EXPERIMENTAL INVESTIGATION ON THE MECHANICAL PROPERTIES OF A PMC AND HYBRID PMC

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Abstract - *In this experimental work, the mechanical properties of a Glass Fiber Reinforced composite are compared with Hybrid composite laminate reinforced with stainless steel wire mesh is investigated. The stainless steel wire mesh along with Glass fiber is sequentially stacked to fabricate hybrid composite material. The laminates are fabricated using the hand-layup method with a 50 % weight fractions of epoxy resin, 50 % weight fractions of glass fiber and the remain being SSWM and with a 40% weight fractions of epoxy resin, 60% of glass fiber, SSWM,. The mechanical characteristics of the composites are obtained using tensile and drop weight impact tests and results were compared with the theoretical calculations.*

Key Words: *Glass fibre, Hybrid composite, hand layup process, laminate, SSWM.*

1. INTRODUCTION

Polymer-matrix composites consist of a polymer resin as the matrix, with fibers as the reinforcement medium. These materials are used in the greatest diversity of composite applications, as well as in the largest quantities, in light of their room-temperature properties ease of fabrication, and cost. Hybrid Composite: A relatively new fiber-reinforced composite is the hybrid, which is obtained by using two or more different kinds of fibers in a single matrix; hybrids have a better all-around combination of properties than composites containing only a single fiber type. A variety of fiber combinations and matrix materials are used.

2. FABRICATION OF COMPOSITE

The laminates are fabricated using the hand-layup method. The processing steps are quite simple. First of all, a release gel is sprayed on the mold surface to avoid the sticking of polymer to the surface. Thin plastic sheets are used at the top and bottom of the mold plate to get good surface finish of the product. Reinforcement in the form of mesh or strand mats are cut as per the mold size and placed at the surface of mold. Then thermosetting polymer in liquid form is mixed thoroughly in suitable proportion with a prescribed hardener and poured onto the surface of mesh already placed in the mold. The polymer is uniformly spread with the help of brush. Second layer of mat is then placed on the polymer surface and a roller is moved with a mild pressure on the mat-polymer layer to remove any air trapped as well as the excess polymer present. In present work the resin LY556 with hardener is selected as polymer and Glass Fibers for composite sheet, glass fiber and Stainless Steel wire mesh for hybrid composite. The following Laminates were made using Hand Lay-Up method.

Resin + Glass Fiber (PMC) .
Resin + Glass Fiber + Stainless Steel Wire Mesh (HPMC).

3. Test Specimen Preparation

Consider the typical tensile specimen shown in Fig. 1. It has enlarged ends or shoulders for gripping. The important part of the specimen is the gage section. The cross-sectional area of the gage section is reduced relative to that of the remainder of the specimen so that deformation and failure will be localized in this region. The gage length is the region over which measurements are made and is centered within the reduced section. The distances between the ends of the gage section and the shoulders should be great enough so that the larger ends do not constrain deformation within the gage section, and the gage length should be great relative to its diameter.

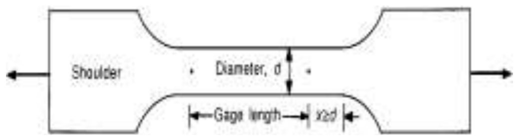


Fig. 1: Tensile specimen

Izod Impact testing is an ASTM standard method of determining the impact resistance of materials. A pivoting arm is raised to a specific and then released. The arm swings down hitting a notched sample, breaking the specimen. The energy absorbed by the sample is calculated from the height the arm swings to after hitting the sample. A notched sample is generally used to determine impact energy and notch sensitivity. Charpy impact testing involves striking a standard notched specimen with a controlled weight pendulum swung from a set height. The standard Charpy-V notch specimen is 55mm long, 10mm square and has a 2mm deep notch with a tip radius of 0.25mm machined on one face.

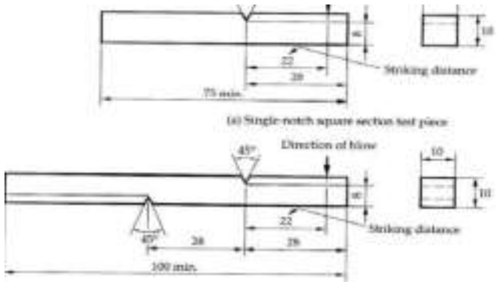


Fig 2: Izod & Charpy Test Specimen

4. EXPERIMENTAL RESULTS

The test sample is securely held by top and bottom grips attached to the tensile or universal testing machine. During the tension test, the grips are moved apart at a constant rate to pull and stretch the specimen. The force on the specimen and its displacement is continuously monitored and plotted on a stress-strain curve until failure. The measurements, tensile strength, yield strength and young's modulus, are calculated after the tensile test specimen has broken. The tensile test and Impact test results are tabulated corresponding to the two composites, PMC (Glass fiber) and HPMC (Glass fiber + SSWM).

Table -1: Tensile Test (Glass Fiber)

S.No	Composite (Random Orientation)	Ult.Load (KN)	Disp.at F_{Max} (mm)	Max.Disp (mm)
1	Glass Fibre	10.16	4.7	5.5
2	Glass Fibre	10.78	3.4	4.0
3	Glass Fibre	11.46	5.0	5.3
	Average	10.8	4.36	4.93

Fig 3: Before Testing

Fig 4: After Testing

Table2: Tensile Test (Glass Fiber + Stainless Steel)

S.No	Hybrid Composite (Random Orientation)	Ult.Load (KN)	Disp.at F_{Max} (mm)	Max.Disp (mm)
1	GF+ SS	15.08	3.8	4.1
2	GF+ SS	13.46	4.4	4.6
3	GF+ SS	13.94	10.7	11.0
	Average	14.16	6.3	6.56

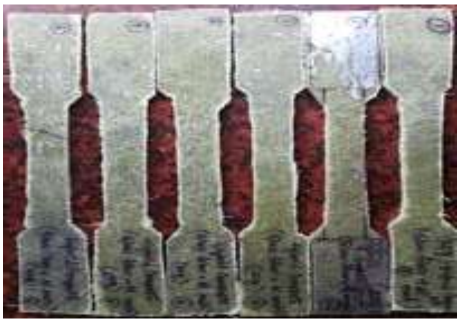


Fig 5: Before Testing

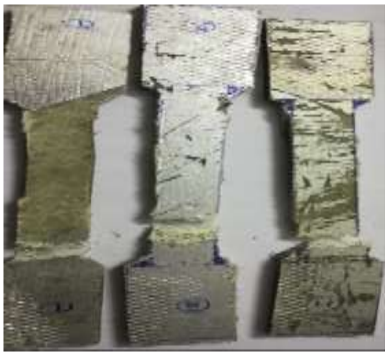


Fig 6: After Testing

Table3: IZOD Test (Glass Fiber)

S.No	Composite (Random orientation)	Area at the Notch (mm^2)	Energy absorbed (J)	Impact (J/mm^2)
1	Glass Fibre	80	166	2.075
2	Glass Fibre	80	164	2.05
3	Glass Fibre	80	162	2.025
	Average		164	2.05

Fig 5: Before Testing

Fig 6: Before Testing

Table 4: IZOD Test (Glass Fiber + Stainless Steel)

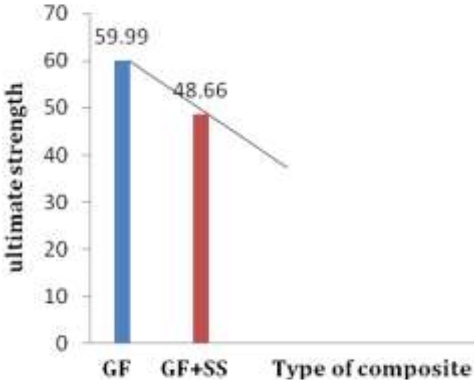
S.No	Hybrid Composite (Random orientation)	Area at the Notch (mm²)	Energy absorbed (J)	Impact (J/mm²)
1	Stainless	80	286	3.575
2	Stainless	80	288	3.6
3	Stainless	80	290	3.625
	Average		288	3.6

Fig 7: Before Testing

Fig 8: Before Testing

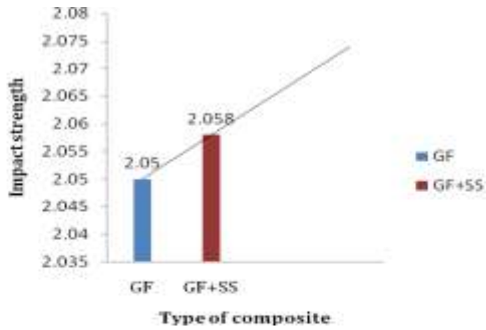
The test results were compared by plotting graphs between the two composites.

Graph 1: Tensile Test



The graph trend shows that there is a decrese in the ultimate strenghth because of introducing SSWM into Glass fibers.

Graph 2: IZOD Test



The graph trend shows that there is a slight increment in the impact strength because of introducing SSWM into Glass fibers.

5. CONCLUSIONS

- From the results, the following observations and conclusions are drawn.
- The ultimate strength and breaking load of GFRP (random orientation) is 59.99 Gpa and Impact strength =2.05 J/mm².
- The ultimate strength and breaking load of Hybrid composite is 48.66 GPA and Impact strength =2.058 J/mm².
- The Stainless Steel Wire Mesh is completely laminated under glass fiber, as a result the hybrid composite material has the same brittle property at outer layers as that of GFRP, due to which the ductile properties of stainless steel wire mesh has less significance when compared to GFRP.
- The orientation of Glass fibers is random, due to which the applied load is not completely transferred to SSWM. Hence the significance of load bearing capacity of wire mesh is not appreciable. If the Glass Fibers are laminated in predefined orientations then there is a chance of significant improvement in the properties can be observed in hybrid composite.

6. REFERENCES

[1] Ranga Raj R., Velmurugan R., Dinesh C., Balaji S. (Department of Aeronautical Engineering, Anna University, Chennai)"Experimental Test of Stainless Steel Wire Mesh and Aluminium Alloy With Glass Fiber Reinforcement Hybrid Composite". Int. Journal of Engineering Research and Applications ISSN : 2248-9622, Vol.5, Issue 5, (Part -6) May 2015, pp.80-88.

[2] C. Soutis, Carbon fibre reinforced plastics in aircraft construction, Materials Science and Engineering, A, 412 (2005), 1–2, 171–176, doi:10.1016/j.msea.2005.08.064

[3] V. S. Sreenivasan, D. Ravindran,V. Manikandan, R. Narayanasamy, Mechanical properties of randomly oriented short Sansevieria cylindrica fibre/polyester composites, Materials and Design, 32 (2011) 4, 2444–2455, doi:10.1016/j.matdes.2010.11.042

[4] M. I. Ismail, Q. Payam Shafigh, Md. Zamin Jumaat, A. Ibrahim Abdull, Z. Ibrahim,U. Johnson Alengaram, The use of wire mesh–epoxy composite for enhancing the flexural performance of concrete beams, Materials and Design, 60 (2014) 11, 250–259, doi:10.1016/j.matdes.2014.03.075

[5] 7 M. I. Okereke, Flexural response of polypropylene/ E-glass fibre reinforced unidirectional composites, Composites Part B: Engineering, 89 (2016), 388–396. doi:10.1016/j.compositesb. 2016.01.007