JOURNAL OF SCIENTIFIC RESEARCH IN ALLIED SCIENCES
ISSN NO. 2455-5800
Contents available at www.jusres.com

MECHANICAL STRENGTH ANALYSIS BEHAVIOUR OF E-GLASS FIBRE REINFORCED COMPOSITES

Vinod Kumar Yadav, Nitin Nayak, A K Khandelwal
Department of Mechanical Engineering, Chouksey Engineering College Bilaspur

ARTICLE INFO | **ABSTRACT** | **ORIGINAL RESEARCH ARTICLE**

Article History
Received: Sep 2020
Accepted: Oct 2020
Keywords:
Milling machine, Optimization, parameters.
Corresponding Author
***Yadav V. K.**

As an alternative method, it has been used for monitoring and evaluation of the structural integrity of glass fiber-reinforced polymer composite structures. In the present work, E-glass fiber is used as a reinforcing agent. The effect of fiber loading and filler content on mechanical properties like tensile strength also studied. Discussions and significant parameters are identified in the research are presented. An effort evaluates the advantages offered by the tensile load for the development of glass fiber reinforced polymer material.

1. INTRODUCTION

A typical fiber-reinforced composite material where the reinforcement is in the form of fibers, which are in this example aligned in two directions, namely longitudinal and transverse, forming a cross play configuration. It should be noted that the end-use applications for fiber-reinforced composites are rarely in the form of a monolithic laminate panel, but more shaped in complex geometry. The role of lay-up orientation designs utilizes the load-bearing capability of the material during its service life [2]. However, from a materials design point of view, this fulfills the criteria of a standard test pyramid. Nevertheless, in this illustration, it can be seen that the fibers are surrounded well by the binding matrix laminate, which is stacked in through-the-thickness direction, at the end forming a laminated composite structure, i.e., a layered product consisting of plies of fibers embedded within the matrix.

Polymer matrix composites consist of a polymer resin as the matrix material which filled with a variety of reinforcements. This kind of composite is used in the greatest diversity of composite applications due to its advantages such as low density, good thermal and electrical insulator, ease of fabrication, and low cost. The properties of polymer matrix composites are mainly determined by three constitutive elements such as the types of reinforcements (particles and fibers), the type of polymer, and the interface between them. Polymers are divided into two categories such as thermoplastics and thermosets. Thermoplastic is in general, ductile, and tougher than thermoset materials. They are reversible and can be reshaped by the application of heat and pressure.

2. LITERATURE REVIEWS

A great deal of work has been done by many researchers on synthetic fiber based polymer composites. Jawaid and Khalil [5] presented a review that deals with the recent development of cellulosic/cellulosic and cellulosic/synthetic fibers based reinforced hybrid composites. They intended to present an outline of the main results presented on hybrid composites focusing the attention in terms of processing, mechanical, physical, electrical, thermal, and dynamic mechanical properties. Marom et al. [6] focused on the elastic properties of synthetic fiber-reinforced polymer composite materials that pertain to biomedical applications and demonstrates the range of stiffness obtainable through the selection of constituents and by choice of angle of reinforcement. Erden & Yıldız [4] proposed Fiber reinforcements can also have a form of connected structures named as fabric or cloth, which can be woven, nonwoven, knitted, or braided. Woven fabrics are produced by the interlacing of warp and weft yarns with types of weave styles such as plain, twill, satin, etc., which affect main fabric properties such as stability, drape, porosity, smoothness, balance, symmetry, and crimp. Jansons et al. [7] studied the effect of water absorption, elevated temperatures and Strength on the mechanical properties of carbon-fiber-reinforced epoxy composites. Kutty and Nando [8] studied the effect of processing parameters on the mechanical properties of short Kevlar aramid fiber-thermoplastic polyurethane composite and observed that processing parameters like nip gap, friction ratio, and mill roll temperature have extreme influence on the fiber orientation and hence on the mechanical properties of short Kevlar aramid fiber-thermoplastic polyurethane composite.

3. MATERIALS AND METHOD

Glass fibre (or glass fibre) is a material consisting of numerous extremely fine fibre of glass and other material shown in fig 1. Glass fibre has roughly comparable mechanical properties to other fibres such as polymers and carbon fibre. Although not as rigid as carbon fibre, it is much cheaper and significantly less brittle when used in composites. Methyl ethyl ketone peroxide (MEKP) is an organic peroxide a high explosive similar to acetone peroxide. MEKP is a colorless, oily liquid whereas acetone peroxide is a white powder at STP; MEKP is slightly less sensitive to shock and temperature, and more stable in storage. Resin (in the liquid form) undergoes thermosetting, which strengthens (hardens) the liquid plastic when heated. However, they cannot be remolded or reheated after the initial heat forming. They transition from liquid to solid by way of polymer reactions called cross-linking forming molecular chains that become strong and rigid. The higher cross-linking results in a harder polymer.

E Glass Fibre

Hardner

Resin

Fig 1 Materials for Fibre casting

Testing

The tensile test is conducted on all the samples as per standards. Specimens are positioned in the grips of the universal testing machine and a uniaxial load is applied through both the ends until it gets failure will show in fig 2. The specimen finally fails after necking and the ultimate tensile strength. Tensile Test specimens are cut as per the standard dimension of ASTM E8 as shown in Fig 3.

Fig. 2 Tensile Testing Machine

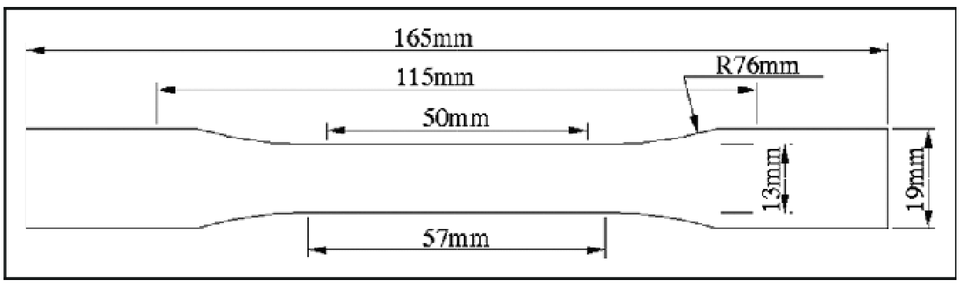

Fig 3 Tensile Test Specimen Dimension

4. PREPARATION OF GLASS FIBRE

To make glass fiber, firstly some items are required which are of the following type like plastic-polythene, epoxy resin, and hardener, etc. first, casting resin is mixed with about some percent with Catalyst (percentage should be maintained of casting resin 80-95% with catalyst 5-10%) and applied on a layer of plastic polythene, glass fibers are placed as fibers to increase its strength and then the second layer of plastic polythene is applied over them. Pressing this layer is put to dry and after drying a glass fiber sample is prepared by reinforcement. Pressing this layer is put to dry and after drying a glass fiber sample is prepared by reinforcement. The dimension of glass fibre is prepared 200x50x4mm. The preparation of glass fibre parameters is shown in table 1.

Table 1 Parameters and level

	Level 1	Level 2	Level 3
Clear Casting Resin (ml) (£)	45	50	60
MEKP Catalyst (ml) (©)	2.5	3	3.5
Glass Fibre Quantity (gm) (€)	15	20	25

The clear castings resin and makeup catalyst mix well together and then put it on top of the structure. There is a need to be careful while adding glass fiber. Because glass fiber can cause harm to humans. And in the last, hard polythene is offered properly from above. Plastic polythene is to be kept properly so that there is no roughness in the sample. We see that the temperature of the sample starts increasing. The sample has to be pressed properly so that the size and shape of the sample are good, in which we have to test. After some time, the sample is ready which is shown in fig 4.

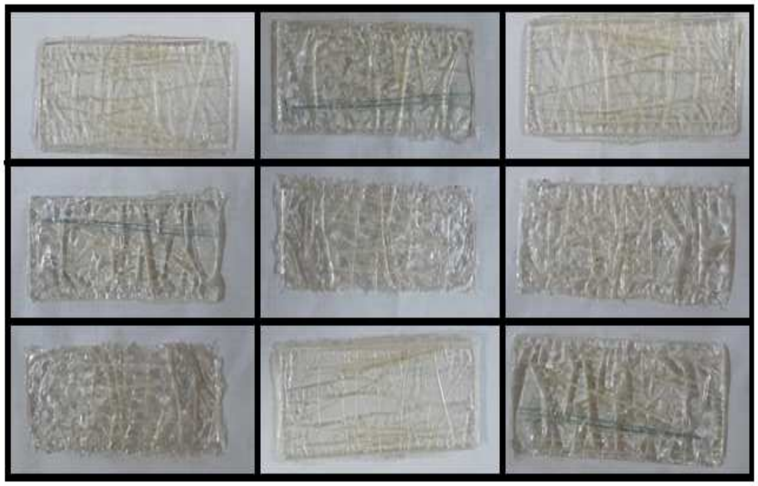

Fig 4 Glass Fiber Casting

5. RESULTS

In this experiment finally, samples are prepared and it is tested as per discusses in chapter 4. A tensile test is conducted through a universal testing machine. The universal testing machine consists of three units the first unit is the control unit. second is the graphical section and the third unit is the loading unit, the loading unit consists of three heads. Preparing a specimen for the tensile test as per ASTM E8 standard shown in Fig 5.

A

B

Fig 5 Tensile Test Specimen

The design of experiments is also useful to combine the factors at appropriate levels, each with the respective acceptable range, to produce the best results and yet exhibit minimum variation around the optimum results. Prepare a structure result obtained by tensile test will show in table 2.

Table 2 Test Result of tensile and wear

S. No.	(£)	(©)	(€)	Tensile (T) (N/mm^2)	Wear Rate (WR) (cm^3/Nm)
1	45	2.5	15	23	0.004743
2	45	3	20	26	0.004348
3	45	3.5	25	33	0.002372
4	50	2.5	20	25	0.006324
5	50	3	25	23	0.004743
6	50	3.5	15	36	0.003162
7	60	2.5	25	28	0.005534
8	60	3	15	27	0.005929
9	60	3.5	20	38	0.0036

6. INFLUENCES ON TENSILE TEST

The analysis of variance (ANOVA) has been used to check the adequacy of the second-order model. The results for the three different secondary bed materials are presented in response. MEKP catalyst is influenced in between all factors such as Clear casting resin and Glass Fiber are not a significant factor for used level. The various types of MEKP catalyst or hardener parameters used in the industries to obtain good tensile strength. It means that tensile strength increases with increasing the MEKP catalyst. The results of tensile tests best parameter are presented in terms of graphs in fig 6.

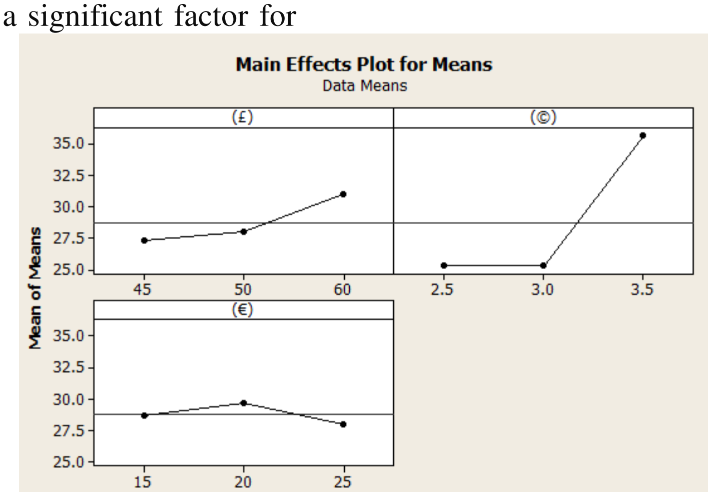

Fig 6 Main effect plot of Tensile test

If the Clear casting resin and MEKP catalyst is increase will also increase the tensile strength. The optimum value of the MEKP catalyst for tensile strength is 3.5ml. glass fiber is slightly increasing so there is not significantly effect on tensile strength that are also described in the ANOVA analysis of tensile test are shown in table 3. The response table also show the rank of parameters which is more significant are shown in table 4.

Table 3 Analysis of Variance for Tensile test

Source	DF	Seq SS	Adj SS	Adj MS	F	P
(£)	2	22.889	22.889	11.444	3.32	0.231
(©)	2	213.556	213.556	106.778	31.00	0.031
(€)	2	4.222	4.222	2.111	0.61	0.620
Residual Error	2	6.889	6.889	3.444		
Total	8	247.556				

Fig 4 Response Table for Tensile test

Level	(£)	(©)	(€)
1	27.33	25.33	28.67
2	28.00	25.33	29.67
3	31.00	35.67	28.00
Delta	3.67	10.33	1.67
Rank	2	1	3

7. CONCLUSION

The experimental work done on the effect of fiber loading, filler content on mechanical and also the effect of coating on sliding wear behavior of E-glass reinforced epoxy composite leads to obtain the following conclusions from the present study as follows:

1. Fabrication of E- glass fibre reinforced epoxy composites with filler composites is done using a simple hand lay-up technique.
2. The addition of glass fibre in the composites improves the mechanical property of polymer resin. The tensile strength of the composites increases with the increase in fibre loading. Also found significant factor is hardener in terms of MEKP catalyst by ANOVA analysis.

REFERENCES

[1] Madu K, Okoronkwo G O, Nwankwo E I. Effects of fiber volume fraction and curing time on impact – Hardness strength properties of Areca fibers reinforced polyester thermoset composites. Research Journal of Mechanical Operations, 2019, 1, 31−37.

[2] Dhanalakshmi S, Ramadevi P, Basavaraju B. A study of the effect of chemical treatments on areca fiber reinforced polypropylene composite properties. Science and Engineering of Composite Materials, 2017, 24, 501−520.

[3] Bobbili R, Madhu V. Sliding wear behavior of E-glass-epoxy/MWCNT composites: An experimental assessment. Engineering Science and Technology, an International Journal 19 (2016) 8–14

[4] Erden S, Yıldız H. Enhancement of interfacial strength in 'carbon fiber/thermoplastic matrix' composites. In: 3rd international technical textiles congress, Istanbul, December; 2007. p. 426–45.

[5] M. Jawaid, H.P.S. Abdul Khalil. Cellulosic/Synthetic Fiber Reinforced Polymer Hybrid Composites: A Review, Carbohydrate Polymers, Vol. 86, pp. 1–18, 2011.

[6] Gad Marom, Albert Reuveni and Daniel Cohn, "Stiffness Variability and Stress-Dependent Elastic Response of Synthetic Fiber-Reinforced Composites for Biomedical Applications", Biomaterials, Vol. 14, No. 2, (1993).

[7] Jansons, J.O., Glejbol, K., Rytter, J., Aniskevich, A.N., Arnautov, A.K. & Kulakov, V.L. "Effect 0f Water Absorption, Elevated Temperatures And Strength on the Mechanical Properties of Carbon-Fiber-Reinforced Epoxy Composites for Flexible Risers", Mechanics of Composite Materials, Vol. 38(4), pp.299-310, 2002.

[8] Kutty, S. K. & Nando, G. B. "Effect of Processing Parameters on the Mechanical Properties of Short Kevlar Aramid Fiber-Thermoplastic Polyurethane Composite Plastics", Rubber and Composites Processing and Applications, Vol.19 (2), pp.105-110, (1993).

[9] Cho, J., Chen, J. Y. & Daniel, I. M. "Mechanical Enhancement of Carbon Fiber/Epoxy Composites by Graphite Nanoplatelet Reinforcement", Scripta materialia, Vol.56 (8), pp. 685- 688, (2007).

[10] Chauhan, S. R., Gaur, B. & Dass, K. "Effect of Fiber Loading on Mechanical Properties, Friction and Wear Behaviour of Vinylester Composites Under Dry and Water Lubricated Conditions", International Journal of Material Science,Vol. 1(1), pp. 1-8, (2011).