FABRICATION AND EXPERIMENTATION OF HYBRID COMPOSITES

K. Chellamuthu[1], G. Sakthi Balan[2]
A.Ram Mohan[3], B.Santhosh[3], T.G. Vijay Raj[3], M .Vinoth Kumar[3]

1,2. Assistant Professor, Mechanical Engineering, K.Ramakrishnan College of Engineering, Samayapuram, Trichy.

3. Department of Mechanical Engineering, K.Ramakrishnan College of Engineering, Samayapuram, Trichy.

ABSTRACT

Upgraded engineering materials are increased day to day. High performance and lightweight composite materials are required for different sectors. In this research work, found that high strength to weight ratio is obtain in fibre reinforced polymer. Various fibre composite materials are obtained in the market and each fibre has its own behaviour depend on their size, shape and composition. The present are going to formulate a new material high performance polymer composite. Epoxy is taken as a base (matrix) of the component and further glass fibre (fillers), polyethylene terephthalate (bio-fillers) are added into it. These materials can be mixed with a proper rule of mixture to make as a hybrid composites by using a compression moulding. The entire specimen has been tested along with tensile test, hardness test and water absorption test. The tensile test result is also obtained through ANSYS software. The performance of our composite material shows positive results in the above tests.

KEYWORDS: *glass fibre, epoxy resin, bio fillers, polyethylene terephthalate.*

I. INTRODUCTION

Glass fibre is a material which is made up of enormous number of fine fibres of glass. Glass fibre are the best materials for strengthening the products related to polymers. The properties of glass fibre , carbon fibre and other fibre reinforced plastics are similar due to its less weight and high strength.

The glass fibre are of several type are available, c glass fibre is selected in this research work. By adding polyethylene terephthalate at a appropriate composition along with glass fibre and epoxy resin, the properties of resulting specimen can be upgraded in divergence to the normal glass fibre.

Polyethylene terephthalate is based on a polyester family, it is used to manufacture water bottles and also as in fiber clothing. Polyethylene terephthalate can be recycled and reused. It shows good strength and lesser weight.

This project portrays about the properties of the hybrid composites along with the following tests . The epoxy resin are considered as a base(matrix) and further glass fiber (fillers),polyethylene terephthalate (bio-fillers) are bonded with together to make as a hybrid composites, which are good in strength and more rigid.

II. MATERIAL AND METHADOLOGY

A. Materials used

1. Glass fibre

In this project we have used mat type C-glass fibre. This glass fibre is made up of enormous amount of fine strands of glass fibres. Glass reinforced plastic is the resulting material we get by using this glass fibre.

2. Epoxy resin and Hardener

The main purpose of the epoxy resin is to increase the toughness and resilience of the materials that has to be tested .Epoxy is selected because it can easily bond with the others. Also epoxy acts as a shield to resist the heat, electrical and chemical environment. Epoxy is best selected as a matrix because of good wetting property.

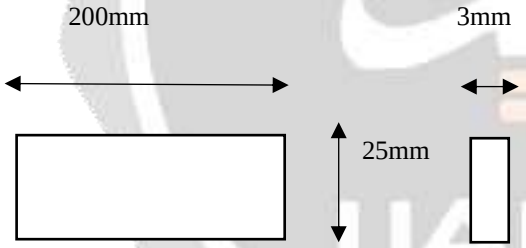
3. Polyethylene terephthalate

Polyethylene terephthalate is a polyester that is obtained from heating of ethylene glycol and terephthalic acid .Polyethylene terephthalate is commonly used for synthetic fibres and bottle production .Polyethylene terephthalate is also known as polyester. Since the Polyethylene terephthalate has an advantage of electrical resistance ,it is a poor water absorber .

B. Specimen Geometry

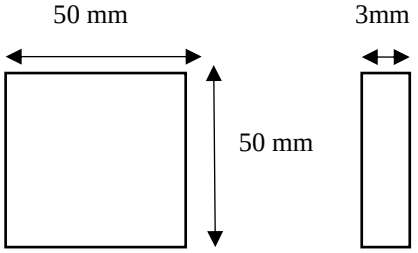
In this paper we have taken the test specimen dimension as specified in the ASTM standard for the respective test. Thus the shape and size of the specimens can be varied for the different tests. We have experimented the specimens as Tensile test ,Hardness test and water absorption test.

1. Dimensions of tensile test specimen as per ASTM D3039

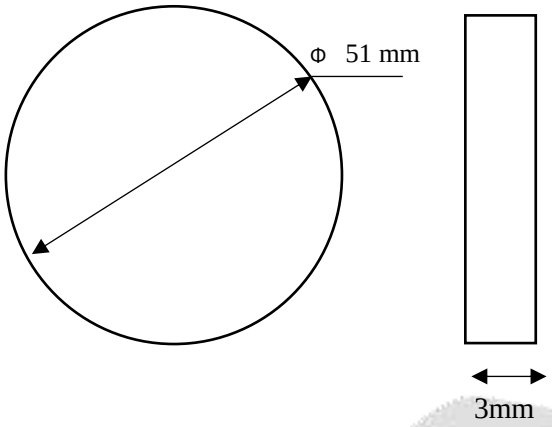


FRONT VIEW

2. Dimensions of Shore D Hardness test specimen as per ASTM D2240



3. Dimensions of water absorption test specimen as per ASTM D570



C. Rule of mixture

The rule of mixture is used to speculate new composite materials made up of different type of fibers that have different property. In this paper the rule of mixture we have is,

	Glass fibre	Epoxy resin	BIO FILLERS
SPECIMEN 1	30%	60%	10%
SPECIMEN 2	40%	50%	10%
SPECIMEN 3	60%	30%	10%

By the above rule of mixture the specimen is created by compression moulding process at a pressure of 500 KPa and 35 °C for the specimen size of,

Length = 290 mm
Width = 290 mm
Thickness = 3 mm

III. EXPERIMENTS

A. Tensile test

Tensile test is an test in which are commonly used in metallurgical engineering, where the specimen undergoes an tension even its breaks. we have to prepared an specimen for the respective ASTM standard D3039 . this test can be carried out to find out the elongation of the specimen, ultimate tensile strength and the break point of the specimen.

B. Hardness test

Hardness test is to measure the surface hardness of the specimen. An ASTM standard D2240 is selected and the specimen can be cutted along with the specific dimensions. Shore Durometer Hardness test has many scales, we have use an shore D scale. Shore D scale is selected, because it can be measured by thermosets and thermoplastics.

C. Water absorption test

Water absorption test can be carried out to regulate the amount of water can be absorbed by the specimen in under the water. In this test ASTM standard D570 is selected and the specimen are cutted along with the standard dimension. At first the specimen are dried with oven to remove the moisture content in the specimen. Then the specimen are get weighed and they are dipped into various types of

water as distilled water, normal water and salt water. These experiment are taken at a time interval of 2hours and 24hours. After the 2hours the specimen are taken out, cleaned properly and weighed. The weight of the specimen are get increases. The procedure can be repeated for the 24hours test. By using an formula to findout the amount of water get absorbed.

Mathematical formula for water absorption test,

$$M\ \% = \frac{m_o - m_i}{m_i}$$

where m_o = final mass (g)

m_i = initial mass (g)

M % = percentage of water absorption

IV. FINITE ELEMENT ANALYSIS

A. Applications of ANSYS- FEA

ANSYS is an software is used to measure the heat transfer, air flow, CFD and thermal conductivity. A very finite element are get analysed in this software. It help to determine the materials under tension, impact, heat transfer and so on. Thus the software can be further analysed with

- Structural mechanics
- Fluid dynamics
- Electromagnetics
- System and physics.

V. RESULTS

A. Tensile test

Test parameters	Observed values		
Sample ID	Id-1	Id-2	Id-3
Cross Sectional Area(mm^2)	86.86	84.45	80.78
Gauge width (mm)	24.96	25.06	25.01
Gauge thickness (mm)	3.48	3.37	3.23
Ultimate tensile load (KN)	4.18	3.72	3.82
Ultimate tensile strength (N/mm^2)	48	44	47

B. Shore D Hardness test

Sample ID	Values Of Shore D Hardness
ID -1	79-81
ID -2	80-82
ID- 3	77-79

C. Water absorption test

1. Distilled water

Time (hours)	m_i (g)	m_0 (g)	Difference (g)	%
2 hours	8.11	8.13	0.02	0.0021
24hours	9.53	9.58	0.05	0.0052

2. Salt Water

Time (hours	m_i (g)	m_o (g)	Difference (g)	%
2 hours	9.01	9.04	0.03	0.0033
24hours	9.87	9.94	0.07	0.0070

3. Normal water

Time (hours	m_i (g)	m_o (g)	Difference (g)	%
2 hours	8.43	8.45	0.02	0.0023
24hours	9.12	9.20	0.08	0.110

D. FINITE ELEMENT ANALYSIS RESULTS- TENSILE TEST

1. AT LOAD 4.18KN

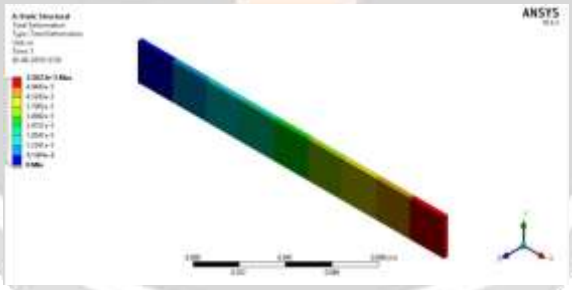


Fig 5.1Total deformation acting on specimen at 4.18KN

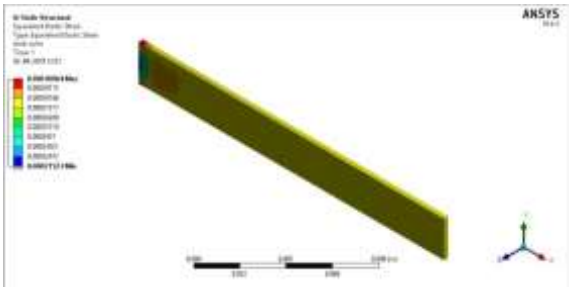


Fig 5.2 Strain acting on specimen at 4.18KN

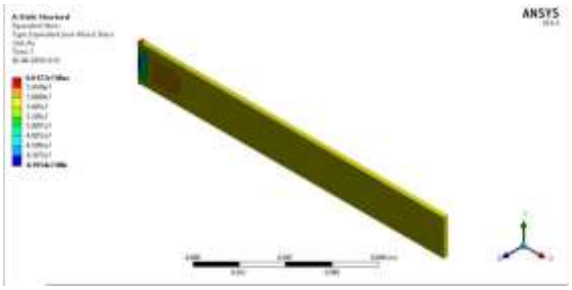


Fig 5.3 Stress of specimen at 4.18 KN

2. AT LOAD 3.72 KN

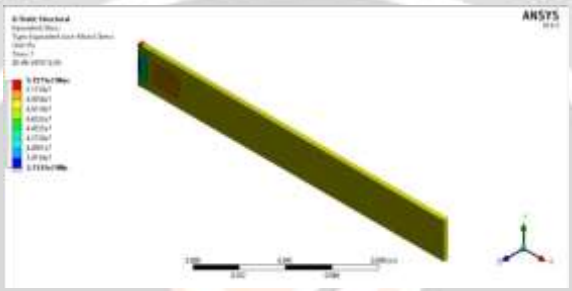


Fig 5.4 Stress acting on specimen at 3.72 KN

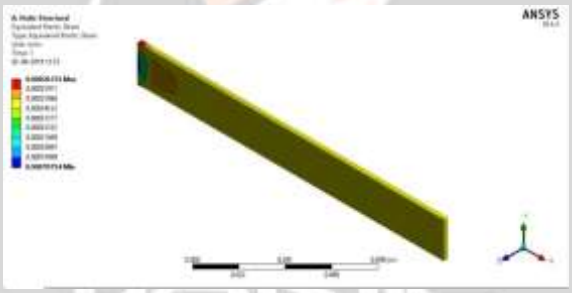


Fig 5.5 strain acting on specimen at 3.72KN

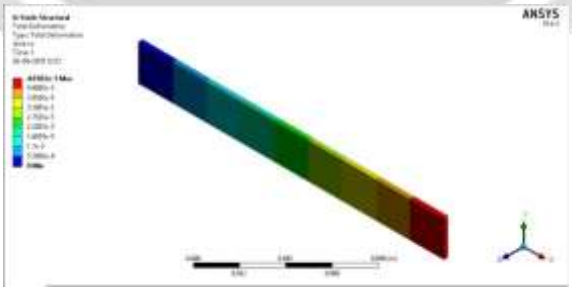


Fig 5.6 Deformation of specimen at 3.72KN

3. AT LOAD 3.82 KN

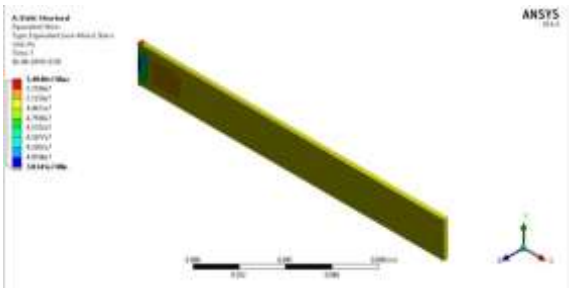


Fig 5.7 Stress acting on specimen at 3.82 KN

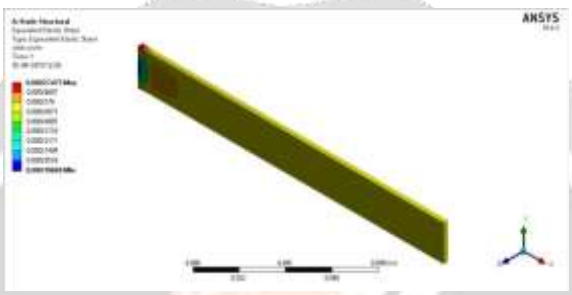


Fig 5.8 Strain acting on specimen at 3.82 KN

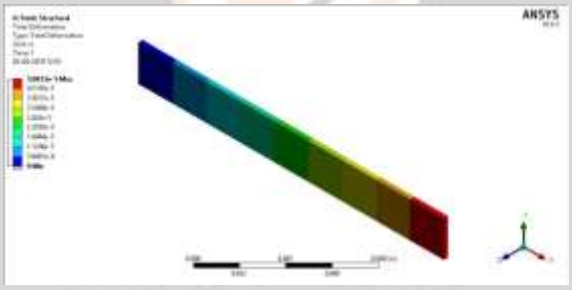


Fig 5.9 Deformation of specimen at 3.82 KN

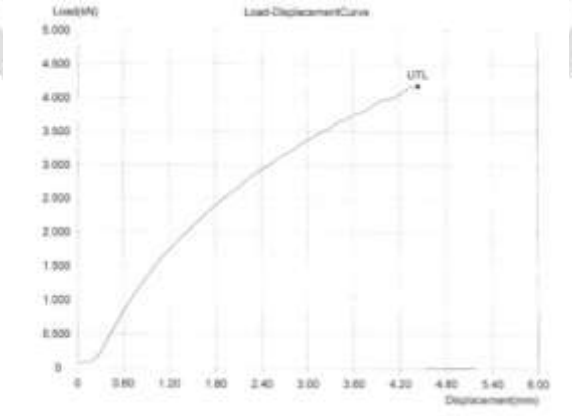


Fig 5.10 Load Vs Displacement graph for tensile test at a Load of 4.18KN

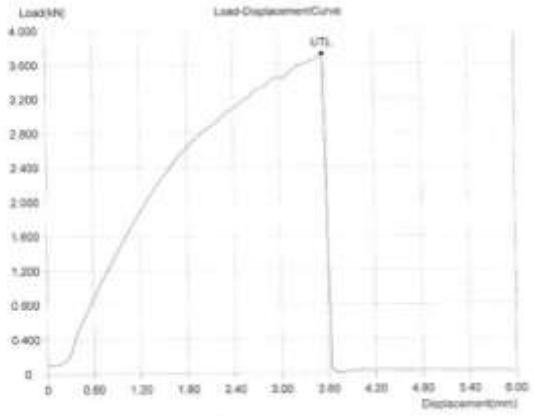


Fig 5.11 Load Vs Displacement graph for tensile test at a load of 3.72KN

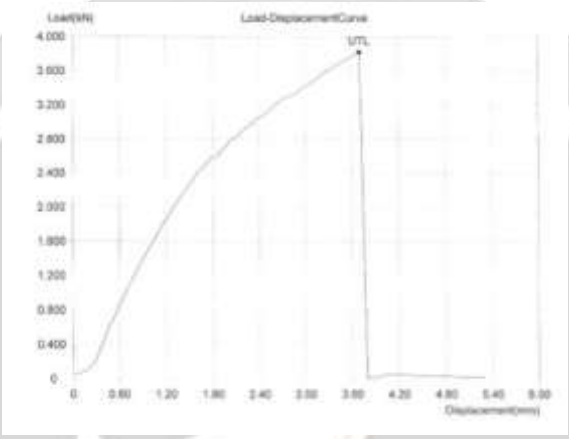
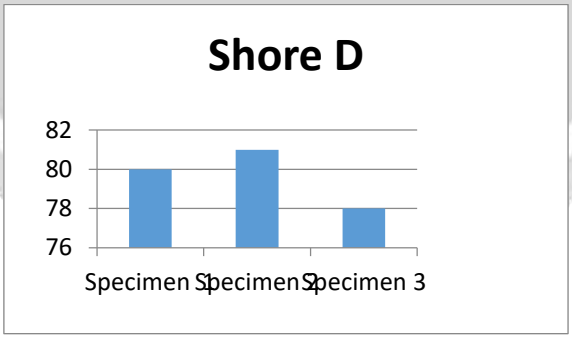


Fig 5.12 Load Vs Displacement graph of tensile test at a Load of 3.82KN

E .HARDNESS TEST RESULTS



VI . **RESULTS CORRELATION**

The hybrid composite encompassing glass fibre, epoxy resin and Polyethylene terephthalate has been intended in detail. The experimental result and analysed results are correspondence through ANSYS software. The graph has been drawn between ultimate tensile strength vs ultimate tensile load .Load of 3.6 KN is applied to the specimen, deformation takes place and ultimate tensile strength of the specimen is 48N/mm².Then we have prepared a bar chart for hardness test .

VII. CONCLUSION

The analysed results are corresponds to the experimental results are obtained and we have discovered a hybrid composites materials are better than the normal composite material.

The rate of water can be absorbed by the specimens are measured by using an water absorbed test. The fillers and bio-fillers in the hybrid composite materials are poor in water absorbent and show a minimum amount of water absorption takes place.

VIII. REFERENCES

[1] Thiru Aravinthan "*Structural applications of fibre reinforced polymer (FRP) composites "*2017, pg.no:513-524.

[2] Milad Bazli and Hamed Ashrafi "*Effect of applied stress and bar characteristics on the short-term fatigue behaviour of FRP bars"* 2018, pg.no:960-968

[3] J.D. Garcia-Espinel, D. Castro-Fresno, P. Parbole Gayo, F. Ballester-Muñoz" *Effects of sea water environment on glass fiber reinforced plastic materials used for marine civil engineering constructions"2015* pg.no: 46-50.

[4] A. Kootsookos, A.P. Mouritz " *Seawater durability of glass- and carbon-polymer composites" 2004* pg.no: 1503-1511

[5] Xuan Truong Nguyen, Shujuan Hou, Taiqu Liu, Xu Han "*A potential natural energy absorption material – Coconut mesocarp: Part A: Experimental investigations on mechanical properties" 2016,* pg.no 564-573

[6] Umar Adli Amra, Sarani Zakaria, Chin Hua Chia, Rasidi Roslan "*Mechanical properties and water absorption of glass fibre reinforced bio-phenolic elastomer (BPE) c*omposite" 2015, pg.no: 54-59

[7] BA A. Francis, S. Rajaram, A. Mohanakrishnan
Mechanical Properties of Sisal Fibre Reinforced Polymer Matrix Composite, *Journal of Mechanics and Mechanical Engineering 22* (No. 1 (2018)), 289–294

[8] *Experimental Design and Analysis of Carbon Fiber Reinforced Composite Drive Shaft*
GR D Valavan, R Balasundaram
Asian Journal of Research in Social Sciences and Humanities 6 (11), 167-178

[9] *SDK M.Ravichandran, Aluminium Metal Matrix Composite with Zirconium diboride Reinforcement: A Review. Materials Today*: Proceedings 5, 19844–19847

[10] A Chelliaha, *Mechanical Properties and Abrasive Wear of Different Weight Percentage of TiC Filled Basalt Fabric Reinforced Epoxy Composites,* Materials Research 22, 2

[11] BA A. Francis, S. Rajaram, A. Mohanakrishnan, *Mechanical Properties of Sisal Fibre Reinforced Polymer Matrix Composite,* journal of mechanics and mechanical engineering 22 (No. 1 (2018)), 289–294

[12] MR B.Radha Krishnan, R.Giridharan, S.Rajaram, R.Sanjeevi, *Prediction of Surface Roughness in turning process by using artificial neural network model,* taga journal of graphic technology 14 (ISSN: 1748-0345 (Online)), 2823-2829