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Fabrication and Mechanical Characterization of Plain and Metal Mesh Glass Fibre Reinforced Hybrid Composites

Senthil J*, Kalyana Kumar S, Saravanan M, Pagalavan M
[1, 2, 3]Mechanical Engineering, Aarupadai Veedu Institute of Technology, Vinayaka Missions University
[4] Manufacturing Engineering, Aarupadai Veedu Institute of Technology, Vinayaka Missions University
***Corresponding author: E-Mail: jsenthil@avit.ac.in**

ABSTRACT

Metal-fibre reinforced hybrid composites are used in various applications in the aircraft, spacecraft, automobile, consumer products sector. The performance characteristics of such re-in forced hybrid composites are to be studied before using them in any applications. Since analytical methods are complicated due to anisotropic nature of composites, investigational procedures are widely used to characterize composite materials.

This work focuses on the fabrication and investigation on tensile, flexural behaviour of plain and metal mesh fibre reinforced hybrid composites. The specimens were fabricated and tested for the above mentioned characteristics as per ASTM standards. The Tensile property of the plain laminates, laminates with single plain mesh and double plain mesh are found to be 100.64 N/mm^2, 55.55 N/mm^2 and 66.05 N/mm^2 respectively viz., Laminate with plain mesh have more tensile strength. The Flexural strength of the plain laminates, laminates with single plain mesh and double plain mesh are found to be 900 N/mm^2, 1000N/mm^2 and 1000N/mm^2 respectively. Flexural strength of metal mesh laminates shows some improvement when compared to plain laminates.

KEY WORDS: Hybrid composites, Metal mesh, Glass Fibre.

1. INTRODUCTION

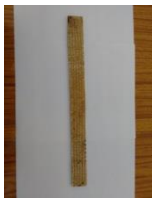
The main components of structural composites are the reinforcements and the matrix. The reinforcements that are tough in property are dispersed in a comparatively less tough material. The reinforcements withstand more load in many cases, especially in a weak matrix dispersion. The strength and stiffness of such composites are, dependent on fibres. When the properties of reinforcements and matrices are not much deviated, matrix stakes the load. Generally composites are classified based on reinforcements or the matrices used. There are two major forms of reinforcements: Fibre and particulate reinforced composites.

Glass Fibres: Glass was first made by man in 3000 BC in Asia Minor. Continuous glass fibres were known to be used for decorative purposes in ancient times in Syria and Venice. The industrial manufacturing was started in 1930`s for use in filters and insulations. The different types of glasses that are used to make such fibres are A glass (high alkali), C glass (chemical), D glass (low dielectric constant), E glass (electrical) and S glass (high strength).

2. METHODS & MATERIALS

Methodology-Fabrication: Hybrid composites are made-up by hand lay- up molding technique. A three different composite laminate were fabricated viz, Plain Laminates, Laminates with single Metal mesh and Laminates with double Metal mesh alternatively arranged (Sandwich type).

Composite laminates of dimension 300X300X5 ± 1mm were fabricated with glass fabric by laying up one by one and coating each layer with a premixed and homogenized Epoxy LY- 566 and with hardener HY – 956 and pressing each layer by roller. The resin and the hardener were mixed in the ratio 10:1 volume. After laying each layer rolling was carried with a hand roller. Pressure of 1.10MPa was applied on the hand layup laminates and the epoxy was allowed to set for almost a day. A laminate with 5 glass fibre layers (Sample1) was thus manufactured (Figure 1a).



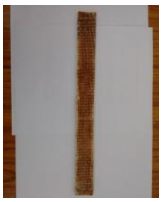


Figure.1(a) **Figure.1(b)** **Figure.1(c)**

Composite laminate with plain mesh was fabricated with a geometric mid layer as metal (Aluminium) mesh. The remaining layers being glass fabric by laying up the layers of the glass fabric one by one and coating each layer with a premixed and homogenized epoxy LY -566 and with hardener HY – 956 and press each other by roller. The mesh is cut as per required size (Figure 1b). The third sample was fabricated by arranging glass fibre and aluminium mesh alternatively (Glass Fibre-Mesh- Glass Fibre-Mesh-Glass Fibre) as revealed in Figure 1c.

Testing: The laminates were exposed to Tensile Test and Flexural Test. The samples were cut according to ASTM D638M 84 standards (Table 1).Then they were tested for tensile strength using the universal testing machine and applying tensile load. Typical photographs of tensile test specimen after testing as given in Figure 2.

Table.1. Tensile Test (ASTMD638M 84)

Parameter	Dimension
Length (l)	250 ± 1 mm
Breadth (b)	25 ± 1 mm
Thickness (t)	5 ± 1mm

Table.2. Flexural Test (ASTM790-02)

Parameter	Dimension
Length (l)	300 ± 1 mm
Breadth (b)	25 ± 1 mm
Thickness (t)	5 ± 1mm

(a) Plain **(b) Single Mesh** **(c) Double Mesh**

Figure.2. Tensile Test Specimens after Testing

As per the ASTM790-02 standards, the samples were tested for flexural strength. Typical photographs of Flexural test sample after testing are portrayed in Figure 3. Figure 3 Flexural Test Samples before Testing

(a) Plain **(b) Single Mesh** **(c) Double Mesh**

Figure.3. Flexural Test Specimens after Testing

3. RESULT AND DISCUSSIONS

Composites were made-up and the tests were performed on the test specimens. The tensile and flexural Strength results of the plain laminates, laminates with single mesh and laminates with double mesh are shown in below table 3 and table 4 respectively.

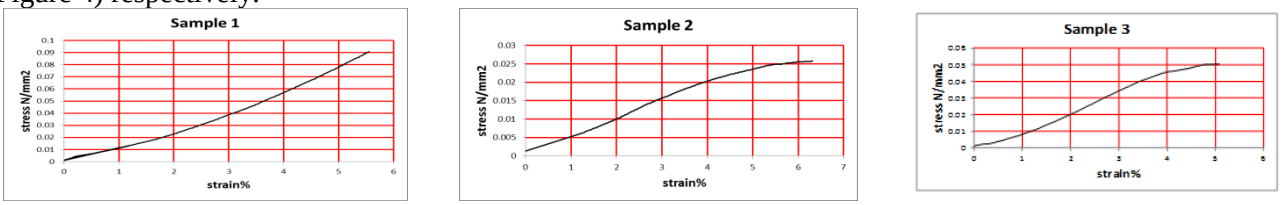
Table.3. Summary of Tensile Test Result

Test Parameters	**Plain Laminate**	**Laminate With Single Mesh**	**Laminate With Double Mesh**
Ultimate Tensile load (KN)	12.455	4.675	6.01
Ultimate Tensile Strength ((N/mm^2)	100.64	55.5545	66.0315

Table.4. Summary of Flexural Test Result

Test Parameters	**Plain Laminate**	**Laminate With Single Mesh**	**Laminate With Double Mesh**
Bending load(KN)	0.565	0.020	0.055
Bending Strength (N/mm^2)	900	1000	1000

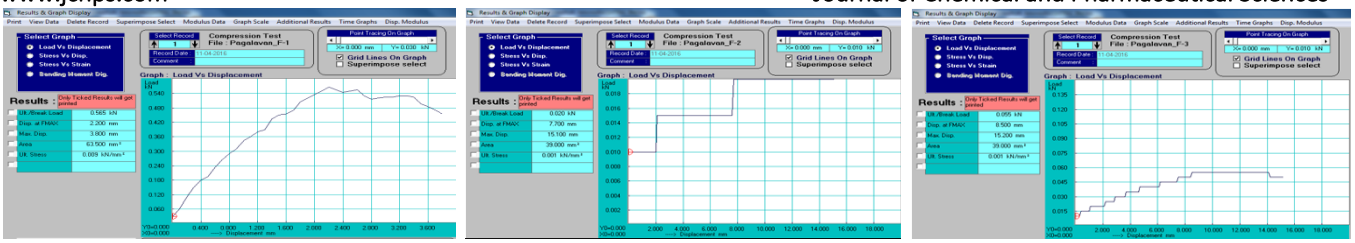
The stress Vs strain graph for the plain laminates, laminates with single mesh and laminate with double mesh (Figure 4) respectively.



(a) Plain **(b) Single Mesh** **(c) Double Mesh**

Figure.4.Stress Vs strain Graph for Laminates

The load Vs Displacement graph for the plain laminates, laminates with single mesh and laminate with double mesh (Figure 5) respectively.



(a) Plain **(b) Single Mesh** **(c) Double Mesh**

Figure.5. Load Vs Displacment Graph for Laminates

4. CONCLUSION

From the above investigation on the tensile and flexural behavior of plain and metal mesh cored glass fibre, the Tensile strength of the plain laminates, laminates with single plain mesh and double plain mesh are found to be 100.64 N/mm^2, 55.55 N/mm^2 and 66.05 N/mm^2 respectively viz., Laminate with plain mesh have more tensile strength. The Flexural strength of the plain laminates, laminates with single plain mesh and double plain mesh are found to be 900 N/mm^2, 1000N/mm^2 and 1000N/mm^2 respectively. Flexural strength of metal mesh laminates shows some improvement when compared to plain laminates.

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