Mechanical Characterization of Thermoset Polyester /Glass Fiber Pmc's

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***Abstract*--The aim of this work is to synthesis and evaluation of the mechanical characterization such as tensile, compression & bending test. The mechanical properties of the thermoset polymer changes gradually or drastically by changing the layers of fiber. Specimen is prepared as per the ASTM standard. Glass fiber reinforced polyester composite with different layers of glass fibers of woven mat & chopped mat were prepared to conduct tests. The results have been plotted & compared.**

Key words : Polyester, Glass fiber, Mechanical Properties.

INTRODUCTION

A composite material is a non uniform solid consisting of two or more different materials that are mechanically bonded together. Each of the various components retains its identity in the composite and maintains its characteristic structure and properties. Generally, the structure of a composite consists of two phases, matrix and reinforcement. The matrix is a continuous phase and the reinforcement is a discontinuous one. The composite materials, however, generally possess combination of properties such as stiffness, strength, weight, high temperature performance, corrosion resistance, hardness and conductivity which are not possible with the individual components. Indeed, composites are produced when two or more materials or phases are used together to give a combination of properties that cannot be achieved otherwise. The different fiber reinforced polyester laminates were prepared with different layers of glass fibers. Glass fiber reinforced plastics composite is extensively used as a structural material for pools, oil pipes and tanks because it has good corrosion resistance properties. The mechanical properties of the FRP composites will alter by addition of other materials to the resin [3]. The mechanical properties have increases by changing or modifying the surface properties of the fiber's [4].

EXPERIMENTAL PROCEDURE

The basic manufacturing process is simple. Fabrics are laid up as a dry stack of materials. These fabrics are sometimes pre-pressed to the mould shape, and held together by a binder. These 'performs' are then more easily laid into the mould tool. A second mould tool is then clamped over the first, and resin is injected into the cavity. Vacuum can also be applied to the mould cavity to assist resin in being drawn into the fabrics. This is known as Vacuum Assisted Resin Injection (VARI). Once all the fabric is wet out, the resin inlets are closed, and the laminate is allowed to cure. Both injection and cure can take place at either ambient or elevated temperature.

Mechanical properties (i.e, Tensile, bending and Compression) were measured using INSTRON testing machine as per prevailing ASTM testing standards. An INSTRON -UTM of 100KN capacity with the necessary specimen holding accessories was used to evaluate the properties of glass fiber reinforced polyurethane composites and polyurethane based fiber metal composites. The tensile test was carried out at the speed of 1mm/min in the UTM. The graphs which were obtained are studied. The three point bending test was carried out and the graphs were analyzed.

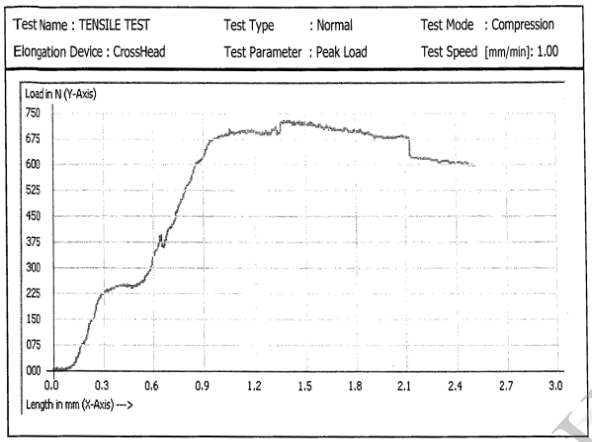
Figure 1 : Specimen prepared & cut for tensile test

In this study, six different types of three layered GFRP (3 specimen samples of chopped stand glass fibers and 3 specimen samples of woven stand glass fibers) were prepared.

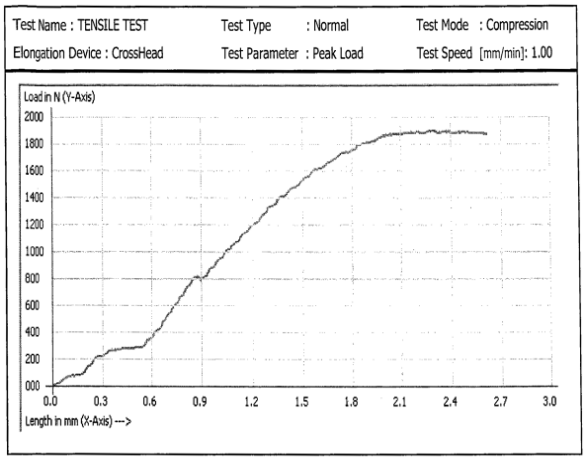
RESULTS AND DISCUSSION

Tensile test: The tensile test is conducted for the specimen of GFRP composite with 1,2 and 3 layers of woven and chopped strand glass fibers at a rate of 1mm/min on the Instron UTM and the results are noted down. The graph is generated for the tested specimens. And the graphs are as shown below.

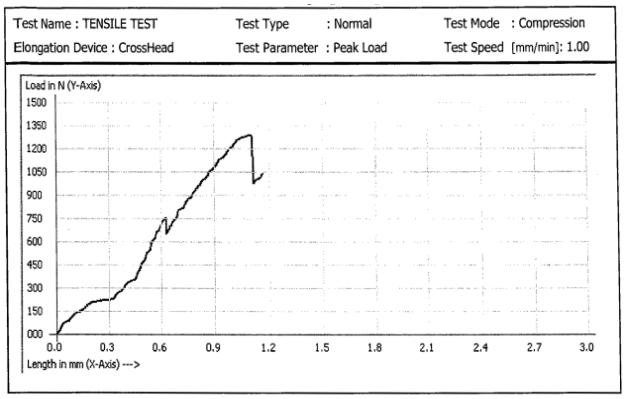
For 1 layer chopped stand glass fiber.



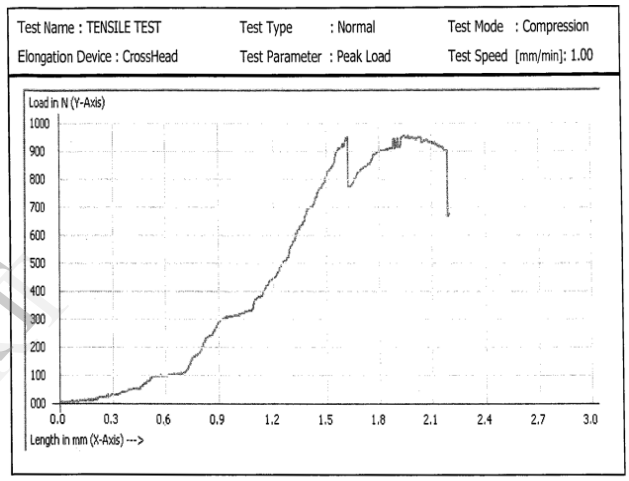
For 2 layer chopped stand glass fiber



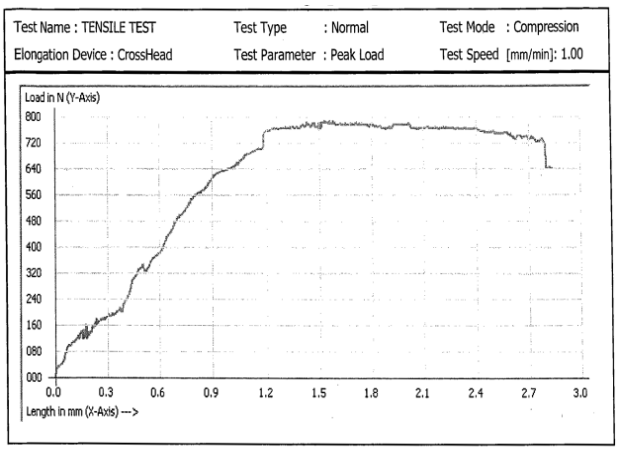
For 3 layer chopped stand glass fiber.



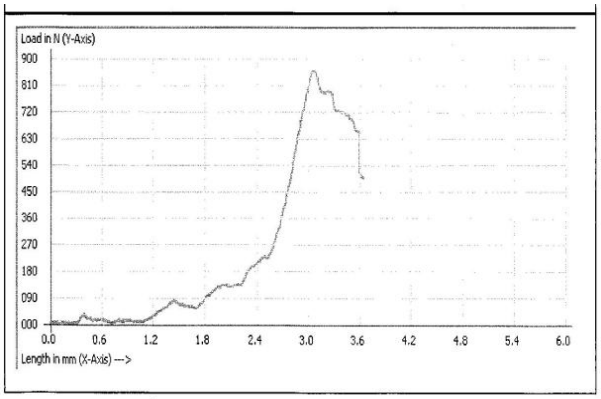
For 1 layer woven strand glass fiber.



For 2 layer woven strand glass fiber.



For 3 layer woven stand glass fiber



Sample Details : 3LW

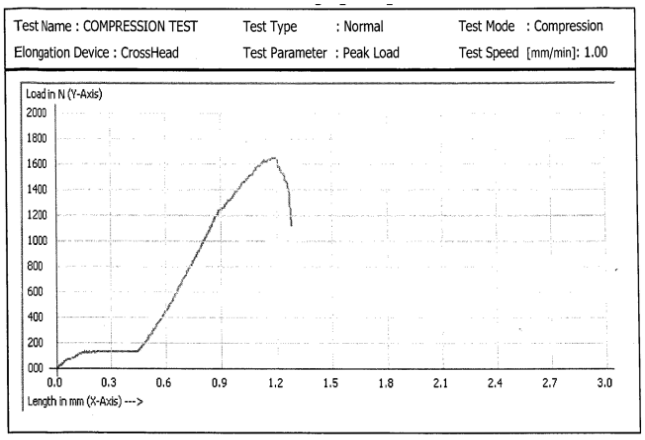
Samples	Specimen type	Peak Load (N)	%Elongation	Break Load (N)
1	1LCSM	729	1.3	600
2	2LCSM	1895	2.3	1850
3	3LCSM	1286	1.1	1050
4	1LWSM	1437	0.8	1425
5	2LWSM	787	1.5	640
6	3LWSM	850	3.2	500

Table of tensile test

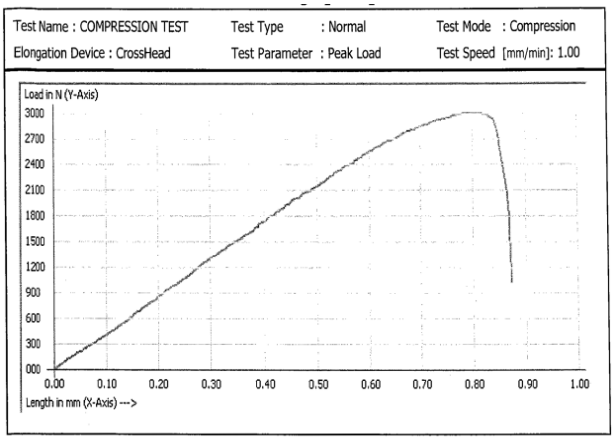
COMPRESSION

The compression test is conducted for the specimen of GFRP composite with 1,2 and 3 layers of woven and chopped strand glass fibers at a rate of 1mm/min on the Instron UTM and the results are noted down. The graph is generated for the tested specimens. And the graphs are as shown below..

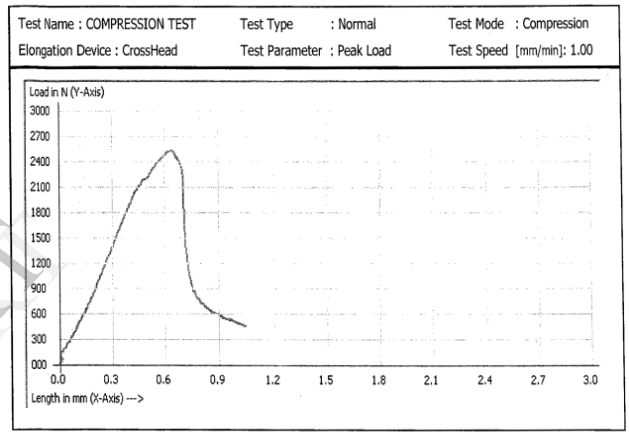
For 1 layer Chopped strand glass fiber



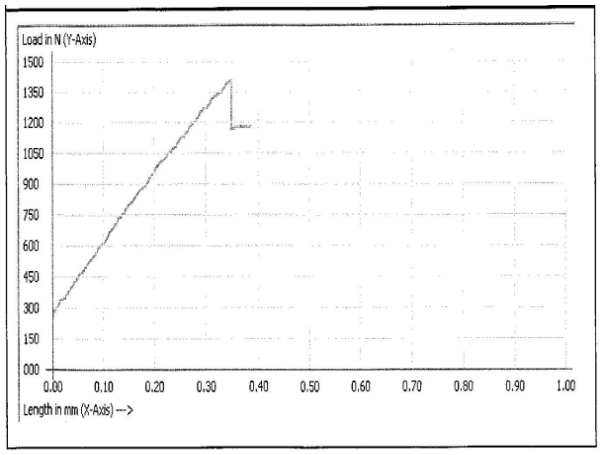
For 2 layer Chopped strand glass fiber



For 3 layer Chopped strand glass fiber

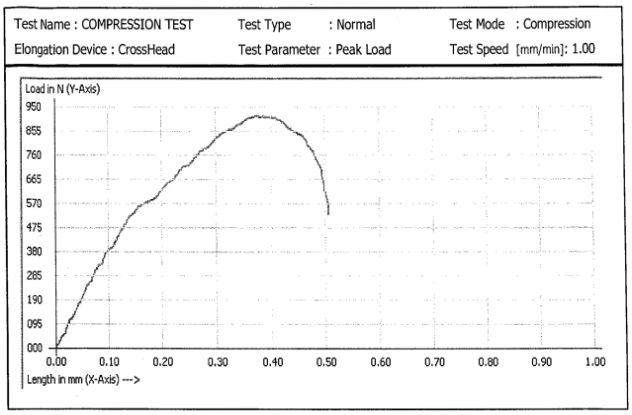


For 1 layer Woven strand glass fiber

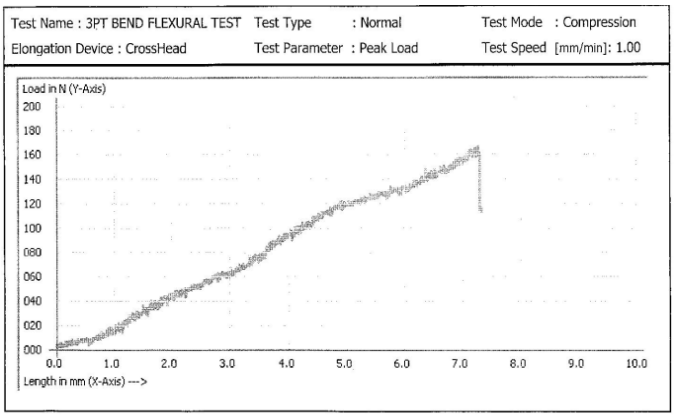


Sample Details : 1LW

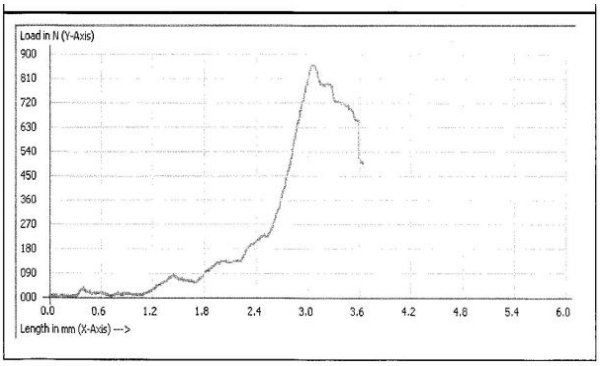
For 2 layer Woven strand glass fiber



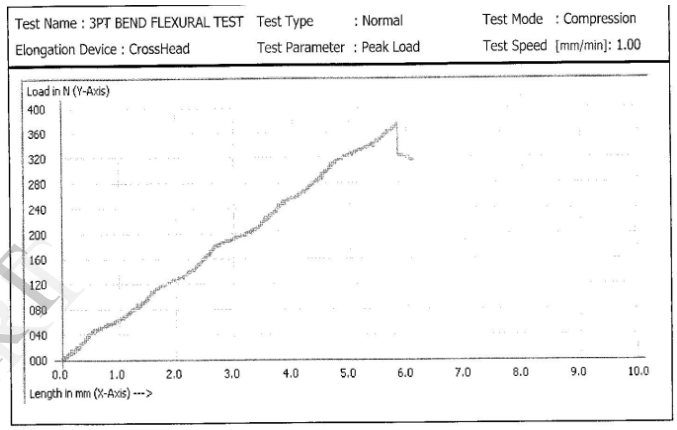
For 3 layer Woven strand glass fiber



For 2 layer chopped strand glass fiber



Sample Details : 3LW



Sample Details : 2LC

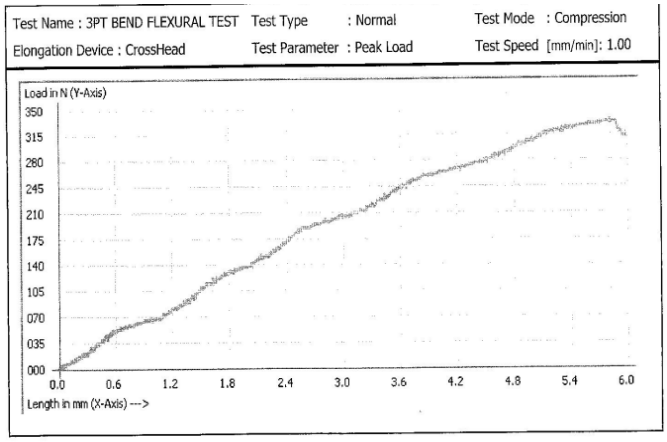
For 3 layer chopped strand glass fiber

Samples	Specimen type	Peak Load (N)	%Elongation	Break Load (N)
1	1LCSM	1643	1.2	1100
2	2LCSM	2999	0.8	521.8
3	3LCSM	2532	0.65	550
4	1LWSM	1400	0.35	1200
5	2LWSM	912	0.38	510
6	3LWSM	860	0.37	500

Table for compression test

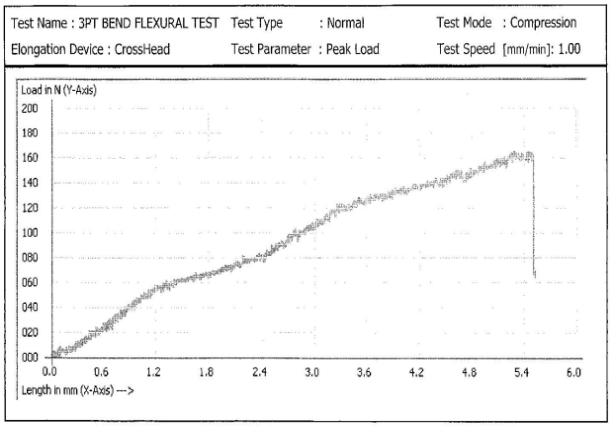
Bending: The three bending test is conducted for the specimen of GFRP composite with 1,2 and 3 layers of woven and chopped strand glass fibers at a rate of 1mm/min on the Instron UTM and the results are noted down. The graph is generated for the tested specimens. And the graphs are as shown below..

For 1 layer chopped strand glass fiber



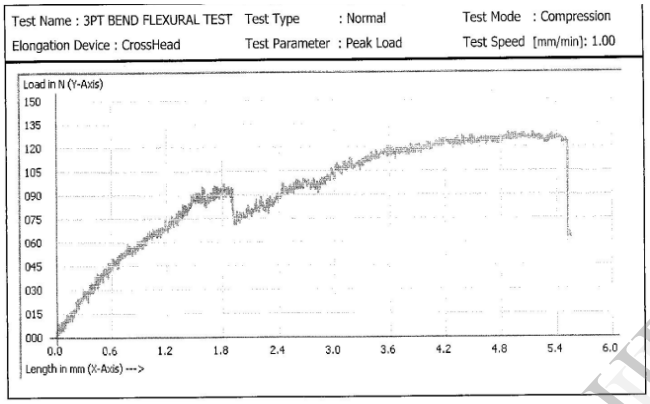
Sample Details : 3LC

For 1 layer Woven strand glass fiber



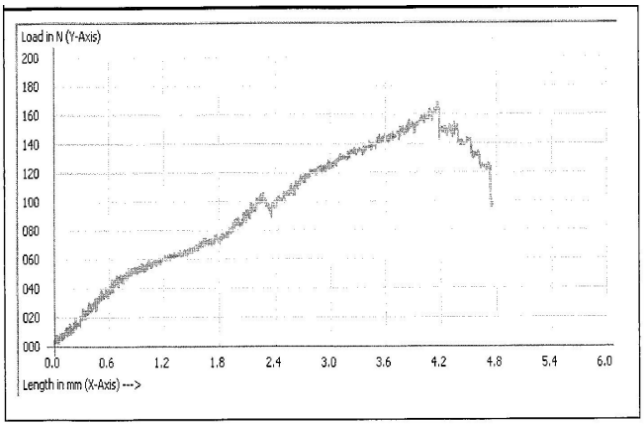
Sample Details : 1LW

For 2 layer Woven strand glass fiber



Sample Details : 2LW

For 3 layer Woven strand glass fiber



Sample Details : 3LW

Samples	Specimen type	Peak Load (N)	%Elongation	Break Load (N)
1	1LCSM	167	9.19	110
2	2LCSM	375	7.66	300
3	3LCSM	334	7.5	310
4	1LWSM	165	6.93	70
5	2LWSM	129	6.95	68
6	3LWSM	168	5.5	100

Table bending testing

DICUSSION

TENSILE :

- From the obtained graph we can observe that the laminate with 2 layer of chopped strand glass fibers can with stand more load than the rest of the laminates.
- The elongation % of the 3 layered woven mat laminate has more compare to that of others.
- The break load required for the composite with 2 layer chopped strand FRP is more than that of others.

COMPRESSION

- We can observe from the obtained graph that the load withstanding capacity is more for the 2 layer chopped strand composite matrix than that of the other types.
- The breaking load for the composite with 3 layer woven strand matrix is less than that of the other types.
- The 3 layer chopped strand matrix composite has got considerable high strength and it has less %elongation that of the other.

BENDING

- We can observe from the obtained graph that the load withstanding capacity is more for the 2 layer chopped strand composite matrix than that of the other types.
- The breaking load for the composite with 3 layer woven strand matrix is more than that of the other types.

CONCLUSION

- All the results obtained from the test we can observe that the composite laminate with 2 layer of chopped strand glass fiber matrix is more stronger than that of the rest of the samples

REFERENCES

1. **"**Introduction to Composite Materials" F.C Campbell Structural Composite Materials Copyright © 2010, ASTM International.
2. **"**Laminated Composite Plates" David Roylance Department of Materials Science and Engineering Massachusetts Institute of Technology Cambridge, MA 02139 February 10, 2000
3. M. Ramesh, K. Palanikumar, K. Hemachandra Redd"Mechanical property evaluation of sisal–jute–glass fiber reinforced polyester composites" Composites Part B: Engineering, Volume 48, May 2013, Pages 1-9
4. Cs. Varga, N. Miskolczi, L. Bartha, G. Lipóczi "Improving the mechanical properties of glass-fibre-reinforced polyester composites by modification of fibre surface" Materials & Design, Volume 31, Issue 1, January 2010, Pages 185-193
5. N. Miskolczi "3 – Polyester resins as a matrix material in advanced fibre-reinforced polymer (FRP) composites" Advanced Fibre-Reinforced Polymer (FRP) Composites for Structural Applications, 2013, Pages 44-68.
6. ASTM D 3039 Test Method for Tensile Properties of Polymer Matrix Composite Materials
7. Haşim Pıhtılı, Nihat Tosu "Investigation of the wear behaviour of a glass-fibre-reinforced composite and plain polyester resin" Composites Science and Technology, Volume 62, Issue 3, February–March 2002, Pages 367-370.
8. Lekhnistskii's G, Tsai WS, Cheron T. Anisotropic plates. NewYork: Gordon and Breach Science Publishers; 1968
9. "Polyester resins as a matrix material in advanced fibre-reinforced polymer (FRP) composites"Advanced Fibre-Reinforced Polymer (FRP) Composites for Structural Applications, 2013, Page 44-68 N. Miskolczi
10. "Improving the mechanical properties of glass-fibre-reinforced polyester composites by modification of fibre surface" Cs. Varga, N. Miskolczi, L. Bartha, G. Lipóczi Materials & Design, Volume 31, Issue 1, January 2010, Pages 185-193