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Experimental Investigation of Thermal Properties in Glass Fiber Reinforced with Aluminium

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Abstract. A test method of a Guarded heat flow meter are used to measure the thermal conductivity of glass fiber and filled with a aluminum powder epoxy composites using an instrument in accordance with ASTM. This experimental study reveals that the incorporation of aluminum and glass fiber reinforced results in enhancement of thermal conductivity of epoxy resin and thereby improves its heat transfer capability. Fiber metal laminates are good candidates for advanced automobile structural applications due to their high categorical mechanical and thermal properties. The most consequential factor in manufacturing of these laminates is the adhesive bonding between aluminum and FRP layers. Here several glass-fiber reinforced aluminum were laminates with different proportion of bonding adhesion were been manufactured. It was observed that the damage size is more preponderant in laminates with poor interfacial adhesion compared to that of laminates with vigorous adhesion between aluminum and glass layers numerically calculated ones and it is found that the values obtained for various composite models using experimental testing method.

1. Introduction

The most significant among them is their response to impact loading. A structure is subjected to an impact force when a foreign object hits it [1]. For instance, the loads imparted by dropped tool on the bonnet cover of car body, bird hit and runway debris on an aircraft engine are typical example of impact loads [6]. In its most rudimentary form a composite material is one, which is composed of at least two elements collaborating to engender material properties that are different to the properties of those elements on their own [2]. In practice, most composites consist of a bulk material (the 'matrix'), and a reinforcement of some kind, integrated primarily to increment the vigor and stiffness of the matrix [7]. This reinforcement is conventionally in fiber form. It withal avails to achieve directional properties. Reinforcements may be in the form of fibers, particles or flakes [3]. The fiber factors which contribute to the mechanical performance of a composite are length, orientation, shape and material. Matrix gives shape and forbends the reinforcement from the environment[4]. It also makes the individual fibers of the reinforcement act together and provides transverse shear strength and stiffness to the laminated composites[5].

2. Materials and Methods

In this laminate, Reinforcement such as Glass Fiber Reinforcement Plastic and E- Glass with Epoxy are utilized. The epoxy is having the correct ratio of resin and hardener is 10:1 where Resin: LY556 and Hardener HY951. The glass fibers come in variety of forms predicated on silica (SiO₂) which is amalgamated with other elements to engender specialty glass [8]. Fibers of glass are engendered by



extruding molten glass, at a temperature around 1200°C through apertures in a spinneret with diameter of 1 or 2 mm. Aluminum has a unique and unvanquishable cumulation of properties that make it into a multifarious, highly utilizable and alluring construction material

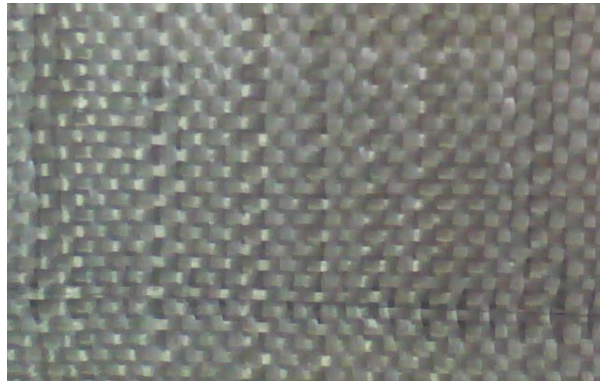


Figure.1 Glass Fiber

2.1 Laminate Preparation

Glass fiber with aluminum bidirectional type as shown in figure 2. is expected to withstand more stress. Albeit the method has been superseded with automated techniques, the lay-up of preimpregnated material by hand is the oldest and most mundane fabrication method for advanced composite structures such as laminated glass fiber as shown in figure.



Figure.2 Glass fiber with aluminum bidirectional type



Figure.3 Glass Fiber Laminated

3. Experimental Procedure

In the present work is to investigate the mechanical properties such as Flexural, Tensile and Impact Vigor of glass fiber epoxy laminate with and without Aluminum alloy. Tensile load applied to a composite as shown in figure 4. The replication of a composite to tensile loads is very ward on the tensile rigidity and vigor properties of the reinforcement fibers, since these are far higher than the resin system on its own. Test was carried out with the avail of UTM (Macroscopic Testing Machine).



Figure 4. Tensile Test

A beam has an unpredictable cross section area where subjected to a crosswise loads the beam will bend as shown in figure 5. In addition to bending the other effects such as crumple and buckling may occur, and to scrutinize a problem that includes all the compound effects of crumple, bending and buckling could become a convoluted one. Thus we are paying attention to scrutinize the bending property alone we have to put certain restrictions on the geometry of a beam and the manner of loading.



Figure 5. Compression Test

Static tension tests of the un-notched specimen's do not always divulge the sensitivity of metal to brittle fracture. This paramount factor is purposeful in impact test. In impact tests we utilize the notched specimen's as shown in figure 6. This specimen is settle on its fortifies on anvil so that gust of the striker is antithesis to the notch an impact vigor is defined as the energy A , required to break the specimen, $\text{Impact Vigor} = A / f$ Where $f = A$ cross sectional area of the specimen in cm^2 at crack & conspicuously at notch. The main purport of jagged – bar tests is to study the collateral effect of stress concentration and high velocity load application Impact test are of the most astringent type and facilitate brittle friction.



Figure 6. Impact Test

4. Results and Graphs

Ultimate tensile load (KN) : 6.81
Ultimate tensile strength (MPa (or) N/mm²) : 90.87

4.1. Tensile Test

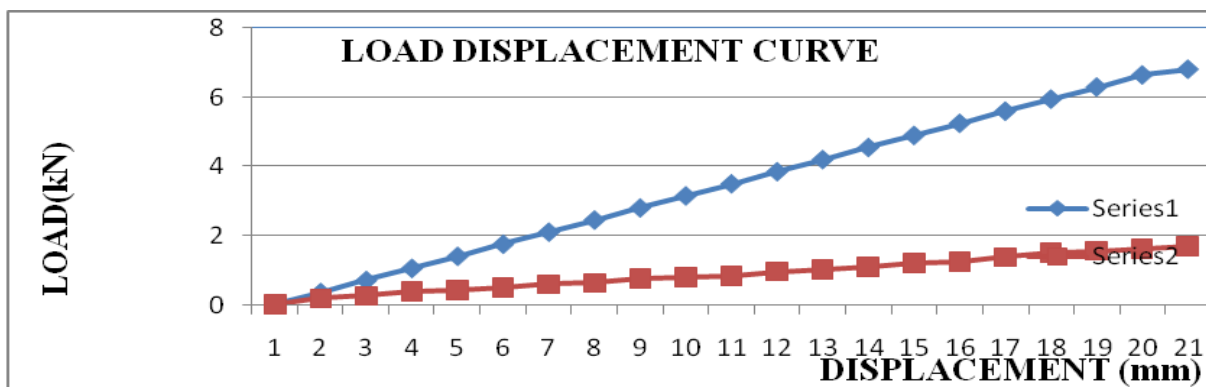


Figure 7. Load Displacement Curve GFRP

The Tensile test curve shows when the load applied on the specimen increases, the displacement also made of Glass Fiber Reinforced Polymer increases. The figure 7. indicates the load and displacement on tensile test for two different specimens.

4.2. Stress Vs Strain Graph

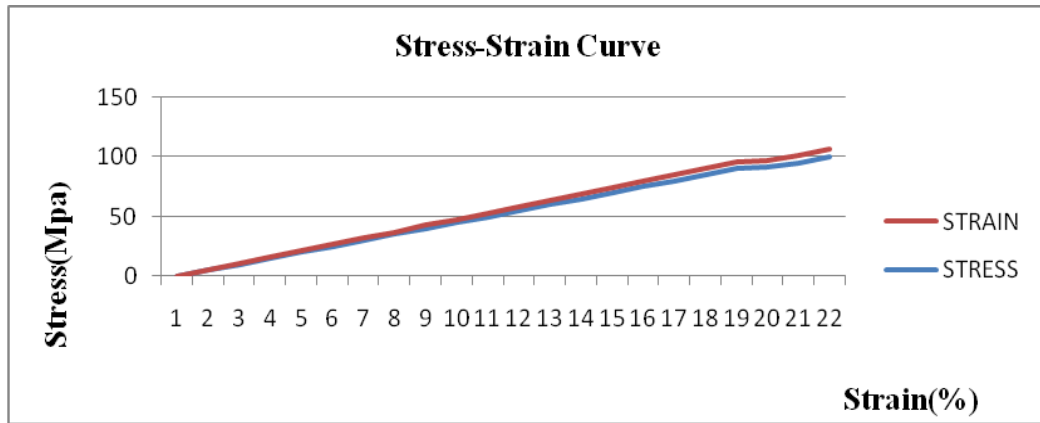


Figure 8. Stress Strain Curve GFRP

Figure 8. shows that when the stress of the specimen increases the strain also increases on glass fiber reinforced polymer. At the final stage stress is reduced compared to the strain curve.

4.3 Compression Test

Ultimate compressive load (KN) : 0.43
 Ultimate compressive strength (MPa (or) N/mm²) : 5.733

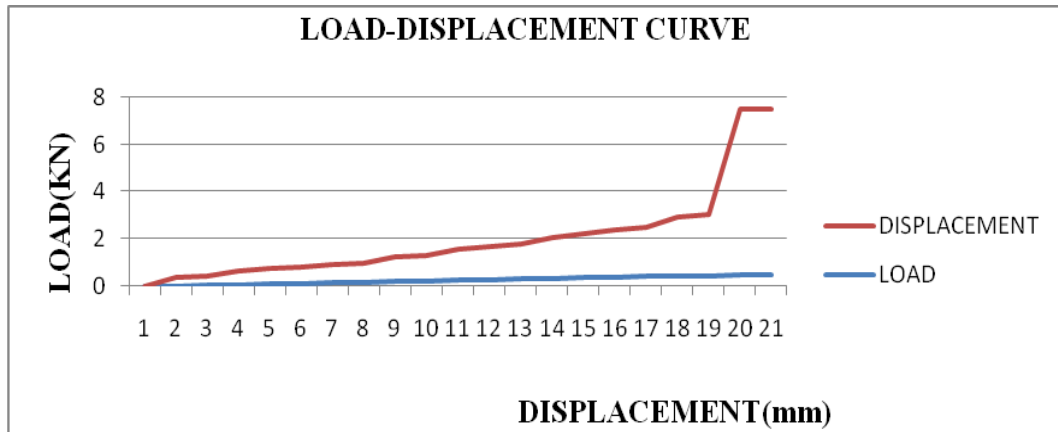


Figure 9. Load Displacement Curve GFRP

Figure 9. Shows the plot between load and displacement, initially when the load increases displacement also increases gradually and further when load reaches the maximum limit then the displacement will also reaches maximum. The load curve implies a linear distribution.

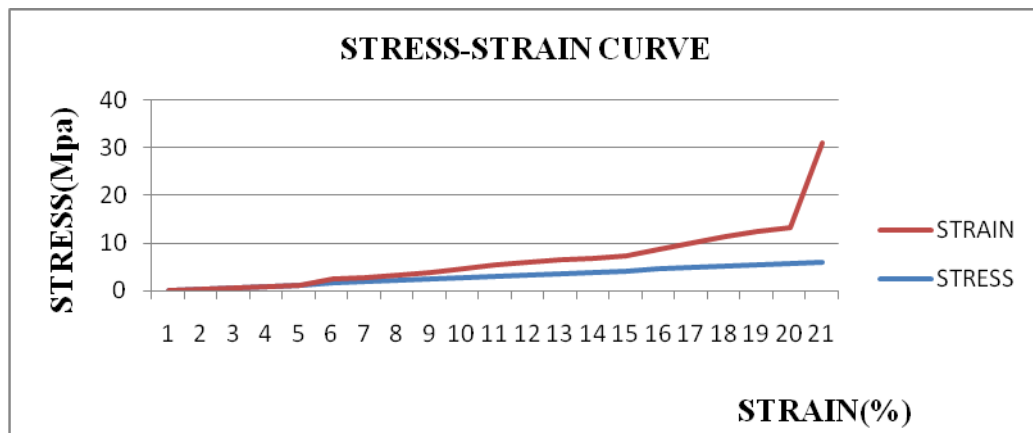


Figure 10. Stress Strain Curve GFRP

The plot between stress and strain for Glass Fiber Reinforced Polymer as shown in figure 10. represents when the stress increases strain gradually increases. Up to certain limit stress increases proportional to the strain, at the final stage stress limited to a minimum value.

Table 1. Impact Test GFRP

| Test parameters | Sample 1 | Sample 2 | Sample 3 | Average |
|-------------------------|----------|----------|----------|---------|
| Absorbed Energy- Joules | 6 | 6 | 6 | 6 |

5. GFRP- Al Result

5.1 Tensile Test

Ultimate tensile load (KN) : 7.90
 Ultimate tensile strength (MPa (or) N/mm²) : 105.33

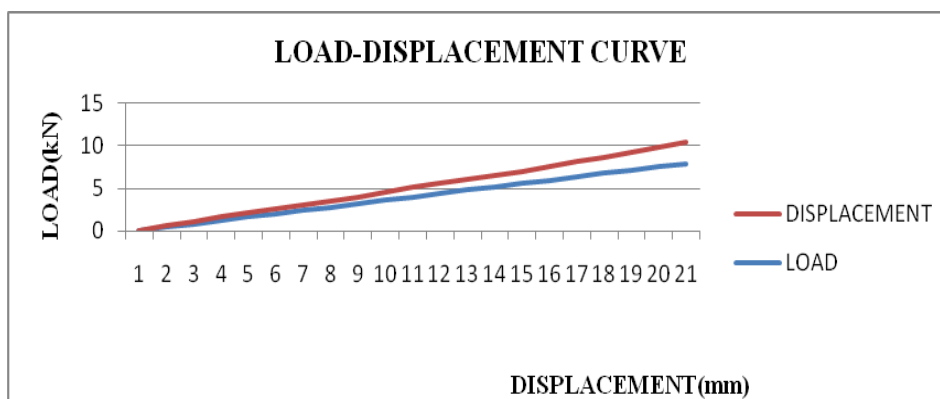


Figure 11. Load Displacement Curve GFRP with Aluminum

The figure 11. Shows the plot between load and displacement for GFRP with Aluminum where load absorbing capacity is very high compared to glass fiber reinforced polymer.

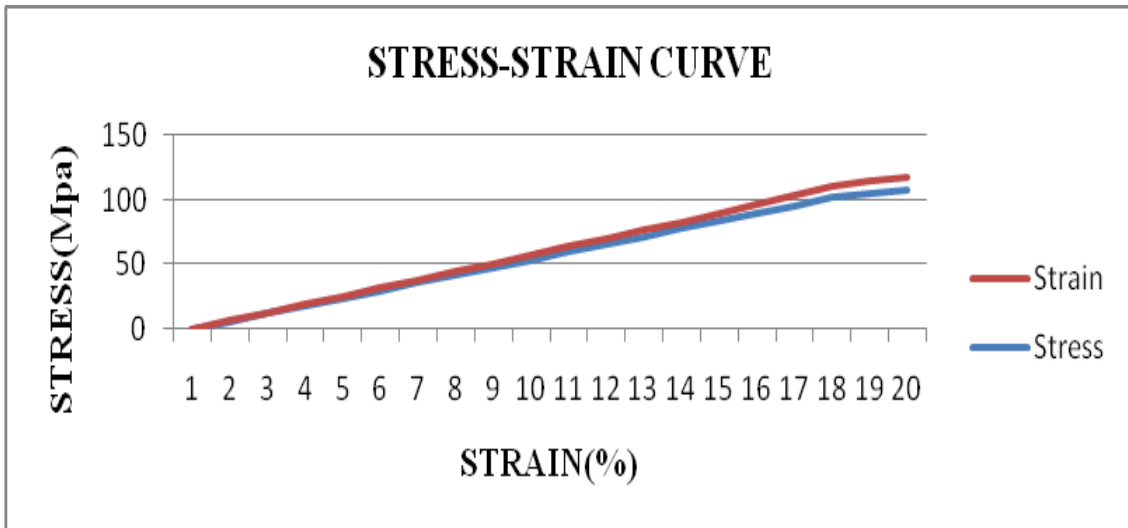


Figure 12. Stress Strain Curve GFRP with Aluminum

The figure 12. shows the plot between stress and strain for GFRP with Aluminum where the stresses is reduced due to reinforcement with aluminum.

5.2 Compression Test

Compressive Load KN : 0.66

Compressive strength in Mpa : 8.80

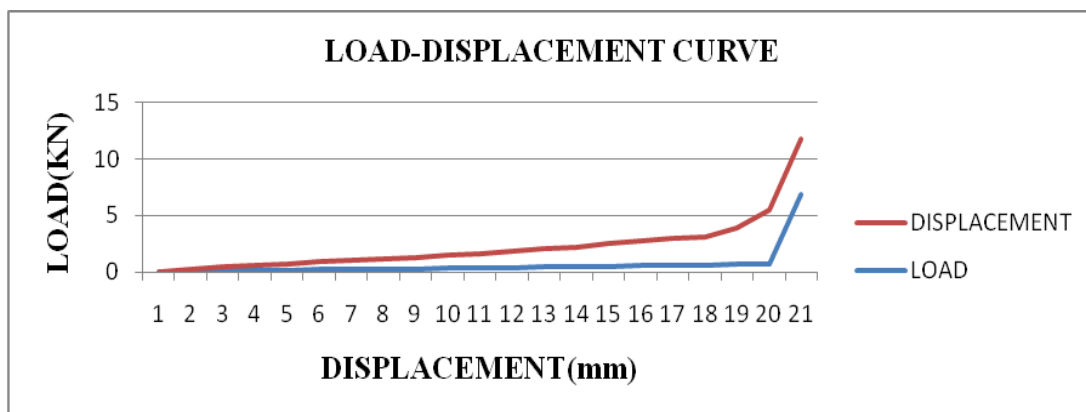


Figure 13. Load Displacement Curve GFRP with Aluminum

The figure 13. shows the plot between load and displacement for GFRP with Aluminum where displacement capacity is very high compared to glass fiber reinforced polymer.

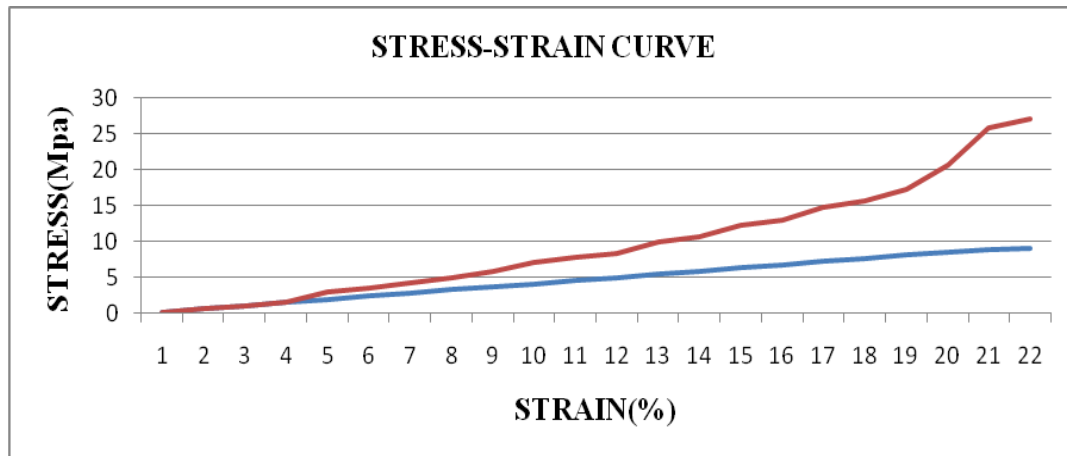


Figure 14. Stress Strain Curve GFRP with Aluminum

Table 2. Impact Test GFRP with Aluminum

| Test parameters | Sample 1 | Sample 2 | Sample 3 | Average |
|------------------------|----------|----------|----------|---------|
| Absorbed Energy-Joules | 8 | 6 | 8 | 7.33 |

6. Conclusion

The following are concluded from the above experimental analysis

- Impact Test performed for GFRP with Aluminum shows that higher energy absorbing capacity than GFRP.
- From the obtained results, it is found that the GFRP reinforced with aluminum is providing better thermal and mechanical properties.
- Further it will improve the performance of the pressure vessel and domestic applied gas cylinder also.
- It is also found that the stresses are reduced due to reinforcement with aluminum.

7. References

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