm by few orders of magnitude. Hence the asymmetric ratio can be used to find the site symmetry of Eu^{3+} ions using the relation:

$$A_{21} = \frac{\oint I_2(5_{D_0} \rightarrow 7_{F_2})d\lambda}{\oint I2(5_{D_0} \rightarrow 7_{F_1})d\lambda} \text{ ---------- (3)}$$

Where I_2 is the intensity at 615 nm and I_1 is the intensity at 588 nm respectively. This asymmetric ratio can be used as an effective tool for site symmetry of Eu^{3+} ions in host matrix. There is an increment in the ratio up to 7 mol% and thereafter decrement with an increase of Eu^{3+} ions as in Fig.4

.

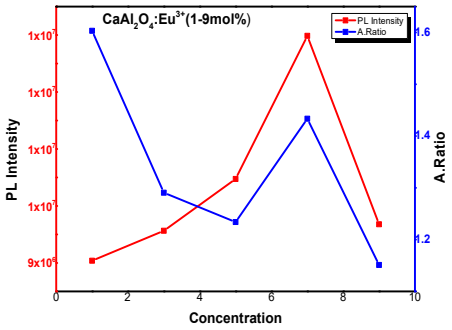


Fig.4: variation of PL intensity and asymmetric ratio with Eu^{3+} concentration.

The SEM micrographs of Eu^{3+} (9 mol %) doped $CaAl_2O_4$ nanophosphor shown in Fig.5. synthesised with ultrasound irradiation time 1 h using 30 ml of fresh lemon juice as biosurfctant. At 1 h ultrasound irradiation time, spike like structures are observed on the surface which fallows the self assembly to grow as a clear structure with a typical width of 1-10 µm.

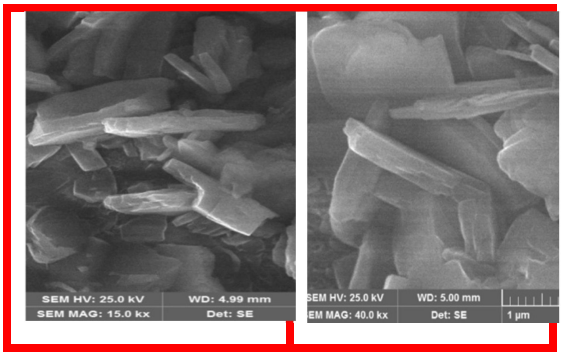
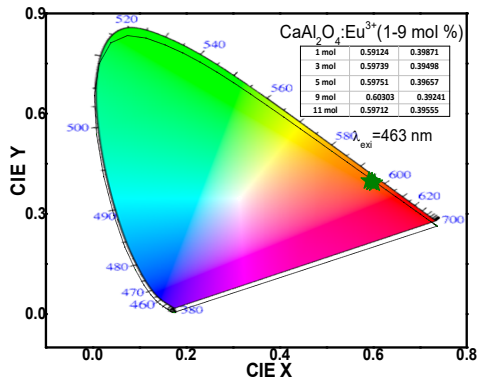


Fig.5: SEM pictures of $CaAl_2O_4$: Eu^{3+} (9mol %) nanophosphor

In the reaction mixture, the growth and collapse of the bubbles takes place due the irradiation of ultrasound waves.

The evaporated water molecules and gas molecules are included in bubbles and collapse of these bubbles happens when the bubbles reach the unstable size in the reaction mixture.



.

The Fig.6. gives the CIE chromaticity diagram of $CaAl_2O_4:Eu^{3+}$ (1 -9 mol%) nanophosphors, CIE co ordinates of the synthesised samples were noticed in red region.

CONCLUSIONS

In summary, $CaAl_2O_4:Eu^{3+}$ (1-9 mol %) NPs were fabricated by ultrasound assisted sonochemical route using lemon juice as a bio-surfactant. From PXRD results, the average crystallite size of the prepared nanophosphor were estimated and found to be ~ 30 nm. The noticeable upsurge in the PL intensity up to 7 mol % was noticed and later it decreases with further increase of Eu^{3+} concentration due to CQ. The finding indicates that the d–d interaction among Eu^{3+} ions is mainly responsible for the observed CQ. The estimated CIE coordinates fall on pure red region of chromaticity diagram which confirms that the prepared NPs has warm red emission. Hence, the prepared nanophosphors were quite functional for WLED's and solid state lightning applications

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REFERENCES

[1] Y. Zhang, J. Chen, C. Xu, Y. Li, and H. Jin Seo, "Photoluminescence and abnormal reduction of Eu3+ ions in CaAl2O4:EU nanophosphors calcined in air atmosphere," *Phys. B Condens. Matter*, vol. 472, pp. 6–10, 2015, doi: 10.1016/j.physb.2015.04.018.

[2] J. Y. Lao, J. G. Wen, and Z. F. Ren, "Hierarchical ZnO Nanostructures," vol. 02467, 2002.

[3] Y. Wang, C. Lin, H. Zheng, D. Sun, L. Li, and B. Chen, "Fluorescent and chromatic properties of visible-emitting phosphor," *J. Alloys Compd.*, vol. 559, pp. 123–128, 2013, doi: 10.1016/j.jallcom.2013.01.063.

[4] R. Naik *et al.*, "A single phase, red emissive Mg2SiO4:Sm3+ nanophosphor prepared via rapid propellant combustion route," *Spectrochim. Acta - Part A Mol. Biomol. Spectrosc.*, vol. 140, pp. 516–523, 2015, doi: 10.1016/j.saa.2015.01.011.

[5] R. J. Xie and N. Hirosaki, "Silicon-based oxynitride and nitride phosphors for white LEDs-A review," *Sci. Technol. Adv. Mater.*, vol. 8, no. 7–8, pp. 588–600, 2007, doi: 10.1016/j.stam.2007.08.005.

[6] B. S. Shashikala, H. B. Premkumar, G. P. Darshan, H. Nagabhushana, S. C. Sharma, and S. C. Prashantha, "Rational design of bi-functional RE $^{3+}$ (RE = Tb, Ce) and alkali metals (M $^{+}$ = Li, Na, K) co-doped CaAl <inf>2</inf> O <inf>4</inf> nanophosphors for solid state lighting and advanced forensic applications," *Mater. Res. Bull.*, vol. 115, 2019, doi: 10.1016/j.materresbull.2019.03.002.

[7] V. Singh, T. K. Gundu Rao, and D. K. Kim, "Characterization, photoluminescence and correlation between thermoluminescence and ESR of combustion synthesized CaAl2 O4 : Sm3 + material," *Radiat. Meas.*, vol. 43, no. 7, pp. 1198–1203, 2008, doi: 10.1016/j.radmeas.2008.01.024.

[8] K. N. Venkatachalaiah, H. Nagabhushana, G. P. Darshan, R. B. Basavaraj, and B. D. Prasad, "Research highlights Facile solution combustion route was used to prepare the optimized composite core shell," *Sensors Actuators B. Chem.*, 2017, doi: 10.1016/j.snb.2017.05.022.

[9] H. B. Premkumar, H. Nagabhushana, S. C. Sharma, S. C. Prashantha, and H. P. Nagaswarupa, "Structural , photo and thermoluminescence studies of Eu 3 + doped orthorhombic YAlO 3 nanophosphors," *J. Alloys Compd.*, vol. 601, pp. 75–84, 2014, doi: 10.1016/j.jallcom.2014.02.066.

[10] F. Femila Komahal, H. Nagabhushana, G. P. Darshan, and B. Daruka Prasad, "Hierarchical zinc aluminate 3D nanostructures, synthesized by bio-inspired ultrasound assisted sonochemical route: Display and dosimetry applications," *Arab. J. Chem.*, vol. 13, no. 1, pp. 580–594, 2020, doi: 10.1016/j.arabjc.2017.07.002.

TEMPERATURE DEPENDENT TRANSPORT PROPERTIES EU^{3+} DOPED BORATE BASED TELLURITE GLASSES

DEVARAJA C[1], JAGADEESHA GOWDA G V[*2]

Department of Physics, Sapthagiri College of engineering
#14/5 Chikkasandra, Hesaraghatta main road, Bangalore- 57 India
[1]deva.drr@gmail.com
[2]Jagadeeshagowdagv@gmail.com

***Abstract* - The DC conductivity of Eu^{3+} ions embedded in lead boro-tellurite glasses has been accomplished as a function of temperature in the range of 343 to 483 K. The Cole-Cole (Impedance) plots of glasses contained only one perfect semicircle at different temperatures. This realizes the material's conductivity which presumes an ideal Debye type relaxation. In the Cole-Cole plot at 483K, the semicircle is well defined and fitted into an equivalent parallel RC circuit. The DC conductivity exhibits the Arrhenius behavior and compositional dependence. The DC activation energy (E_{dc}) was estimated for all samples by using linear regression analysis. The values range from 0.202 to 0.231 eV.**

Keywords –Lead boro-tellurite glasses; Europium Oxide; Cole-Cole graph; DC conductivity.

I. INTRODUCTION

It is well known that oxide glasses comprising alkali ions like Li^+, Na^+, and K^+ are fundamentally solid electrolytes, and current is conceded by moderately mobile alkali ions [1-4]. The presence and movement of alkali ions in glasses are most significant, not only due to their chemical durability and ion exchange kinetics but also because of its electrical conductivity. The review of the literature revealed that in the present era, considerable research is on-going on boro-tellurite glasses due to their extensive diversified applications in the field of optoelectronics, solid-state laser, optical amplifiers, optical device, and solid-state electrolytes [3-6]. These applications are specifically due to the unique properties of boro-tellurite glasses such as high transparency, high refractive index, relatively low phonon energy, slow crystallization rate, good mechanical strength, and long durability. Further, these glasses show good infrared transmission and less hygroscopic as well [5-8]. The electrical conductivity originated from polaron hopping can be identified in transition metal oxides (TMO) implanted glasses, and the ionic conductivity can be acknowledged in alkali doped glasses. PbO as both glass former and network modifier can give stable glass with low rates of crystallization [9,10]. The rare-earth ions embedded in glasses affect the conductivity in them. The europium trioxide embedded glasses find their desirable applications in solid-state laser, optical amplifiers, display due to their sharp emission bands in visible and near-infrared regions [11,12]. The glasses exhibit enhanced mechanical strengths and moisture resistance with the addition of alkali oxides such as Na_2O and Li_2O. Na_2O is used to convert BO_3 triangular units into BO_4 tetrahedral units and hence makes structure more compact, which in turn leads to development in mechanical strength. Dielectric and structural studies on alkali oxides and heavy metal oxide ions doped borate glasses are reported in references [13-15]. Until now, only few transport property studies on alkali boro-tellurite glasses activated with Eu^{3+} ions are reported by others[1-3]. Therefore, in this paper, transport property studies have been investigated, and results are reported.

II. MATERIALS & METHODS

By using H_3BO_3, Na_2CO_3, PbO_2, and Eu_2O_3 chemicals as starting materials, the decided lead boro-tellurite doped with europium oxide glasses were made-up through the conventional melt quenching method. All the chemicals were Analytical Reagents (AR) grade and were utilized straight away without any refinement. The homogenous mixture of precursors was taken into crucibles as per the stoichiometric amounts. The porcelain crucible was kept

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in the high-temperature electrical muffle furnace for heating at 1100 ˚C for one hour. Further, to ensure complete melting and homogeneity, the molten liquid was stirred several times. The molten liquid was cast into pre heated brass mold and quickly pressed with another preheated brass mold to obtain a flat type of discs having a thickness around 1.5 - 2.5 mm. The prepared set of glass is named LBTE0, LBTE1, LBTE2, LBTE3, LBTE4, and LBTE5, and to remove internal thermal stress and strain, these glasses were kept in a furnace at temperature 300 ˚C for 2 hours. To obtain shiny and proper flat disc-shaped samples, the glasses were well polished using emery papers for electrical conductivity measurements. The electrical conductivity measurements have been employed by using Hewlett Packard HP 4192A impedance gain phase analyzer from 40Hz to 60 MHz frequency and in the temperature range of 343 K to 483 K.

III. RESULT AND DISCUSSIONS

DC CONDUCTIVITY

In the temperature range of 343 K to 483 K, the capacitance (C_p) and conductance (G) were recorded by using an impedance analyzer in the frequency range of 40 Hz to 60 MHz. The real (Z′) and imaginary (Z″) parts of complex impedance were calculated with known values of capacitance and conductance by using mathematical expressions (1), (2), and (3).

$$Z^* = Z' + jZ'' = \frac{1}{(G+j\omega C_p)} \quad (1)$$

$$Z' = \frac{G}{(G^2+\omega^2 C_p^2)} \quad 2)$$

$$Z' = \frac{\omega C_p}{(G^2+\omega^2 C_p^2)} \quad (3)$$

Here, ω implies the angular frequency. From the semicircle complex impedance plot of Z′ versus Z″, DC conductance was evaluated by taking the intersection values at the low-frequency end of on the Z′ axis. The conductivity (σ) of each sample was found by using relation (4)

$$\sigma_{dc} = \frac{1}{Z}\frac{d}{A} \quad (4)$$

where A and d are the area and thickness of the glass sample, respectively, and Z refers to resistance taken from the impedance plot (Z′ Versus Z″).

Fig.1 depicts the Cole-Cole (Impedance) plot of LBTE2 glass at different temperatures. The plots of impedance for all LBTE glasses contained only one perfect semicircle. It infers the material's conductivity, which may be due to the grain. It also presumes an ideal Debye type relaxation. In the Cole-Cole plot, the semicircle is well defined and fitted into an equivalent parallel RC circuit. In Fig.2, the well-fitted semicircle of LBTE2 glass at 483K was depicted. For the ready glass system, the DC conductivities were evaluated by the impedance plots using intersections on the positive axis (real Z′ axis). Also, it is noticed that the conductivity is decreasing with the increasing of Eu_2O_3 concentration, which infers the fact that the glass is losing its conducting property. The DC conductivity values at 483K temperature and calculated DC activation energy values of LBTE glasses are listed in Table.1. The DC activation energy (E_{dc}) was estimated for all samples by using linear regression analysis of log σ_{dc} versus 1000/T plot. Fig.3 shows the Arrhenius plot of LBTE glasses for DC conductivity, and Fig.4 depicts DC activation energy versus concentration of Europium oxide.

In Fig.3 and Fig.4, it is noticed that the DC conductivity gradually decreases, but activation energy values increase with significant values, which indicates the dependency of log (σ_{dc}) versus 1000/T. The relation between conductivity and activation energy reveals the fact that the decrease in conductivity might be related to less availability of oxide ions in the glass [16-18].

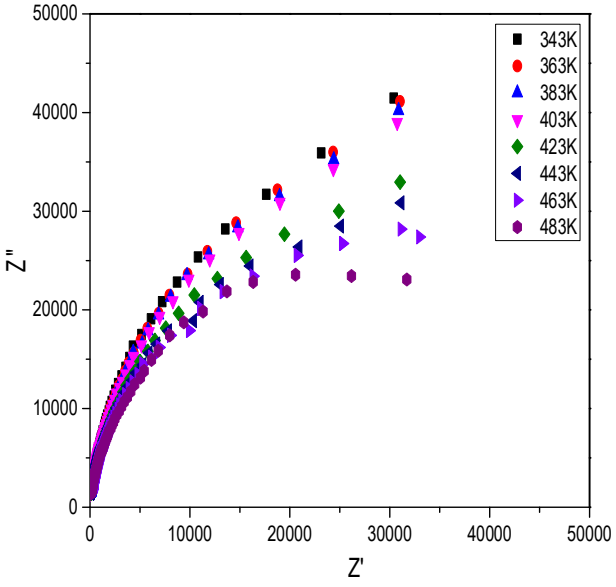

Fig 1. Typical Cole-Cole plot of LBTE2 glass at various temperatures.

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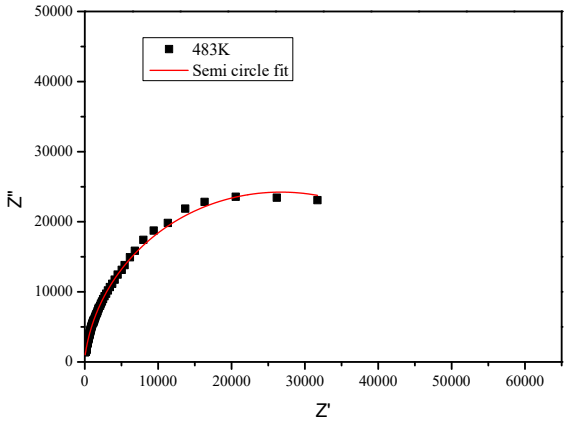

Fig 2. Typical equivalent circuit model fit of LBTE2 glass at 483K.

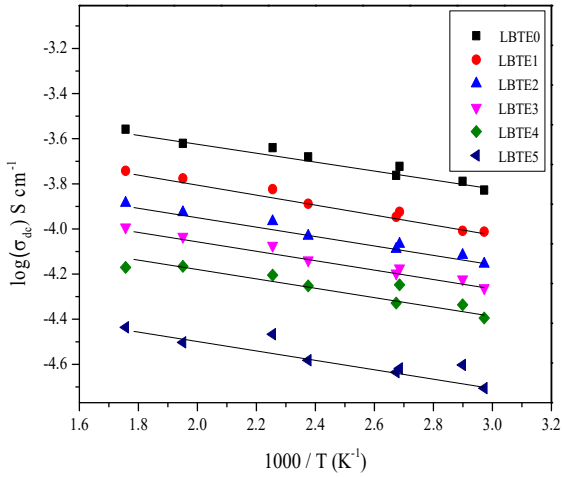

Fig 3. The plot of log (σ_{dc}) versus 1000 / T (Arrhenius plot).

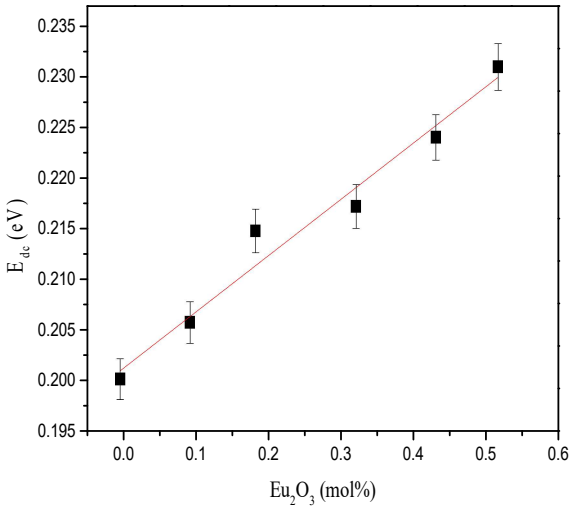

Fig 4. The plot of E_{dc} versus Eu_2O_3 concentration.

Table 1. The DC conductivity values, DC activation energy of LBTE glasses

Glass code	σ_{dc} at 483 K (S cm^{-1})	E_{dc} /eV
LBTE0	4.671×10^{-8}	0.202
LBTE1	4.136×10^{-8}	0.206
LBTE2	3.861×10^{-8}	0.215
LBTE3	3.672×10^{-8}	0.217
LBTE4	3.561×10^{-8}	0.224
LBTE5	3.368×10^{-8}	0.231

The decrease in oxide ions might be due to the modification in the structural units in the network of glass by inclusion of a small concentration of Eu_2O_3 rare earth oxide [18].

Furthermore, the DC conductivity decrement with the replacement of Na_2O / TeO_2 by Eu_2O_3 could be because of the heavy mass of Eu^{3+} ions. Thus, the activation energy increases, and the conductivity of glasses decreases with the adding of Eu_2O_3. However, the very less amount of conductivity in the LBTE glasses could be due to oxide ions of Na_2O / TeO_2. It is also noticed in Fig.3 that the presence of linear dependence between the reciprocal of the absolute temperature and log of DC electrical conductivity is a general characteristic of the ionic conductivity wherein the activation energy might not change with temperature. Also, when the conduction is present due to polarons in the glass, then the activation energy can change with temperature. The conduction due to polarons is a characteristic dependence on activation energy.

IV. CONCLUSIONS

The influence of Eu^{3+} ions on DC conductivity of LBTE glasses was examined in the frequency range of 40 Hz to 60 MHz at various temperature ranges from 343 K to 483 K. It is concluded from the electrical study that the conductivity of glasses reduces when the mobility of oxide ions decreases due to the larger mass of Eu^{3+} ions. Besides, the outcome shows that the conduction process is both temperature and composition independent in LBTE glasses. From the obtained values of conductivity and dielectric properties of the glass, the system specifies the possibility of the development of solid-state device applications.

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REFERENCES

[1] J.S. Ashwajeet, T. Sankarappa, T. Sujatha, R. Ramanna, J. Non-Cryst. Solids 486 (2018) 52–57.

[2] AmarkumarMalge, T. Sankarappaa,T. Sujatha, P. Abdul Azeem, G. B. Devidas, SantoshkumarKori, Materials Today: Proceedings, 26, (2020) 1960-1963.

[3] D.Vijayatha, N.Sivasankara Reddy, C.Narayana Reddy, Materials Today: Proceedings, 22 (2020) 2103-2108.

[4] M. Anand Pandarinath, G. Upender, K. Narasimha Rao, D. Suresh Babu, J. Non- Cryst. Solids 433 (2016) 60–67.

[5] S. Selvi, K. Marimuthu, G. Muralidharan, J. Lumin. 159 (2014) 207–218.

[6] G. Lakshminarayana, Kawa M. Kaky, S.O. Baki, A. Lira, I.V. Priyanka Nayar, M.A. Mahdi Kityk, J. Alloy. Compd. 690 (2017) 799–816.

[7] C. Devaraja, G.V. Jagadeesha Gowda, B. Eraiah, J. Ceramic International,47 (2021) 7602-7607.

[8] C. Devaraja, G.V. Jagadeesha Gowda, B. Eraiah, J. Vacuum, 177 (2020) 10942.

[9] B. Eraiah, M.G. Smitha, R. V. Anavekar J. Phys. Chem. Solids. 71 (2010) 153.

[10] T. Annapurna, M. Kostrzewa A. Siva Sesha Reddy, J. Vacuum.179 (2020) 109171.

[11] H. Karimi, Y. Zhang, S. Cui, R. Ma, G. Li, Q. Wang, J. Non. Cryst. Solids. 406 (2014) 119.

[12] J.B. Prasanna Kumar, G. Ramgopal, Y.S. Vidya, K.S. Anantharaju, Spectrochim. Acta - Part A Mol. Biomol. Spectrosc. 141 (2015) 149.

[13] Sunil Thomas, Sk. Nayab Rasool, M. Rathaiah, V. Venkatramu, Cyriac Joseph, N. V. Unnikrishnan, J. Non-Cryst. Solids 376 (2013) 106–116.

[14] L. Vijayalakshmi, K. Naveen Kumar, G. Bhaskar Kumar, Pyung Hwang, J. Non- Cryst. Solids 475 (2017) 28–37.

[15] G.V. Jagadeesha Gowda, B. Eraiah. R. V. Anavekar, J. Alloys and Compounds, 620 (2015) 192-196.

[16] S. Selvi, K. Marimuthu, G. Muralidharan, J. Lumin. 159 (2014) 207–218

[17] V. V. Gowda and R. V. Anavekar, J. Mater. Sci., 42 (2007) 3816–3824.

[18] G.Rajashekara, J.Sangameshb, N.Nagarajac, T.Sankarappa, Prashantkumar,SantoshKumarKorie, Materials Today: Proceedings 5 (2018) 16821-16831.

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The Flow of a Micropolar Fluid through a Cylindrical Tube with Catheter Insertion

Roopa.K.R[1], Shripad Markande[2], R.G.Deshpande[3]
1& 2 Department of Mathematics Engineering, Sapthagiri College of Engineering
3 Department of Mechanical Engineering, Sapthagiri College of Engineering
1roopakr@sapthagiri.edu.in
2mshripad@gmail.com
3deshpande@sapthagiri.edu.in

Abstract: ***An exact solution to the problem involving a non-steady flow of a micro polar fluid through an annular region is obtained. A coupling coefficient and two length ratios arise in the study. The effect of the suspended particles is to stabilize the flow. The classical Newtonian results are obtained as a limiting case of the present general study. The problem has possible extra – corporeal and intra – corporeal applications***

Keywords – Seismic Sensors, Lunar applications

1. INTRODUCTION

Probing physiological situations is a common phenomenon in today's medical world wherein sophistication in equipments is so much that sizes, big or small, do not seem to matter. Sizes of non – invasive probes seem to be decreasing by the day. Irrational shrinking of sizes can, however, not be done. There has to be some rationale in going for telescoping. In view of the above there is a dire need for a proper analysis to suggest optimum size for non – invasive probes. With an ultimate aim of peeping into actual situations, we consider a representative situation involving a fluid with micronsized suspended particles flowing in an annular region. The result of the study is expected to throw light on the possible answers to questions raised above. The theory of micro-fluids introduced by Eringen [1,2] deals with a class of fluids which exhibit certain microscopic effects arising from the local structure and micromotions of the fluid elements. A sub class of these fluids is the micropolar fluid[3]. This class of fluids possesses certain simplicity and elegance in its mathematical formulation. Animal blood and polymeric fluids may be represented by the mathematical model underlying these fluids (see Power[4] , Lukaszewicz [5] and Eringen [6]). In this paper, we solve an unsteady shear flow problem involving an Eringen – micropolar fluid [3] and extract qualitative insights into more general situations. An analogous problem in a cartesian frame was investigated by Mizukami[7].

II. MATERIALS & METHODS

FIELD EQUATIONS

The linear constitutive equations for the micro polar fluid is,

$$t_{kl} = (-\pi + \lambda_1 v_{r,r})\,\delta_{kl} + 2\mu\, d_{kl} + 2\tau\, \varepsilon_{klr}(\omega_r - \sigma_r)$$

$$m_{kl} = \alpha\, \sigma_{r,r}\, \delta_{kl} + \beta\, \sigma_{k,l} + \gamma\, \sigma_{l,k}$$

$t_{kl}, m_{kl}, v_r, \sigma_r$ and π

are stress tensor, couple stress tensor, velocity micro rotation and thermodynamic pressure respectively.

The quantities,

d_{kl} and ω_k $\qquad 2d_{kl} = v_{k,l} + v_{l,k}$

are defined through,

$$2\omega_k = \varepsilon_{klr} v_{r,l}$$

Where λ_1 and μ are viscosity coefficients of classical fluid mechanics and where λ1 and μ are viscosity coefficients of classical fluid mechanics and are the new viscosity coefficients of micro polar fluids. The field equations for micro polar fluids in vectorial form is given by,

$$\frac{\partial \rho}{\partial t} + \nabla \cdot (\rho v) = 0$$

$$(\lambda + 2\mu)\nabla\nabla\cdot v - (\mu + \tau)\nabla\times\nabla\times v + 2\tau\nabla\times\sigma - \nabla\pi + \rho f = \rho\dot{v}$$

$$(\alpha + \beta + \gamma)\nabla\nabla\cdot\sigma - \gamma\nabla\times\nabla\times\sigma + 2\tau\nabla\times\sigma - 4\tau\sigma + \rho l = \rho j\dot{\sigma}$$

Where ρ, j, f and l are mass density, micro inertia, body force per unit mass and body couple per unit

mass respectively. From the local Clausius- Duhem inequality, the material coefficients must be subjected to the restrictions,

$$\tau \geq 0, \quad \mu \geq 0, \quad \gamma \geq 0,$$
$$3\lambda + 2\mu \geq 0, \quad 3\alpha + \beta + \gamma \geq 0, \quad -\gamma \leq \beta \leq \gamma.$$

. Finally, we record here that λ, μ are of dimension ML-1T-1, while others are of dimension MLT-1 and j has dimension L2, where M, L and T denote the dimensions of mass, length and time respectively.

SIMPLE SHEAR FLOW

In this section we analyze the incompressible flow of micropolar fluids (modeled as micropolar fluid) within an annular region bounded by two coaxial cylinders whose axis lies along z axis. The radius of the inner cylinder is 'b' and that of outer cylinder is 'a'. The inner cylinder is moving with the constant velocity (0 ,0 ,V). We assume that the velocity v and the micro rotation have respectively the components (0, 0, v) and (0,v,0) at any point within the flow and further that all the field variables depend only on the r – coordinate and time t.

From above equations, we obtain the following governing system of mutually – coupled partial differential equations.

$$\gamma \frac{\partial}{\partial r}\left(\frac{1}{r}\frac{\partial}{\partial r}(r\sigma)\right) - 2\tau\frac{\partial v}{\partial r} - 4\tau\sigma = \rho j \frac{\partial \sigma}{\partial t}$$

$$(\mu+\tau)\frac{1}{r}\frac{\partial}{\partial r}\left(r\frac{\partial v}{\partial r}\right) + 2\tau\frac{1}{r}\frac{\partial}{\partial r}(r\sigma) = \rho\frac{\partial v}{\partial t}$$

When micro rotation is equal to the vorticity (1) is symmetric and reduces to the stress of the Navier - Stokes fluids. Ericksen [8] indicated that this case was possible and meaningful. Then requiring that above equations can have the solution we obtain the relation,

and equation now becomes,

$$\mu j \frac{\partial}{\partial r}\left(\frac{1}{r}\frac{\partial}{\partial r}(r\sigma)\right) - 2\tau\frac{\partial v}{\partial r} - 4\tau\sigma = \rho j \frac{\partial \sigma}{\partial t}$$

$$\gamma = \mu j$$

The boundary conditions are,

$$v(a,t) = 0 \quad v(b,t) = V$$

for the micro rotation it seems that the selection of boundary condition depends on the type of micro polar fluid such as blood, liquid crystals, etc. We investigate here two limiting cases of the boundary condition suggested by Aero et. al [9], which are given as,

$$\sigma(a,t) = 0 \qquad \sigma(b,t) = 0$$

$$m_{kl} n_k = 0$$

at r = a , b .

Where, r is the unit normal vector to the boundary. In the cylindrical polar coordinates equation (16) can be written as

$$\frac{\partial}{\partial r}(r\sigma) = 0$$

In steady state the velocity is independent of time and hence the equation of motion for Newtonian fluid can be written as,

$$\frac{1}{r}\frac{\partial}{\partial r}\left(r\frac{\partial v}{\partial r}\right) = 0$$

The solution of satisfying is given by,

$$v(r) = V\frac{\mathrm{Log}(r/a)}{\mathrm{Log}(b/a)}$$

and the angular velocity which is same as the micro-rotational velocity is given as,

$$\sigma(r) = \frac{V}{\mathrm{Log}(b/a)}\frac{1}{r}$$

We consider that the flow is in steady state (19) & (20), and that the inner cylinder stops suddenly at time t = 0. Here the initial conditions are,

$$v(r, 0) = V\frac{\mathrm{Log}(r/a)}{\mathrm{Log}(b/a)}$$

$$\sigma(r, 0) = \frac{V}{\mathrm{Log}(b/a)}\frac{1}{r}$$

as the fluid is still flowing with the earlier velocity and the boundary conditions are,

$$v(a,t) = v(b,t) = 0$$

$$(t>0), \qquad \frac{\partial}{\partial r}(r\sigma) = 0$$

at $r = a,b$ $(t>0)$.

Now we consider the functions f (y,t) and g(y,t) which satisfy

$$j(\mu+\tau)\frac{\partial}{\partial r}\left(\frac{1}{r}\frac{\partial(rg)}{\partial r}\right)-4\tau g = \rho j\frac{\partial g}{\partial t}$$

Now we consider the functions f (y,t) and g(y,t) which satisfy,

$$j(\mu+\tau)\frac{\partial}{\partial r}\left(\frac{1}{r}\frac{\partial(rg)}{\partial r}\right)-4\tau g = \rho j\frac{\partial g}{\partial t}$$

$$v = f-\frac{1}{2}j\frac{1}{r}\frac{\partial(rg)}{\partial r}$$

Then the velocity v and micro rotation σ defined through,

$$\sigma = g-\frac{1}{2}\frac{\partial f}{\partial r}$$

$$g(r,t)=G(r,t)\,\mathrm{Exp}\left\{-\frac{4\tau}{\rho j}\right\}t$$

are constants ,J_n and Y_n are the spherical Bessel functions of order *n*

$$\zeta(t) = \mathrm{Exp}\left\{-\frac{\mu+\tau}{\rho}\lambda^2 t\right\}$$

$$\frac{1}{\phi}\frac{1}{r}\frac{\partial}{\partial r}\left(r\frac{\partial\phi}{\partial r}\right) = \frac{\rho}{\mu}\frac{1}{\psi}\frac{\partial\psi}{\partial t} = -\lambda^2$$

$$Y_0(\lambda_n a)\,J_0(\lambda_n b)-J_0(\lambda_n a)\,Y_0(\lambda_n b) = 0$$

$$\mu\frac{1}{r}\frac{\partial}{\partial r}\left(r\frac{\partial f}{\partial r}\right) = \rho\frac{\partial f}{\partial t}$$

Satisfy the governing equations.

Thus, unsteady shear flow of micro-polar fluids may be solved in terms of two uncoupled partial differential equations of the parabolic type the boundary conditions may be written as,

$$f(a,t) = \frac{1}{2}j\left(\frac{\partial g(a,t)}{\partial r}+\frac{g(a,t)}{a}\right) = \frac{1}{4}j\left(\frac{\partial^2 f(a,t)}{\partial r^2}+\frac{1}{a}\frac{\partial f(a,t)}{\partial r}\right)$$

$$f(b,t) = \frac{1}{2}j\left(\frac{\partial g(b,t)}{\partial r}+\frac{g(b,t)}{b}\right) = \frac{1}{4}j\left(\frac{\partial^2 f(b,t)}{\partial r^2}+\frac{1}{b}\frac{\partial f(b,t)}{\partial r}\right)$$

$$G(r,t) = \xi(r)\zeta(t)$$

$$f(r,t) = \phi(r)\psi(t)$$

$$\frac{1}{\xi}\frac{\partial}{\partial r}\left(\frac{1}{r}\frac{\partial(r\xi)}{\partial r}\right) = \frac{1}{\zeta}\frac{\rho}{\mu+\tau}\frac{\partial\zeta}{\partial t} = -\lambda^2$$

$$\phi(r) = A'J_0(\lambda r)+B'Y_0(\lambda r)$$

$$\frac{(\mu+\tau)}{\rho}\frac{\partial}{\partial r}\left(\frac{1}{r}\frac{\partial(rG)}{\partial r}\right) = \frac{\partial G}{\partial t}$$

$$\psi(t) = \mathrm{Exp}\left\{-\frac{\mu}{\rho}\lambda^2 t\right\}$$

$$\xi(r) = A''J_1(\lambda r)+B''Y_1(\lambda r)$$

$$A', A'', B', B''$$

Using the conditions we can find out the values of constants and using these results in equations (32), *f* and *g* may be written as

$$f(r,t) = \sum_{n=0}^{\infty}A_n\mathrm{Exp}\left(-\frac{\mu}{\rho}\lambda_n^2 t\right)\left[Y_0(\lambda_n a)\,J_0(\lambda_n r)-J_0(\lambda_n a)\,Y_0(\lambda_n r)\right]$$

$$g(r,t) = \sum_{n=0}^{\infty}B_n\mathrm{Exp}\left\{-\left(\frac{4\tau}{\rho j}+\frac{(\mu+\tau)}{\rho}\lambda_n^2\right)t\right\}\left[Y_0(\lambda_n a)\,J_1(\lambda_n r)-J_0(\lambda_n a)\,Y_1(\lambda_n r)\right]$$

where A_n , B_n ($n = 0,1,2,\ldots$) are constants which are to be determined from the initial conditions and ’s are the roots of the equation

$$\mu\frac{1}{r}\frac{\partial}{\partial r}\left(r\frac{\partial f}{\partial r}\right) = \rho\frac{\partial f}{\partial t}$$

($n = 0, 1, 2, \ldots$).

Substituting we obtain

$$v(r,t)=\sum_{n=0}^{\infty}\left[A_n\mathrm{Exp}\left(-\frac{\mu}{\rho}\lambda_n^2 t\right)+\frac{j\lambda_n}{2}B_n\mathrm{Exp}\left\{-\left(\frac{4\tau}{\rho j}+\frac{(\mu+\tau)}{\rho}\lambda_n^2\right)t\right\}\right]\left[Y_0(\lambda_n a)\,J_0(\lambda_n r)-J_0(\lambda_n a)\,Y_0(\lambda_n r)\right]$$

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$$\sigma(r,t)=\sum_{n=0}^{\infty}\left[B_n\exp\left\{-\left(\frac{4\tau}{\rho j}+\frac{(\mu+\tau)}{\rho}\lambda_n^2\right)t\right\}+\frac{\lambda_n}{2}A_n\exp\left(-\frac{\mu}{\rho}\lambda_n^2 t\right)\right]\left[Y_0(\lambda_n a)\,J_1(\lambda_n r)-J_0(\lambda_n a)\,Y_1(\lambda_n r)\right]$$

Setting $t = 0$ in the above two equations, we get,

$$v(r,0)=\sum_{n=0}^{\infty}\left[A_n+\frac{j\lambda_n}{2}B_n\right]\left[Y_0(\lambda_n a)\,J_0(\lambda_n r)-J_0(\lambda_n a)\,Y_0(\lambda_n r)\right]$$

$$V\,\frac{\mathrm{Log}\,(r/a)}{\mathrm{Log}\,(b/a)}=\sum_{n=0}^{\infty}\left[A_n+\frac{j\lambda_n}{2}B_n\right]\left[Y_0(\lambda_n a)\,J_0(\lambda_n r)-J_0(\lambda_n a)\,Y_0(\lambda_n r)\right]$$

$$\sigma(r,0)=\sum_{n=0}^{\infty}\left[B_n+\frac{\lambda_n}{2}A_n\right]\left[Y_0(\lambda_n a)\,J_1(\lambda_n r)-J_0(\lambda_n a)\,Y_1(\lambda_n r)\right]$$

$$\frac{V}{\mathrm{Log}(b/a)}\,\frac{1}{r}=\sum_{n=0}^{\infty}\left[B_n+\frac{\lambda_n}{2}A_n\right]\left[Y_0(\lambda_n a)\,J_1(\lambda_n r)-J_0(\lambda_n a)\,Y_1(\lambda_n r)\right]$$

We now make use of orthogonally property of Bessel's functions to obtain the A_n's and B_n's as,

$$A_n+\frac{j\lambda_n}{2}B_n=\frac{b/a}{\lambda_n a[Y_0(\lambda_n b)\,J_1(\lambda_n a)-J_0(\lambda_n b)\,Y_1(\lambda_n a)]+b/a[J_1(\lambda_n b)\,Y_0(\lambda_n a)-Y_1(\lambda_n b)\,J_0(\lambda_n a)]}$$

Equations can be solved to find A_n and B_n.

$$B_n+\frac{\lambda_n A_n}{2}=0$$

$$U=\frac{u}{v},\quad y=r/a,\quad k_n=\lambda_n a,\quad h=\frac{\sqrt{j}}{a},$$

$$\mathrm{Sc}=\frac{\mu}{\rho D},\quad z=\frac{\tau}{\mu},\quad T=\frac{t}{a^2/D},\quad R=b/a$$

where R is the ratio of the radii , Sc is the Schmidt number, h denotes the ratio of the material characteristic length to the geometrical characteristic length a denotes the ratio of the viscosity coefficient of viscocity.

We now introduce the following non dimensional parameters:

(n = 0, 1, 2, …)

micro polar fluid, τ, to the viscosity coefficient μ, of classical Navier-Stokes fluids. Using these (44) in governing equations (10), (13) and also in (21) ,(22),(36) and (37), we get their non-dimensional versions in the form:

$$\begin{matrix}U(y,0)\\W(y,0)\end{matrix}=\begin{matrix}\frac{\mathrm{Log}\,y}{\mathrm{Log}\,R}\\-\frac{1}{2}\frac{1}{y}\end{matrix}$$

$$U(R,T)=U(1,T)=0;\quad \frac{\partial(yW)}{\partial y}(R,T)=\frac{\partial(yW)}{\partial y}(1,T)=0$$

$$\frac{1}{y}\frac{\partial}{\partial y}\left(y\frac{\partial U}{\partial y}\right)-\frac{1}{\mathrm{Sc}}\frac{\partial U}{\partial T}+z\left[\frac{1}{y}\frac{\partial}{\partial y}\left(y\frac{\partial U}{\partial y}\right)+2\frac{1}{y}\frac{\partial}{\partial y}(yW)\right]=0$$

$$h^2\left[\frac{\partial}{\partial y}\left(\frac{1}{y}\frac{\partial}{\partial y}(yW)\right)-\frac{1}{\mathrm{Sc}}\frac{\partial W}{\partial T}\right]-2z\left(\frac{\partial U}{\partial y}+2W\right)=0$$

$$W=\sum_{n=1}^{\infty}\frac{2k_n}{4+h^2k_n^2}C_n\left[\mathrm{Exp}\,(-k_n^2\,\mathrm{Sc}T)-\mathrm{Exp}\left\{-\left(\frac{4z}{h^2}+(1+z)k_n^2\right)\mathrm{Sc}\,T\right\}\right]\psi_2(n,y)$$

$$U=\sum_{n=0}^{\infty}\frac{8}{4+h^2k_n^2}C_n\left[\mathrm{Exp}\,(-k_n^2\,\mathrm{Sc}T)+\frac{h^2k_n^2}{4}\mathrm{Exp}\left\{-\left(\frac{4z}{h^2}+(1+z)k_n^2\right)\mathrm{Sc}\,T\right\}\right]\psi_1(n,y)$$

where the non-dimensional form of C_n is now given as

$$C_n=\frac{R}{k_n[Y_0(k_nR)\,J_1(k_n)-J_0(k_nR)\,Y_1(k_n)]+R[J_1(k_nR)\,Y_0(k_n)-Y_1(k_nR)\,J_0(k_n)]}$$

(T>0)

$$\psi_1(n,y)=Y_0(k_n)J_0(k_ny)-J_0(k_n)Y_0(k_ny)$$

$$\psi_2(n, y) = Y_0(k_n)J_1(k_n y) - J_0(k_n)Y_1(k_n y)$$

RESULTS AND DISCUSSION

The ratio of material length *h* and viscosity ratio *z*, is a measure of micropolarity of the micropolar fluids. As *h* → *0*, equation (48) reduces to the classical angular momentum equation i.e., $\omega = -1/2\ \nabla \times v$. Also as z → 0, equation (47) reduces to the classical Navier-Stokes equation for the cylindrical geometry. Thus, it is clear that the limits *h* → *0* and z → 0 in our study yield Newtonian fluid flow results.

Fig 1. Plot of U(Y) Vs Y for different h's,T = 0.01 & Z = 10.0

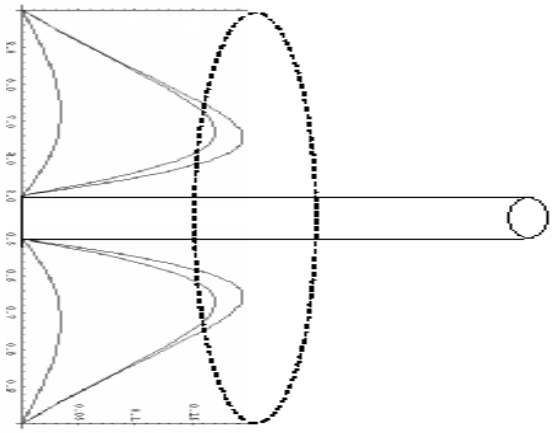


Figure 1 is a plot of non-dimensional velocity *U* versus the dimensionless axial coordinate *y* for different values of *h*. We observe from the figure that as *h* decreases from *1.0* to *0.001, U*(*y*) increases and approaches the Newtonian fluid result. *h* = depends on the geometry of the flow. The greater the outer cylinder radius, lesser will be the value of *h* and hence greater will be the velocity of the fluid. This result reiterates the observed result that the blood, eventhough non-Newtonian in character, behaves like a Newtonian fluid in larger arteries.

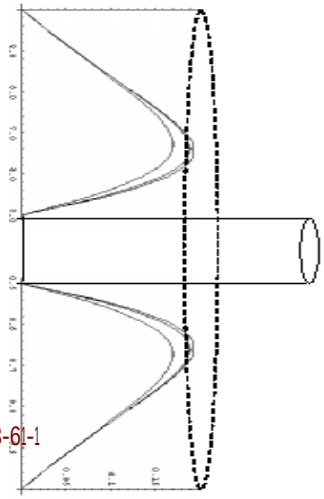
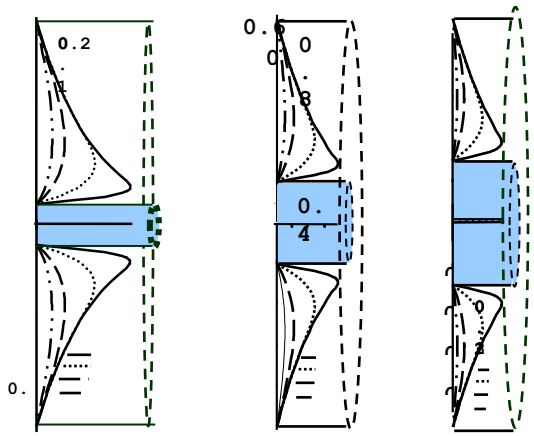


Figure 2. Plot of U(Y) Vs Y for different z's. h =0.1, T = 0.01.

Figure 2 is a plot of the velocity *U*(*y*) versus *y* for different values of *z,*the ratio of viscosities, for fixed value of *h*. We know that *z* is a measure of the micropolar behaviour of the fluid as it depends on the number of suspended particles present in the fluid. More the number of the suspended particles, the more is the value of *z*. It is seen that as *z* decreases, the velocity *U*(*y*) increases and approaches its Newtonian value when z → 0. The reason for this being that suspended particles stabilize fluid flows, a well-established fact



Figures 3, 4 and 5 are plots of *U*(*y*) versus *y* for different values of the ratio *b/a*, where *b* is radius of the inner cylinder and *a* is the radius of outer cylinder. It is observed that as *R* increases the velocity also increases. This is due to the obvious reason that as *R* increases the radius of the inner cylinder increases and the region available for the fluid flow

decreases thereby more number of layers in the vicinity of the inner cylinder are affected by the moving cylinder initially. When the inner cylinder is stopped suddenly, the more number of layers, because of the shear, flow with the velocity of the inner cylinder which results in increase in the velocity. Moreover for large *R* it is observed that though the velocity is high initially, it vanishes rapidly. The reason for this is two-fold. One being as the region available for the flow in this case is so small that the density of the layers is much higher that it gives a lot of resistance to the flow. The other reason being that since the region of flow is small there will be a lot of interaction between the neighbouring suspended particles which in turn offer much more resistance to the flow.

From the aforementioned discussion, it is obvious that, it is not just the ratio *b/a* which is crucial but also the individual permissible diameters of the two co-axial cylinders as also the concentration of the suspended particles. If the concentration of the micron-sized suspended particles is small and the particles are irregular then we will have to model the micropolar fluid.

Representative study provides an analysis to suggest judicious insertion of optimum radius of the catheter 'a' to consider eccentric cylinders.The problem has possible extra – corporeal and intra – corporeal applications.

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REFERENCES

[1] Eringen AC., Int. J. Engng. Sci., 1964; 2:205.

a Saffman micropolar fluid (see Siddheshwar[11]). The work is under progress to include a basic flow by incorporating a pressure gradient as well as

[2] Eringen AC., Proc.XI Int. Cong. Appl. Mech., 1965;

Springer, New York.

[3] Eringen AC, J. Math. Mech.,1966; 16: 1.

[4] Power H., Advances in Fluid Mechanics,W.I.T. press, U.K.,1995;3:336

[5] Lukaszewicz G., Micropolar Fluids Theory and Applications, Birkhquser, Boston, M.A., U S A, 1998.

[6] Eringen AC.,Micro Continuum Fluid Theories,
Springer Verlag,1999.

[7] Mizukami A, Int. J. Engng. Sci..,1981; 19: 75.

[8] Ericksen JL., Kolloid-Z, 1968; 173: 117.

[9] Aero EL., Buligyn AN. and Kuvshinskii EU., J. Appl. Math. Mech.,1965;29: 333 .

[10] Kline KA. and Allen SJ., Phys. Fluids.,1970;13: 263.

[11] Siddheshwar PG.,Acta Mechanica,2000

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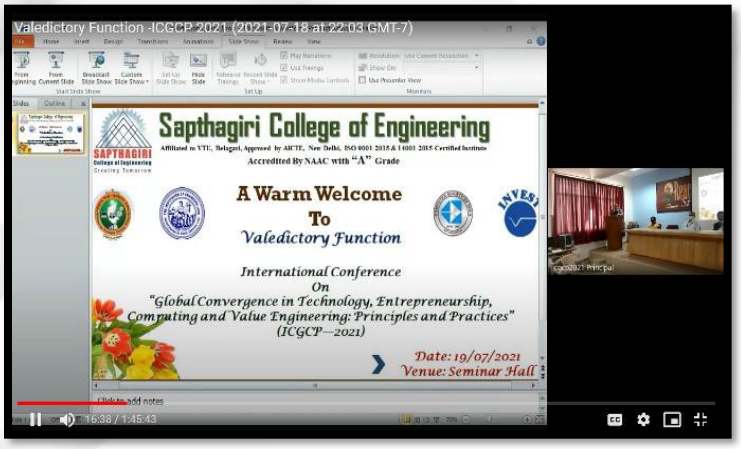

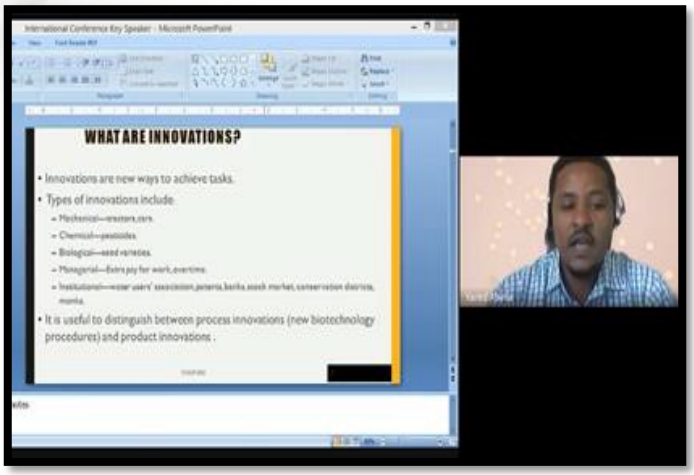

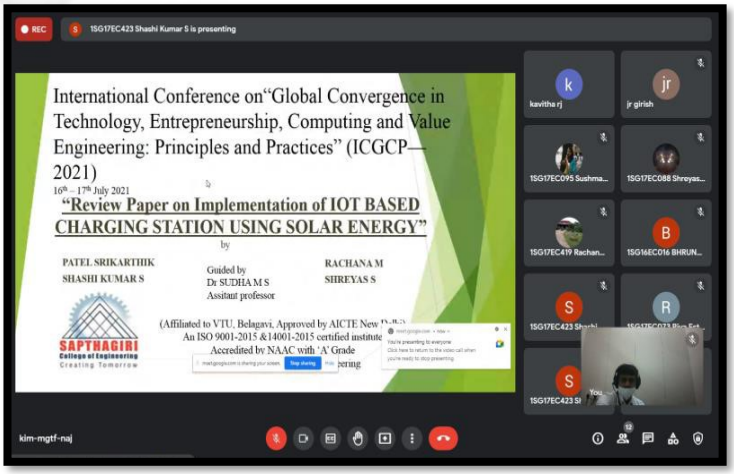

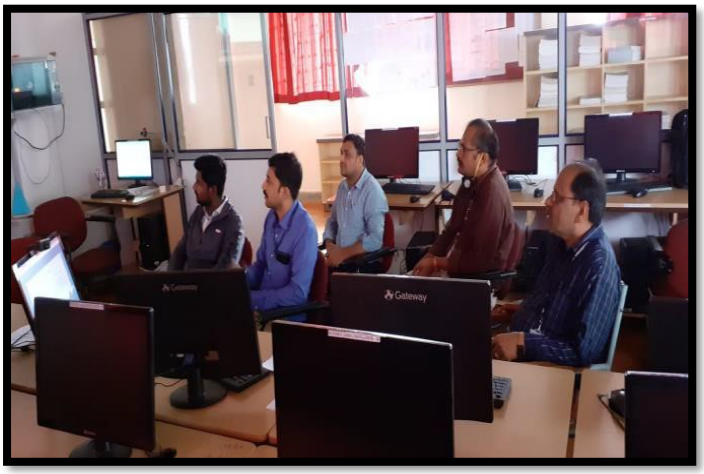

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