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CONFERENCE PROCEEDINGS

National e-Conference on Advanced Materials and Applications

Date : 23rd October 2021

Organised by

Department of Applied Sciences and Humanities
Vidya Prasarak Mandal's
Maharshi Parshuram College of Engineering, Velneshwar,
Hedvi Guhagar Road, Taluka : Guhagar,
District : Ratnagiri, Maharashtra, India

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(AMA-2021)

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- To encourage scientific research activities in the material sciences field & applications
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It would be our immense pleasure to invite you all to the national e-conference on "Advanced Materials and Applications (AMA-2021)". The conference theme is "Current and Emerging Trends in Advanced Materials". It's the premier event that bring together renowned experts, researchers and academicians. This conference aims on various emerging topics such as Advanced Material Processing, Materials Synthesis & Processing, Nanotechnology, Batteries, Super capacitors, Fuel Cells, Gas Sensors and Solar Cells etc.

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Metal Oxides	Polymers
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Ferroelectric Materials	Optically active Materials
Superconducting Materials	Solar Cells
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Photo-catalytic Materials	Optoelectronic Materials
Fuel cells	Nano-Materials

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A Green Synthesis of Coumarin Derivatives Using Activated Fly Ash as Catalyst

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ABSTRACT

Compounds containing coumarin backbone are a very important group of compounds due to their usage in pharmacy and medicine. Properties and biological activities of coumarin derivatives have a significant role in the development of new drugs. Therefore, many different methods and techniques are developed in order to synthesize coumarin derivatives. Coumarin derivatives could be obtained from different starting materials with various methods but with big differences in yield. Some substituted coumarins have been synthesized by von-Pechmann condensation using Activated Fly Ash as catalyst in ethanolic medium. The reactions are simple, easy in handling and environmentally benign

Keywords: Coumarin von-Pechmann condensation Activated Fly Ash

I. INTRODUCTION

Coumarins constitute an important class of compound due to their presence as an important constituent of natural products [1] as well as their variety of medicinal applica- tions such as anti-inflammatory [2], anti-convulsant [3], anti-viral [4], anticoagulent [5], antioxidant [6], antibacterial [7], antifungal [8], anti-HIV [9], anti-carcinogenic material [10] and as antihistamine [11]. Besides the wide spectrum biological applications of coumarin and its derivatives the chemical literature also embodies their some applications from the material view point such as cosmetics [12], optical brightening agents [13], and laser dyes [14]. A recent literature report has revealed the anion sensing ability of some coumarin derivatives [15]. There are several well established protocols for the synthesis of coumarin and its derivatives [16–23]. For the last several years there has been an upsurge in the field of synthesis of coumarins through the catalysis of von Pechmann reaction by a variety of Lewis acids [24–34].

Introduction

Activated Fly Ash has been used as a catalyst for the synthesis of heterocycles [35–38] for the last few years but this has not been used to catalyze von Pechmann reaction leading to the synthesis of coumarins so far. Our earlier and current research interests in the synthesis of biologically important molecules [39–40] prompted us to synthesize some coumarin derivatives through catalysis of the von Pechmann reaction with a catalyst Activated Fly Ash for this purpose.

The experimental procedure followed in the present communication is simple, easy to handle, which is benign towards our ecosystem. Thin layer chromatography (TLC) was used to monitor the completion of reactions. The yield of the products formed, ranged from 60–34% (Table 1). The IR and 1H NMR spectral data of the resulting products matched well with their structures and are in excellent accordance with their earlier reports.

II. EXPERIMENTAL PROCEDURE

For the synthesis of coumarin derivatives a general procedure was adopted. This involved dissolution of 2 m Mol of the corresponding phenol in ethyl alcohol (2 mL) in a 25 mL round bottom flask followed by addition of 2 m Mol (*0.3 mL) of ethylacetoacetate with constant stirring and warming followed by addition of Activated Fly Ash in portions. The respective reaction mixtures were boiled under reflux with stirring at the temperature of 80 °C. Thin layer chromatography (TLC) was used to monitor the completion of reactions. On the completion of reactions indicated by TLC, solvents were evaporated and the solid residues were extracted with hot water for the isolation of 2a–2b and hot ethanol–water mixture (50%v/v) for the isolation of 2c–2e. Under the same reaction conditions TLC did not indicate a similar reaction between p-Nitrophenol and ethylacetoacetate. A probable reason may be the total use of Activated Fly Ash for the conversion of nitro phenol into amino phenol [41] leading to nonavailibility of the catalyst (Activated Fly ash) for the expected von Pechmann reaction. The corre- sponding extracts were cooled and resulting microcrystalline products were filtered, washed with cold water and dried under vacuum separately followed by their characterization through 1H NMR and IR spectro- scopic methods. The corresponding spectroscopic data matched very well with the earlier reports for these compounds. The entire course of reaction described above may be given schematically as follows; Scheme 1

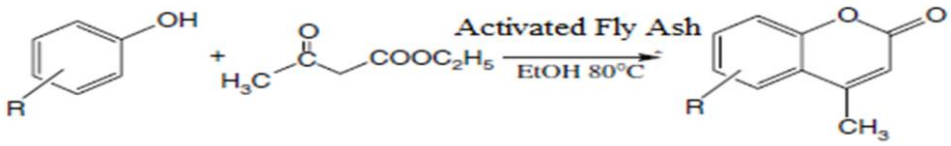
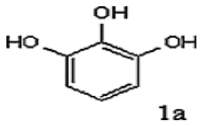
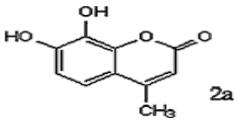
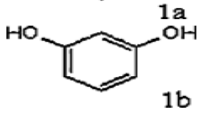
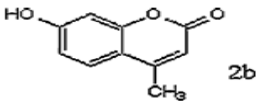
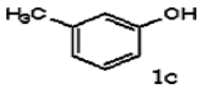
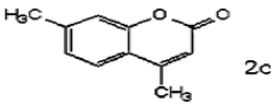
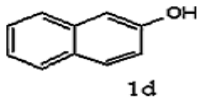
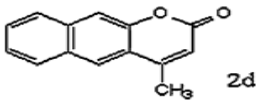
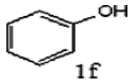
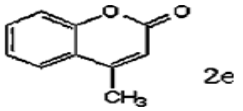
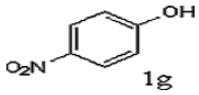


Table 1 Synthesis of coumarins via von Pechmann condensation of phenols with ethylacetoacetate catalyzed by Activated Fly Ash

Entry	Substrate	Reaction product	Reaction temperature	Reaction time (Min)	Yield[a] %
1	 1a	 2a	80	75	60
2	 1b	 2b	80	150	52
3	 1c	 2c	80	135	48
4	 1d	 2d	80	210	40
5	 1f	 2e	80	300	34
6	 1g	No reaction	75	360	–

[a] Recrystallised yield

III. SELECTED SPECTROSCOPIC DATA

3.1 7,8-Dihydroxy-4-methyl-chromen-2-one

Compound 2a: (1H NMR, 300 MHz, (CDCl3): 2.41(s, 3H, Me), 6.13(s, 1H, C=CH), 6.90–7.25(m, 2H, ArH), ArOH
peak not observed. IR KBr (cm–1) 3419, 3240, 2925, 1652,
1596, 1512, 1440, 1388, 1335, 1306, 1186, 1062, 1006,
804, 722, 629, 542, 468, 430.

3.2 7-Hydroxy-4-methyl-chromen-2-one

Compound 2b: (1H NMR, 300 MHZ, DMSO-d6): 2.36 (s, 3H, Me), 6.13(s, 1H, C=CH), 6.7–7.6(m, 3H, ArH), 10.52(s, 1H, ArOH). IR KBr (cm–1) 3498, 3115, 2952,
2819, 2635, 1670, 1606, 1453, 1392, 1275, 1212, 1136,
1072, 986, 901, 846, 805, 748, 583, 535, 476, 443.

3.3 7,4-Dimethyl-chromen-2-one

Compound 2c: (1H NMR, 300 MHZ, DMSO-d6): 2.31 (s, 3H, Me), 2.10(s, 3H, Me) 4.17(s, 1H, C=CH), 6.71–7.29 (m, 3H, ArH) IR KBr (cm–1) 2970, 2920, 1704, 1636,
1579, 1442, 1378, 1248, 1212, 1146, 1070, 560.

3.4 4-Methyl-benzo[g]chromen-2-one

Compound 2d: (1H NMR, 300 MHZ, DMSO-d6)- 2.48 (s, 3H, Me), 7.10–8.30 m, (1H, C=CH + 6H, ArH). IR KBr (cm–1) 3056, 1702, 1622, 1595, 1512, 1461, 1381, 1344,
1272, 1213, 1173, 1144, 1078, 957, 847, 816, 784, 749,
664.

3.5 4-Methyl-chromen-2-one
Compound 2e: (1H NMR, 300 MHZ, DMSO-d6): 1.63 (s, 3H, Me), 6.63–7.43, m (1H, C=CH + 4 ArH) IR KBr (cm–1) 2975, 1705, 1602, 1570, 1444, 1375, 1238, 1185,
941, 835, 667, 559.
The chemical shift values given above are all in d ppm.

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An ANSYS Based Simulation Analysis of Crank Shaft of an Internal Combustion Engine

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[1]Student, Department of Mechanical Engineering, Gandhi Institute of Engineering and Technology, Gunupur, Odisha, India

ABSTRACT

In this fast-evolving world where technology advancement is taking place in automobile sectors or we can say automobile industries. In the recent trend there is a huge demand in the SUV and hybrid cars which are also being improved or are being replaced by some up to the date technologies. Crankshaft is a shaft driven by a crank mechanism, consisting of a series of cranks and crankpins to which the connecting rods of an engine is attached. It is a mechanical part able to perform a conversion between reciprocating motion and rotational motion.it can be applied to both petrol as well as diesel engines. In this research paper a flywheel is designed using CATIA and the analysis i.e., numerical computation is carried out to know the various stress; strain; total deformation and the von misses stress using ANSYS software. ANSYS used FEM for solving the numerical problem by applying constraints and the result will be recorded according to the loading conditions. Thus, this research article is presented for the analysis of the flywheel which is one of the most important components of the power train of the automobile transmission system.

KEYWORDS: -flywheel, ANSYS, CATIA, static dynamic analysis, transmission system.

I. INTRODUCTION

As from the first industrial revolution when the steam engines came in the 18th century there is a lot of advancement till today because after the first industrial revolution the technologies gone to expand rapidly and then the electricity came into picture and the 1st industrial conveyer was used for various applications but as it is shown that the automobile industries have also developed as production lines got automated but all the components starting from the engine then going down to power train as then further to the wheels remains unchanged and one of the component is the crank shaft that does the complete rotation and coverts the energy of the fuel to the mechanical energy that is transmitted through the power train and the vehicle will run. But that is not only the major component. Almost all the traditional components of IC engines powered vehicles remain unchanged. The overall automobile is classified into various associated system which are classified below:

1) Automobile Power Plant.
2) Automobile Transmission System
3) Automobile Control Systems

4) Automobile Electric and Electronics Systems
   a) Starting System
   b) Charging System
   c) Lighting System
5) Automobile Body Engineering
   a) Body Design
   b) Stress Over the Body
   c) Resistances over the Body {Ra; Rr; Rw}
   d) Body Repairing
   e) Body Painting
6) Automobile Servicing and Maintenance
   a) Preventive Maintenance
   b) Breakdown Maintenance
   c) Hourly Maintenance
   d) Kilo meter Maintenance
   e) Reconditioning of engine
      1) Re-boring
      2) Valve side cutting
      3) Valve lapping
      4) Valve grinding
      5) Honing

II. OBJECTIVES

1) To study the various parts of internal combustion system.
2) Modelling of the crankshaft using cad model software
3) Stimulation using some numerical computation software like Ansys and Catia.

III. LITERATURE REVIEW

1) MODELLING& ANALYSIS OF THE CRANKSHAFT USING ANYSIS SOFTWARE, BY K. THRIVINI, D.T. 8. JAYA CHANDRAIAH, ON MAY, 2013.

Here it is clearly mentioned about the crank shaft and its various applications. I C engine crankshaft is basically a larger component which is consisting of a more complex geometry in the I C engine. It experiences larger forces from the gas combustion. The forces are being applied on top of the piston and the connecting rod helps in connecting the piston to the crank shaft. There are various researches which are being mentioned on this paper various researchers are being carried on the crankshaft model and the various models like the crank throw was created by the Pro/E Software and the import was then done to the ANSYS software. The results that were shown displayed strength of the crankshaft as the maximum limits of stresses,

total deformation because of which then the strain is then reduced. The weight of the crankshaft was also reduced. It also reduces the inertia force. In another research it was found about the computer aided Modeling and optimization of the crankshaft and also about the comparison of the fatigue performance of materials namely forged steel and the ductile cast iron. The 3D model of the crankshaft was being created by the solid edge software and then was imported to the ANSYS software. Then the 3d model of the diesel engine crankshaft was done by the PRO/E software and then the analysis that the high stress region is being mostly concentrated on the knuckles of the crank arm and main journal and then the connecting rod journal were the areas which are being easily broken. Then some modifications were done on the crankshaft where the edge of the major journal is the high stress area. Thus are the various researches done on crankshaft.

2) DESIGN AND ANALYSIS OF A CRANK SHAFT BY V. SOWJANYA, C. RAGHUNATHA REDDY

Here is clearly mentioned about the crankshaft and the significance of it in a internal combustion system. In this paper a analysis has been taken place of crankshaft of a single cylinder 4- stroke diesel engine. Here pro-e software is used to create a three-dimensional replica of diesel engine crankshaft and to find the difference of stress magnitude at critical positions Finite element analysis (FEA) is carried out. from engine specification chart stimulation inputs have been taken. From which the load is put in o the FE model in ANSYS, and according to the engine mounting conditions the boundary conditions are applied. this analysis is been carried to find critical locations in the crankshaft. It is also investigated the difference over the engine cycle and the effect of torsion and bending load in the analysis.it is also stated that static analysis provides overestimated results whereas dynamic loading analysis of the cranckshaft results in more realistic stresses. Bending and torsional load on the crankshaft can happen from both different load inertia and combustion.it is also stated that the weight of crankshaft was reduced by 26%.

3) DESIGN AND STRESS ANALYSIS OF CRANKSHAFT FOR SINGLE CYLINDER 4 STROKE DIESEL ENGINE BY K. DURGA PRASAD, K.V.J.P. NARAYANA, N. KIRANMAYEE

Here it is clearly mentioned that a static stimulation has been taken place on crankshaft which is from a single cylinder 4 stroke diesel engine. a three-dimensional model of crankshaft of a diesel engine is created by using Catia v5 software. to find the difference of stress magnitude at important places of crankshaft finite element analysis have been taken place. The load spectrum applied to crank pin bearing was resulted by FEA software HYPERMESH. And by keeping in mind the engine mounting conditions the boundary conditions are applied. Here it is stated that crankshaft has many applications in many engineering branches. Whenever there is a need to translate reciprocating linear motion into rotation or vice versa always crankshaft is used. it is stated that the crankshaft is usually handed down internal combustion engines but are also used in piston steam engines also. here in this paper, it is told that the movement of the piston and rod into the rotating motion is required to drive the transmission. The paper suggests that FEA is a good tool to reduce time consuming theoretical work. The maximum deformation appears at the centre of crankpin neck surface. the maximum amount of stress can be appeared at the fillets between the crankshaft journal and crank cheeks and near the central pin journal. The high stress area of main journal the edge.

IV. MATERIAL SELECTION:

The materials that are being selected for the manufacturing of the automobile parts should have some definite characteristics.

The following table shows the characteristics and chemical composition of the materials being used:

1. Cast iron

Carbon	Silicon	Manganese	Sulphur	Phosphorus	chromium	Nickel	molybdenum
3.04	0.11	0.42	0.11	0.068	0.07	0.02	0.005

2. Alloy steel

Carbon	Silicon	Manganese	Sulphur	Phosphorus	chromium	Nickel	molybdenum
0.273	0.203	0.650	0.054	0.035	0.169	0.119	0.011

V. SOFTWARE USED

1) CATIA source(https://edu.3ds.com/en/software/catia-v5-student-edition)

CATIA is the world's engineering and design leading software for product 3D CAD design excellence. It is used to design, simulate, analyse, and manufacture products in a variety of industries including aerospace, automotive, consumer goods, and industrial machinery, just to name a few.

2) ANSYS source(https://en.wikipedia.org/wiki/Ansys)

Ansys Mechanical finite element analysis software is used to simulate computer models of structures, electronics, or machine components for analysing strength, toughness, elasticity, temperature distribution, electromagnetism, fluid flow, and other attributes.

VI. DESIGN PARAMETERS

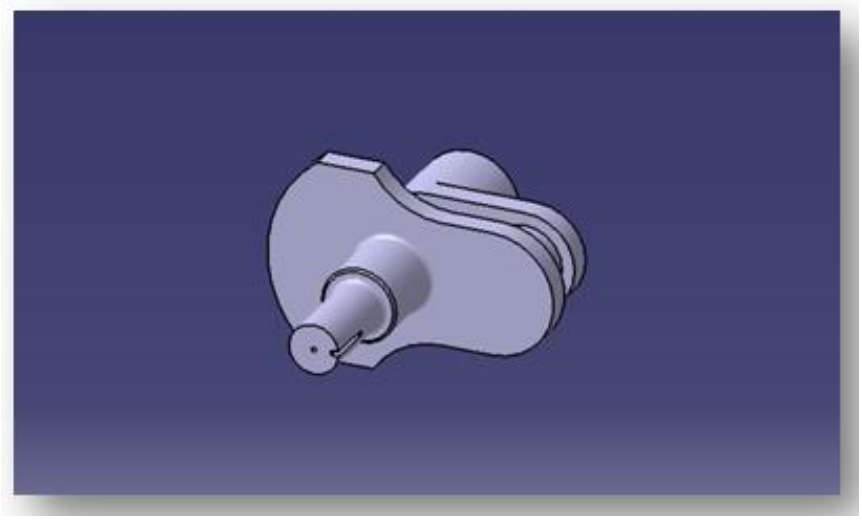
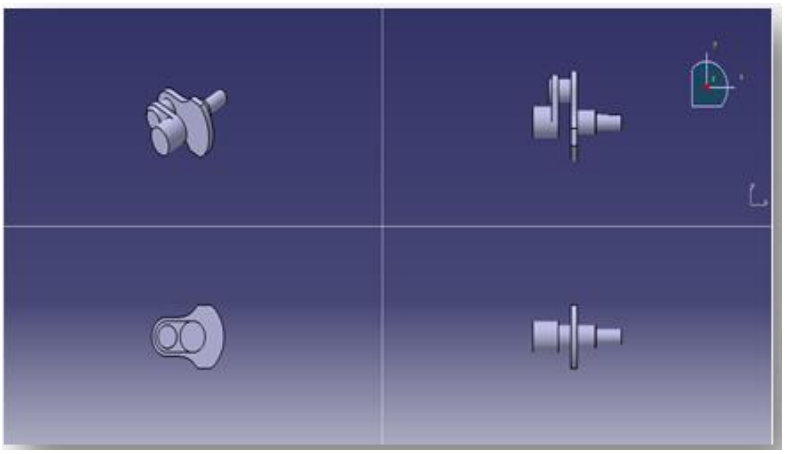
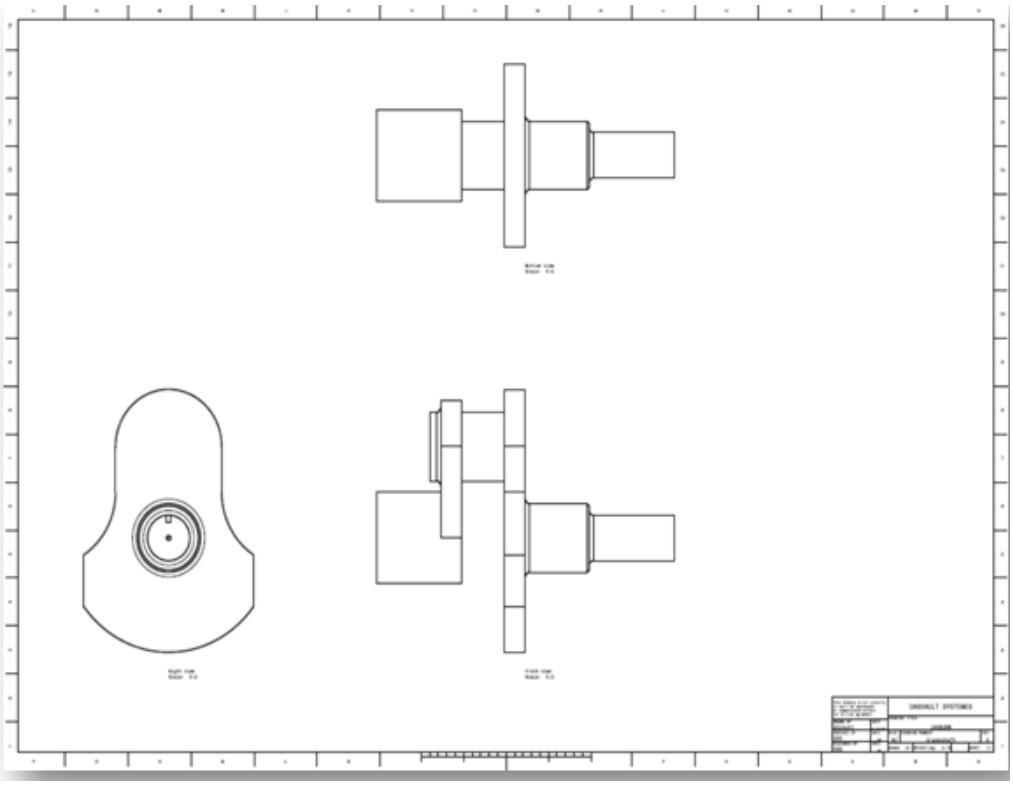


FIGURE SHOWING 3D CAD MODEL IN CATIA INTERFACE





VII. ANALYSIS

The analysis of the specified materials is done using ANSYS software for the calculation of various parameters as specified below.

Meshing:

It is one of the important parts of the analysis portion in which the CAD model is divided into various elements and nodes and in this project all the parameters are specified to fine smoothing and the number of nodes and elements are shown below:

NODES= 23668

ELEMENTS= 13376

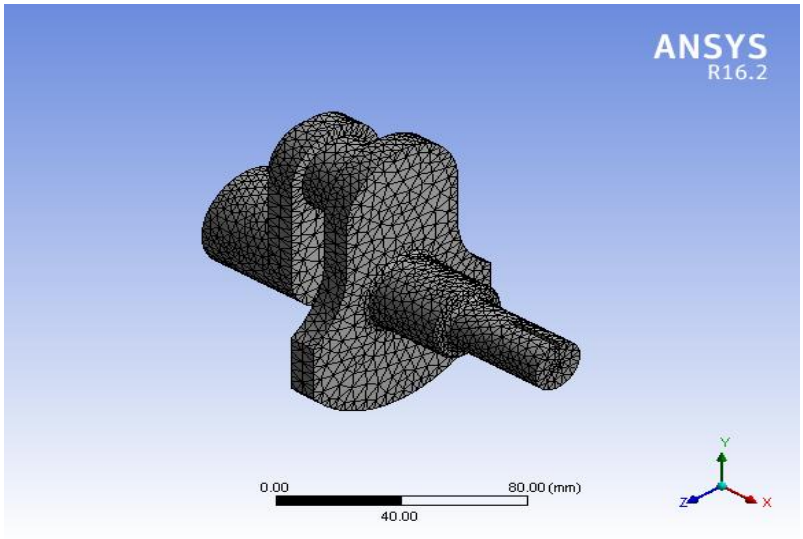
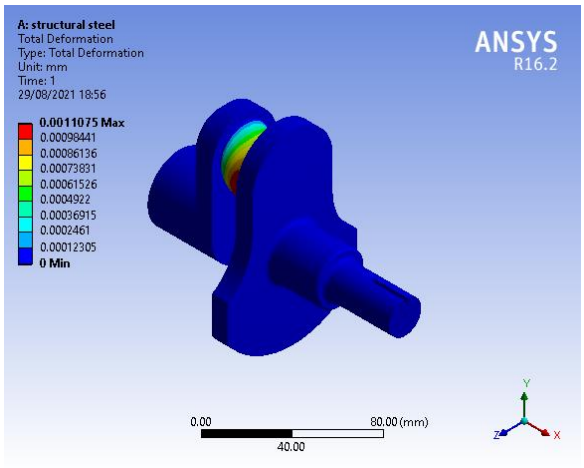
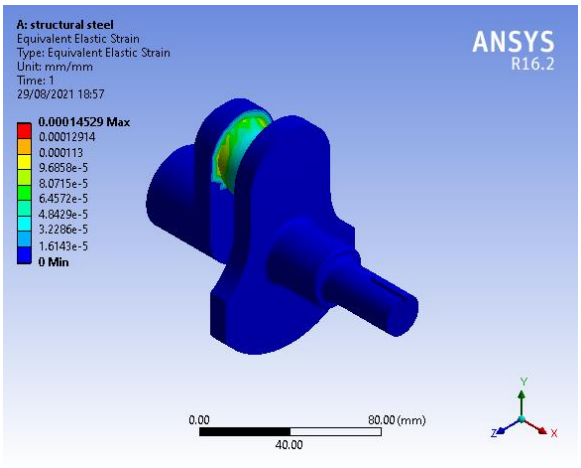


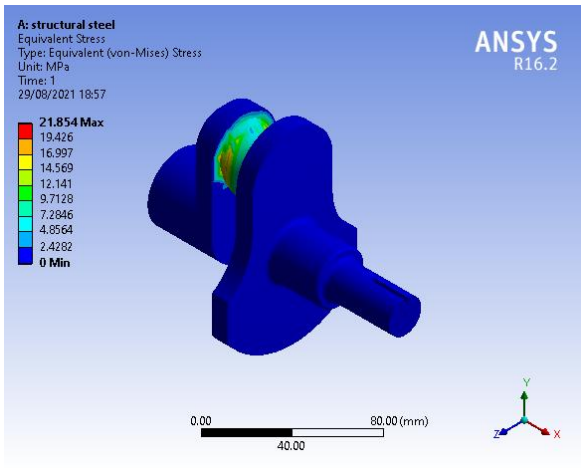
Figure showing meshed image in ANSYS

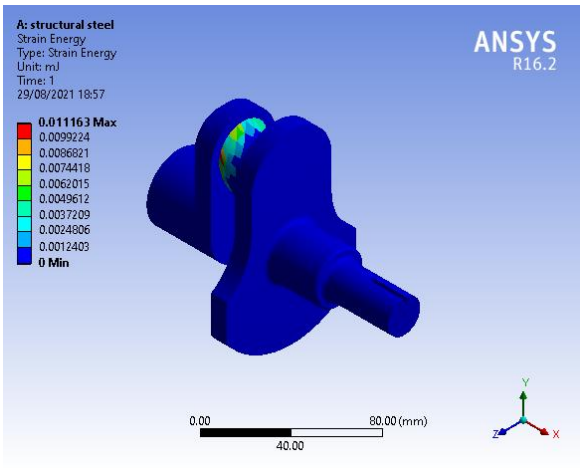
ANALYSIS FILES: STATIC STRUCTURAL: CRANKSHAFT (rotation=100 rad s^{-1})

1) STRUCTURAL STEEL

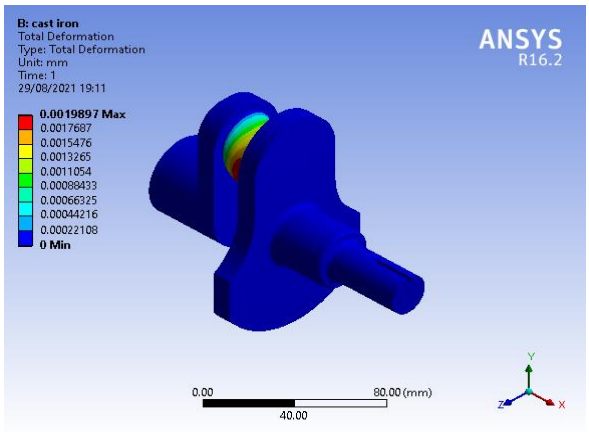


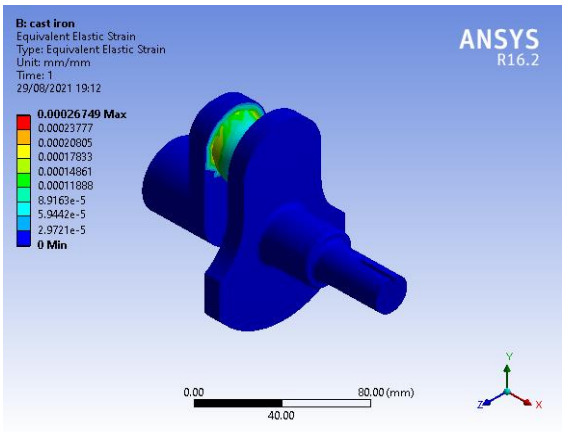


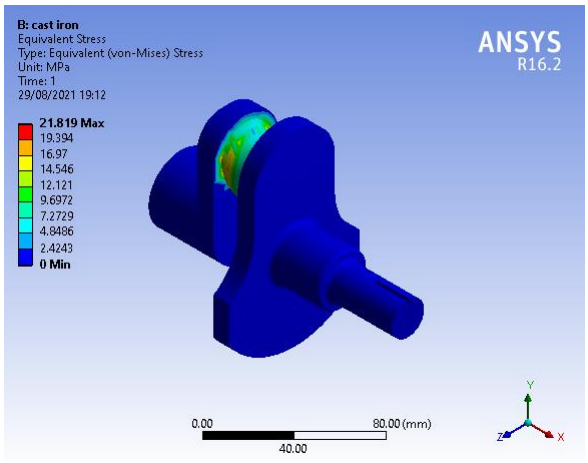


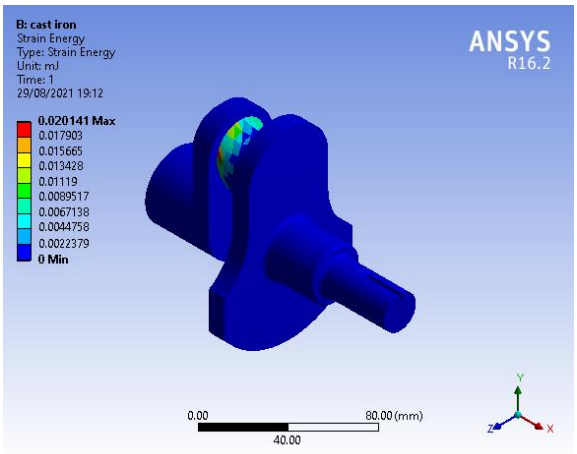


2) CAST IRON

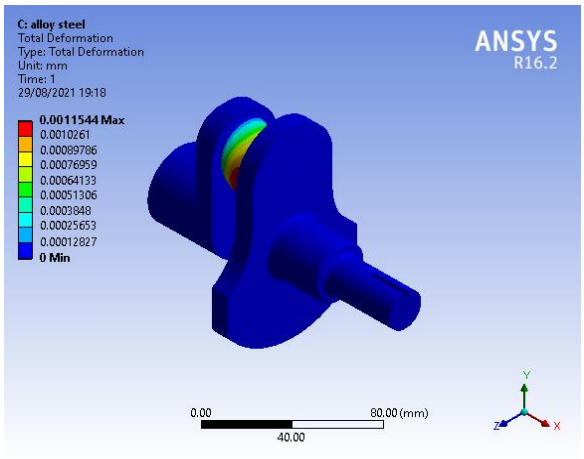


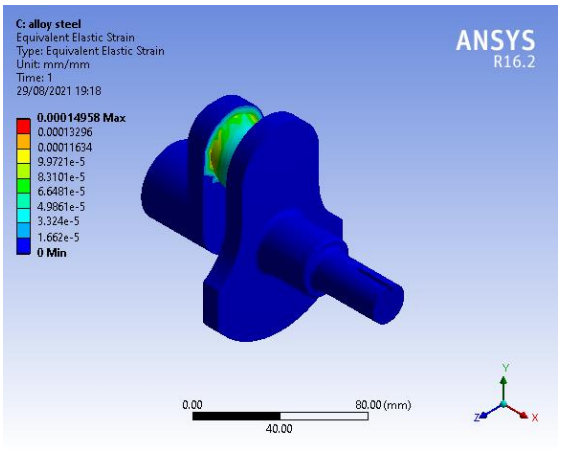


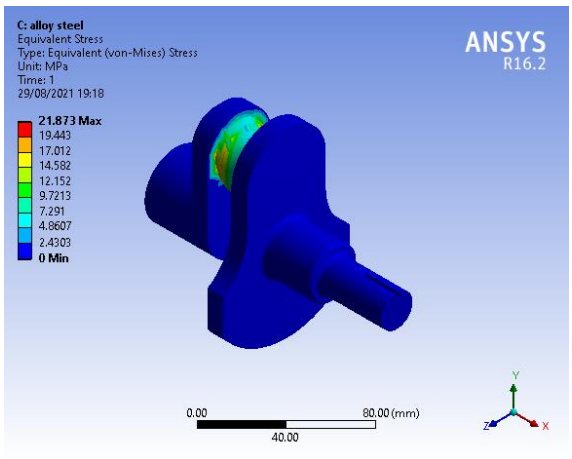


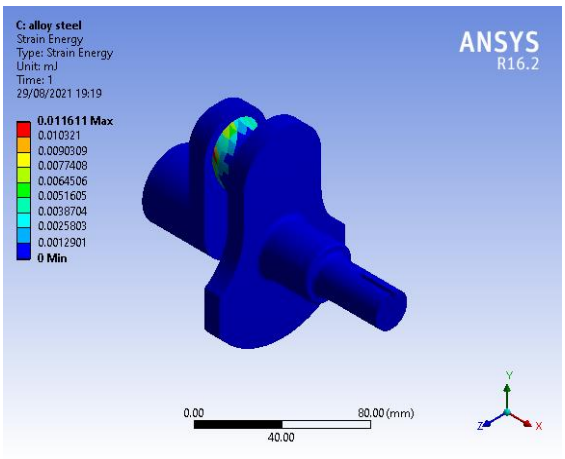


3) ALLOY STEEL









VIII. RESULTS

S.NO	MATERIALS	TOTAL DEFORMATION meter		STRAIN Unit less		STRESS Pascal		STRAIN ENERGY mJ	
		MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX
1.	STRUCTURAL STEEL	0	0.0011075	0	0.00014529	0	21.854	0	0.011163
2.	CAST IRON	0	0.0019897	0	0.00026749	0	21.819	0	0.020141
3.	ALLOY STEEL	0	0.0011544	0	0.00014958	0	21.873	0	0.011611

IX. CONCLUSION

From the above work it is shown 3 materials that are most commonly used for manufacturing of the crankshaft but through the analysis i.e., static structural analysis the most suitable material for the

development is the cast iron because it has shown satisfactory results and it can be used for development of the crankshaft of the internal combustion engine.

X. ACKNOWLEDGEMENT

The author would like to thank all the members those are involved in the completion of the research work in a prescribed period of time. The enthusiasm and the dedication to work towards this kept the work on track.

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Banana and Glass Fiber Hybrid Polymer Based Composites on Mechanical Characterization

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ABSTRACT

In a variety of applications, natural fibre composites are establishing themselves as viable alternatives to glass-reinforced composites. Due to their lower cost and density, natural fibre composites such as banana fibre, hemp fiber-epoxy, flax fiber-polypropylene (PP), as well as china reed fiber-PP are especially attractive in automotive applications. Additionally, natural fibre composites are claimed to provide environmental benefits such as decreased reliance on non-renewable energy/material sources, reduced pollutant emissions, decreased greenhouse gas emissions, increased energy recovery, and component end-of-life biodegradability. Due to the fact that such superior environmental performance is a significant driver of future growth in the use of natural fibre composites. This article discusses banana-glass fibre composites. It is a fibre reinforced composite material. As reinforcement, banana and glass fibre are used, and a polymer-based resin is used as a matrix. Mechanical properties such as tensile, flexural, as well as impact strength are thoroughly analyzed.

Key Words: Natural Fiber, Hand lay, Tensile properties, Flexural properties, Impact properties.

I. INTRODUCTION

In a technologically advanced society like ours, almost everything we use is made of composite materials. The use of composite materials goes back a long way. Although their origins are obscure, history is littered with allusions to composite materials of some sort. The first modern composite was fibre glass, which was invented in the late 1940s and is still widely used today. Fibers from natural sources are used in composite plastics. For commodity fiber-thermoplastics, the results suggest that fibres derived from agricultural sources could be an alternative to fibres made from inorganic/material sources. The specific properties of these renewable fibres are high despite their low densities. When it comes to plastic reinforcing fillers, kenaf fibers, for example, have excellent specific properties and have the potential to be industry leaders. From the literature reviewed it was identified the analyzes on banana and the glass fiber combination need to have attention. So the objective of this work is,

- For the production of layered natural fibre reinforced composites.

- To examine the material's tensile, flexural, and impact strengths.

II. EXPERIMENTAL DETAILS

Hand-layup method is used to fabricate multiple composite layers. Mechanical properties such as tensile as well as flexural strength of the prepared composites were tested and will be presented in this work using a Universal Testing Machine (UTM). In addition to the stress-strain diagram, important parameters such as maximum deflection, ultimate stress, peak load, and so on are separately examined. The flexural strength of prepared composites is also tested using a UTM with the appropriate attachment. Izod impact was used to determine the toughness of the prepared composites.

Fabrication of composites

Our fabrication process makes use of the following materials such as General Purpose Resin (G.P.Resin chemically Polyester), Accelerator (Methyl Ethyl Ketone), Catalyst (Cobalt), Poly Vinyl, Polythene Sheets & Glass Plates, Banana Fibers & Glass Fibers

Fabrication Procedure

The following steps are followed taken during fabrication: Make the banana as well as glass fibre composite plates to the desired size, say 15cm X 15cm. Preparation of a proper proportion of binding mixture resin. For 60ml of GP Resin, combine 20 drops Accelerator as well as 12 drops Catalyst. Allow the Polyvinyl to dry on the plain polythene sheet. Apply the binding solution to the dried sheet, which serves as a polymer resin matrix. Reinforce the necessary fibres on top of the polymer matrix material. Apply the resin binding mixture to the fibre reinforcement once more. Polyvinyl-coated polythene sheet is used to cover the reinforcement. Allow the reinforcement to dry for 3 to 5 hours between two glass plates. The required composite can be obtained after drying. In the fabrication process, there are two types of layers: double layer as well as triple layer.

Double Layer

A double layer of banana and glass fibre acts as reinforcement, and a polymer-based resin acts as the matrix. A polythene sheet is placed in which a resin mixture is poured during the fabrication of a double layer. And then the banana fibre is placed on top of the resin mixture, and the glass fibre is placed on top of that, then the mixture is poured, and at last it is protected by a polythene sheet as shown in figure 1

Figure 1 One Banana and a Glass Fiber Composite

Triple Layer

The triple layer is made up of two layers of banana as well as a layer of glass fibre in between the two layers, or two layers of glass fibre and a layer of banana fibre act as reinforcement and a layer of polymer based resin acts as the matrix.

a) Two banana fibers and a glass fiber composite

This composite is made up of two layers of banana fibre and one layer of glass fibre. The resin mixture is first applied over the polythene sheet in the fabrication of two banana fibre and a glass fibre composite. The banana fibre is then placed on top, and resin is applied once more. The resin mixture is then applied again, followed by a layer of glass fibre. Then another banana fibre is added, followed by the resin mixture, and finally by a polyvinyl applied polythene sheet.

b) Two Glass Fiber and a banana Fiber Composite

This composite is made up of two layers of glass fibre and one layer of banana fibre. The resin mixture is first applied over the polythene sheet in the fabrication of two glass fibre and a banana fibre composite. The glass fibre is then placed on top, and resin is applied once more. The banana fibre is then placed on top, and the resin mixture is applied once more. Then another glass fibre is added, followed by the resin mixture, and finally by a polythene sheet as shown in figure 2.

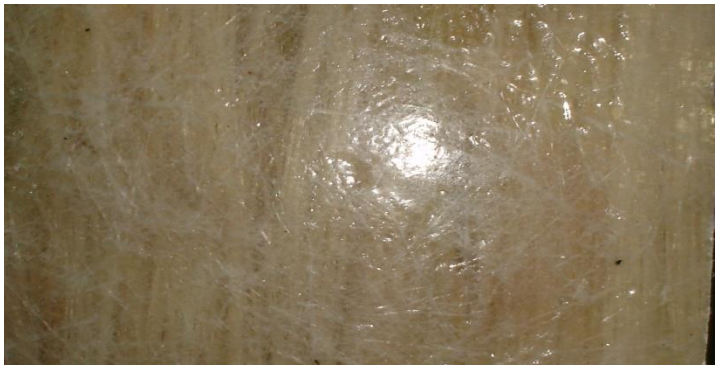

Figure 2 Two Glass Fiber and a Banana Fiber Composite

III. RESULTS AND DISCUSSIONS

Tensile Test

Tensile testing is performed on a dried specimen measuring 15cm X 1.5cm X.3cm. The figure below depicts a sample stress-strain curve for fabricated composites. Figure 3 show that when the load exceeds 13 KN, the composites begin to deform. As the load increases, so does the deformation. The fluctuations in the figure are caused by fibre particle breaking and the composite material breaking at the point of breaking load. The figure shows depicts the different variants of numerous different parameters to layers. The graph depicts the effect of layer on peak load and displacement. Glass fibres have the highest peak load because they are brittle. Despite the fact that the displacement is nearly the same for all layers, the two glass fibre and a banana fibre layer exhibits superior mechanical properties.

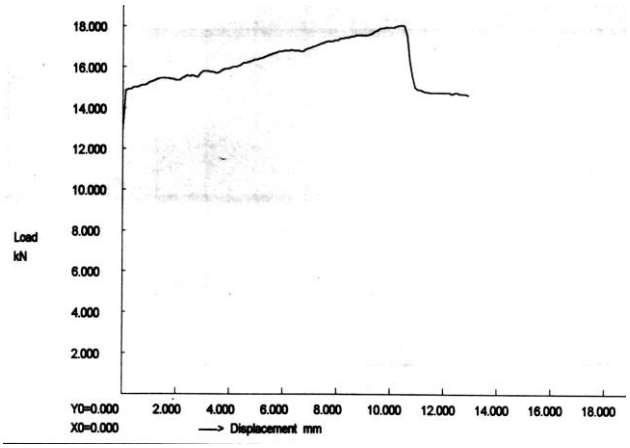

Figure 3 Two Banana & A Glass Fiber Composites

1- One Banana and A Glass Fiber Composite
2- Two Banana and a Glass Fiber Composite
3- Two Glass and a Banana Fiber Composite

The resin matrix evenly distributes the load to the glass as well as two banana fibre composites, allowing them to withstand heavy loads and exhibit improved mechanical properties. Glass fibres have the greatest displacement because they elongate when subjected to load shown in figure 4 and 5.

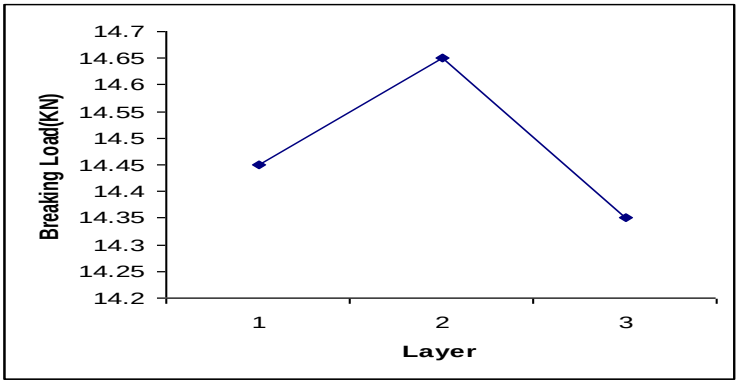

Figure 4 Effect of layer on Breaking Load

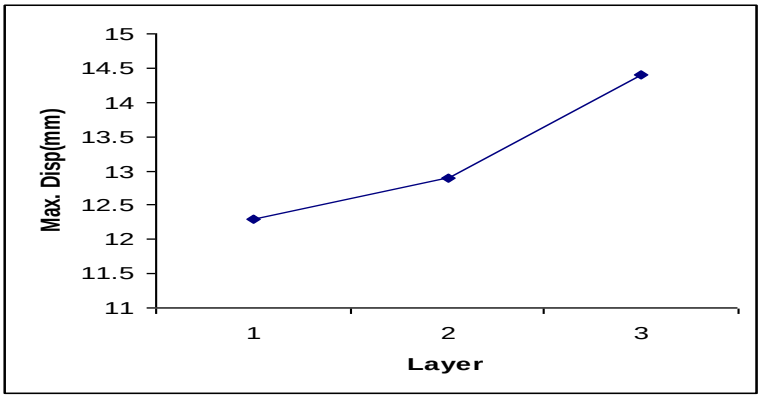

Figure 5 Effect of layer on Max Displacement

Flexure Test

A specimen measuring 15cm X 2.5cm X.3cm thick is used for the flexure test. It is carried out on the UTE (100) Universal Testing Machine. The failure of the specimen when subjected to a load is depicted in the figure 6 below.

Figure 6 Flexure Failure of the Specimen

The flexure test is carried out on a specimen that has been dried and removed of all moisture. A layer's impact on various parameters is illustrated in the figure 7 and 8 below. Because of its brittleness, banana and glass fibre composites can withstand heavy loads. Composite fracture occurs as a result of brittle fracture. The two-layer composite shows mechanical properties when put through this wringer.

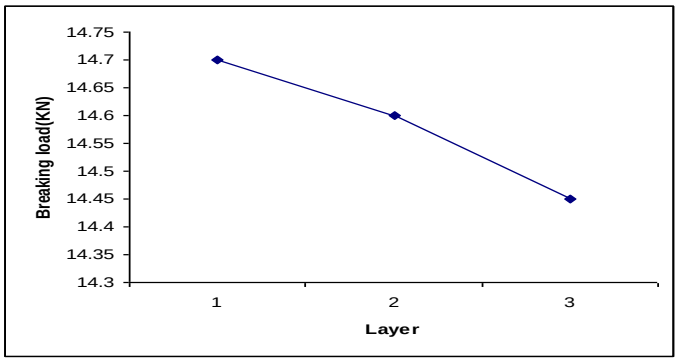

Figure 7 Effect of layer on Breaking Load

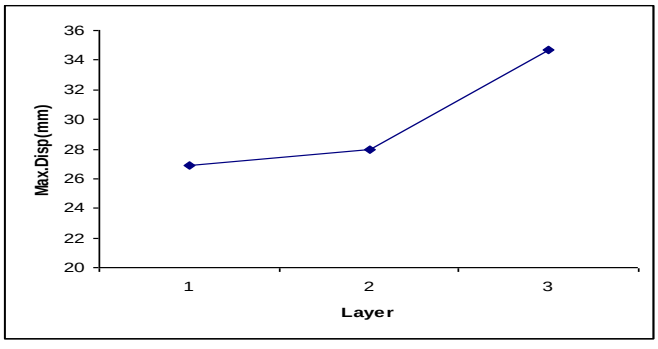

Figure 8 Effect of layer on Maximum Displacement

Impact Test

The Chorpy Impact test bed is used to conduct impact tests. The impact test specimen has the following dimensions: 9cm X 1.5cm X.3cm. The specimen is laid out flat on the testing surface. The pendulum is raised to a new height and used to strike the specimen. When an object hits a particle from below, it absorbs energy. Figure 9 shows the specimen failing under an impact load.

Figure 9 Impact Failure of the Specimen

The results of the impact tests show that as the number of layers increases, so does the impact strength. Glass fibres have higher impact strength because they can withstand more impact loading. Consequently, the impact strength of two glass/banana fibre composites is very high. As a result, the resin matrix helps composites withstand shock and vibration better.

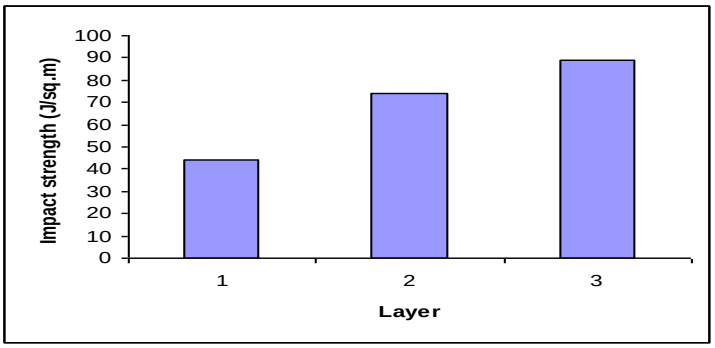

Figure 10 Effect of layer on Impact Strength

The impact strength of the two glass and a banana fiber composite is found to be high due to the presence of glass fibers. The glass fiber is brittle in nature and hence it exhibits better impact strength.

IV. CONCLUSION

- In the absence of moisture, tensile testing of fibre composites shows that a glass as well as two banana fibre composites performs better.
- One glass as well as one banana fibre composites has better flexural strength, as shown by flexure testing on materials free of moisture.
- These tests show high impact strength in the two glass and a banana fibre composite.

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Fabrication and Testing of a Polyester/ Groundnut Husk Powder Reinforced Composites

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ABSTRACT

A preliminary study of the mechanical properties (tensile strength, compression strength and impact energy) of groundnut husk powder filled polyester composite was carried out and reported in this project. Filler content was varied between 4 and 6 weigh percent of matrix. It was observed that the tensile strength increased marginally with increase in filler content while the impact strength decreased with increased filler loading. These effects are attributable to the poor interfacial interaction between fibre and matrix. More work is therefore suggested to optimise the composite production and improve the interfacial interaction of the fibre and matrix for possible uses shoe soles.

Keywords: Groundnut Husk Powder, Polyester Resin, Tensile, Impact, Hardness

I. INTRODUCTION

Present day technology requires materials with unusual combination of properties that cannot be meet by the conventional classes of materials metals, ceramics and polymers. As a result engineers are compelled to search for alternative materials to meet the complex service requirements for today applications amongst the desired material properties requirement are: low density, strong, abrasion and impact resistant and are not easily corroded. These material property combination and ranges have been met and are yet being extended by the development of composite materials. Composite materials are materials having two or more distinct phases such that a better combination of properties is achieved. The constituents must be chemically and physically dissimilar and separated by a distinct interface. The composite consists of matrix, which is continuous and surrounds the filler, which provides the reinforcement such that the resulting composite property is a function of the properties of both the matrix and filler. The matrix materials commonly used are the metals, ceramics and polymer. Polymers are the most widely used matrix materials because of their low specific gravity, chemical stability, and use of fabrication. Polymers have also been viewed as a viable substitute for

other engineering materials with a strong and formidable end product when processed. Thus, composites with polymers as a matrix have found wide application in automobile, construction, and aerospace industries. Composites are combinations of two materials in which one of the materials, called the reinforcing phase, is in the form of fibers, sheets, or particles, and are embedded in the other materials called the matrix phase. The reinforcing material and the matrix material can be metal, ceramic, or polymer. Composites are used because overall properties of the composites are superior to those of the individual components.

II. MATERIAL PREPARATION

The basic raw materials for any composite are the reinforcement and the matrix materials. Reinforcements are the principle of load bearing members. The matrix forms the continuous phase in the composites. The important functions of the matrix are; to transverse stresses between the fibres, to provide a barrier against an adverse environment and to protect the surface of the fibres from mechanical abrasion.

The design benefit of polymer matrix composites (PMC) is the ability to select the type of reinforcement, quantity and orientation required to meet the specific mechanical and physical requirement of the composite at end-use. However, if there is no particle or cost effective way to place the optimum reinforcement during fabrication due to limitations of the process, full design benefits in the application of polymer matrix composites may be impractical or unattainable. To meet the wide range of needs that may be required in fabricating composites product, the composites industry has evolved over a dozen separate manufacturing process as well as a number of hybrid processes. Each of these processes offers advantages and specific benefits in the fabrication of PMCs and is briefly explained.

Reinforcement

Reinforcements are in the form of particles, flakes, whiskers, short fibres continuous fibres, or sheets. Most reinforcements used in composites have a fibres form because materials are stronger and stiffer in the fibrous form than in any other form. Specifically, in this category, we are most interested in the so-called advanced fibres, which possess very high strength and very high stiffness coupled with a very low density.

Groundnut Husk Powder

The Groundnut is a specious in the legume or “bean” family as shown in figure 1. The Groundnut is also known as earthnuts, goober peas, monkey nuts and pig nuts. Groundnuts grow best in light loam soil. Groundnuts are particularly susceptible to the contamination during growth and storage. Poor storage of groundnuts can load to an infection by the mold fungus, releasing the toxic and highly substance aflatoxin.

Figure 1 Groundnut Husk powder

Matrix

The matrix plays a minor role in the tensile load carrying capacity of composite structures. However selection of matrix has a major influence on the inter-laminar shear as well as in plane shear properties of composite materials. The inter-laminar shear strength is an important design consideration for structures under bending loads, whereas the in-plane shear strength is important under torsional loads. The matrix provides lateral support against the possibility of the fibres buckling under comparison loading, thus influencing to some extent the compressive strength of the composite material. The interaction between fibres and matrix is also important in designing damage tolerant structures. Finally, the process ability and defects in a composite material depend strongly on the physical and thermal characteristics, such as viscosity, melting point and curing temperature of the matrix. Polyester resin as a matrix material and hand lay-up manufacturing methods is used in this work.

Hand Lay-Up Process

Fibreglass spray lay-up process is very different to the hand lay-up process as shown in figure 2. Workers roll out the spray-up to compact the laminate. Wood, foam, or other core material may then be added, and a secondary spray-up layer embeds the core between the laminates. The part is then cured, cooled, and removed from the mould. Applications include making of custom parts in low to medium volume quantities. Bathtubs, swimming pools, boat hulls, storage tanks, duct and air handling equipment, and furniture components are some of the commercial uses of this process.

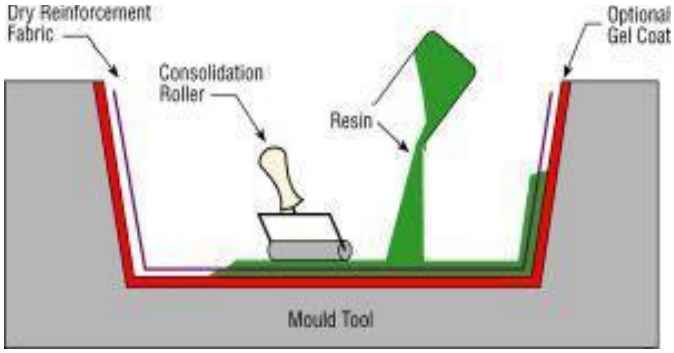

Figure 2 Hand layup method

Preparation of Ground Nut Husk Powder

3kg of the filler material (ground nut husk) was obtained locally from the farmer. Filler material was dried in an open air. Then the dried filler material was packed in a closed box. After that the filler material was powdered in the rice mill.2g, 4g of the sample were measured out and labelled. These were stored in an airtight bag. The matrix was measured out and each blended with the previously prepared filler sample using a hand layup process until a homogenous mixture was obtained. The mixtures were then separately poured into a prepared mould and allowed to cure for 6hrs.

III. TESTING PROCESS

Impact Test

The specimen is prepared by hand layup process as shown in figure 3. Work piece is formed into required shape of the specimen. The groundnut husk powder is randomly spread over the specimen mould. Then the resin mixed with 4% of catalyst 2% accelerator is poured at the room temperature. After the reaction gets started the specimen is placed in the way of atmosphere air for cooling.

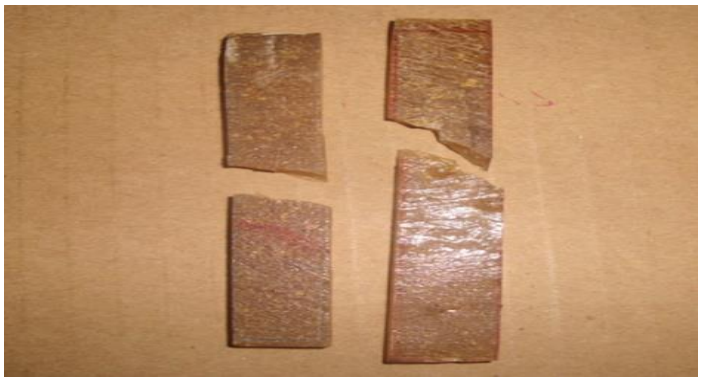

Figure 3 Specimen for impact test

Hardness Test

The specimen is prepared by hand layup process as shown in figure 4. Sheet metal is formed into required shape of the specimen. The groundnut husk powder is randomly spread over the specimen mould. Then the resin mixed with 4% of catalyst and 2% of accelerator is poured at the room temperature. After the reaction gets started the specimen is placed in the way of atmospheric air for cooling. The composite is machined to the required shape during finishing operations.

Figure 4 Specimen for hardness test

Tensile Test

The rod is prepared by using wiring pipe of diameter 16mm. The resin mixed with 4% of catalyst and 2% of accelerator is poured at the room temperature. Then the groundnut husk powder is mixed with resin. This mixing is poured into the pipe. After the reaction gets started the specimen is placed in open atmospheric. At last that pipes are separate to bring out the composite rod. Here tensile specimen shown in figure 5.

Figure 5 Specimen for tensile test

IV. RESULTS AND DISCUSSIONS

Impact Test

S.no	Impact strength in joules			
	Material	Specimen 1	Specimen 2	Average
1.	Coconut fibre composite	34	38	36
2.	Ground nut husk powder	60	64	62
3.	Soft wood	19	21	20

Table 1 Impact strength

The figure 6 shows that the groundnut husk powder composite gives better impact strength compare to coconut as well as soft wood fibre composites. Each sample two specimen tested and average values are recorded

Hardness Test

Sl.No	Rockwell hardness number			
1.	Groundnut husk powder composites	Specimen 1	Specimen 2	Total Average
		B82	B88	B84.875
		B81	B87	
		B84	B86	
		B83	B88	

	Average	B82.5	B87.25	
2.	Coconut fibre composites	B42	B51	B45.125
		B48	B44	
		B46	B42	
		B43	B45	
	Average	B44.75	B45.5	
3.	Natural fibre(soft wood)	B39	B24	B26.375
		B20	B20	
		B32	B27	
		B15	B34	
	Average	B26.5	B26.25	

Table 2 Hardness number

The table 2 ground nut husk powder showing the excellent Rockwell hardness number comparing to other fibre. Each sample two specimen tested and average values are recorded

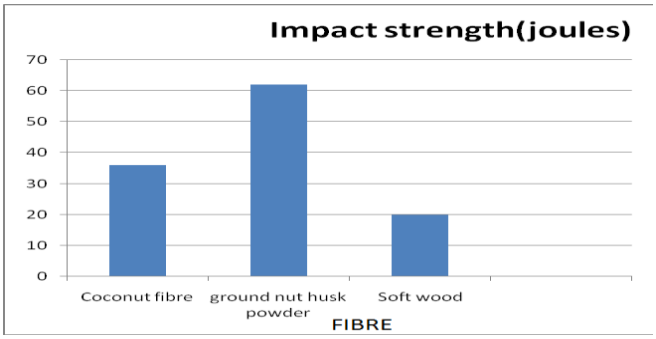

Figure 6 Impact strength

Tensile Test

S. No	Tensile strength N/mm²					
	Material	Ultimate load (KN)		Tensile strength		Average
		Specimen 1	Specimen2			
1.	Coconut fibre	4	3.8	19.04	18.84	18.948
2.	Ground nut husk powder	10	12	49.76	59.71	54.737

Table 3 Tensile strength

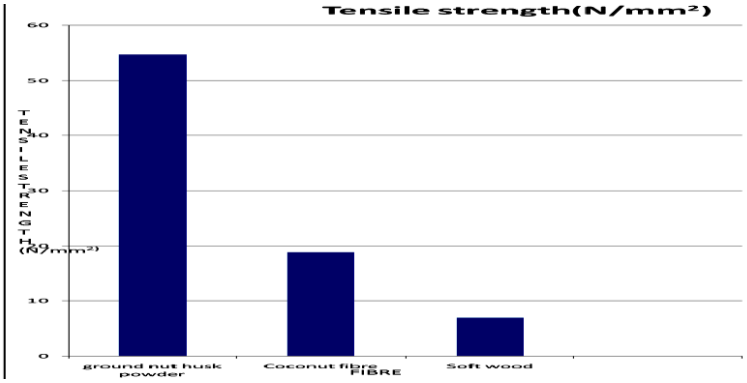

Figure 7 Tensile strength

The above figure 7 evidence that groundnut busk powder composite shows good tensile strength and ultimate load comparing to coconut fibre composites. Each sample two specimen tested and average values are recorded.

V. CONCLUSIONS

According to the results, the tensile strength, hardness, and impact strength of groundnut husk powder composites are superior to other composite combinations. The best combination of impact energy could be used as material for shoe sole production. This being preliminary study, it is suggested that further work be done a filler-matrix interphase optimisation in order to obtain a composite with best mechanical performance. Work needs also to be done on the water absorption character of the composite as well as in making it resistant to fungal attack.

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Improvement of Bearing Capacity of Sandy Soil by using Grouting

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ABSTRACT

The constructional activities in the coastal areas require deep foundations because of the poor engineering properties of weak soil at shallow depths. The very low bearing capacity of the foundation bed causes shear failure. Further, the high water table and limited depth of the top sandy layer in these areas restrict the depth of foundation thereby further reducing the safe bearing capacity. Grouting, which has several applications in the field of civil engineering, was once considered as a mysterious operation. Permeation grouting is a process of filling the pores in the soil with the cement slurry and improves the engineering properties of the possible solutions to the foundation problems by improving the properties of soil at shallow depths by using sodium silicate.

Keywords: Bearing Capacity, Permeation Grouting, Sodium Silicate, Cement

I. INTRODUCTION

The ground improvement of the soil is a technique of improving the engineering properties of the soil that can be carried out at a site. Permeation grouting is a process of low pressure grouting which helps to effluent the cement slurry in the soil with less pressure. Low pressure grouting is a process of injecting the cement slurry into the voids, cavity of the soil. It is improve the properties of the soil, especially reduces the permeability in the sample and the permeability of formations under the water retaining structures, control the erosion of soil, increase the strength of materials below foundation. It is also reduce the deformability of the material in the foundation. The setting of cement grout in the pore space increases both the strength and stiffness.

Soil stabilization, with cement grouts injected under pressure, has come into broad use in construction. At present method of grouting is highly prevalent in a number of branches of structural engineering; and in foundation engineering for the reinforcement of foundations below buildings and structures. Pressure grouting alters strength, failure stain, modulus and mode of failure of sand. It would be both practical and useful to estimate the properties of the grouted sand from the constituent properties. The compressive behaviour of grouted sand will depend on the cohesive behaviour of the grout, bonding and the properties of

the sand. The physical or chemical interaction of two materials at their interface is known as adhesion or bonding. The strength and type of this bond plays an important role in the mechanical behaviour of chemically grouted materials. Grouting is mainly responsible for the gain in cohesion by the material and only affects the friction angle. The cohesion varies with cement content, the magnitude of the cohesion and also the friction angle is a slightly increasing function of cement content. The increase in angle of friction is negligible with respect to cohesion. The Mohr Coulomb cohesion varies between 0.1 and 0.5 MPa depending on the cement content of the grout and the relative density of the soil and increases in proportion with the cement to water ratio.

Objectives

1. Study the different properties of soil.
2. Increasing depth of soil foundation.
3. Compacting and confining the soil.
4. Replacing the poor soil.
5. Stabilizing the soil with chemicals (sodium silicate).
6. Reducing the settlement of soil.
7. Improving bearing capacity and shear strength of soil.

II. LITERATURE REVIEW

1. Gopalsamy.p1, Sakthivel.m2, Arun.k (2017)

the very low bearing capacity of the foundation bed causes shear failure and excessive settlements. Further, the high water table and limited depth of the top sandy layer in these areas restrict the depth of foundation thereby further reducing the safe bearing capacity. Based on this experimental investigation made on sandy and grouted soil was concluded as, it can be seen that grouted soil has good liquid limit, plastic limit, compaction and bearing ratio are high when compared to ordinary sandy soil.

2. Santhosh Kumar. T. (2016) The constructional activities in the coastal areas often demand deep foundations because of the poor engineering properties and the related problems arising from weak soil at shallow depths. the very low bearing capacity of the foundation bed causes shear failure and excessive settlements. The shear strength of the loose sandy soil steadily increases with increase in cement content and also with curing period. The rate of increase in shear strength is very high at higher percentages of cement than at lower percentage.

3. K.VenkatRaman1, P.Dayakar1, K.V.B. Raju(2016)

Permeation grouting is a simple method of ground improvisation technique which helps to stabilize the loose soil stratum. Permeation grouting is a process of filling the pores in the soil with the cement slurry and improves the engineering properties of the soil. The shear strength parameters in the loose and medium dense

state of the soil are investigated by plate load test on the grouted soil sample by determining the correlation between load and displacement on the grouted medium.

III. METHODS AND MATERIAL

The following are some of the materials used in this experiment for analyzing are

1. Sandy soil

Sand is fairly coarse and loose so water is able to drain through it easily. While this is good for drainage, it is not good for growing plants because sandy soil will not hold water or nutrients.

2. Tap Water

Ordinary drinking water available in the construction laboratory was used for casting all specimens of this investigation. Water helps in dispersing the cement even, so that every particle of the aggregate is coated with it and brought into ultimate contact with the ingredients. It reads chemically with cement and brings about setting and hardening of cement. It lubricates the mix and compact property. Potable water, free from impurities such as oil, alkalis, acids, salts, sugar and organic materials were used.

3. Sodium Silicate

Sodium silicate is stable in neutral and alkaline solutions. In acidic solutions, the silicate ion reacts with hydrogen ions to form silica acid, which when heated and roasted forms silica gel, a hard, glassy substance.

4. Grouting Injection

Grouting is made to soil by using injection model, which will be applied pressurized by hand pressure only.

METHODOLOGY

1. Collect the soil (sand soil).
2. Wash it with water free from salts and dry in the oven to ensure it is free from moisture.
3. Perform CBR, compaction, liquid limit, plastic limit, on the sand (usually the result is zero for plastic and liquid limit).
4. Improve the properties of sandy soil by performing grouting.
5. Perform all test on the improved soil.
6. Report the result between both sample.

IV. RESULTS AND DISCUSSION

Test Performed

1. Liquid Limit Test

2. Plastic Limit Test
3. Shrinkage Limit Test
4. Specific Gravity
5. Direct Shear Test
6. California Bearing Ratio test
7. Unconfined compression test

Test Results

Sr. No.	Name of Test	Result
1	Plastic limit test	38.31%
2	Liquid limit test	57.68%
3	Shrinkage limit test	10.95%
4	Specific gravity test	2.19
5	Direct shear test	1.22 kg/cm^2
6	California bearing ratio test	2.01%
7	Unconfined compression test	0.0188 kg/cm^2

V. CONCLUSION

Based on this experimental investigation made on sandy and grouted soil was concluded as, it can be seen that grouted soil has good liquid limit, plastic limit, compaction and bearing ratio are high when compared to ordinary sandy soil. The cost of sodium silicate is low when compared to other grouting materials; it has property to rise the normal properties of soil in effective manner.

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Low Cost Water Treatment by Using Sand Filter

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ABSTRACT

A study has been conducted for designing, constructing and evaluating of an effective sand filter. Different types of sand filter and important filter media was used for the modification of sand filter. The flow rate of the sand filtered water decreases significantly with increase in turbidity.Sand filter an intermittently operated household Slow Sand Filter (SSF) is one of the most promising POU water purification methods used for rural areas.

I. INTRODUCTION

About 884 million people in the world especially in the rural areas and low-income communities still do not have access to safe drinking water sources. Five million people lose their lives due to water-related disease each year. It is estimated that around 37.7 million Indians are affected by waterborne diseases annually, 1.5 million children are estimated to die of diarrhea alone and 73 million working days are lost due to waterborne disease each year. Millennium Development Goal (MDG), Target 10 aims to half the population in 1990 without sustainable access to safe drinking water and sanitation by 2015. Even so, 672 million people will still lack access to improved drinking-water sources in 2015. Central water treatment and distribution system can be economical in urban and densely populated areas but may not be feasible in rural areas with sparsely and remotely located population. The outcome is an unreliable water service in terms of quantity and/or quality. Providing safe drinking water also becomes crucial after any disaster to prevent the spread of waterborne diseases Hence onsite water treatment using Point of Use (POU).

The participants of this study built the sand filter on site and conducted a study. Water, collected prior to this study, was filtered in the sand filter and the obtained water quality was determined. The water quality was investigated by analyses of physical parameters and the presence of the chosen indicator organisms in samples of raw water and filtered water. A literature review was performed to determine what water quality should be achieved and alternative treatment methods should be considered. These methods were used to assess the potential and performance of the sand filter and its disinfecting effect on collected water. The aim of the study was reached by the results from the study and the literature review

II. METHODS AND MATERIAL

The method used in forming the sand filter is by locally available fine sand, coarse sand, gravels.
Fine River Sand (< 1 mm)
Fine Sea Sand (< 1 mm)
Coarse Sand (3 - 6 mm)
Gravel (6 - 15 mm)

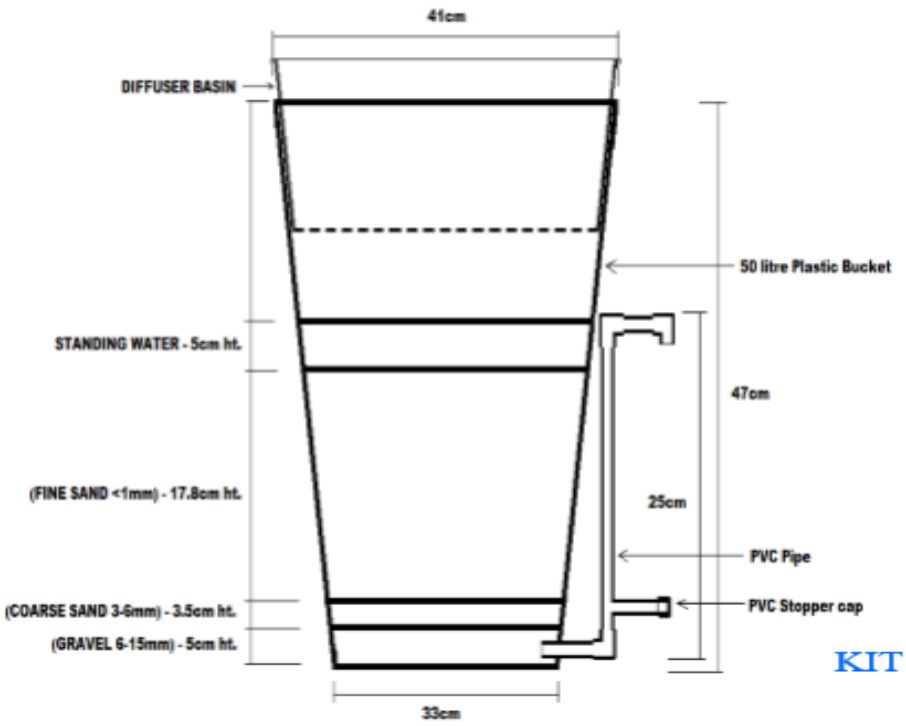
1. Size of Sand Filter - 40 cm X 30 cm
2. Different Filter Media OF Sand Filter –
   Layer 1 - Gravels (6- 15 mm) up to height 5 cm
   Layer 2 -Coarse Sand (3- 6 mm) up to height 5cm.
   Layer 3- Fine Sand (> 1 mm) up to height 17mm
3. Design Consideration –
   Rate of filtration - 10 to 40 lit/hrs/m^2
   Cleaning of filter- After 15 days
   Life Span of filter- 1 to 2 year

III. RESULTS AND DISCUSSION

After conducting all these tests the result are as follows:
Test Result of Water Sample

Sr. No	Parameter	Without Sand Filter	Sand Filtered Water	Water Quality Standard IS: 10500
1.	pH	6.12	6.7	6.5-8.5
2.	Turbidity (NTU)	6	1	5
3.	Suspended Solid (mg/lit)	600	180	500
4.	Dissolve Oxygen (mg/lit)	4	5	6.5-8
5.	Alkalinity (mg/lit)	146	98	200
6.	Chloride (mg/lit)	120	60	250

A. Figures and Tables



Typical Sand Filter

IV. CONCLUSION

1. All water quality parameter within the limit according to IS: 10500.Which is safe for domestic and drinking purpose.
2. The efficiency of sand filter depends on raw water quality and filter design.
3. The use of sand filter is very much suitable for the larger family, school etc.
4. It can be used for higher quality of water at lower costs.
5. The sand filter becomes cost effective and could be afforded by rural people.
6. The study has shown that designed sand filter shows the low health risk.
7. The constructed sand filter has lowered the flow rate so it has the good result for the water analysis and test.
8. The higher flow rate can be achieved by washing sand layers.
9. The sand filter users can use filtered water after one and half hour of pouring water into the filter.
10. This may be recommended that proper care must be taken for washing and moving the filter as there might be disturbed the filter media and layer.

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Mechanical Characterization of Natural Fibre Reinforced Polyester Matrix Composite Materials

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ABSTRACT

Natural fibres are now regarded as a viable alternative to glass fibres due to benefits such as low cost, high strength-to-weight ratio, recyclables, and so on. Combining natural fibres reduces the use of glass fibre as well. Natural fibres such as sisal, and glass fibre composites were fabricated using hand lay-up method for this study. Investigating the tensile, flexural strength of the fabricated composites was measured with a Universal Testing Machine (UTM) as well as impact strength is measured by Izod Impact tester. The load-displacement graph obtained from UTM, as well as the effect of fibres and their combinations on peak load and displacement at various layers were studied. The impact strength of the composites was measured with an unnotched Izod Impact tester. The experiments revealed that the two sisal-glass hybrid composites have higher tensile as well as flexural strength shows composites has been found to be increased from combinations of one glass and one sisal. The impact strength shows better from Sisal-two glass fibre combinations. As reinforcement, sisal and glass fibre are used, and a polymer-based resin is used as a matrix especially polyester. Mechanical properties such as tensile, flexural, and impact strength are thoroughly examined.

Keywords: Hand lay-up, Natural Fibre, Tensile strength, Flexural strength, Impact strength.

I. INTRODUCTION

Over the last decade, researchers have paid close attention to natural fibres. Natural fibres are now being looked at as a viable alternative to glass fibres when it comes to reinforcing agents in composite materials. When compared to glass fibres, natural fibres have the following advantages: lower cost, lower density, higher strength-to-weight ratio, and greater resistance to breakage during processing. Many factors, such as fibre combinations, composite processing, volume fraction, aspect ratio, water absorption, and others, can influence or modify the properties of natural fibre-based composites. There are various fibre and matrix combinations, and each has its own set of process parameters and effects on the final product's properties. The method of fabrication has a significant impact on the final properties. Compression moulding, injection

moulding, extrusion moulding, hand layup method, and others are all fabrication methods for natural fibre composites. Injection moulding improves fibre dispersion, which raises tensile and flexural properties in these materials. Extrusion and injection moulding, on the other hand, degrade the natural fibres' properties. This is in contrast to the moulding method proposed, which does not damage or orient the fibres during processing, preserving the composites' isotropic properties and reducing physical property changes.

The term "hybrid composites" refers to composites that contain two or more fillers in the same matrix. The effects of oil palm fibre reinforced composites hybridized with glass fibre. Nikhil Guptha et al. investigated the compressive and impact properties of glass fibre epoxy hybridized with fly ash. Sisal and oil palm hybrid composites reinforced natural rubber composites were studied for their mechanical properties and cure characteristics. The tensile and flexural properties of banana/sisal and PALF/glass hybrid composites were improved, but this had a negative impact on thermal conductivity. Mechanical properties such as strength and stiffness are improved due to hybridization in glass/palmyra fibre/waste switch composite materials. Because of this, hybridization is critical to the improvement of composite properties. Wood as a building material is in high demand around the world, but there is a limited supply. As a result, new materials have been created as substitutes. The polymer composites, in particular the natural fibre reinforced polymer composites, have been explored among the various synthetic materials as an alternative to glass fibres. The purpose of this study is to evaluate the mechanical characterization like tensile, flexural and impact strength of natural fibre reinforced with polyester resin composites materials with various layers. Thus, the objectives of this work are as follows:

- To fabricate the natural fibre reinforced composites with different layers.
- To investigative the properties like tensile, flexural, and impact strength.

II. EXPERIMENTAL DETAILS

Materials

The matrix material used in this study was commercially available polyester known as satyan polymer, which was supplied by GV Traders. For curing, the matrix was mixed with curing catalyst at a concentration of 0.01 w/w of the matrix. As reinforcement, commercially available sisal, glass, and a glass/sisal combination were used.

Fabrication of Composites

The hand-lay up method is used to create various layers of composites during the fabrication process. Our fabrication process makes use of the materials like General Purpose Resin (G.P.Resin chemically Polyester), Accelerator (Methyl Ethyl Ketone), Catalyst (Cobalt), Poly Vinyl, Polythene Sheets & Glass Plates, Sisal Fibres & Glass Fibres

Fabrication Procedure

Sisal and glass fibre can be prepared for fabricating the required size of 15cm X 15cm. Preparation of a proper proportion of a binding resin mixture. Mix 20 drops of Accelerator and 12 drops of Catalyst in 60ml GP Resin. Allow Polyvinyl to dry after applying it to the plain polythene sheet. Over the dried sheet, apply the binding

mixture to create a polymer resin matrix. Reinforce the polymer resin matrix with the necessary fibres. Reapply the resin-binding mixture to the fibre reinforcement and let it dry. Polyvinyl sheet coated with polythene should be used to cover the reinforcement. Dry the reinforcement for 3 to 5 hours between two glass plates. We can get the required composite after drying it out. The various types of layers in the fabrication process are Double Layer and Triple Layer

Double Layer

Sisal and glass fibres are used in the Double Layer as reinforcement, while polymer-based resin serves as the matrix. Polythene sheet is used to make the double layer, and then resin mixture is poured into it. After that, Sisal fibre is added, and the resin mixture is applied once more. Finally, glass fibre is added, and the mixture is poured, and the whole thing is covered with a polythene sheet to complete the construction. Fig 1 shows One Sisal and Glass fibre Composite

Fig. 1 One Sisal and Glass fibre Composite

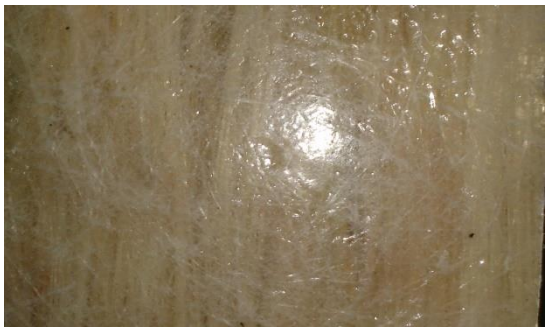

Fig. 2 Two Glass and one Sisal Fibre Composite

Triple Layer

In the Triple Layer, two layers of sisal are sandwiched between two layers of glass fibre as reinforcement, and a polymer-based resin serves as the matrix.

(a)Two Sisal Fibres and a Glass Fibre Composite

There are two layers of sisal fibres in this composite, and a third layer of glass fibres. First, a resin mixture is applied to a polythene sheet to create a sisal and glass fibre composite. After that, a layer of sisal fibre is added, and more resin is applied on top of that layer. The resin mixture is then reapplied after a layer of glass fibre is

placed on top. Afterwards, another layer of sisal fibre is added, followed by the resin mixture, and finally, a polyvinyl-coated polythene sheet is applied to finish it off.

(b)Two Glass Fibre and a Sisal Fibre Composite

Sisal fibres and glass fibres make up this composite. The resin mixture is first applied over the polythene sheet in the fabrication of a two-glass fibre and a sisal fibre composite. Glass fibre and more resin are then applied on top of each other. After that, a layer of sisal fibre is applied on top, and the resin mixture is applied once more. After that, another glass fibre is added, followed by the resin mixture and a polythene sheet. Fig 2 shows that Two Glass and one Sisal Fibre Composite

III. RESULTS AND DISCUSSIONS

Tensile test

The specimens' tensile strength was measured with a computer-controlled Universal Testing Machine. Each of the test specimens was cut into a rectangular beam using an ASTM-recommended diamond wheel and a saw. The displacements are shown on the X-axis. Maximum Load is represented on the Y-axis. This illustration shows how the material begins to deform at a load of 12KN. Figure 4.2 shows that the composite strictly follows Hook's law when the applied load is between 12KN and 14KN. After that, as the load increases, so does the displacement. Individual fibres break when the applied load reaches the breaking load, as shown by the small fluctuations in the graph.

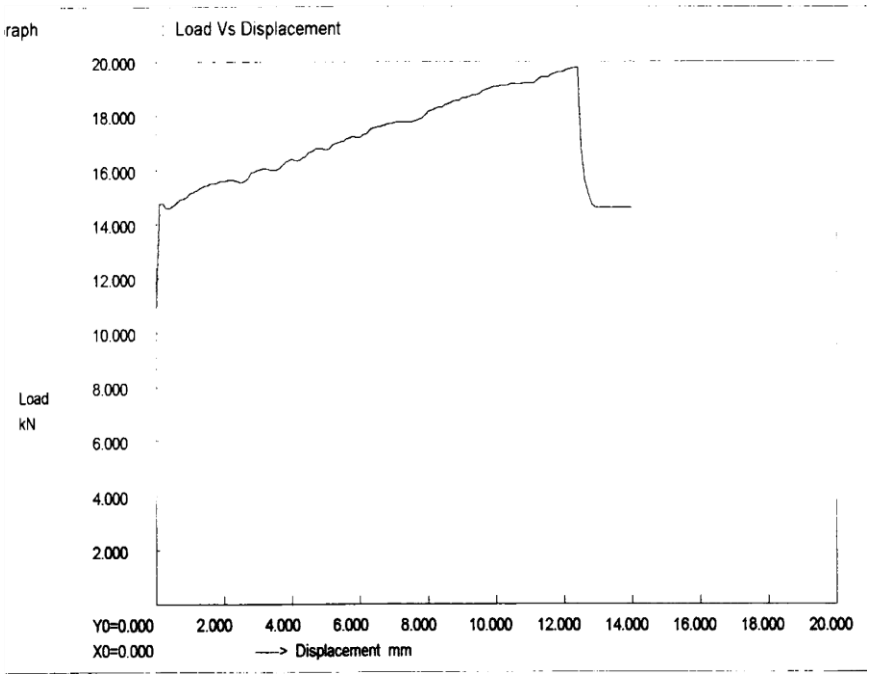

Fig. 3 Two Sisal & One Glass Fibre Composites

A dried specimen measuring 150mm X 15mm X 3mm is used to conduct the tensile test. A peak load (Fig. 4) and displacements (Fig. 5) curve are shown in variety of layers such as Using 1. one sisal and one glass fibre composites, 2. Two sisal and one glass fibre composites and 3. one sisal and two glass fibre composites, there are three options available. In relation to layers, the following graph depicts how various parameters change.

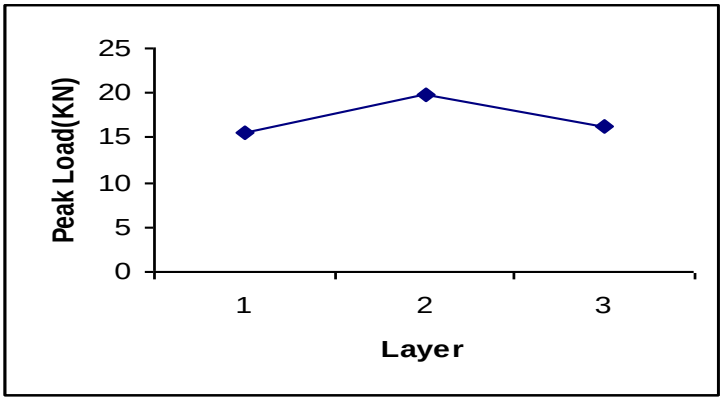

Fig. 4 Peak load at various layers

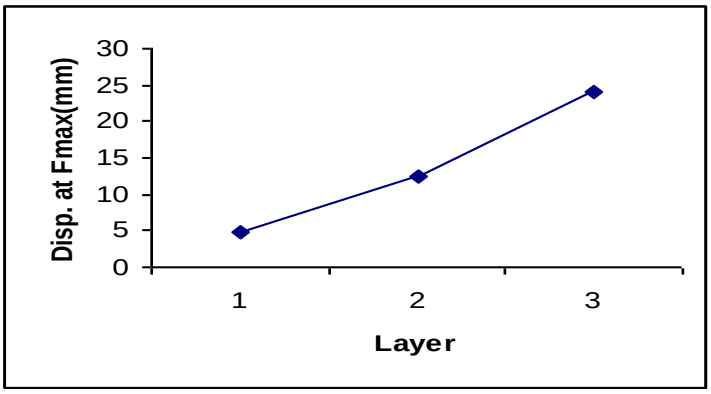

Fig. 5 Displacement at various layers

The graph shows how the number of layers affects the maximum load and the amount of displacement. Glass fibres have the highest maximum load because of their brittle nature. The two sisal and one glass fibre layers have better mechanical properties, even though their displacement is nearly identical. Matrix evenly distributes the load to the glass and sisal fibre composites, and it can withstand large loads while still exhibiting good mechanical properties Glass fibre displacement is limited only by the lengthening of the fibres due to the applied load.

Flexural Test

The effect of flexural loading on the performance of composite materials that have been manufactured. This effect was investigated using a three-point bending test of peak load (Fig 6) and displacement (Fig 7) at various layers. The load was placed in the middle of the supports. Flexural testing revealed that Sisal Glass fibre composites survived more loading than other combinations. The presence of sisal fibre in the reinforcement weakens it. Even in Sisal and Glass fibre composites, the presence of glass fibres with sisal

fibres may cause a slight reduction in flexural behaviour. The flexure test is performed on a dried specimen that is free of moisture. The diagram below depicts the effect of layer on various parameters. Because of their brittleness, sisal fibre and glass fibre composites can withstand high loads. Brittle fracture is the fracture mechanism of composite. The double layer composite exhibits mechanical properties under these conditions.

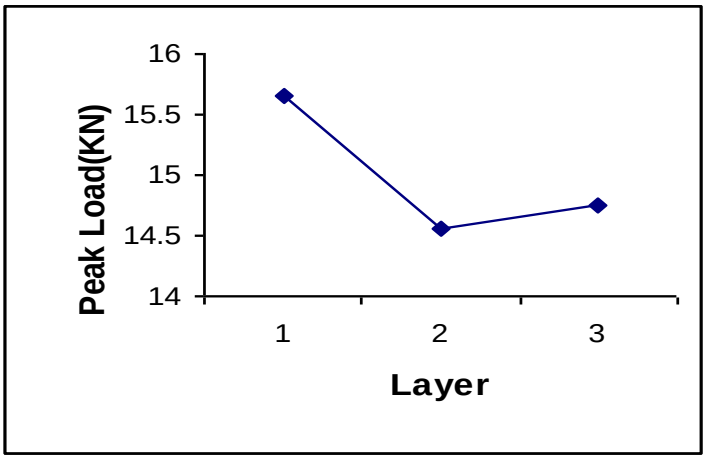

Fig. 6 Peak Load various layers

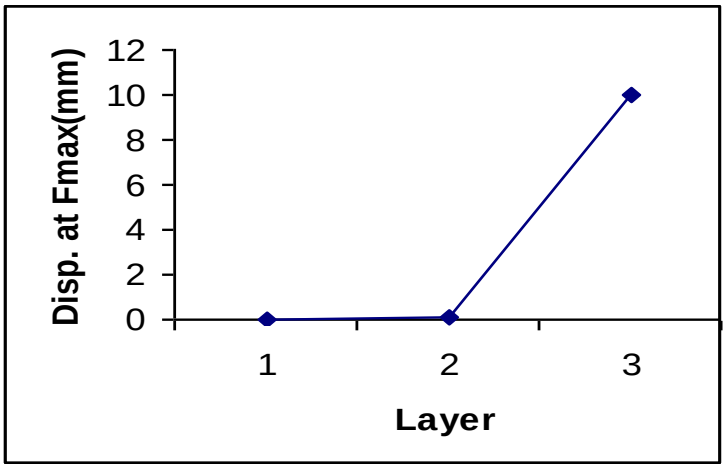

Fig. 7 Displacement at various layers

Impact Test

The energy absorbed by each un-notched sample composites is determined using Izod impact test, which follows the Accordance with ASTM standard. The natural fibre composite's izod impact strength is shown in Fig.8. Sisal's impact strength, combined with two glass fibres, is superior to that of other combinations. This demonstrates that fibre content and fibre length have beneficial effects on the impact strength of Sisal as well as two glass fibre composites' reinforcement. In the Chorpy Impact test bed, the impact test is carried out 90mm X 15mm X 3mm is the size of the specimen. As shown in Fig 9, the impact strength increases as the layer increases. Impact loading is more resistant to glass fibres. As a result, composites made of two glass and sisal fibre have a high impact resistance. The resin matrix evenly distributes the impact load and

improves the composites' impact resistance. When a composite material is subjected to an impact load, the figure depicts the fracture. Its brittle nature is evident from the profile.

Fig.8. Fractured Impact Test sample

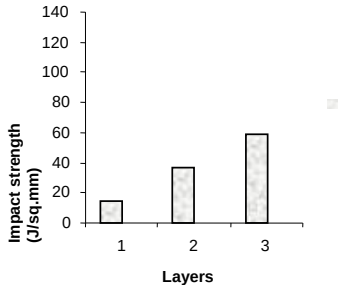

Fig 9 Effect of layer on Impact Strength

The impact test results show that the two glass and a sisal fibre have higher impact strength because the glass fibres are brittle and absorb more energy until it breaks completely. Because of the presence of three layers, two sisal and a glass fibre composite has good impact toughness and absorbs more energy.

IV. CONCLUSION

Tensile testing of fibre composites demonstrates that the two sisal and one glass composites have higher tensile strength. Flexure testing of fibre composites demonstrates that the one glass and one sisal composite has higher flexure strength. The impact testing results of fibre composites show that the two glass and sisal fibre composites have a high impact strength. Hard particle dispersion on layers does not improve over sisal fibre composites.

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Novel Materials for Selected Solar Cell Technologies and Their Flexible Aspect

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ABSTRACT

The solar photovoltaic is proved to be one of the most promising renewable energy resources, but the high cost and complicated fabrication technology of solar cells become the constraint of this technology for its wide application in many fields. The better conversion efficiency, along with the efficient preparation technologies and flexible structures would make a significant positive impact on the usage of Solar PV. People are looking forward to the applications of solar PV technology in day to day life due to fast degradation of conventional sources of energy. In this paper, the focus is made on the flexible solar cells, which have gained increasing attention in the Solar PV field. Despite of availability of wide range of Solar Cell technologies, the scope of this paper is kept limited to Dye sensitized solar cell technology, Perovskite Solar Cell technology and CIGS technology. The latest progress in flexible solar cells materials and manufacturing in these technologies is overviewed. The advantages and disadvantages of different manufacturing processes are also discussed in brief.

Keywords: Solar Cells, Fabrication Technology, CIGS, Perovskite, Dye sensitized, Flexible materials

I. INTRODUCTION

This paper aims to provide speculative knowledge about various types materials used to manufacture solar panels, their working efficiencies, and their scope of application, advantages and disadvantages. Further, the paper focuses only on few specific types of materials to keep it short.

Various solar cell technologies are depicted below:

- Monocrystalline Si Solar Cells
- Polycrystalline Si Solar Cells
- Amorphous Solar Cells
- Dye Sensitized Solar Cells (DSSC)
- Cadmium Telluride Solar Cells (CdTe)
- Copper Indium Galium Selenide Solar Cells (CIGS)

- String Ribbon Solar Cells
- Perovskite Solar Cells

Of these types of technologies only CIGS, DSSC and Perovskite solar cells have been discussed in detail. The reason behind choosing these materials is, they can be fabricated with flexible structures. Due to flexibility, such solar cells have scope to mount them on walls, concave or convex shapes, irregular surfaces, etc. The efficiency of these cells varies roughly between 3% to 21%.

The Mono crystalline and Poly crystalline solar cells have a large market share due to ease of availability of Silicon and its higher efficiency. The recent advancements have brought above chosen materials (CIGS, DSSC and Perovskite) in the field of Solar PV to fabricate the flexible cells.

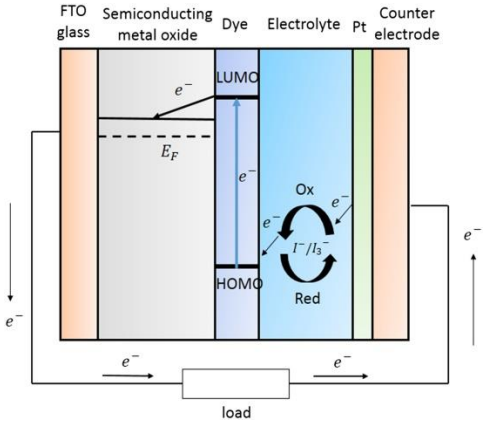
In particular, transparent electrode is an essential part for solar cells, and Indium Tin Oxide (ITO) conductive films are commonly used for this purpose. The cells with opacity electrodes made up of fibres have also been reported.

II. METHODS AND MATERIAL

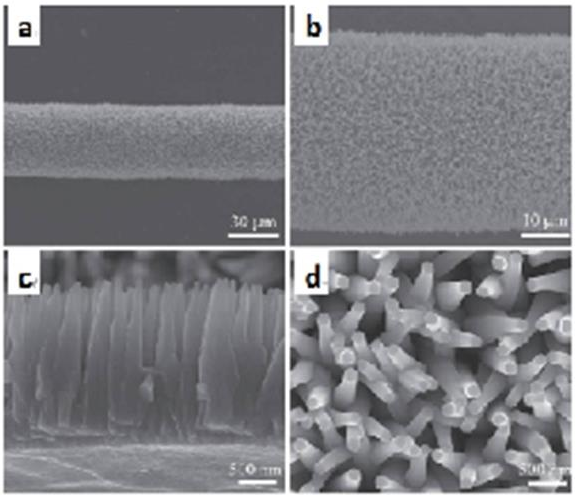
[A] DSSC MATERIALS:

A material like ruthenium metalorganic dye, can absorb a broad range of the visible region of sunlight. An inorganic mesoporous nanoparticle layer, usually titanium dioxide, increases the area for light absorption. Solar cells using these materials can be made using solution processing, making them inexpensive to fabricate. DSSC materials are more pure and cost effective than their counterparts like Perovskite and CIGS materials. They are the new option for moderate scale applications of Solar Energy. They are advantageous in the sense that they have abundance of raw material which can be processed with simple manufacturing materials. The structure of DSSC consists of:

- A conductor
- Dye photosensitizer
- A nanoporous semiconductor membrane
- Counter electrode and electrolyte

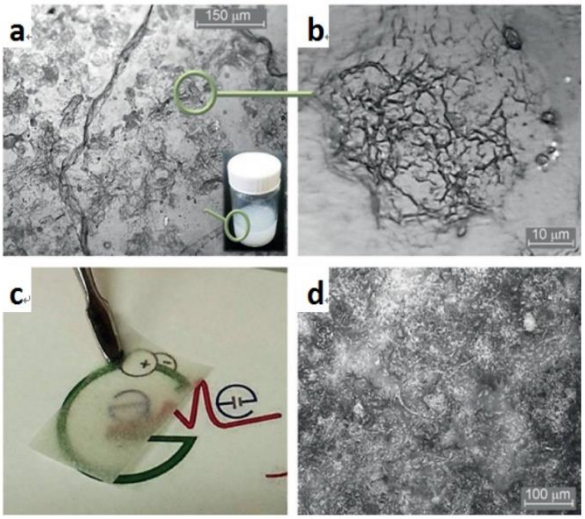


The photo-anode and counter electrode are vital components of the DSSC structure. Indium doped tin oxide (ITO) glass and fluorine doped tin oxide (FTO) coated glass is generally used as transparent conductors. The deposition of transparent conductive oxide like ITO – sputtered Polyethylene Naphthalate (PEN) and polyethylene terephthalate (PET) on flexible substrate have been widely used due to their superior electrical conductivity and light weight. Due to processing at high temperature, the ITO – PEN and PET substrates experience lot of mechanical or chemical changes.
Hence preparation of TiO_2 on ITO-PEN substrate by electrospray deposition at low temperature is preferred. The efficiency of such a cell is found to be 5.57%.
The production of ITO to large scale is limited due to lack Indium resources which hampers the cost effectiveness of the product. Hence alternative material like fabric based electrodes are used to fabricate DSSC. The transparent PEN woven fabric and electrochemically platinized tungsten wires in vertical directions are used to form a flexible cathode. The FTO, on contrary enhances ohmic resistance. The electrode so formed exhibits good stability and storage capacity. The ZnO nanowires grown on the wires of Au, Ag, and Cu serve as working electrode whereas Pt wires work as counter electrode.



(a) SEM image of ZnO nanowire arrays grown on stainless-steel microwires. (b) Magnified SEM image of a wire section, uniformly covered with high-density ZnO nanowires. (c) Cross-section and (d) top-view SEM images showing the well-aligned, high-density ZnO nanowire arrays grown on the stainless-steel microwire.
The flexible glass called Willows Glass, whose thickness was only 100 μm, significantly increases the substrate flexibility and reduces the rigidity with bend stress less than 100 MPa at a bend radius of 5 cm. This allows roll to roll modelling of DSSC solar cells for intended applications with higher thermal stability and shows potential for mass production. Moreover, compared with ITO glass conventional DSSC, the flexible DSSC shows approximately same efficiency.
In DSSC, electrolyte between the electrodes play an important role to provide stable structure. In flexible DSSC Gel or solid state electrolyte are preferred over liquid electrolyte. The ability of electrolyte to enhance speed up the process of charge transfer can be increased by adding Platinum nanoparticles to it. One of the flaw of flexible DSSC is, the electrodes may come in contact when the cell is bent causing short circuit. The

Polymer electrolyte membranes (PEM) like cellulose nano fibre can be introduced into the electrolyte to overcome this defect. This technic is proving fruitful to enhance efficiency of the sell to 7.03%.



(a, b) Optical microscope analysis of the NFC dried network of fibers; (c) appearance of a 30 wt% NFC-based PEM; (d) a 30 wt% NFC-based PEM observed with an optical microscope

[B] PEROVSKITE CELLS:

Perovskite structured materials used in solar cells are generally hybrid organic-inorganic lead or tin-halide materials, such as methylammonium lead halide. These materials can be solution-processed, hence enable inexpensive and simple fabrication. One of the key advantages of these materials is their ability to absorb sunlight across the entire visible spectrum.

The efficiency of perovskite-based solar cells has been steadily increasing. The photo conversion efficiency of these cells was only 3.28% in its initial stage in 2009. With progress in the technology, the efficiency is found to be 20.1% in 2018. This is a drastic increase in efficiency observed in short span of time. The light absorption layer material of $CH_3NH_3PbX_3$ (X: I^-, Br^- or Cl^-), is a typical perovskite structure, and was first used as a novel dye in DSSCs. Perovskite nanoparticles can be used as light harvesters, and with standard AM-1.5 sunlight, such cells generate large photocurrents exceeding 17 mA/cm^2.

The difficulties in the flexible aspect of perovskite cells are:

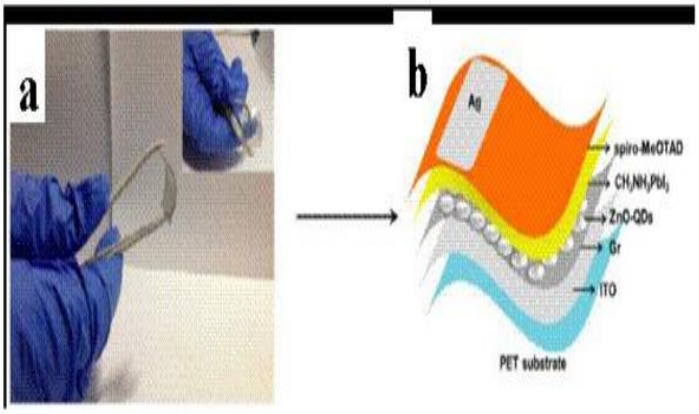
1. Flexible materials for both sides of substrates
2. Alternative electrode materials to take place of Au or Ag to be the counter electrode.
3. Requirement of high temperature to produce TiO2 layer.

It is observed that, with the PET substrate the cell becomes bendable and its efficiency improved upto 13%.

By employing p-type poly (3,4-ethylenedioxythiophene):poly (styrenesulfonate) (PEDOT:PSS) to replace TiO_2 making up as the blocking layer, the process temperature is able to control and ensure a high efficiency of 12.3%.

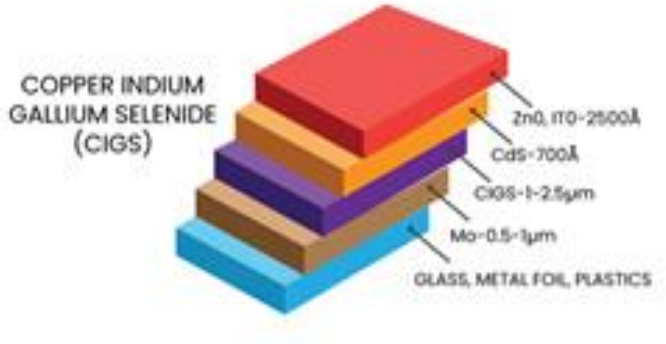
Nanoparticles, a few nm in size, called quantum dots are another type of emerging materials used in solar cells. They are low bandgap semiconductor materials such as CdS, CdSe, and PbS. Their bandgaps can be tuned over a wide range by changing the size of the particles. Many common materials used for fabricating quantum dots such as Cd and Pb are considered toxic.

ZnO quantum dots treated by the atmospheric plasma jet can also be used as the electron transport layer and ITO-PET as the substrates to assemble highly flexible perovskite solar cells. The ZnO quantum dots are coated on the ITO substrate by the atmospheric plasma jet method to improve the photo current density. Additionally, the fabrication process with simplified procedures, long-term stability and flexible structure reveals the high developing potentials of such novel perovskite solar cells.



a) Photograph of ITO-PET/Gr, (b) a schematic illustration of the fabricated ITO-PET/Gr/ZnO-QDs(AP jet)/$CH_3NH_3PbI_3$/spiro-MeOTAD/Ag flexible perovskite solar cell

[C] Cu(In, Ga)Se_2 (CIGS):

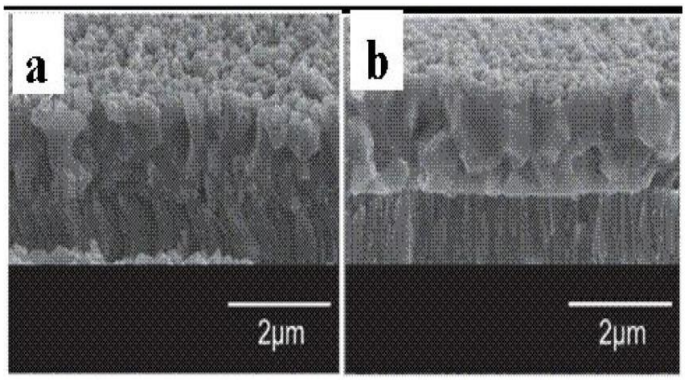


They are considered as next generation solar cells due to high efficiency, low cost and flexile possibility. With the deposition of rigid glass substrate they were as efficient as 20.8%. Flexible CIGSs are lighter, foldable and

can be applied to uneven surface. They find many applications on ground as well as in space. Methods like evaporation, sputtering and deposition are suitable for flexible electrode producing and how to better coordinate the connection of cells also becomes the key points. The choice of flexible substrate requires good thermal stability to bear the high temperature environment when producing the absorption layer, chemical stability without reacting with Se, and adaptability of vacuum and suitable for coiling.

Most commonly used flexible substrates are flexible foils, they are demonstrated with cost-effectiveness and versatility. As per reports, CIGS can be deposited on stainless steel with a special Ti/TiN composite structure. The efficiency of such a composition was found to be 9.1%. Combined flexible foils are also tested as the supporting layer, and the addition of Mo and Cr on stainless steel deliver the highest conversion efficiency of 9.88%. The similar experiment with Na/Mo exhibited efficiency of about 15.1%.

CIGS deposition on polymers substrates like polyimide obtained efficiency of around 7%. Following figure presents the SEM images of the CIGSs cross-sections made by the traditional method and the modified method, respectively.



SEM images of CIGS thin films grown with (a) traditional process and (b) new process.

III. CONCLUSION

Usually solar cells are fabricated on rigid slabs or filmy cells on the glass substrates. On the contrary, the most important traits of flexible solar cells are of light weight, shatter-resistant and they exhibit high specific power. The technology of flexible solar cells is also reposed on the flexible substrates, for instance: the stainless steel or polymers. As most of the solar cells have requirements of high transparency of the electrodes, researchers are searching for flexible transparent materials to replace the hard glasses in the part of light blocking layer. The flexible structure of solar cells provides opportunities to continuous and mass production of power supply in the future. It can be expected that flexible energy applications will eventually change the energy structure profoundly and transform our life enormously.

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Paver Blocks from Waste Plastic

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ABSTRACT

It has been observed that around 56 lakh tones of plastic waste are produced around the country annually, it is necessary to minimize its rate by reusing it. Replacing binding material with plastic waste is a productive way of disposal of plastic waste which will not only make block eco-friendly but will also reduce the cost of paver block. This block has low water absorbing capacity and are chemically resistant. Use of plastic in block will surely impact on its weight and will make it light in weight. Plastic waste used in different proportions along with laterite powder, ceramic waste, coarse aggregates, fine sand. This block has low compressive strength than original cementitious paver block hence these blocks are used in low traffic areas, walkways, footpaths, pedestrian plazas, monument premises, waterlogged areas, etc.

Keywords: Recycled plastic, Alternative binding material, Paver block, LDPE.

I. INTRODUCTION

With the continuous increase in plastic waste generation, it leads to death of animals and thereby causing health hazard for living beings. The only way to get rid of it is to minimize its use, whereas there is need to recycle/ reuse the existing waste in the best manner possible.

One of the productive ways to utilize waste plastic is to utilize it as an alternative to binding material. With the natural resources depleting worldwide along with the generation of waste from industry and residential areas increasing substantially, the sustainable development for construction involves the use of non-conventional 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.

Plastic as a replacement of cement possess several advantages as it is environment friendly and has economic benefits.

II. METHODS AND MATERIAL

In general, techniques used in manufacturing cement binding paver block doesn't change much in plastic binding paver block. The melted plastic is used as a replacement of cement.

The materials collected are aggregates, plastic waste, sand, quarry dust, etc.

Type of material are as follows:

1. Plastic waste

Plastic waste which is use as a binder is collected from local vendors which consist of plastic bottles, polythene bags, etc. The size of which ranges from 6.5 microns to

0.10 microns.

With the increase in waste generation there is need to dispose it properly as per the regulation in order to minimize the effects on lives.

PROPERTIES OF LDPE

Sr. No.	Properties	Value
1.	Melting point	150^0
2.	ThermalCoefficientofexpansion	$100\text{-}200\times10^{-6}$
3.	Density	0.910 – 0.940
4.	Tensile strength	0.2 –0.4(N/mm^2)

2. Coarse aggregate

Crushed basalt stones from local queries were used as aggregate. The maximum size of aggregate used was 12.5 mm and 10 mm retained. The aggregates were washed to removed dirt and dust and were dried to surface dry condition.

3. Fine aggregate (Sand)

Sand is collected from sea shores and is sieved from

2.36 mm sieve.

4. Laterite dust: 9 microns

Laterite stone is used majorly for construction purposes in Konkan region. The powdered form which is used in this project i.e., laterite dust which is obtained while cutting the stone.

5. **Mould Size:** 200x100x60 mm

6. Lubricating oil

Lubricating oil is used for membrane between mould and mixture.

III. METHODOLOGY

1. The plastic waste which is thrown away by vendors was collected from them and was brought to the place of experimental analysis.
2. Other materials such as coarse aggregates, fine aggregates, laterite dust, etc. were collected.

3. Shredding of plastic waste was done for easymelting.
4. Mould of size (200×100×60 mm) was asked tomade.
5. Sieving of material was done with specific sized sieve.

Sr. No.	Type	Sieve Size
1.	Fine aggregate (Sand)	2.36 mm
2.	Coarse Aggregate (Type 1)	10 mm
3.	Coarse Aggregate (Type 2)	12.5 mm
4.	Laterite dust	9 microns

6. The outcome from the research paper studied was, the plastic binded paver block casted with the ratio of 1:3 (Plastic: Aggregates) gives maximum strength compared to other ratios. As a result, we decided to go with this ratio scale. Detailed information is given in the table below:

	Type 1	Type 2	Type 3
Plastic waste	1	1	1
Fine aggregate	1.8	0.8	1.3
Laterite dust	0.2	0.2	0.2
Coarse Aggregate	1	2	1.5

7. Plastic waste is heated in metal bucket at a temperature at above 150oC. As a result, heating of plastic waste melt.
8. The materials quarry dust, aggregates and other materials as described in above tables are added in it in right proportion.
9. Melted material is then well mixed.
10. Wooden moulds are lubricated with lubricating oil.
11. Melted material is then transferred in to wooden mould of certain shape.
12. After transferring melted material, the wooden mould is quickly placed on vibrating table.
13. Paver blocks are placed for 24 hrs curing in open environment.
14. After that this paver blocks are ready to use.

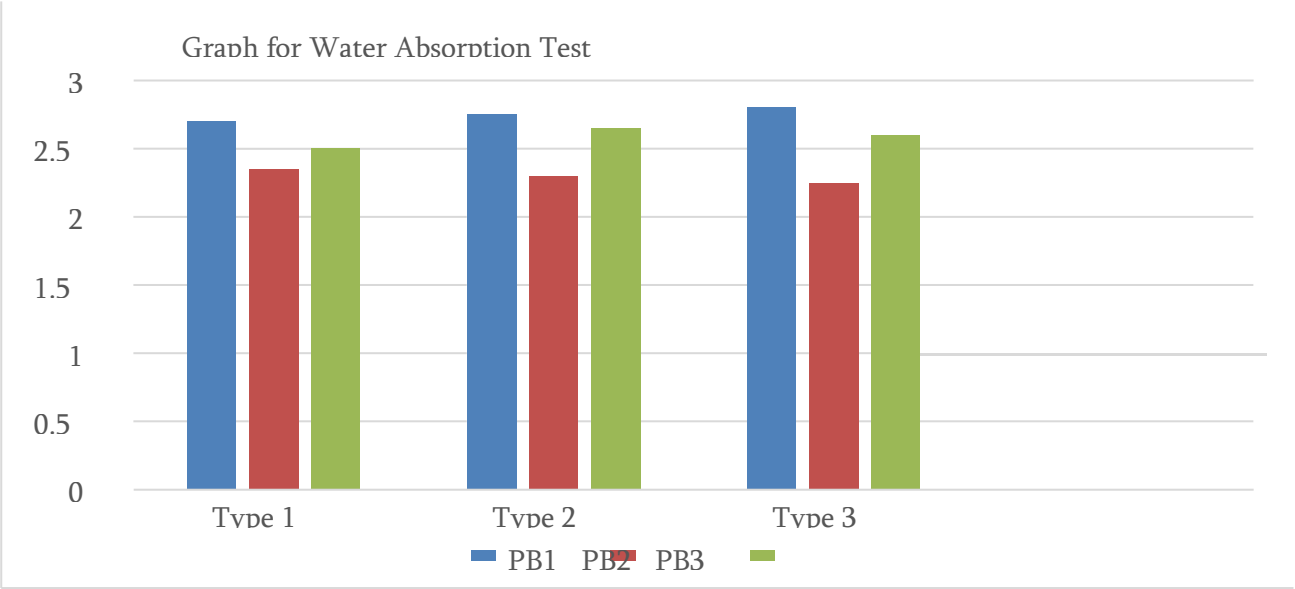
IV. RESULTS AND DISCUSSION

Tests Performed

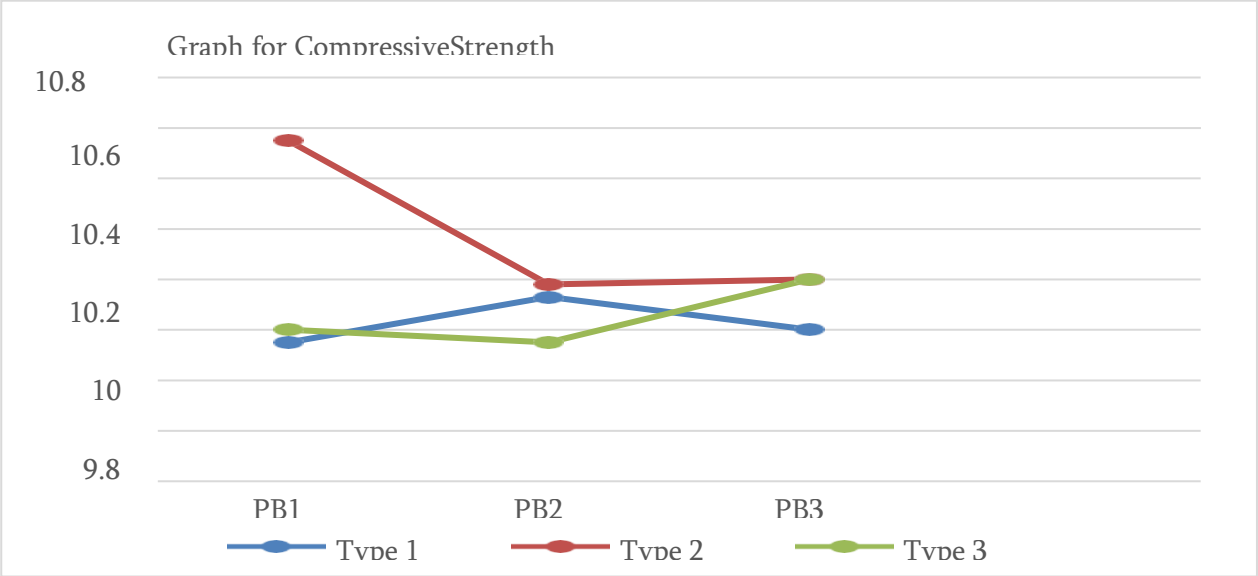
1. Water Absorption test
2. Compressive Test
3. Heat resistant test

Result Interpretation

1. Water Absorption Test



Compressive Strength Test



Heat Resistance Test

FOR TYPE 1

Sr.No.	Specimen	Temperature (°C)	Remark
1.	PB1	50	No changes
		100	No changes
		150	**Melts**
2.	PB2	50	No changes
		100	No changes
		150	**Melts**

3.	PB3	50	No changes
		100	No changes
		150	**Melts**

FOR TYPE 2

Sr.No.	Specimen	Temperature(°C)	Remark
1.	PB1	50	No changes
		100	No changes
		150	**Melts**
2.	PB2	50	No changes
		100	No changes
		150	**Melts**
3.	PB3	50	No changes
		100	No changes
		150	**Melts**

FOR TYPE 3

Sr.No.	Specimen	Temperature (°C)	Remark
1.	PB1	50	No changes
		100	No changes
		150	**Melts**
2.	PB2	50	No changes
		100	No changes
		150	**Melts**
3.	PB3	50	No changes
		100	No changes
		150	**Melts**

V. CONCLUSION

The following conclusions were drawn from the experimental investigation:

1. The utilization of waste plastic in production of paver block has productive way of disposal of plasticwaste.
2. The cost of paver block is reduced when compared to that of concrete paver block.
3. Paver block made using plastic waste, quarry dust, coarse aggregate has shown better result.
4. It also shows good heat resistance.
5. Though the compressive strength is low when compared to the concrete paver block it can be used in gardens, pedestrian path and cycle way etc.
6. It can be used in non-traffic and light traffic road.
7. Minimization of plastic waste can prove to be highly effective and can help us to reduce plasticpollution.

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XRD and 3D LASER Characterization Studies of Hydrogen Ion Implanted Graphene

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ABSTRACT

In the present work, the graphene material were implanted with H^+ ion at different energies 100 and 200 keV for various fluences ranging from 1×10^{14} to 1×10^{15} ions cm^{-2} using Electron Cyclotron Resonance Ion Accelerator (ECRIA) facility at TIFR, Mumbai. The structural and morphological studies were carried out using XRD and 3D Laser Microscopy techniques respectively. XRD of non-implanted graphene sample showed the reflection peak at 26.65°. After implantation, the crystallite size was found to be varying from 22.38 nm to 35.87 nm for the different energy ranges from 100 to 200 keV. 3D Laser Microscopy showed the increase in irregular defects on the crumpled structure of graphene.

Keywords: Graphene, Ion Implantation, H^+ ion, XRD, 3D Laser Microscopy

I. INTRODUCTION

A smart and novel material of sp^2-hybridized carbon atoms, known as graphene material which has received wide scientific attractions because of its remarkable properties such as high carrier mobility, high electrical and thermal conductivity, and significant mechanical strength [1]. Graphene is discovered in 2004 by Andre Geim and Konstantin Novoselov, and they received Noble Prize in 2010 for groundbreaking experiments on graphene [2]. However, a new era of two-dimensional materials ignited an incredible revolution of discovery and inventions in science and technology [3,4]. Graphene has remarkable transport, optical and mechanical properties, it has great potential for being used in a wide range of applications [5-7]. After modification in the structure of graphene materials, it enhances technological properties in terms of sensors, touch screens, efficient electronics, and solar panels to strong composite materials.

Many researchers have synthesized graphene by the method such as CVD, Magnetron Co-Sputtering and ion implantation etc. However, ion implantation is a versatile tool for purposes including synthesis and modification of materials. Being two-dimensional material, graphene seems to be extremely sensitive to surface adsorbates, so its electronic properties can be effectively modified by the deposition of different ions, atoms, or molecules [8]. Mukesh Tripathi et al. showed heavy atoms can be inserted into the graphene lattice, opening the door for advanced applications such as single-atom catalysis [9]. S. Mathews et al. studied the

effects of MeV proton irradiation on suspended and supported graphene samples. The damage mechanism originating from intense electrically induced atom desorption is suggested [10]. The prominent modifications in properties of graphene in terms of large bandgap leading to numerous applications in many fields.

Herein, the graphene materials were implanted with H^+ ion at different energies 100 and 200 keV for various fluences ranging from 1×10^{14} to 1×10^{15} ions cm^{-2}. Ion implantation was carried out at Electron Cyclotron Resonance based Ion Accelerator (ECRIA) laboratory at Tata Institute of Fundamental Research (TIFR), Colaba, Mumbai. The non-implanted and implanted samples were characterized using XRD and 3D laser techniques.

II. METHODS AND MATERIAL

The pure form of few-layered graphene sheet material for the synthesis procured from industrial manufactures. The graphene sheet cut up in 1×1 cm piece sample for the ion implantation. The fluence, ion ranges, depth, and energy estimated from mathematical calculations using software (SRIM 2008). The effect of low energy hydrogen ion implantation on graphene sheet is studied using the Electron Cyclotron Resonance based Ion Accelerator (ECRIA) at the Tata Institute of Fundamental Research (TIFR), Colaba, Mumbai, India. The pressure of the ion irradiation chamber was 2.4×10^{-6} mbar and the high vacuum maintained at 1×10^{-6} Torr. The graphene samples then subjected for implantation with 100 - 200 keV hydrogen ions with fluences of 1×10^{14} to 1×10^{15} ions cm^{-2}. X-Ray Diffraction (XRD) pattern of implanted and non-implanted samples of graphene recorded on the Rigaku Miniflex 600 machine (λ=1.54 Å) with the 2θ range varying from 5^o to 70^o. The tube voltage and current were at 40 kV and 15 mA respectively. Optical images were recorded by using 3D Laser microscopy on the Olympus LEXT OLS5000 machine.

III. RESULTS AND DISCUSSION

A) XRD Studies:

Figure 1 and Figure 2 shows XRD spectra of non-implanted and implanted graphene for the fluence ranging from 1×10^{14} to 1×10^{15} ions cm^{-2} at energies of 100 and 200 keV respectively. The non-implanted graphene sample showed the peak at 26.65^0 attributed to the graphene reflection [Fig.1 and Fig.2]. After H^+ ions implantation at 100 keV for the fluence ranging from 1×10^{14} and 1×10^{15} ions cm^{-2}, the shift in the peak observed at 26.62^0 and 26.44^0 respectively [Fig.1]. Whereas, the sample implanted at 200 keV and for the same ion fluence, showed the peak at 26.52^0 and 26.61^0 respectively [Fig.2].

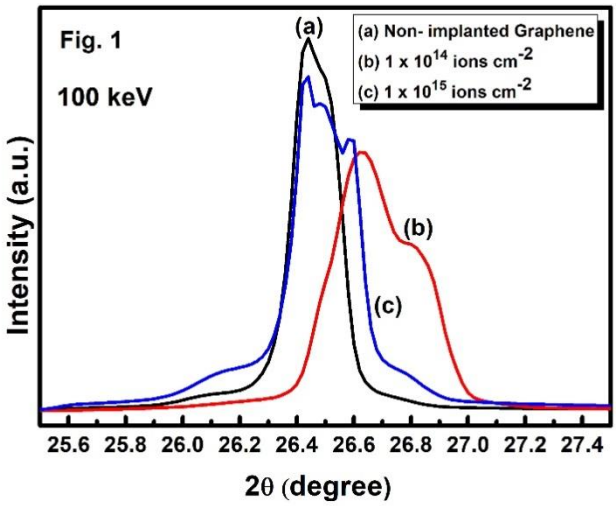

Figure 1: XRD spectra of non-implanted and H^+ ion implanted graphene for the different fluences at 100 keV

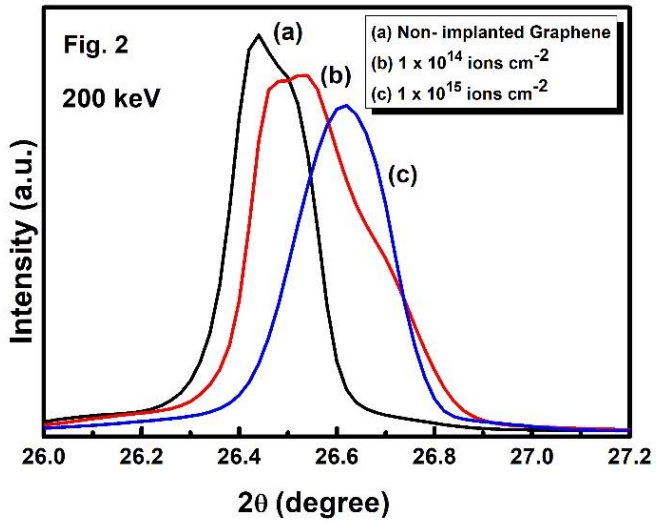

Figure 2: XRD spectra of non-implanted and H^+ ion implanted graphene for the different fluences at 200 keV

The result showed that after implantation the intensity is found to be varying due to the structural changes. The calculated FWHM and crystallite size of non-implanted and H^+ implanted graphene is shown in Table-I. The crystallite size of all samples estimated by Scherrer's equation,

$$D = \frac{k\lambda}{\beta cos\theta} \qquad \ldots\ldots (1)$$

Where D is the crystallite size, k is Scherrer's constant which is set as 0.9, λ is the wavelength of the X-Ray used, β is the Full Width Half Maxima (FWHM) and θ is the Bragg's angle. According to Williamson and Hall,

the broadening of diffraction lines is due to the contribution of crystallite size and strain of lattice. The crystallite strain is given by,

$$\varepsilon = \frac{\beta}{4\,tan\theta} \qquad \ldots\ldots (2)$$

Where ε is the micro-strain of the lattice, β is FWHM and θ is Bragg's angle.

Table–I: Estimated Crystallite Size (D) and Strain (ε) of Non- implanted and H^+ ion implanted graphene.

Sample/ Energy (keV)	Ion Fluence (ions cm^{-2})	2θ (degree)	β (degree)	D (nm)	Strain (ε)
Non-implanted	-	26.65	0.3731	22.85	0.3957
100	1×10^{14}	26.62	0.3811	22.38	0.4027
	1×10^{15}	26.44	0.2409	35.38	0.2564
200	1×10^{14}	26.52	0.2794	30.52	0.2964
	1×10^{15}	26.61	0.23782	35.87	0.2514

From the estimated values in Table-I, it is revealed that after increasing the energy and ion fluence of the samples, the crystallite size gradually increases and the Micro-strain induced on the lattice decreases.

B) 3D Laser Microscopy Studies:

Figure 3 (a) and (b) shows the 3D Laser microscopy images of H^+ ion implanted graphene at energy 100 keV for fluences 1×10^{14} and 1×10^{15} ions cm^{-2}, where the irregular defect formation observed. However, Figure 3 (c) and (d) shows 3D Laser microscopy images of H^+ ion implanted graphene at energy 200 keV for ion fluences 1×10^{14} and 1×10^{15} ions cm^{-2}, where the irregular defect formation observed with more flaws.

These images shows that the formation of varying irregular defects on the surface of implanted graphene samples. From Figure 3 (a) – (d) it is observed that the formation of defects like irregular cuts on the surface which has heights and depths found to be increased. These defects created are due to the energy impact of H^+ ions on the graphene surface [10-12].

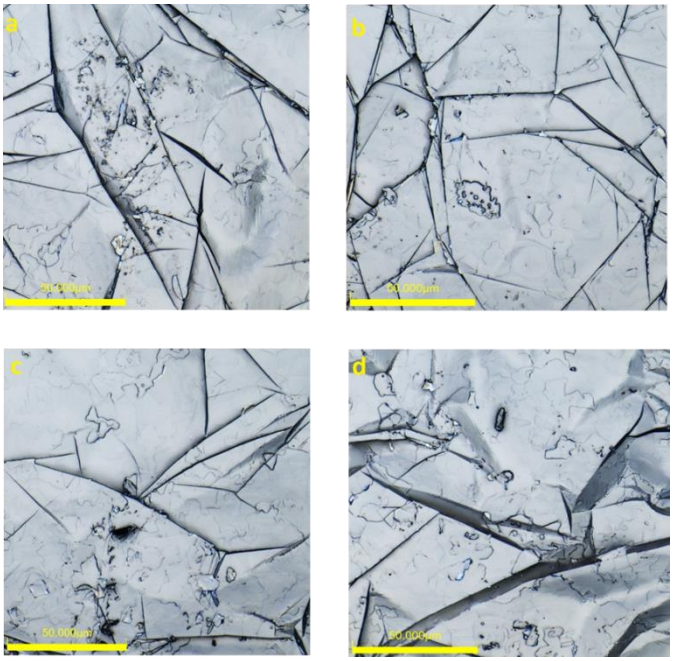

Figure 3: 3D Laser Microscopy images of implanted graphene; at energy 100 keV for (a) 1×10^{14} ions cm^{-2}, (b) 1×10^{15} ions cm^{-2}; and at 200 keV for (c) 1×10^{14} ions cm^{-2}, (d) 1×10^{15} ions cm^{-2}.

IV. CONCLUSION

Graphene samples were synthesized at different energies and fluences using ion implantation methodology. The structural and morphological study of non-implanted and H^+ implanted graphene samples were carried out using X-Ray Diffraction and 3D Laser Microscopy techniques. XRD analysis study showed decrease in FWHM. It is also observed that an increase in crystallite size and decreasing strain in the samples. 3D Laser Microscopic study showed the formation of random varying flaws on the surface of sample.

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Review of Smart Material Led Innovations-Transforming Life

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ABSTRACT

Over the past few decades lifestyle of the global population has witnessed a radical positive transformation, improvising lifestyle and satiating the happiness quotient of individuals. Mankind has seen magic being created in various aspects of their lives, to speak of a few drugs specifically released into the bloodstream smart buildings that intelligently react to geographical crisis like earthquakes, mobile phone screens that repair themselves, Prosthetics articulately designed to mimic a human organ at a specific activity level to name a few. All these and much more have been a contribution of the development of smart materials from various interdisciplinary streams of research. The contribution of smart materials augmenting the lifestyle of humanity is unfathomable and interminably moving ahead towards a more glorious future. Peer research groups who conducted studies on the various concepts, about the structural and functional aspects of this fascinating class of materials, substantiated through their relevant and consistent research work and discoveries that smart materials will continue to see newer members being added to the already available array of materials extending benefits to various dimensions of life. This paper reviews materials largely polymers which have transformed the lives of mankind extending multiple benefits and transforming lives.

Keywords: Polymers, Biocompatible, Smart materials, Stimuli-responsive polymers, Prosthetics .

I. INTRODUCTION

Over the past few decades lifestyle of the global population has witnessed a radical positive transformation, improvising lifestyle and satiating the happiness quotient of individuals. Mankind has seen magic being created in various aspects of their lives, to speak of a few let us talk about drugs specifically released into the bloodstream at the first sign of infection, smart buildings that intelligently react to geographical crisis like earthquakes, mobile phone screens that repair themselves, Prosthetics articulately designed to mimic a human organ at a specific activity level to name a few. All these and much more have been a contribution of the development of smart materials from various interdisciplinary streams of research. The contribution of smart materials augmenting the lifestyle of humanity is unfathomable and interminably moving ahead towards a more glorious future. Smart materials have occupied the spotlight in the research of material science extending conglomerated benefits leveraging outstanding industrial applications. Peer research groups who conducted studies on the various concepts, about the structural and functional aspects of this fascinating

class of materials, substantiated through their relevant and consistent research work and discoveries that smart materials will continue to see newer members being added to the already available array of materials extending benefits to various dimensions of life.

II. BACKGROUND

Material science led innovations have dated back in history. The much talked about concept of this brilliant class of smart materials may have recently come to limelight, but the history of these materials themselves go back a long way. Piezoelectrics, a member of this group, produces electrical signals when squeezed; the Curie brothers discovered the piezoelectricity of minerals like this as early as 1880. Some natural minerals are piezoelectric, such as quartz. In the late 1940s a robust piezoelectric ceramic material called barium titanate was discovered, and it became used as a sensor for mechanical vibrations in sonar devices, today the use of lead zirconate titanate, abbreviated as PZT is quite prevalent.

Smart materials can be defined as a class of materials that exhibit a strong, repeatable change in physical properties in response to changing external conditions.1 A recent work reported Smart materials (SMAs) as the materials that change their behavior in systematic manner as a response to specific stimulus which could alter in magnetic or/and electric fields, stress, acoustic, temperature, nuclear radiation, or/and chemical properties 2 . Earlier smart materials had been articulately defined well as “intelligent materials and structures super ceding the recently defined variable-geometry trusses and shape memory alloy-reinforced composites; the substances envisioned will be able to autonomously evaluate emergent environmental conditions and adapt to them, and even change their operational objectives 3. Polymers are macromolecules made up of many repeating units bonded by covalent bonds. The smallest repeating unit of a polymer is called a monomer. Polymers have established outstanding material benefits like excellent mechanical strength, resilience, corrosion resistance, insulating property, color, transparency and low cost. Polymers by virtue of being available in great variations, have multitudes of members, macromolecular, versatile properties and much more, they have been able to match the expectations for maximum manufacturing practices. Smart polymers or stimuli-responsive polymers or functional polymers are high-performance polymers that change according to the environment they are in. These Responsive materials and systems are today widely used to develop unprecedented smart devices, sensors, or actuators; due to the ability to respond to environmental stimuli with a detectable reaction.A very recent study4 overviews comprehensively the main features and modeling aspects of smart polymers. They established that, the quantitative mechanical description of active materials plays a key role in their development and use, enabling the design of advanced devices as well as to engineer the materials' microstructure according to the desired functionality

III. SMART POLYMERS: MIRACLE MEDICAL AIDS

Smart polymers are an integral member of the smart material conglomerate which has extended multiple benefits to various segments of technology. Smart polymers which are stimuli-responsive polymers or

functional polymers that change according to the environment they are in. Such materials can be sensitive to a number of factors, such as temperature, humidity, pH, chemical compounds, the wavelength or intensity of light or an electrical or magnetic field and can respond in various ways, like altering colour or transparency, becoming conductive or permeable to water or changing shape (shape memory polymers). Usually, slight changes in the environment are sufficient to induce large changes in the polymer's properties 5,6,7.

In the field of medicine and surgery the polymers haven proven lifesavers and have extended benefits par excellence. Apart from precise release medication the 3 & 4 dimensional organ printing which is being largely explored is skyrocketing. In this scenario where multidisciplinary research is the buzz, the futuristic technology of multi-dimensional printing that is Three-dimensional (3D) and Four-dimensional (4D) printing is largely emerging as the next generation of innovativion and technology, which is integrating various research areas, like Chemistry Bioinformatics, Life sciences, CAD, and materials science. This concept initiated in the 80's and on further innovation progressed to full fledged bio-printing. The concept was pursued considering the benefit of technology for the human race. 3D technology enables the fabrication of high precision complex forms with the help of layer-by-layer addition of various materials, resulting in elements which can change shape or color, become electrically active, human tissue mimetic, or perform multiple functions. 3D printing or additive manufacturing (AM) is a process for obtaining a 3D object of any shape from a 3D model or other electronic data sources through additive processes in which successive layers of material are laid down under computer controls. 8 This technology of 3D and 4D printing has successfully paved the way for the production of dynamic multidimensional structures, intricate enough to mimic live tissues or organs. 3D bioprinting technology uses printing to combine various bio materials to fabricate biomedical parts that can copy tissue characteristics. 3Dimensional bio-printing is layer-by-layer deposition of bioinks to form structures which have been used successfully in the field of tissue engineering. This is done with the help of bioinformatics for exact precision to form scaffolds of live tissue, for constructing patient specific scaffolds for various applications in tissue engineering. If the scientific imagination is made to explore the research in this futuristic technology, and the benefits it could extend to mankind, we might as well infer that in the near future we could reduce the mortality and morbidity rates multifold. To be precise organ banks would no longer have to wait for donors, the unending wait by organ failure patients, often resulting in untimely death before transplantation, Smart polymers, also referred to as stimuli-responsive polymers or intelligent materials, have found usage in specialized items, which include sensors and actuators like artificial muscles; production of hydrogels used in 3 and 4 D printing; biodegradable packaging; and in biomedical engineering. A recent study discusses this miracle class of stimuli-responsive polymers that can respond to external stimuli are of great interest in medicine, especially as controlled drug release vehicles. This study discusses the types of stimulus response used in therapeutic applications and the main classes of responsive materials developed to date 9. For an expansive coverage on smart materials an encyclopedia provides a comprehensive discussion of the entire field of intelligent materials 10. It also includes discussions on theory, fabrication, processing, applications, and uses of these unique materials with references from the world's experts in this field--including scientists, educators and engineers.

A colossal chunk of the human population worldwide experience deformation due to diseases like cancers, congenital defects, or accidental trauma, leading to significant psychological, social, and economic deprivation of some sort. Prosthetics aim to reduce their anguish by restoring function and aesthetics using synthetic materials that mimic the characteristics of human tissue. Remarkable progress has been made in the field of Prosthetics. In fact these novel inventions have made life easier for the huge global population using prosthetics. A text book on Advanced Materials Polymers have contributed to these inventions to the maximum due to their inherent biocompatible characteristics 11 . Besides Prosthetics the Polymers have played an integral role in the progress of drug delivery technology especially controlled release of therapeutic agents in doses over long periods, cyclic dosage, and tunable release of both hydrophilic and hydrophobic drugs. A study has successfully reviewed the origins and applications of stimuli-responsive polymer systems and polymer therapeutics mainly polymer-protein and polymer-drug conjugates 12. The recent developments in polymers competent of molecular recognition or directing intracellular delivery were surveyed to depict areas of research advancing the frontiers of drug delivery. Advanced Drug delivery systems which mean approaches used to deliver drugs at the target sites inside our body, uses the biomaterials for this purpose. This technology uses materials, like lipitor polymer-based nanoparticles that can effectively release drugs at a controlled rate at the targeted location in the body, for specific action. Various types of formulations, approaches, technologies and systems are used to transport a drug to a specific part of the body. The concept of drug delivery is precisely integrated with the dosage of a drug and route of administration. The anticancer drug Doxorubicin induces certain usage limiting side effects. A certain study discusses the pros and cons of these drug delivery systems 13. Further studies have been conducted to devise a drug delivery using certain liposomes, hydrogel and nanoparticulate systems, which could eliminate the side effects, this brings a new ray of hope to anti-cancer patients for Drug Delivery Systems

IV. BIOCOMPATIBLE POLYMERS- TRANSFORMING LIVES

How the common man's lifestyle has drastically changed as a result of the usage of bio-compatible materials needs little to be explained. Apart from just affecting the rate of mortality and morbidity, the usage of these in biomedical applications have been a reason for great awe for the common man, or even the intellectual cluster of society untouched by developments in this field. Our cardiovascular system, which is supposedly one of those systems which is equally complex and vital, parallelly to our Central Nervous System, has been a huge beneficiary to the invention of biomaterials. In the cardiovascular system which comprises the heart and the blood vessels meant to be circulating blood to all our body parts, certain structural or functional problems can spurt up at any point, posing a serious life threat for the individual. This often relates to the heart valves and arteries, both of which can be thrivingly treated with implants. Arteries, particularly the coronary arteries and the vessels of the lower limbs which are the most affected by the process of atherosclerosis which means the blockage of the blood vessels due to fatty deposits can be best replaced by vascular prostheses with polymer material 14.Conclusively it can be summed up that these have dramatically

impacted the mortality and morbidity rates and hence have largely affected the lifestyle of mankind for the better.

V. SMART POLYMERS IN THE FIELD OF CONSTRUCTION

Polymers have been an integral part of the construction field since time immemorial, from timber, wood, rubbers to composites of various nature polymers have extended various material benefits to the construction industry. Off late Self-sensing composites are attracting the attention of civil engineers, their applications to improve the safety and performance of structures is extensive. These smart composites show a detectable change in their electrical resistivity with applied stress or strain and this unique characteristic makes them useful for health monitoring of structures. Till date, different forms of carbon composites, i.e. short fibre, continuous fibre, particles, nano fibres, nanotubes, etc. have been utilized for this purpose. In this context, a recent paper reports an overview of different self-sensing composite systems used for the health monitoring of civil engineering structures 15. A new type of smart basalt fiber-reinforced polymer bars as both reinforcements and sensors for civil engineering application has been discussed in a study which has potential applications for long-term structural health monitoring (SHM) as embedded sensors as well as strengthening and upgrading structures 16. Moreover the coefficient of thermal expansion for smart BFRP bars is similar to the value for concrete. Concrete is the major building material used in the construction industry but it is vulnerable and has a tendency to collapse when it comes in contact with environmental stimuli such as water, wind, stress and pressure. A new type of smart concrete contains dormant bacteria and when they come into contact with stimuli like water, they create limestone, filling up the cracks and thus creating a self-healing repair mechanism. The coatings, made with polymers internally react with one another when ruptured, thus creating a self-healing mechanism 17.

VI. CONCLUSION

Continued research by various scientific communities across the globe are consistently proving that various smart material led innovations are adding newer beneficial dimensions and facilitating the lifestyle of mankind. The subject is vast and much more work is required in this field to have a substantial say. But then it goes without saying that the contribution of materials such as certain polymers which have versatility beyond compare, are now centerstage of research. These inventions augmenting the lifestyle of humanity is unfathomable and hence constantly moving ahead towards a brighter tomorrow.

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Super Capacitive Behaviour of Manganese Dioxide (MnO_2) Thin-Film Prepared By Electrode Position Technique and Characterization

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ABSTRACT

The work deals with fabrication of Manganese Dioxide (MnO_2) Thin-Film prepared by electrodeposition technique on stainless steel (AISI304) substrate. In order to enhance the super-capacitive properties of the electrodes, we have deposited a thin layer of MnO_2 by electrodeposition method by adopting potentiostatic technique from an aqueous manganese sulphate monohydrated ($MnSO_4.H_20$). We studied the effect of thickness on the electrochemical properties of the samples between 600 Sec, 750 Sec, 1050 Sec, and 1200 sec. Best performance for supercapacitor applications was obtained after annealing at 150 °C with a specific capacitance of 136 F g–1 at 10mV s–1 at 1200 sec. Surface morphology have characterized using Scanning Electron microscope (SEM) for 600 Sec, 750 Sec, 1050 Sec, and 1200 sec. The electrochemical characterization have studied with the help of Cyclic Voltammogram from which maximum value of specific capacitance was estimated to be $136Fg^{-1}$. In this paper super capacitive behavior has been studied using galvanostatics charging discharging technique.

Keywords: Electrochemical Properties, Cyclic Voltammogram and Thermal Annealing

I. INTRODUCTION

Electrochemical capacitors [1] are very interesting as charge storage devices for electrical energy due to their ability to deliver high power and survive high cycle counts. The range of potential practical applications extends from cell phones and other types of personal electronics to hybrid vehicles. The application in hybrid vehicles is particularly interesting because successful development of cost effective charge storage could have a beneficial impact on oil consumption Patterns and help to mitigate their contribution to climate change. In a broader sense, any application where load levelling of electrical power or rapid charge/discharge is needed could be addressed by electrochemical capacitors.The supercapacitors consists of highly porous material with very high specific surface area, or electroactive materials with several oxidation within the potential window of solventdecomposition. On the basis of electric charge storage mechanism, energy stored in SCsis either electric double layer (EDLC) or pseudo capacitive in nature. The EDLC (non-Faradaic) process is based on charge separation at the electrode/electrolyte interface, which is mainly focused on carbon based materials [3]. The pseudo capacitive (Faradaic) process relies on redox reactions that occur in the electrode materials and

ions in theappropriate potential window [4]. The major classes of materials applied for SCs includevarious forms of carbon, transition metal oxides, and conductive polymers [5].

Transition metal oxides received considerable attention in the area of electrochemistrynot only due to their beneficial reported structural, morphological, mechanical orelectronic properties, but because of their capacitive properties ascribed to theirmultiple oxidation states. They exhibit pseudocapacitances which carbon counterpartsgenerally cannot. Amongst various transition metal oxide electrode materials, such asRuOx [6], NiOx [7], Co3O4 [8] and IrOx [9], MnO_2, has high specific capacitance, highenergy density, wide charge/discharge potential range [10, 11] with low toxicity,abundance, environmentally friendly nature, and high theoretical specific capacitance(~1370 F g–1) [12-15] have attracted significant interest as active electrode materialsfor SCs. Supercapacitors based on MnO_2 as active electrode materials are currently attracting a lot of interest due to the relatively low cost, low toxicity, excellent electrochemical performance, environmentally friendly character in comparison with other transition metal oxides [4]. Up to now,manyMnO_2 with various structures and morphologies have been fabricated via electrochemical and chemical routes, and their electrochemical properties have been investigated.Chemical methods are very much suitable for synthesis of materials than the physical methods since they have good control on the thickness and grain size. Chemical methods have their own advantages such as simplicity, reproducibility, non-hazardous, cost effectiveness, etc. Among different chemical methods electrodeposition is economical and suitable for large-scale applications. We know that, there are three different ways (i.e. varying electric field, constant voltage and constant current) by which we can apply the electric field in electrodeposition method. These three different types of applied electric fields significantly affect the surface morphology, crystal structure and hence the supercapacitive properties of deposited material. It is well-known that the performance is highly dependent on MnO_2morphologies as well ascrystallographic forms [5].

D.P. Dubal[5] have reported supercapacitance of 184 F g–1 for hydrous MnO2 synthesized by potentiostatic method. Pravin R. Jadhav[14] have reported supercapacitance of 392 F.g-1 for hydrous MnO2 synthesized by potentiodynamic electrodeposition method J.N. Broughton ∗, M.J. Brett have reported supercapacitance of 100 F g–1 for MnO_2 synthesized by galvanostatics method. Chang and Tsai [6] have reported supercapacitance of 240 F g–1 for hydrous MnO2 synthesized by potentiostatic method. MnO2 multilayer nanosheets were prepared by galvanostatic mode by Feng et al. [7] and reported supercapacitance of 521 F g–1.

The goal of present investigation is the preparationof MnO_2 thin films using, Potentiostatic mode at variousdeposition time. The effects of variation of time on structural, morphological and supercapacitive properties of MnO_2 thin films have been investigated. Additionally charge–discharge of MnO_2 thin films have been studied in 1MNa_2SO_4electrolyte.

II. EXPERIMENTAL DETAILS

MnO_2 thin film was prepared by AR grade chemicals. The bath consisted of an aqueous solution of 0.1M manganese sulphate ($MnSO_4.H_2O$) (molychem, A.R. Grade), pH of the solution is adjusted to ~6.5 by adding

KOH. The MnO_2 films are deposited onto the stainless steel (SS) for 600, 750, 900, 1050, 1200 sec by Potentiostatic mode. Before deposition, stainless steel was polished with zero grade polish paper and washed with soft detergent, rinsedstainless steel in acetone, ethanol and etch in HNO_3 then ultrasonically cleaned with distilled water. A potentiostatic electrodeposition of MnO_2 was carried out in a three electrode electrochemical cell with conventional three-electrode arrangement comprising stainless steel thin film as a working electrode, graphite as counter electrode and saturated calomel electrode (SCE) as reference electrode. The electrodeposition was carried out by applying 0.95 V dc voltages in at room temperature. After deposition all sample annealed at temperature 150^0C.

The structural characterization was carried out using X-ray diffraction on computer controlled Philips PW-3710 using CrK_radiations. The surface morphologies were carried out using SEM (scanning electron microscopy). The super capacitor studies were carried out Metrohm autolab PGSTAT 204, forming an electrochemical cell comprising MnO_2 film as a working electrode, graphite as a counter electrode and SCE as a reference electrode in 1M Na_2SO_4 electrolyte. Charge–discharge study was carried out using Metrohm PGSTAT 204.

III. RESULTS AND DISCUSSION

3.1 XRD:-XRD pattern of MnO2 which is shown in fig.1. no distinct diffraction peak other than SS substrate is observed in XRD pattern, which means that the film consisted of MnO_2 colloidal particles in amorphous phase. The peak obtained due to steel are indexed by the triangles. Amorphous phase of the oxide material is feasible for supercapacitor application due to easy penetration of ion through the bulk of the active material.

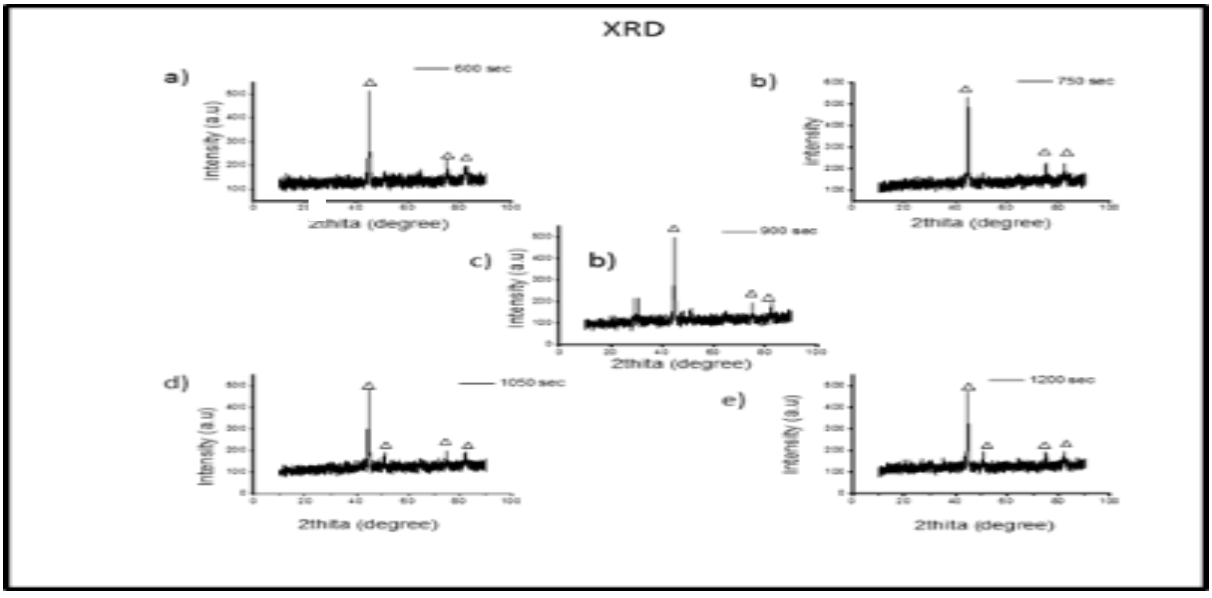

Fig 1: XRD pattern of MnO2 : a) for 600 sec b) for 750 sec c) for 900 sec d) for 1050 sec e) for 1200 sec

3.2. Raman Spectra: - Raman spectra of MnO_2 which is shown in fig 2. Ramanspectroscopy is very useful to confirm the structure and phase of prepared samples, as it is very sensitive to local structure of material [16]. The variation of the Raman bandWavenumbers as a function of *Pr* for the pyrolusite intergrowth in γ-MnO_2. The peaks in the wavenumber range 500–700 cm^{-1} are considered as the characteristic features of γ-MnO_2[456]. In fig2. The sharp peaks at 650,628,654,652,637$cm^{-1}$are attributed to streching mode of Mn-O bond in the [MnO_6] octahedral units.

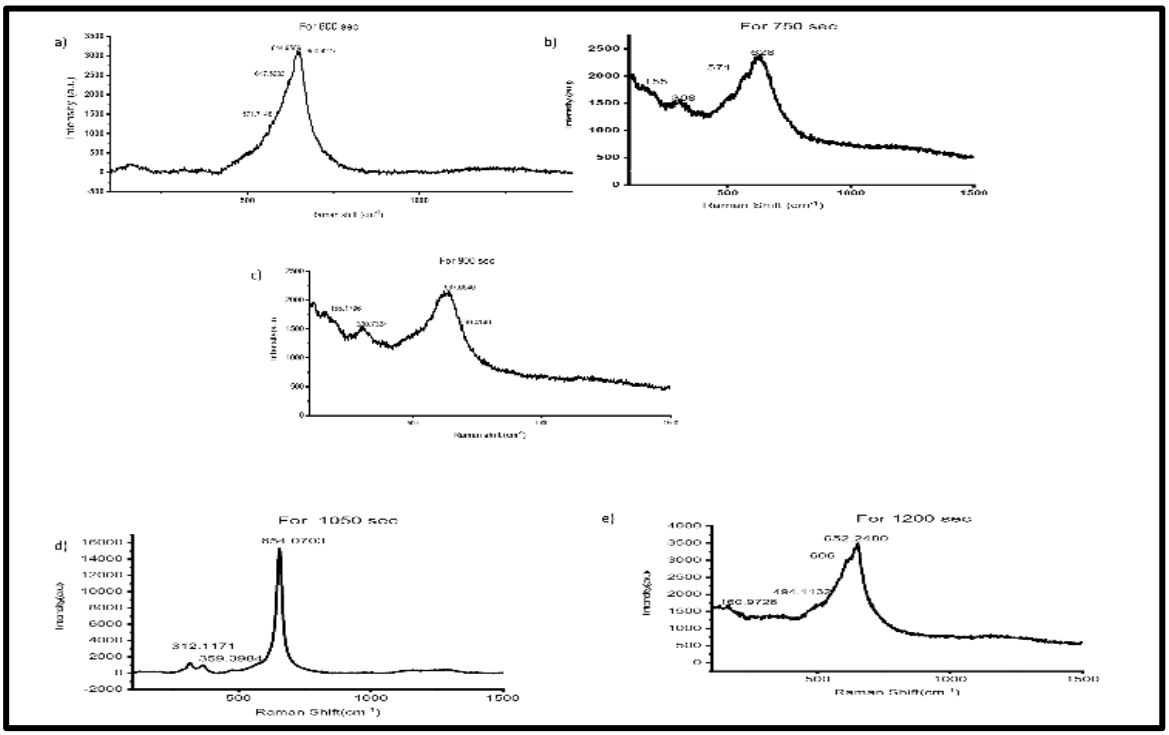

Fig 2: Raman Spectra of MnO2 for 600 sec,750 sec,900 sec,1050 sec,1200sec

3.3. FTIR Analysis:-The FTIR transmittance spectrum of the powder collected from MnO_2 thin film in the range 450-4000 cm^{-1} is shown in fig.3 spectra consist of four measure peak,the peak at 3481 cm^{-1},3426 cm^{-1} are obtain due to stretching of water molecule or hydroxyl group . The peak at 1641cm^{-1} can attribute bending of water molecule or hydroxyl group,585 cm^{-1} peak can attribute to Mn-O vibration in MnO6 octahedral structure so it confirms presence of gamma MnO_2.

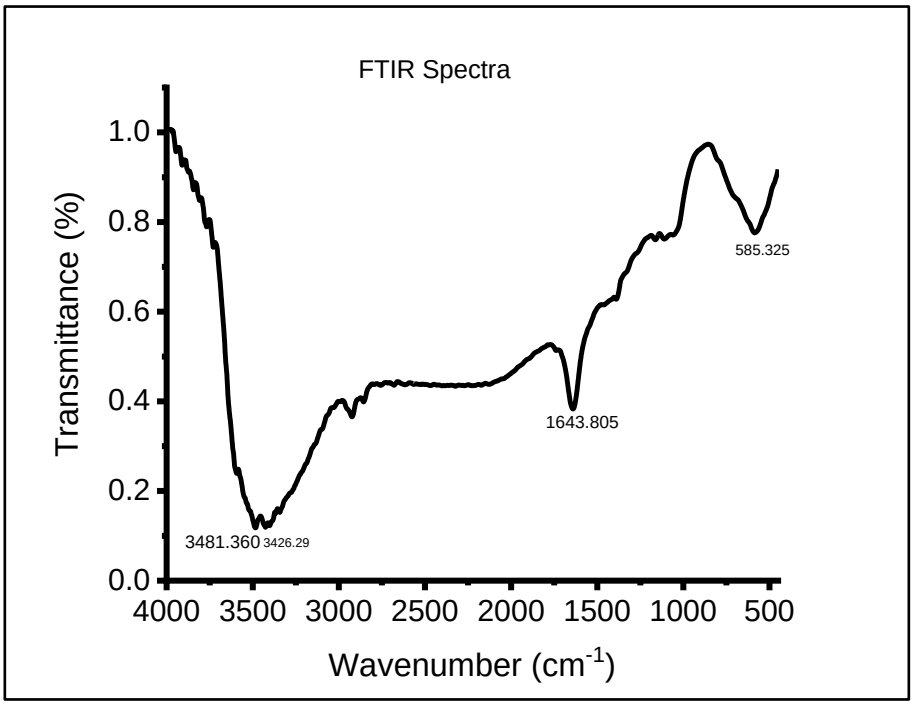

Fig 3: FTIR Spectra of MnO2

3.4. Surface Morphology: Scanning Electron Microscope:-fig 4 (a-e) show the surface morphology of 600 sec750 sec 900 sec 1050 sec 1200 sec samples.SEM image shows that nano particle nature of MnO_2, it's a compact structure and average size of nanoparticles for 1200 sec is 72 nm.

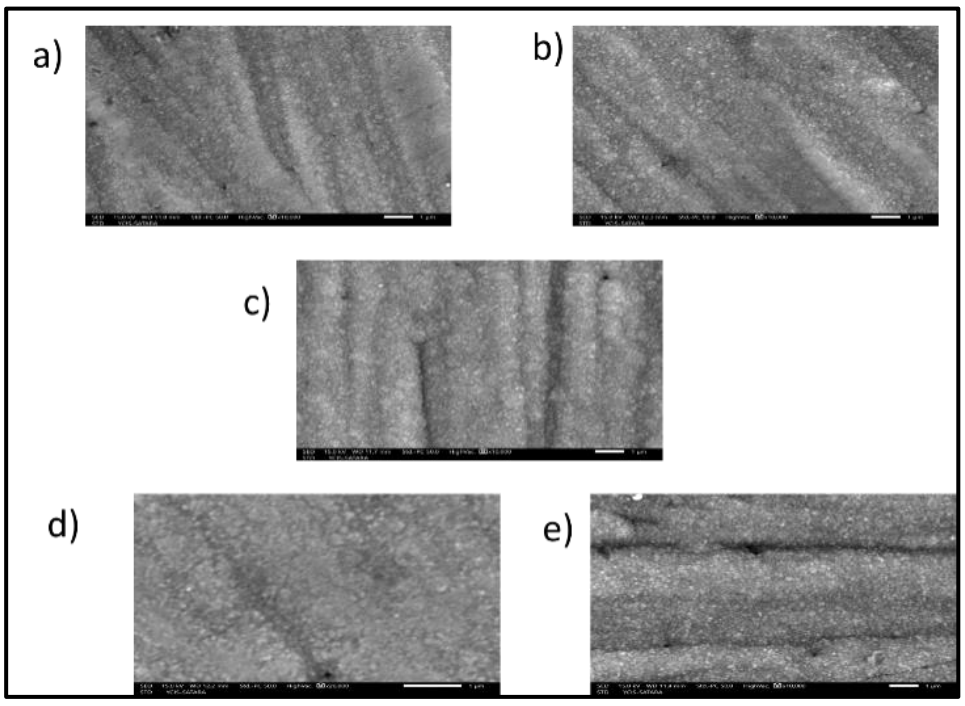

Fig 4: SEM image of MnO_2 a) for 600 sec b) for 750 sec c) for 900 sec d) for 1050 sec e) for 1200 sec

3.5.Electrochemical studies:

3.5.1. Cyclic Voltammetry: - the electrochemical performance of MnO_2 was studied with the help of CV Technique. the CV of all MnO_2 samples were recorded in the potential window 0 to 1 V Vs. SCE in 1 M Na_2So_4 electrolyte using 10 mV/sec scan rate which is shown in following fig.6a.It is observed that the curves of all electrodes are quasi rectangular mirror images, which is the characteristic of an ideal pseudo capacitive behaviour. The specific capacitance were obtained from measuring area under the curve and calculated by

$$C_{sp} = \frac{\int I\, dv}{2mV}$$

Where $\int I\, dv$, is average charge deduced from CV, m is mass of active material which is deposited on working electrode and V is scan rate. The variation of specific capacitance is shown in table 1, from this table the specific capacitance using CV technique ,increases with increasing time and increasing surface area , the maximum capacitance is observed for 1200 sec(136F/g)due to the voltammetry current response of the coating, increased substantial with increase in deposition time from 600 s up to 1200s.

There are two mechanism proposed for the charge storage in MnO_2 based electrodes: First the intercalation of proton (H+) or alkali cations in to bulk of oxide particle upon reduction followed by the deintercalation upon oxidation [16].

$MnO_2 + M^+ + e^- \leftrightarrows MnooH$

Where M^+ represents the proton H^+ or alkali metal ion such as Na^+.Second it is based on the surface adsorption of electrolyte cataion (M^+) on MnO_2 [11].

$MnO_{2\,surface} + M^+ + e^- \leftrightarrows MnooH_{surface}$

Bothreaction mechanism involve a redox reaction between the III and IV oxidations state of Mn

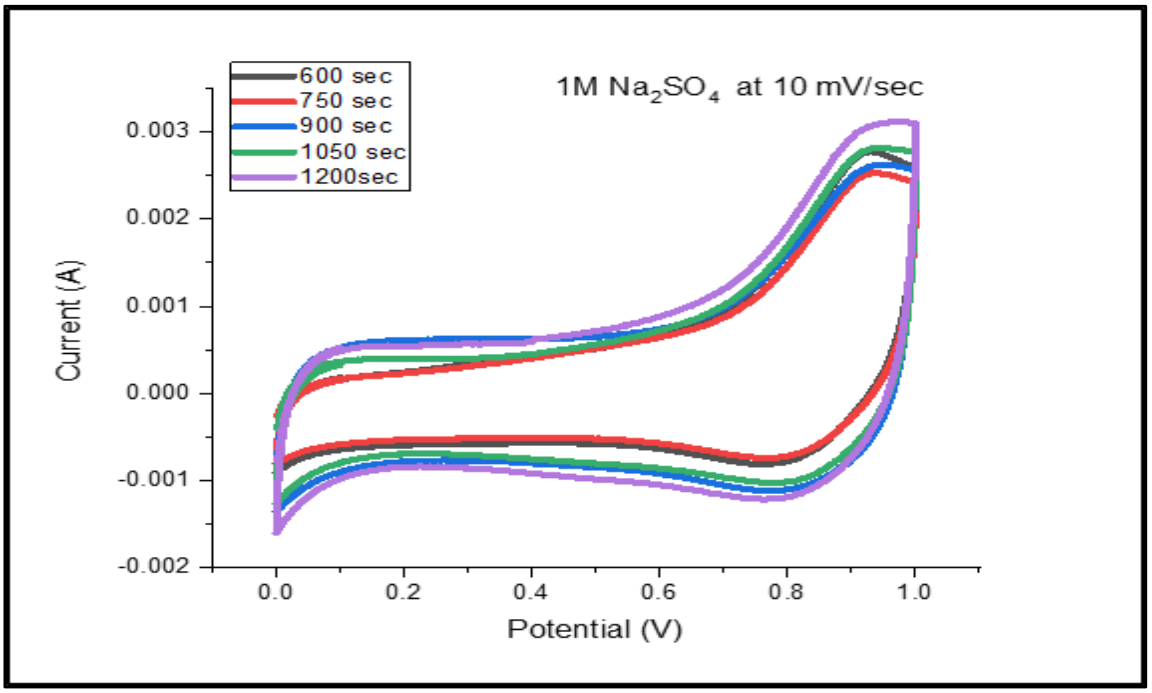

Fig (6a): Cyclic Voltammetry of MnO_2 for 600 sec,750 sec,900 sec,1050 sec,1200 sec in 1M Na_2 SO_4

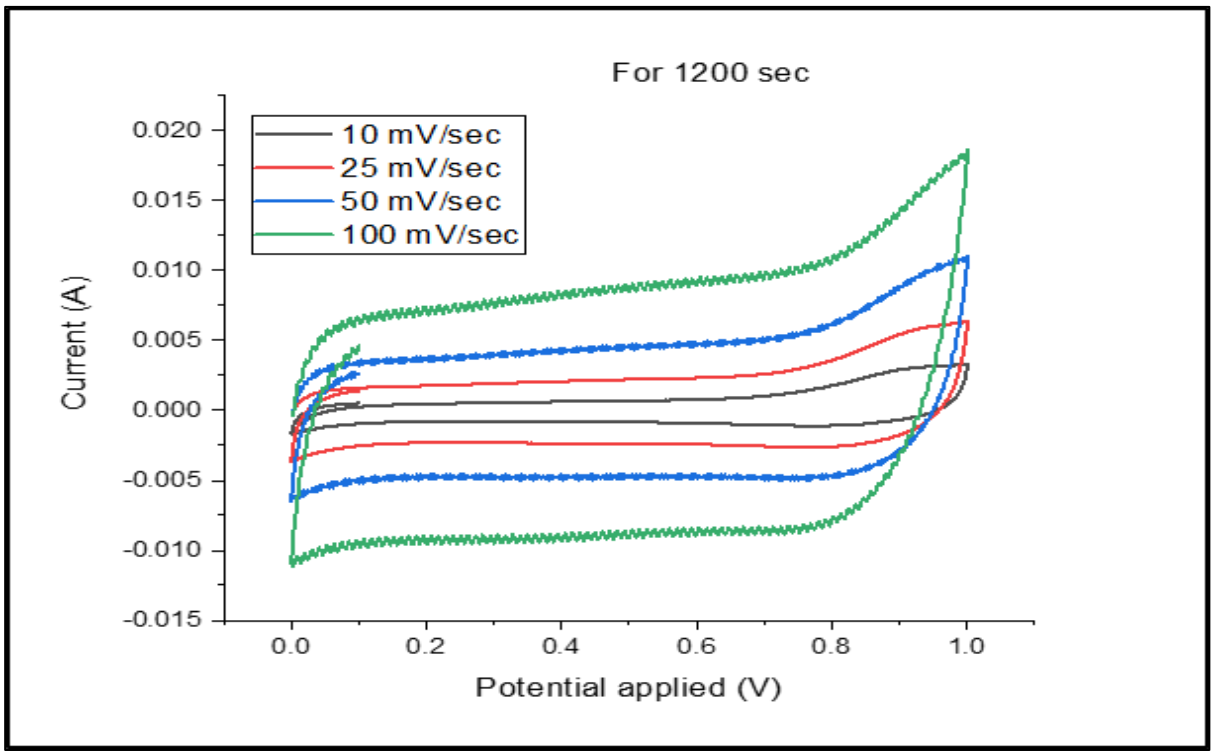

Fig. 6(b) Figure: Cyclic Voltammetry of MnO_2 at 1200 sec for scan rate 10mV/sec, 25mV/sec, 50 mV/sec, 100 mV/sec

Time (sec)	Specific Capacitance by CV (F/g)	Specific Capacitance by charging discharging curve (F/g)	Energy density (Wh/kg)	Power density (W/kg)
600	19.74103	15.6546	5.115604	373.121
750	20.14	17.65581	6.006163	424.203
900	30.84921	29.30936	9.530842	460.828
1050	35.80769	29.63243	9.420843	474.486
1200	136.1006	157.6359	51.26017	1825.92

Table 1:-for measurement of specific capacitance, energy density, power density

The effect of scan rate on the capacitance performance was studied by varying the scan rate from 10 to 100 mV/sec which is shown in fig .6b shows CV curves for all sample recorded at different scan rate. As the scan rate increases, area under the curve increases and the CV shape diverges from the ideal capacitive behaviour. At lower scan rates, the diffusion of Na^+ from the electrolyte can gain access to the almost all interior of the nanoparticles matrix, leading to a complete insertion reaction and hence a reduction process. At fast scan rates, Na^+ ions only reached the outer surface layer of the electrode and cannot utilize the interior pores of the nano particles matrix. So that, the effective interaction between the ions and the electrode is significantly reduced; thus the surface in the deep pores does not actively contribute to the capacitance, which reduces specific capacitance.

3.5.2. Galvonostatic charging discharging studies:

The good capacitive behaviour and low internal resistance areconfirmed by the galvonostatic charge-discharge experiment of MnO_2supercapacitor devices. The charge discharge curves recorded in potential ranges from 0 to 0.8 V at 1 mA current density. This charge discharge curve show small voltage drop at the start of discharge curve. Itis indicating small internal resistance between electrode and current collector.

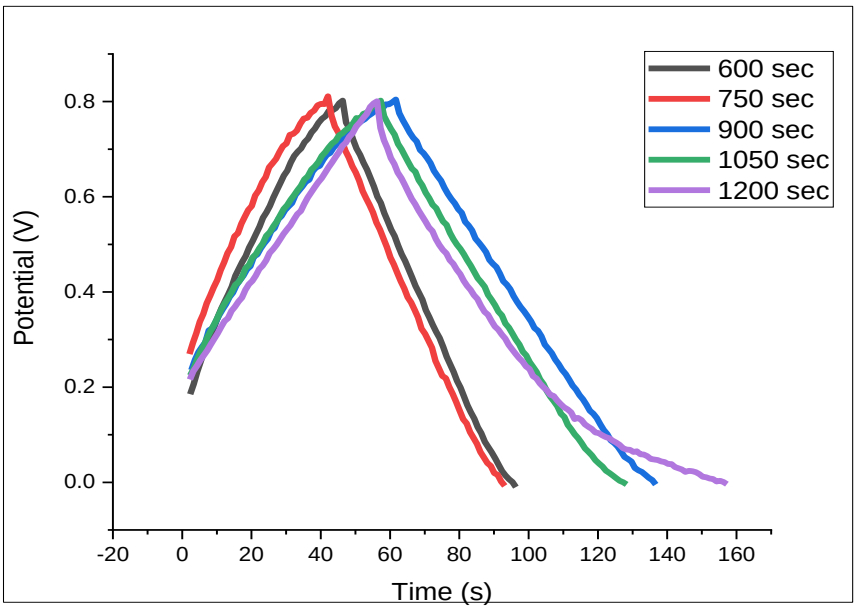

Fig. 7: Charging Discharging curve of MnO2 for 600 sec 750 sec 900 sec 1050 sec 1200 sec

The specific capacitance has been evaluated from charging discharging curve according to the following equation

$$C_{sp} = \frac{I}{m \times dv/dt}$$

Where I is applied current, m is mass of deposited material, dv/dt discharge time from slope of galvonostatic charge discharge curve, the maximum specific capacitance is 157.6359 F/g for 1200 sec at 1mA current density. The energy density of super capacitor can be calculated from following equation;

$$E = \frac{1}{2} C V^2$$

For MnO_2 electrode high energy density is 51. 26017 (wh/kg) and high power density is 1825.925 w/g which shows that excellent pseudocapacitve behavior.

IV. CONCLUSION

We have successfully preparedMnO_2 film by potentiostatic mode. XRD pattern of MnO_2 revealed the formation of amorphous phase. fromSEM one can see that surface morphology of MnO_2 films is nano particle ,the value of specific capacitance (136 F/gm),specific power(1825.925 w/kg) and energy density(51.26017 wh/kg) for 1200 sec MnO2 are greater than 600 sec,750 sec,900 sec,1050 sec MnO2 thin film.

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Synthesis and Characterization of Copper Oxide Nanoparticles

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ABSTRACT

Copper oxide nanoparticles are synthesized by aqueous precipitation method employed copper acetate as a starting materials and alkaline hydroxide solution as stabilizing agent for controlled synthesis. This reaction gives high scale yield of copper oxide nanoparticles easily. Characterization of X-ray diffraction design shows monoclinic structure. The transmission electron microscope reveals 5-6 nm size of synthesized copper oxide material. The scanning electron microscopic study reveals that rectangular morphology of synthesized materials.

Keywords: Copper oxide, Nanoparticles, Precipitation.

I. INTRODUCTION

Metal oxide nanoparticles was very challenging research work as different type of applications, it attract researcher to explore its properties. Transition metal oxides are an important class of semiconductor, their applications which have batteries, sensors[1], heat transfer fluid, nanofluid[2], energy storage system[3], solar energy transformation[4], catalysis and electronics[5]. The transition metal of oxides, copper oxide nanparticles are most interest because their efficiency as nanofluids in heat transfer application. Also the example shown or reported 4% addition of copper oxide increase the thermal conductivity of water by 20%[7]. Semiconducting compound as a copper oxide its band gap is narrow and used for photothermal and photoconductive applications[8]. The number of reporting methods on preparation and characterization of crystalline copper oxide are relatively other transition metal oxides like iron oxide, titanium oxide and zinc oxide. Recently reported some methods for the preparation of nanocrystalline copper oxide such as Sol-gel techniques[9], electrochemical methods[10], thermal decomposition of precursors[11]. Co-implementation of metal and oxygen ions[12] and so on.

In this research paper, we have synthesized copper oxide nanoparticles by aqueous precipitation method. The synthesized nanoparticles are analysed by X-ray diffraction, transmission electron microscope (TEM) and scanning electron microscope techniques (SEM).

II. METHODS AND MATERIAL

2.1 Chemicals:

All the chemicals used are AR grade. Double distilled water was used throughout the experiment.

2.2 Synthesis:

Copper acetate was dissolved in distilled water and 2.0 ml acetic acid was added. The solution was stirred well and heated at 900 °C. Cool the reaction mixture and then 0.7 gm NaOH was added. After addition of NaOH black precipitate was formed. The product was washed with hot water and dried.

2.3 Sample Analysis:

The X-ray diffraction of copper oxide sample was analysed by employing Philips P. W. 1710 diffractometer with 0.15405 nm Cu Kα radiation. SEM has been examined at different magnification using JEOL6390LV. Transmission Electron Microscope of Copper Oxide nanoparticle was investigated using E.M. –C.M.-12 (Philips) operating at 200 KeV.

III. RESULTS AND DISCUSSION

3.1 X-ray Diffraction Analysis

Copper oxide nanoparticle is characterized by X-ray Diffraction is shown in figure 1. The figure demonstrates that, it is a monoclinic structure with single phase. The value of Lattice parameters are a = 3.82 Å, b = 3.41 Å, c = 4.88 Å. The peak intensities and peak positions are in good agreement with the certified data. The crystallite size of copper oxide nanoparticles was obtained to be 10 nm employed Debye Scherrer formula.

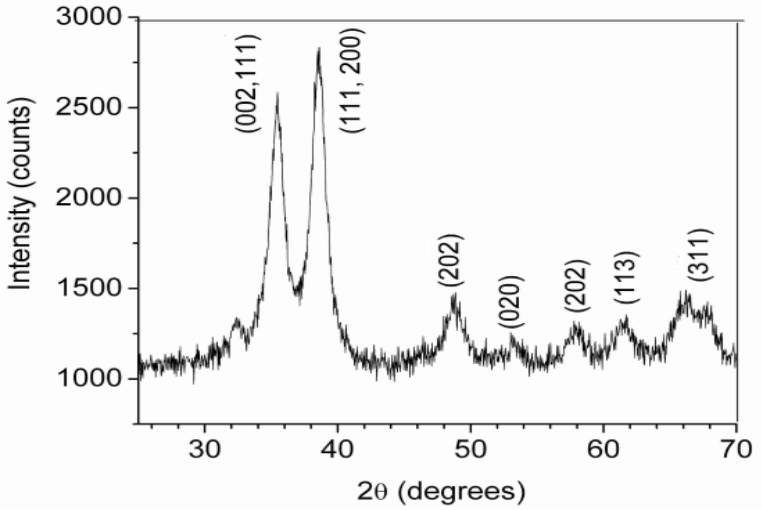

Fig. 1: X-ray diffraction of Copper Oxide Nanoparticles

3.2 Scanning Electron Microscopy study

The synthesized copper oxide was characterized by Scanning Electron Microscope. The image exhibits that synthesized copper oxide nanoparticle are rectangular in shape (Figure 2).

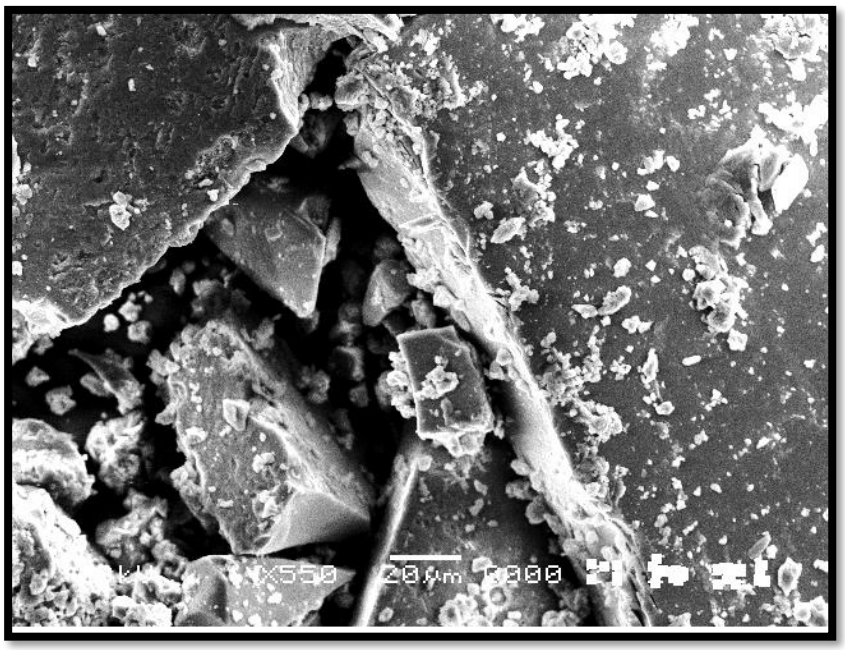

Figure 2: Scanning Electron Microscopy image of copper oxide nanoparticle

3.3 Transmission Electron Microscopy study

The prepared copper oxide nanoparticle was analysed with transmission electron microscope (Figure 3). The particle size of copper oxide nanoparticle was found to be 10 nm. The reported value is in good agreement with determined by Scherrer equation.

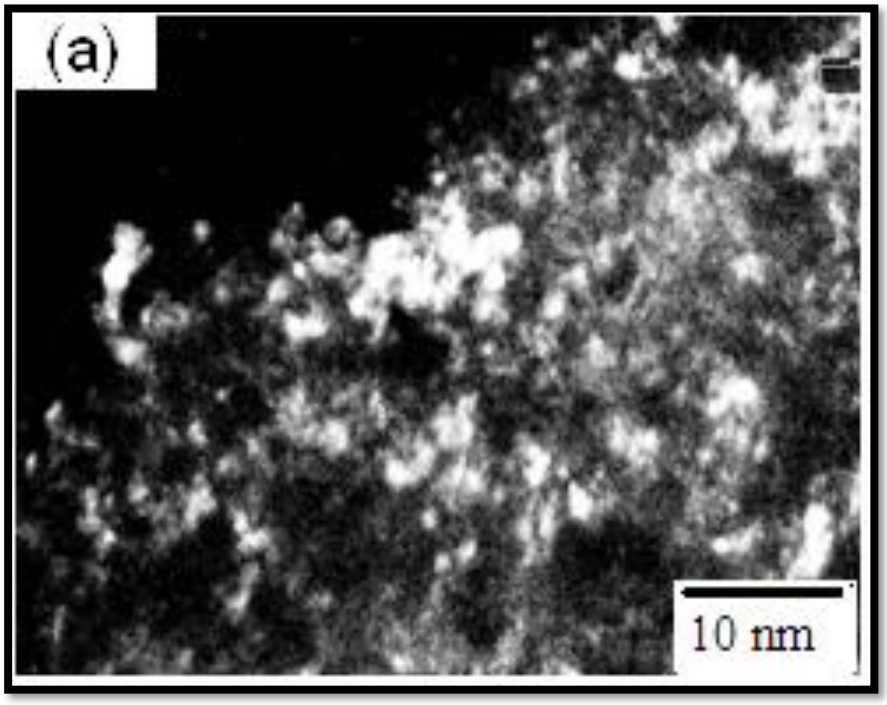

Figure 3: Transmission Electron Microscopy of Copper Oxide Nanoparticle

IV. CONCLUSION

We have successfully synthesized Copper oxide nanoparticles with monoclinic structure by aqueous precipitation method. Rectangular shape was observed in scanning electron microscopic study. The average particle size of copper oxide nanoparticle was found to be 10 nm.

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The Effect of Fly Ash, Saw Dust Ash on the Behavior of Black Cotton Soil

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ABSTRACT

The study is an attempt to analyze the effect of Saw Dust Ash and Fly Ash on Black Cotton soil, for improvement in compressive strength and swelling and shrinkage characteristics and increase its suitability for effective use in construction. The proportion for Addition of Saw Dust Ash and Fly Ash was taken as1%,2%,3%,4% and 5%. We used to proportion for addition of Saw Dust Ash and Fly ash taken as 1%,2%,3%,4%and 5%.

Keywords: Saw Dust Ash,Fly Ash And Black Cotton Soil

I. INTRODUCTION

We all know that the soil nature is an isotropic i.e. the properties of soil are not same at each location therefore to improve the properties of soil we add Saw dust ash and Fly Ash to the soil. Stabilization is one of the solutions. The Black Cotton soil possesses peculiar properties such as swelling and shrinkage. In monsoon, these soils absorb water and swell, whereas in summer they shrink due to evaporation of water. Due to such behavior of soil it is inappropriate to rely on the strength characteristics, different stabilizing materials are used in varying percentages, so that they can match the specifications of the construction industry. This study is an attempt to analyze the effect of Saw Dust Ash and Fly Ash on Black Cotton soil, for improvement in compressive strength and swelling and shrinkage characteristics and increase its suitability for effective use in construction. The proportion for Addition of Saw Dust Ash and Fly Ash was taken as1%,2%,3%,4% and 5%.We used to proportion for addition of Saw Dust Ash and Fly ash taken as 1%,2%,3%,4%and 5%.

The experimental investigation was carried out on soil as well as on Saw Dust Ash and Fly Ash contained soil by considering the varying percentage of Saw Dust Ash and Fly Ash. Liquid Limit (LL) decreases as the Saw Dust Ash and Fly Ash content increases up to 5%. Plastic Limit (PL) gradually increases up to 2% . MDD increases as the Saw Dust Ash and Fly Ash content increases up to 1%. Thereafter MDD decreases with increase in Saw Dust Ash and Fly Ash content. OMC decreases as the Saw Dust Ash and Fly Ash content increases upto 2%. decreases thereafter with increase in Saw Dust Ash and Fly Ash content.

The Unconfined Compressive Strength increases as the Saw Dust Ash and Fly Ash content increases up to 2% thereafter it decreases gradually with increase in Saw Dust Ash and Fly Ash content. The CBR value increases as the Saw Dust Ash and Fly Ash content increases up to 2% thereafter it decreases slightly with increase up to 5% Saw Dust Ash and Fly Ash content. For improvement in compressive strength and swelling and shrinkage characteristics and increase its suitability for effective use in construction. when used to this addition percentage of Saw Dust Ash and Fly Ash in Black Cotton Soil to observed the Compressive Strength have increased to used for soil Stabilization in Black Cotton Soil.When all tests are carried out in Black Cotton Soil with Saw Dust Ash And Fly Ash we observed that increased upto 2% have good strength to achieve compressive strength of Black Cotton Soil.

II. METHODS AND MATERIAL

We have to compare of properties of properties of soil without addition of fly ash and saw dust ash And properties of soil with addition of fly ash and saw dust ash.proportion for addition of fly ash and saw dust ash will be taken as 1%,2%,3%,4% and 5%.

- Saw Dust Ash
- Fly Ash
- Black Cotton Soil

The following tests were carried out on various soil samples with treated and untreated soil:

i. Atterberg's Limit Tests
- Liquid Limit
- Plastic Limit

ii. Standard proctor Test
iii. Unconfined Compression Test
iv. CBR Test

III. RESULTS AND DISCUSSION

1. Atterberg's Limit Test

- **Liquid Limit** For **Black cotton soil** is **20.33%**

The following table when adding percentage in Liquid Limit :

Fly ash and Saw dust (%)	Liquid limit(%)
1	17.34
2	30.44
3	37.57
4	34.55
5	63.07

Table no.1

Fig.1

Fig.1.1

Liquid Limit Test

- **Plastic Limit**

For Black cotton soil is 31.88%

The following table when adding percentage in Plastic Limit :

Fly ash and Saw dust (%)	Plastic limit(%)
1	30.47
2	37.57
3	41.70
4	58.90
5	75.47

Table no.1.1

Fig.1.2 Fig1.3

Plastic Limit Test

2. Standard proctor Test

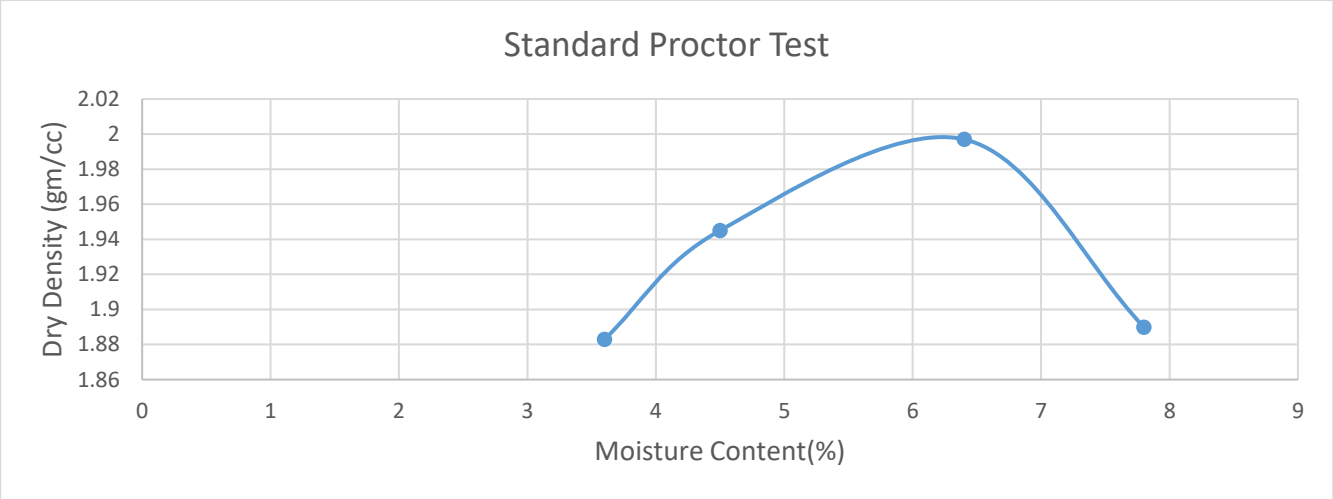
Fig.2

Black Cotton Soil for **MDD** is **2.9 gm/cc** and **OMC** is **7%**

The following table when adding percentage in Standard proctor Test :

Fly ash and Saw dust (%)	MDD(gm/cc)	OMC(%)
1	1.984	6.1
2	1.997	6.4
3	1.975	5.9
4	1.965	5.8
5	1.950	5.2

Table no. 2



Graph.1

The value of **MDD** and **OMC** for **2% fly ash** and **2% saw dust** were addition **1.997gm/cc** and **6.4%** respectively.

3. Unconfined Compression Test

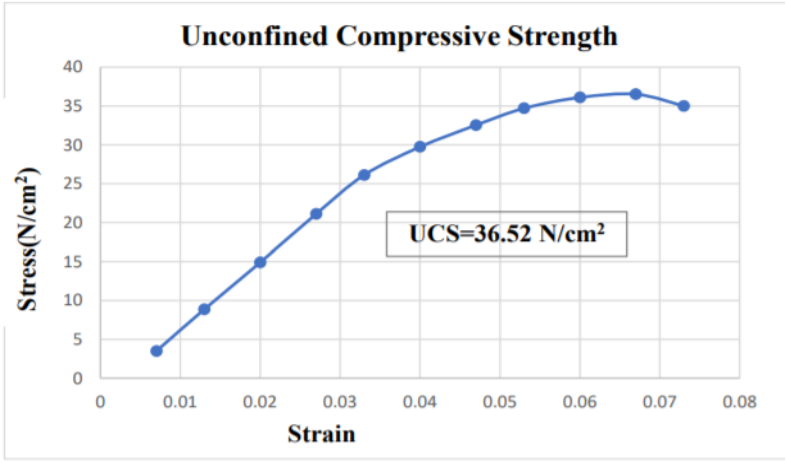
Fig.3

For **Black cotton soil** is **26.50 N/Cm2**

The following table when adding percentage in Unconfined Compression Test :

Fly Ash And Saw Dust (%)	UCS(N/cm2)
1	28.99
2	36.52
3	35.44
4	34.73
5	19.50

Table no.3



Graph.2

The Value of **Unconfined Compression Strength Curve** for **2% Fly Ash** and **2% Saw Dust** were addition **36.52N/Cm2.**

4.California Bearing Ratio Test

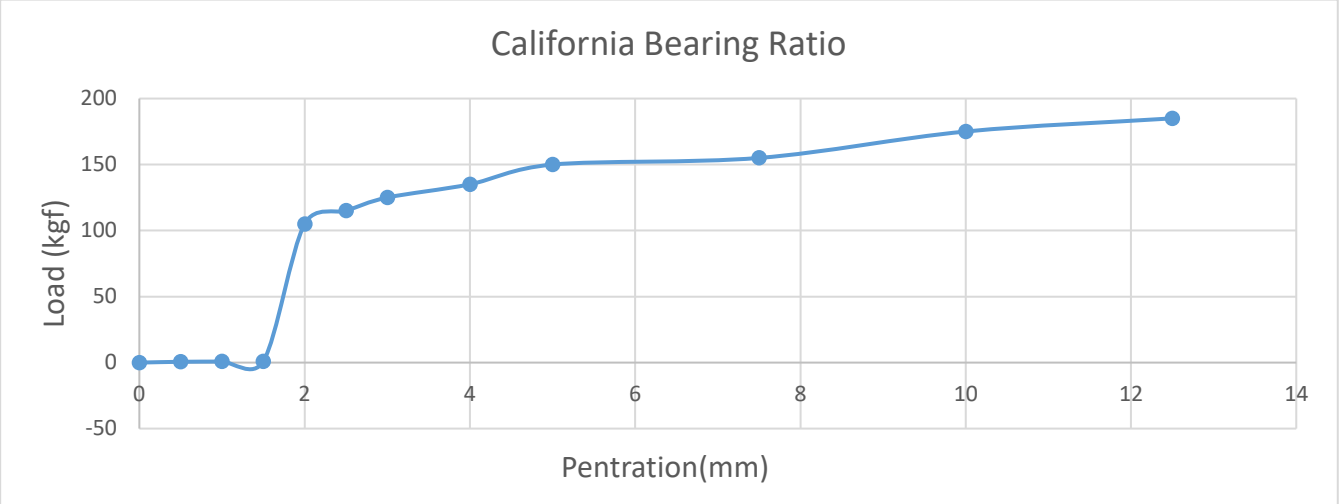
Fig.4

For **Black cotton soil** of **CBR** is **4.65%**

The following table when adding percentage in California Bearing Ratio Test :

Fly Ash And Saw Dust (%)	**CBR(%)**
1	5.12
2	7.97
3	2.08
4	7.68
5	8.67

Table no.4



Graph.4

CBR value for **black cotton soil** with **fly ash** & **saw dust** at **2%** is **7.97%**

IV. CONCLUSION

The experimental investigation was carried out on soil as well as on Saw Dust Ash and Fly Ash contained soil by considering the varying percentage of Saw Dust Ash and Fly Ash. Based on results of present study the following main conclusions are drawn.

1. Liquid Limit (LL) decreases as the Saw Dust Ash and Fly Ash content increases up to 5%.
2. Plastic Limit (PL) gradually increases up to 2% .
3. MDD increases as the Saw Dust Ash and Fly Ash content increases up to 1%. Thereafter MDD decreases with increase in Saw Dust Ash and Fly Ash content.
4. OMC decreases as the Saw Dust Ash and Fly Ash content increases upto 2%. decreases thereafter with increase in Saw Dust Ash and Fly Ash content.
5. The Unconfined Compressive Strength increases as the Saw Dust Ash and Fly Ash content increases up to 2% thereafter it decreases gradually with increase in Saw Dust Ash and Fly Ash content.

6. The CBR value increases as the Saw Dust Ash and Fly Ash content increases up to 2% thereafter it decreases slightly with increase up to 5% Saw Dust Ash and Fly Ash content.

For **improvement in compressive strength** and **swelling** and **shrinkage** characteristics and increase its suitability for effective use in construction. when used to this addition percentage of Saw Dust Ash and Fly Ash in Black Cotton Soil to observed the **Compressive Strength** have **increased** to used for **soil Stabilization in Black Cotton Soil.**

When all tests are carried out in **Black Cotton Soil** with **Saw Dust Ash** And **Fly Ash** we observed that **increased upto 2%** have good strength to **achieve compressive strength of Black Cotton Soil.**

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The Performance Study on Soil Stabilization by Using Different Additives

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ABSTRACT

Expansive soils are often found in most of the parts of India. Black cotton soil is one of the types of expansive soil. Expansive soils possess the tendency of swelling and shrinkage with the variation in moisture content. Due to these soils are not good for construction. To avoid these failures in engineering field soil must be stabilized to achieve soil properties.

Soil stabilization is a process which improves the physical properties of soil, such as increasing shear strength, bearing capacity etc. which can be done by use of controlled compaction or addition of suitable admixtures. In the present study, an experimental program was conducted for stabilization of Black Cotton Soils in the region Pune.

In this study, black cotton soil will be stabilized using waste material on the parameters like economy and strength. This study provides the laboratory investigation such as Atterberg's limit, Compaction Test, Swell Index, CBR, and UCS Test were carried out. These tests were conducted on different proportions of reinforced soil until optimized proportion is arrived.

Keywords: Expansive soil, soil stabilization, polypropylene fiber, fly ash

I. INTRODUCTION

For any land-based structure, the foundation is very important. It has to be strong to support the entire structure. In order for the foundation to be strong, the soil around it plays a very critical role. The roads laid on BC soil bases develop undulations at the road surface due to loss of strength. The process of soil stabilization helps to achieve the required properties in a soil needed for the construction work.

Soil stabilization includes various methods used for modifying the properties of soil to enhance its engineering performance. By stabilization the major properties of soil, i.e., volume, stability, strength, compressibility, permeability, durability and dust control is improved. It makes the soil suitable for use. There are different methods of stabilization, which include physical, chemical and polymer methods of stabilization. Physical methods involve physical processes to improve soil properties.

Chemical soil stabilization uses chemicals and emulsions as compaction aids. It also uses water repellents and binders. The most effective chemical soil stabilization is one which results in non-water-soluble and hard soil matrix.

Polymer methods of stabilization have a number of significant advantages over physical and chemical methods. [1]

II. METHODS AND MATERIAL

1. Collection Of Materials
2. Determination Of Index Properties
3. Determination Of Geotechnical Properties Of Conventional Soil
4. Mixing Of Additives In Soil
5. Comparison Between The Conventional Soil And Soil With Additives

Materials Required

Soil: Black cotton Soil is collected from Khadki Village which is in Daund, Pune. The soil available at the particular location is shallow well drained black cotton soil with moderate erosion.

Fig.1 Black cotton soil sample

Polypropylene Fiber: Polypropylene fiber is collected from Union Traders Chiplun. Polypropylene fiber are synthetic product used to stabilize the soil. They are generally used to solve geotechnical problems of soil.

Fly Ash: Fly Ash is collected from JSW plant near Jaigad. Fly ash is a fine product which is a by-product of burning pulverized coal in electric generation power plants.

Fig.2 Fly ash sample

III. RESULTS AND DISCUSSION

The results of black cotton soil with and without additive are determined by conducting laboratory tests as per IS code specifications, results are tabulated.

IV. CONCLUSION

The effect of polypropylene fiber, fly ash on soil samples were studied by conducting tests with addition of 1%, 3% and 5% of polypropylene fiber, fly ash and the following conclusion were drawn.

1. When 1% PF was added PI was increased and for 3% and 5% PI got decreased.
2. CBR value was increased when 3% FA added and decrease when 3% PF was added.
3. For 3% FA DST got increased and for 3% PF DST value was decreased.
4. The ultimate value of UCS was found for 3% FA.
5. Among two of this additives Fly Ash is more effective for 3% mix.

Future scope

1. Further investigation can be carried out to improve the soil stability with different additives to reduce the cost of operations.
2. Both static and cyclic and triaxial test can be on soil before it use for field application.
3. Research can also be done for comparison between Plastic Granules, Pond Ash and Fly Ash.

Table 1: Combined results for BC soil and BC soil with 1 % additives

Sr.no.	Test	Black Cotton Soil	Black Cotton Soil + 1% Fly Ash	Black Cotton Soil +1% Fiber
1.	Liquid Limit	57.68 %	61.72 %	59.38 %
2.	Plastic Limit	38.31 %	47.77 %	39.01 %
3.	Plasticity Index	19.37 %	13.95 %	20.37 %
4.	Shrinkage Limit	10.95 %	15.73 %	17.68 %
5.	Specific Gravity	2.19	2.06	2.11
6.	Direct Shear (S)			
	For 2 kg,	0.98kg/cm^2	0.50 kg/cm^2	0.44 kg/cm^2
	For 2.5 kg	1.22 kg/cm^2	0.63 kg/cm^2	0.54 kg/cm^2
	For 3 kg	1.47 kg/cm^2	0.75 kg/cm^2	0.65 kg/cm^2
7.	Unconfined Compression (q_u)	0.018 Kg/cm^2	0.023 kg/cm^2	0.020 kg/cm^2
8.	California Bearing Ratio			
	2.5mm	1.91	1.98	1.96
	5.0mm	2.01	1.90	2.14

Table 2: Combined results for BC soil and BC soil with 3 % additives

Sr.no.	Test	Black Cotton Soil	Black Cotton Soil + 3% Fly Ash	Black Cotton Soil +3% Fiber
1.	Liquid Limit	57.68 %	58.69 %	53.4 %
2.	Plastic Limit	38.31 %	44.36 %	40.74 %
3.	Plasticity Index	19.37 %	14.33 %	12.66 %
4.	Shrinkage Limit	10.95 %	13.18 %	20.43%
5.	Specific Gravity	2.19	2.23	2.32
6.	Direct Shear (S)			
	For 2 kg,	0.98kg/cm^2	1.16 kg/cm^2	0.54 kg/cm^2
	For 2.5 kg	1.22 kg/cm^2	1.45 kg/cm^2	0.68 kg/cm^2
	For 3 kg	1.47 kg/cm^2	1.74 kg/cm^2	0.81 kg/cm^2
7.	Unconfined Compression (q_u)	0.018 Kg/cm^2	0.033 kg/cm^2	0.027 kg/cm^2
8.	California Bearing Ratio			
	2.5mm	1.91	1.12	1.83
	5.0mm	2.01	2.18	1.94

Table 5.3: Combined results for BC soil and BC soil with 5 % additives

Sr.no.	Test	Black Cotton Soil	Black Cotton Soil + 5% Fly Ash	Black Cotton Soil +5% Fiber
1.	Liquid Limit	57.68 %	63.90 %	55.20 %
2.	Plastic Limit	38.31 %	44.36 %	40.75 %
3.	Plasticity Index	19.37 %	19.54 %	14.45 %
4.	Shrinkage Limit	10.95 %	25.85 %	20.76%
5.	Specific Gravity	2.19	2.01	2.26
6.	Direct Shear (S)			
	For 2 kg,	0.98kg/cm^2	0.65 kg/cm^2	0.36 kg/cm^2
	For 2.5 kg	1.22 kg/cm^2	0.82 kg/cm^2	0.45 kg/cm^2
	For 3 kg	1.47 kg/cm^2	0.98 kg/cm^2	0.54 kg/cm^2
7.	Unconfined Compression (q_u)	0.018 Kg/cm^2	0.028 kg/cm^2	0.026 kg/cm^2
8.	California Bearing Ratio			
	2.5mm	1.91	1.81	1.66
	5.0mm	2.01	1.99	1.88

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Variable Frequency Inverter Using DSPIC

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ABSTRACT

Induction motors are being used in greater numbers throughout a wide variety of industrial and commercial applications because it provides many benefits and reliable device to convert the electrical energy into mechanical motion. In some applications, it's desired to control the speed of the induction motor. In recent years, with the microcontroller incorporated into an appliance, it becomes possible to use it to generate the variable frequency AC voltage to control the speed of the induction motor.
This study investigates the microcontroller based variable frequency power inverter. The microcontroller provides the variable frequency pulse width modulation (PWM) signal that controls the applied voltage on the gate drive, which provides the required PWM frequency with fewer harmonic at the output of the power inverter. The fully controlled bridge voltage source inverter has been implemented with semiconductors power devices isolated gate bipolar transistor (IGBT), and the PWM technique has been employed in this inverter to supply the motor with AC voltage. From the result, a stable variable frequency inverter over wide range has been obtained.

Keywords: V/F Control, Speed Control, Variable Frequency, PWM.

I. INTRODUCTION

In the various industrial applications the induction motor is widely used. The loads on induction motor most of the time varies as per its application need, but speed of induction motor remains unchanged & does not match with the demand from load. If load on induction motor changed, the speed of induction motor does not change as per the load. Hence it takes rated power from supply so the energy consume by the motor is same. Hence there is energy consumption is same during load varying condition also. This problem can be addressed using a VFD method industrial application to save the energy consumption and electricity billing. Variable frequency drive (VFD) usage has increased dramatically in industrial applications. This device uses power electronics to vary the frequency of input power to the motor, thereby controlling motor speed. Variable Speed Drive (VSD) This more generic term applies to devices that control the speed of either the motor or the equipment driven by the motor (fan, pump, compressor, etc.). This device can be either electronic or electro-mechanical.

Design microcontroller based variable frequency power inverter is presented in [1]. The microcontroller unit (MCU) provides the adjustable frequency pulse width modulation (PWM) which controls the voltage applied to the gate drive. This provides the necessary PWM pulse with minimum harmonics at the output stage. The proposed driver for 3-ϕ&1-ϕ power inverter is simulated using Matlab/Simulink. The simulation results of the proposed system achieved with different SPWM. Author found a stable adjustable frequency for inverter over wide range. In [2] author uses basic principle of variable frequency where, the speed of the AC motor is controlled using PWM pulses produce by PIC 16F873Microcontroller. The wireless technology is helpful to handicapped, paralysed and elder people. In [3] author implement variable speed drive for regulating the speed of 3-ϕAC motor as batching system needs constant speed. The synchronization is important in between batching system and weaving machine. This can be done by using variable voltage variable frequency method with the help of AC drive. Work in [4] presents variable speed control application of induction motor using v/f method. In this work the speed of the induction motor is adjusted to required speed. The actual speed & reference speed is compared. The difference of speed is achieved by changing the firing angles of IGBTs. The system is tested & experimental results are recorded for variable speed under various load conditions.

In early days, the variable speed drives (VFD) had various limitations such as larger space, poor efficiencies, lower speed, etc. But, now with new techniques and invention in power electronics semiconductor devices has changed the situation. Now days, variable speed drives (VFDs) can be constructed in smaller size with high efficiency and reliability. One of mostly control scheme is variable voltage – variable frequency. With this method one can control speed of motor working under any circumstances.

The organization of this document is as follows. In Section 2, detail of method used to implement this work is presented. In Section 3, Results and findings are presented. Finally conclusion is discussed in Section 4.

II. DESIGN AND IMPLEMENTATION

Induction motors generate torque from an electric current flowing through a rotating magnetic field. If the current is held constant, the motor can generate torque at full load. Below the base speed, this is achieved by maintaining the voltage-to-frequency ratio applied to the motor when the frequency is changed to the controlled speed. For 460 and 230V motors, the ratio is 440/50 = 8.8 and 230/50 = 4.6. As the frequency decreases and the motor speed decreases, increasing this ratio increases the motor current and may be too high. As the frequency increases, the torque capacity of the motor decreases. There are exceptions to this rule, which are described below.

The main speed of the motor is proportional to the supply frequency and inversely proportional to the number of poles. So we can change the motor speed by changing the frequency on the display. Above the base speed, this ratio decreases when a constant voltage is applied to the motor. In this case, the motor output torque is lower than the base speed. Below about 30 Hz, the volt/Hz ratio is not always constant. Depending on the load type, the voltage can be increased to a higher gear ratio so that the motor can generate sufficient torque, especially when stopped. This parameter is commonly referred to as overvoltage [2].

Advances in semiconductor manufacturing technology have significantly reduced the quantity and price of semiconductors. This means motor users can replace their low-power machine control systems with frequency converters (VFDs). VFD can not only control the motor speed, but also improve the dynamic and static characteristics of the motor[5] . VFDs can also reduce the average power consumption of the system. Although several induction motor control techniques are currently used, the most common control technique is to create a variable frequency source with a constant voltage/frequency ratio. This method is commonly known as VF control. VF control is widely used in open loop systems and is suitable for a variety of applications where changing the motor speed is a critical requirement to effectively control the motor[5]. It is also easy to implement and inexpensive.

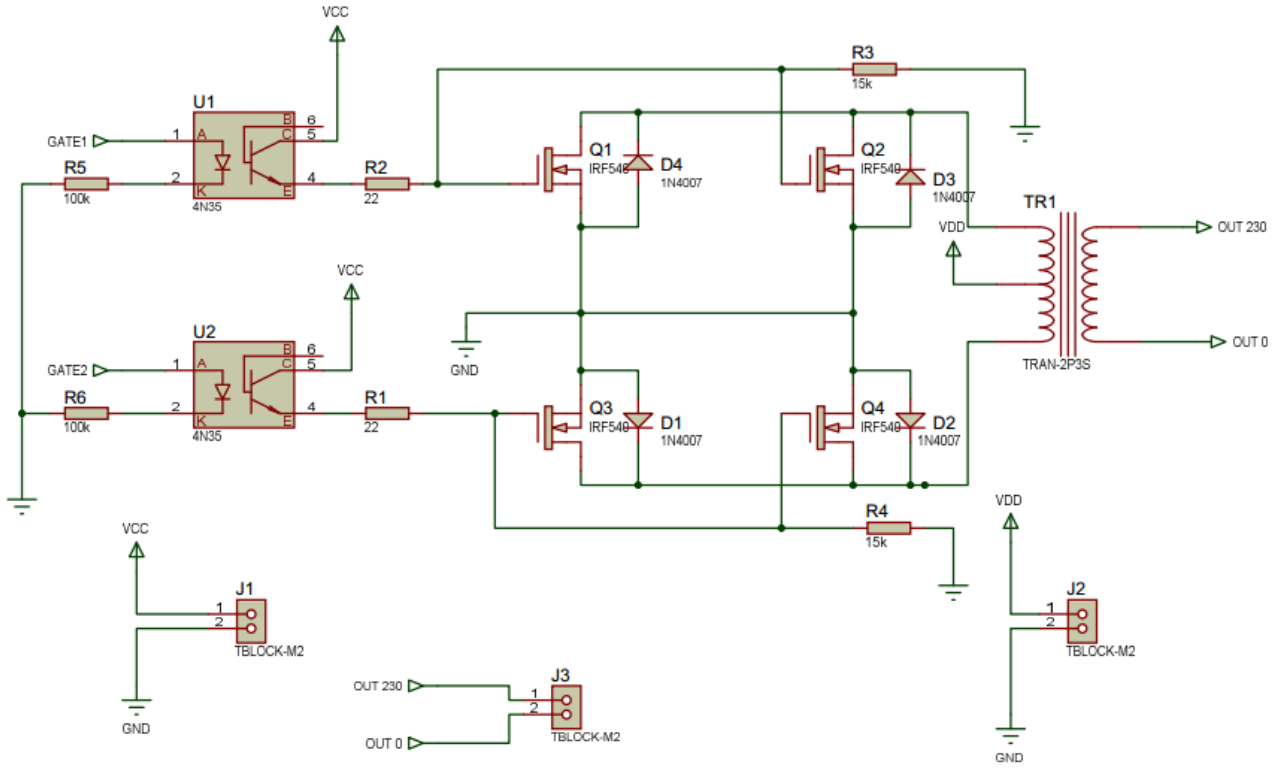

Figure 1: Circuit Diagram

At base speed and low speed, the volt/hertz ratio can be lowered to reduce the motor current when the motor is under light load. Low Motor Voltage This setting reduces the motor solenoid current. So the motor has less torque for transportation. This control is more common in the industry and is commonly referred to as static V/F control.

Variable Frequency and speed control

Many applications require variable speed operation. This is especially true in applications where the input power is directly proportional to the cube of the motor. For applications such as centrifugal pumps based on induction motors, a reduction of up to 20% in speed can result in savings of around 50%. A major concern in todays energy world is the efficient drive and control of induction motors.

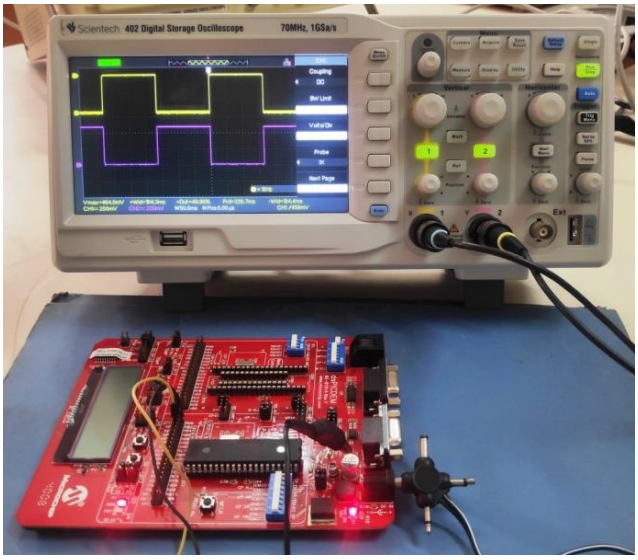

Figure 2: Hardware Setup

Algorithm and flow Chart

Figure 3 is frequency control flow chart. The speed of motor is directly proportional to frequency of applied signal. The advanced sinusoidal PWM generation is used. The sine table is saved in memory. The width of unit pulse and decided by table value and input frequency. Use of sinusoidal PWM technique will reduce harmonics and coil heating of induction motor.The first step in the flowchart is to initialize the input parameters. They are responsible for cold start and motor protection. Gate control for MOSFET banks are kept LOW to protect bank from short circuit.

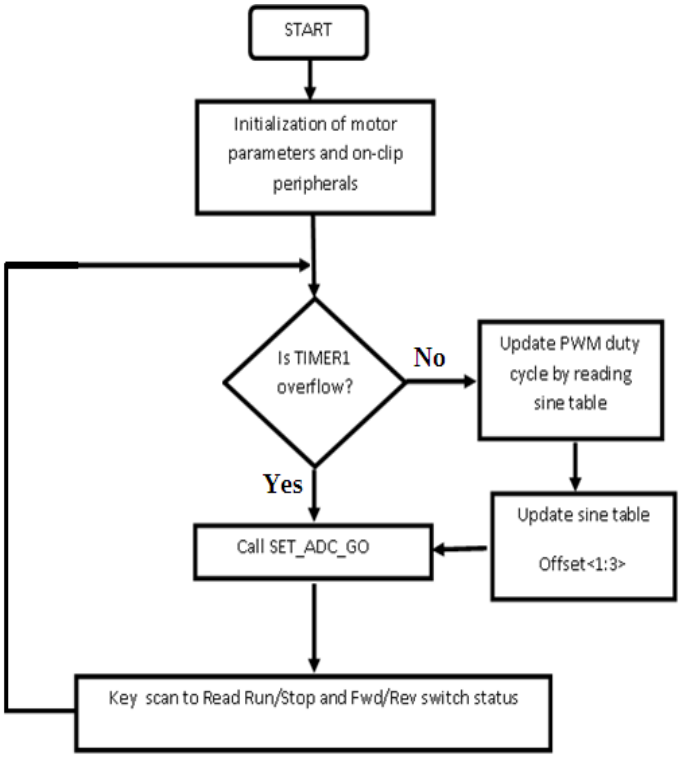

Figure 3: Algorithm Flow Chart

Timer is initialized and compared to ADC value for controlling the pulse width of the waveform. The sine table is read and corresponding proportional value is calculated based on required frequency. This value is loaded in to the timer preset value. Timer runs for presented value and again the cycle repeats for next value in sine table.

Status of input switches is scanned and control parameters are updated. The switches are RUN, STOP. Three phase induction motors includes forward and reverse switches. In every call of sinusoidal adjustment call for ADC scan and switch matrix scan is generated.

Figure 4 displays the ADC scan routine. The time interval for ADC scan is 4ms. The ADC call is initiated. The timer value is updated and system returns to main control loop. The ADC resolution is 10 bit and maximum count is 1023. ADC buffer is read and compared with previous value. If it is differs the process for new frequency setup is initiate. This new value is used to update the timer value and it will change the frequency of waveform. Change in the timer value will.

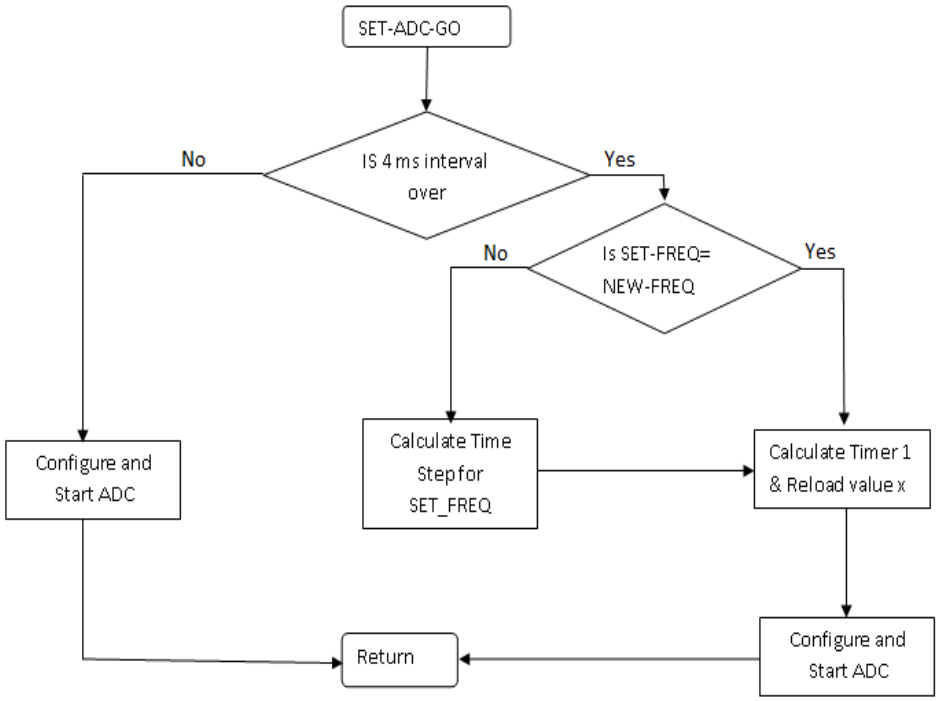

Figure 4: Algorithm Flow Chart

change the step size and hence the overall time period of sine wave. Frequency is reciprocal of time period. Hence the frequency of generated waveform will change

III. RESULTS AND DISCUSSION

With the help of DSPIC DEM development board we get PWM pulses at the output port. These pulses are as per our expiations. Algorithm for PWM pulses shows that response time is much less and it appears in suitable form.

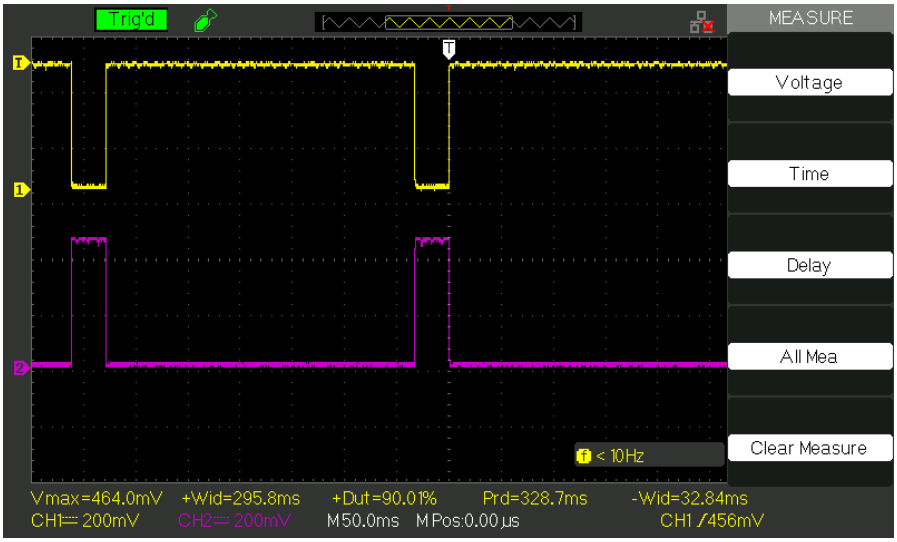

Figure 5: PWM output at 90% Duty Cycle

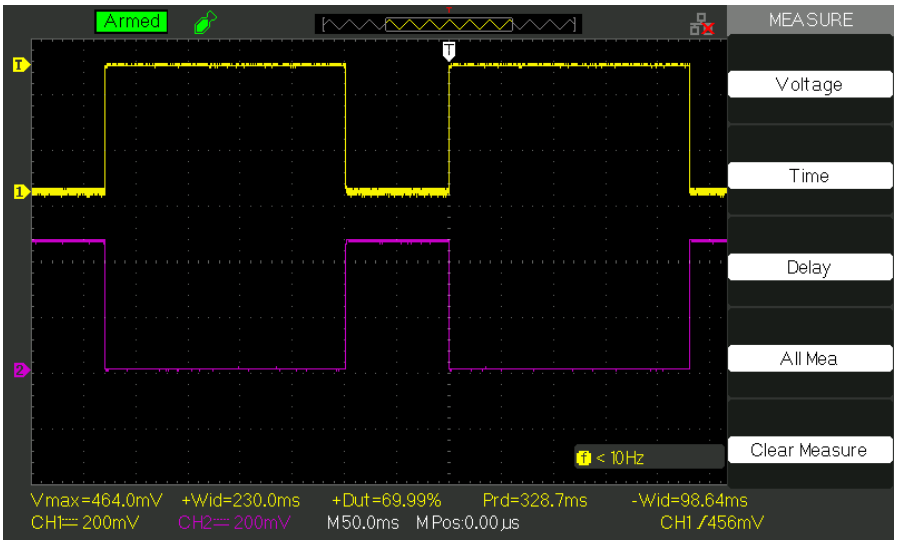

Figure 6: PWM output at 70% Duty Cycle

It is observed that at output port on board LEDs intensity is constant and LEDs switching time is changing with respect to change in frequency of V/F ration. MOSFET driver circuit ON-OFF is observed satisfactorily. Figure 5 to 8 Shows PWM output at different Duty cycle.

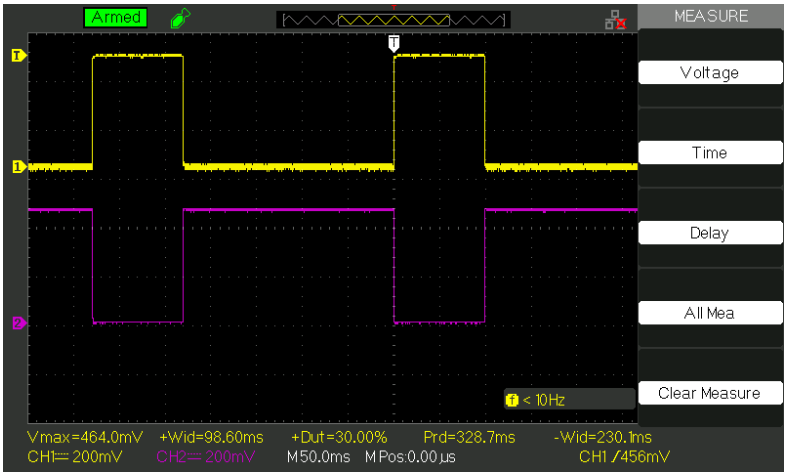

Figure 7: PWM output at 30% Duty Cycle

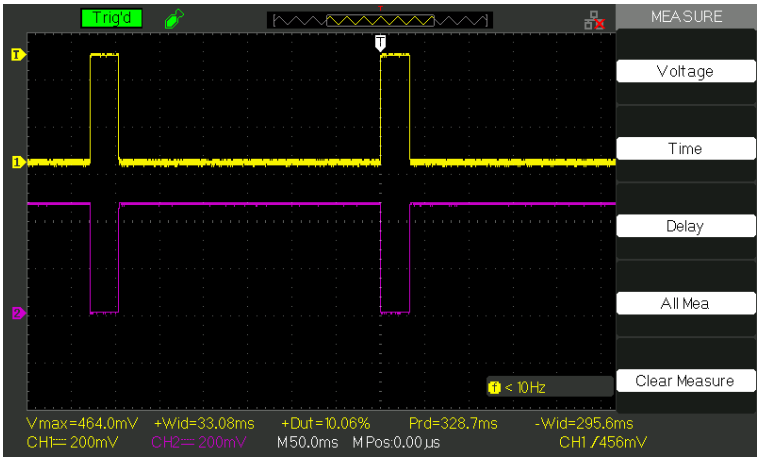

Figure 8: PWM output at 10% Duty Cycle

Following observations made during experimental setup.

% Duty Cycle	Output Voltage (in Volt)	
	Observed	Calculated
10	0.481	0.5
30	1.443	1.5
70	3.367	3.5
90	4.329	4.5

Table 1: Output voltage vs Duty Cycle

IV. CONCLUSION

This work presents implementation of speed and torque control of induction motor using DSPIC. We developed algorithm for generation of PWM to maintain torque at required level for variable speed application. To do this effectively we have adapted method of V/F control. Our Results shows the use of

DSPIC gives better torque stability and quick response as compare with other MCUs. We have successfully able to maintain required torque at low and high speed of AC motor.

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Waste Water Treatment by Using AGFM (Activated Glass Filter Media) and Eco-Clean 2300

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ABSTRACT

Water problems are increased day by day so water treatment is most important. In this project we are going to use Eco-tech process with the help of Eco-clean 2300 and AGFM(Activated glass filtration media) for sewage treatment. ECOCLEAN-2300 is a single dose herbal reagent for water flocculation, sedimentation and disinfection of water. This method remove totally odour and bacteria from the waste water. Eco-clean 2300 it is the herbal extract Neem, Tulsi, Moringa and Cleaning nut with proven water purifying capabilities bound together using a water soluble organic solvent. It totally nontoxic and safe to use. The model consist of layer of activated charcoal and AGFM during a filter. Waste water once filtered through a activated carbon filter and activated glass filter media the treated water is fit for reuse.

Activated glass filtration media replaces traditional sand media in all filtration applications. It is manufactured from a specific glass type and processed to obtain the optimum particle size and shape. Then activated to increase the surface area by 300 times cover crushed glass or sand. We are going to treat domestic waste water by using this new filter technique. We have check for the characteristic of waste water like Total suspended solid, Chemical oxygen demand, Total solid, Biochemical oxygen demand, Alkalinity and pH etc. This treated water by Eco-clean 2300 and AGFM is usefull for gardening, cleaning, washing. This method is economical than other treatment method.

Keywords: Waste water, Activated glass filter media, Eco-clean2300, Characteristic.

I. INTRODUCTION

Waste water treatment is the process of removing contaminants from waste water and household sewage, both effluents and domestic. It includes physical, chemical and biological contaminants. Its objective to produce an environmentally safe fluid waste stream and a solid waste suitable for disposal or reuse. The objective of waste water treatment is to produce a disposable effluent without causing harm to this surrounding environment, and prevent pollution.

It is very important to provide some degree of treatment to waste water before it can be used for reuse. The principle objective of waste water treatment is generally to allow human effluents to be disposed of without danger to human health or unacceptable damage to the natural environment. According to a research, a large number of people die from water born diseases in most of the developing countries. Therefore, it is very important to get the proper treatment of the water for a healthy living.

II. METHODS AND MATERIAL

The material used for forming the filter is gravel, sand, AGFM, activated carbon and wire mesh.

1. Gravel – Filter gravel is an extremely effective filter media because of is ability to hold back precipitates containing impurities. Filter sand size, angularity and hardness are the important filter sand characteristics to ensure proper filtering.

2. AGFM(Activated glass filter media) – In large water filtration systems, it is a modern replacement for traditional sand media. The use of a particular type of glass is activated; it offers an increase in its surface area and is negatively charged to attract an extract both heavu metal compounds and organic residues from water in order to purify it. Activated filter media is a more modern and better replacement for the old sand methods depending on installation and inbound water quality, the use of activated glass can double the performance and effectiveness dramatically over older systems for high output water purification. Whilst glass filtration is more effective than silica, activated glass filtering is even more effective again.

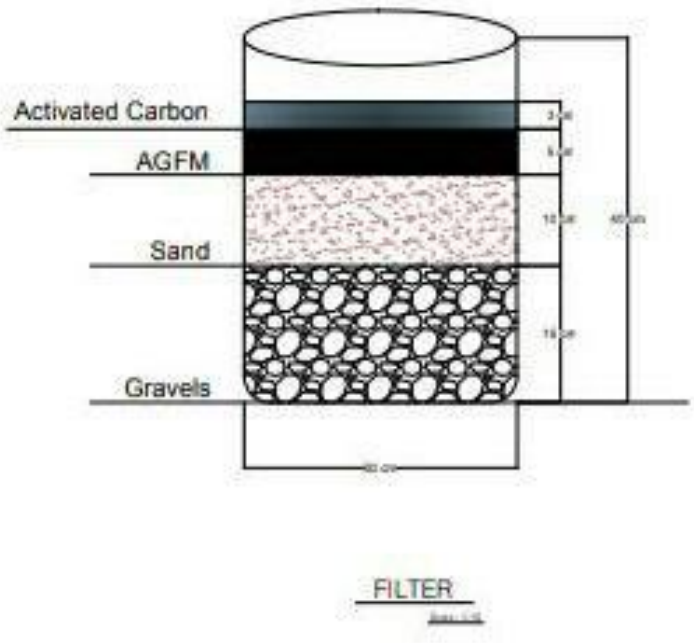
Benefits of activated glass filter media –

- Filters at least 50% better than traditional Sand method.
- Targets efficient removal of organics, or inorganics, oxides and other metals and minerals.
- Eliminates algae growth.
- Over 30% lower running cost vs sand.
- Filtration down to several microns t 100% efficiency without filtration aids.

3. Eco-clean 2300 – Eco-clean 2300 is a single dose herbal reagent for water flocculation, sedimentation and disinfection of water. It is a combination of herbal extracts(Neem, Tulsi, Moringa, and Cleaning nut) with proven water-purifying capabilities, bound toghether using a water-soluble organic solvent. Its totally non toxic and safe to use.

III. EXPERIMENTAL SETUP

The experimental setup was made with a plastic bottle which has a diameter of 30 cm and a depth of 35 cm with a small opening at bottom for collecting filtrate water.



FILTER

IV. PROCEDURE

- Collect the domestic waste and done the primary treatment of this sample.
- 400 ml of sample was taken in a beaker and a single drop of eco-clean was added.
- It was mixed throghly and the flocculation starts.
- Initially the sand gravel are clearly washed and oven dried.
- The activated filter media is washed three consecutive times with potable water and then rinsed it for an hour.
- Gravel are sieved for a grade 3 to 40 mm and sand 0.25 to 2.36 mm.
- Gravel is placed at the bottom for 15 cm depth.
- Sand is placed above gravel to a depth of 10 cm over which grade to activated glass filter is placed to a depth of 5 cm.
- Rinse the entire setup with distilled water twice.
- Now, take 2 litre of water effluent sample and pour it into the setup.
- Collect the treated water from the test setup and test for the physio-chemical parameters and note the values.

V. CHARACTERISTICS

Physical characteristics of waste water –

- Colour
- Odor
- Temperature
- Turbidity

Chemical characteristics of waste water –

- Chemical oxygen demand
- Total organic carbon
- Nitrogen
- Phosphours
- Chlorides
- Alklinity
- pH

Biological characteristic –

- Biochemical oxygen demand
- Oxygen required for nitrification
- Microbial population

VI. RESULT AND CONCLUSION

- The data reveals that some of the parameters tested were not within the permissible limit as prescribed by WHO and others standards. Quantitatively water in the studied is not hard an with metal content at the discharge point.
- The collected water sample where treated with AGFM and all the parameters were within the permissible limits prescribed by WHO and other standards.
- The treated water can be used for gardening, flushing, cleaning, irrigation purpose but not for drinking purpose.

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