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Preparing, Studying and Drilling the Hybrid Composite Material withoutOrientation

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Abstract: This paper presents the research work done to understand the Tensile and Flexural Strength of Hybrid composite compared to glass fiber reinforced composite with 0^0orientation.For this, investigation is done on fiber types and mechanical properties of laminated composite and calculated surface roughness value after drilling on it.
Keywords: Carbon Fiber, Epoxy resin composites, Fiber orientation, Glass Fiber, Hybrid composite, laminated polymer composite, Mechanical properties.

I. INTRODUCTION

Composites are heterogeneous mixture of two or more components, reinforcing fibers and a compactable matrix. The matrix can be ceramic, polymeric in origin or metallic which gives the shape, surface appearance, environmental tolerance and overall durability for the composites. Where the fibrous reinforcement carries most of the structural load that gives strength and stiffness. Composite materials combines the most desirable properties of its constituents while suppressing their least desirable properties so they provide superior and unique mechanical and physical properties. Composites are broadly classified into ceramic matrix (CMC), metal matrix (MMC) and polymer matrix composites (PMC) based on the matrix material which forms the continuous phase. Among these, polymer matrix composites are much easier to fabricate than others. Hybrid composites are those which have a combination of two or more reinforcement fibres. When we want to achieve combination of properties of different types of fibres usually we opt Hybrid composites. Some of the key areas where composite materials play a key role are aerospace industry, automobile industry and other engineering applications as they exhibit outstanding strength to weight ratio. Abroad study is going on high performance rigid composites that are made from glass, carbon, graphite, Kevlar, boron or silicon carbide fibers in polymeric matrices because of their application in aerospace and space vehicle technology.

Prashanth Banakar and H.K. Shivananda [1] made a research on "Preparation And Characterization of The Carbon Fiber Reinforced Epoxy Resin Composites", the objective of this paper was to gain a better understanding epoxy resin composites reinforced with carbon fiber and their mechanical properties. Laminates were prepared by hand layup process and cut to obtain ASTM standards which intern used for investigating the effect of fiber orientation. Universal testing machine is used for testing the flexural and tensile strength. This investigation indicates that the mechanical properties are mainly dependent on the fiber orientation.

Prashanth Banakar, et al. [2] studied "Influence of Fiber Orientation and Thickness on Tensile Properties of Laminated Polymer Composites", the effect of fiber orientation and thickness of laminates is studied to determine property data for material specifications, the method used is hand layup process and made under ASTM standards. This study proved that tensile strength is mainly dependent on orientation and thickness of the composites.

K. Mohamed Kaleemulla et al. [3] made a research on the "Influence of fiber orientation on the In-plane Mechanical Properties of Laminated Hybrid Polymer composites", and established a relationship between the tensile/compressive strength, fiber content and orientation. The laminated specimens prepared under ASTM standards were fabricated using steel and nylon bi-directional mesh as reinforcements and polyester as the binder. The experiment was done by keeping polyester percentage constant (40%) and changing the volume fractions and fiber orientations and concluded that the specimens with higher percentage of steel sustain greater loads & also the strengths are superior in case of 0/90 degree oriented specimens and established a relationship between the tensile/compressive strength, fiber content and orientation.

Hossein Rahmani et al. [4], made a research on "Mechanical performance of epoxy/carbon fiber laminated composites", results show that the mechanical properties, in terms of tensile, flexural and impact strengths, were mainly dependent on the fiber orientations followed by the number of laminates. At a similar fiber orientation, the composites made with EM500 epoxy resin showed the highest mechanical properties (such as tensile and flexural and impact strengths) compared to other evaluated composites.

II. EXPERIMENTAL PROCEDURE

First prepare the hybrid composite with glass and carbon reinforcements respectively. Then specimens are made to cut according to ASTM standards. Perform tensile test and flexural test using computer controlled UTM. Determining the best sample prepared that exhibiting more tensile and flexural strength/ withstand to high load, to enable best outcomes on its application. Perform drilling on prepared samples to determine the best surface roughness value.

III. MATERIALS AND METHODOLOGY

3.1 MATERIAL:

Fig1: Glass Fiber Mat Type Fig2: Carbon Fiber Mat Type

Glass fiber mat type has increasing popularity in different applications. The present investigation carried on epoxy resin bi woven glass fiber mat type, bi woven carbon fiber, the matrix materials are epoxy resin LY556 and hardener HY951 mixed in appropriate ratio with room temperature curing cycle of 24 hours duration.

3.2 INSTRUMENTAL:

Fig3: Computer controlled UTM Fig4: Flexural Fixture UTM

Fig5: Tensile Fixture

Loads are applied on laminates under computer controlled UTM. Laminates are subjected to tests by clamping them and the results are monitored at room temperature. The ultimate tensile/flexural load is defined as the load at which the fracture of the specimen occurred.

3.3 PREPARING OF GLASS FIBER REINFORCED EPOXY COMPOSITE:

Fig6: Sample Preparation of Gfrp Fig7: Sample Preparation of hybrid composite

The specimen was prepared in shape of rectangular plates by hand layup technique at room temperature and proper care was taken during fabrication of laminates to ensure uniform thickness in the material. The laminates were fabricated by placing the Glass fiber and Carbon fiber one over the other alternatively with a matrix in between the layers. Tools were used to distribute resin uniformly. The laminates were cured in room temperature and constant pressure. The laminated test specimens were prepared by a cutting machine to suit ASTM dimensions.

3.4 TEST CONFIGURATION:

Fig8: Preparing gfrp specimen Fig9: Frauctured specimens of gfrp

Fig10: Drilled specimen of gfrp Fig11: Fractured hybrid specimen

Fig12: Fractured hybrid specimen on applying Tensile test

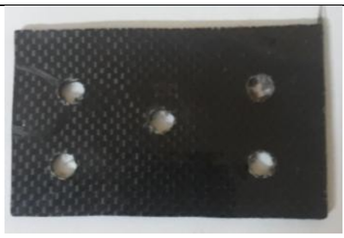

Fig13: Drilled Hybrid specimen

3.5 GRAPHS FOR TENSILE AND FLEXURAL TEST:

3.5.1 Stress vs Strain Curves in gfrp:

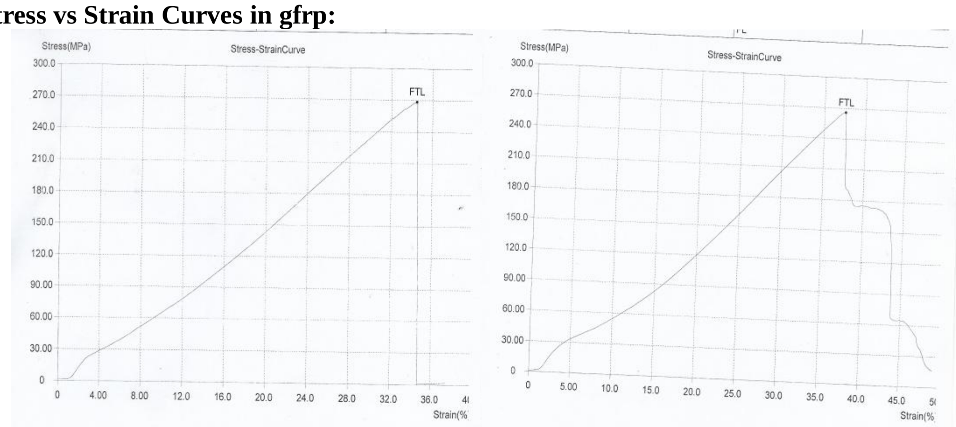

Fig14: Stress Vs Strain 0^0 (Tensile test)

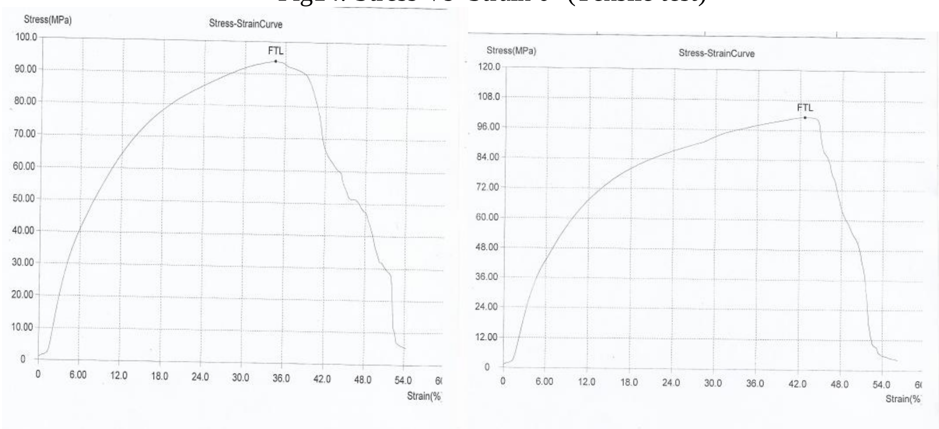

Fig15: Stress Vs Strain 30^0 (Tensile test)

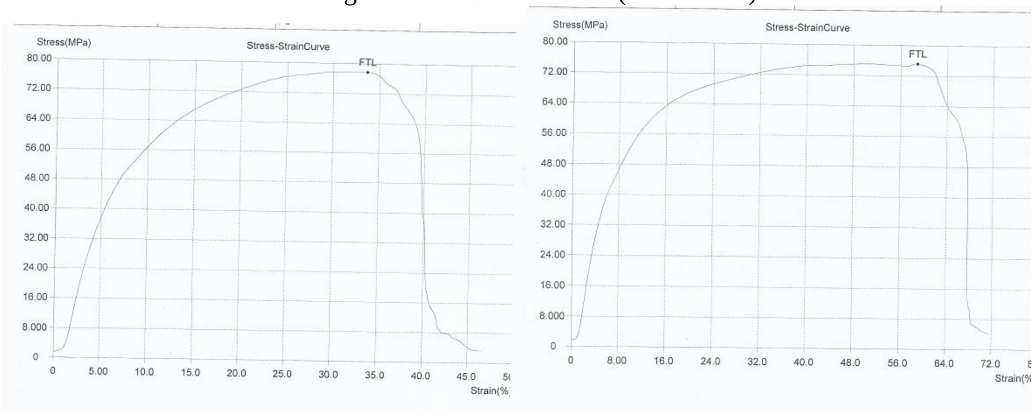

Fig16: Stress Vs Strain 45^0 (Tensile test)

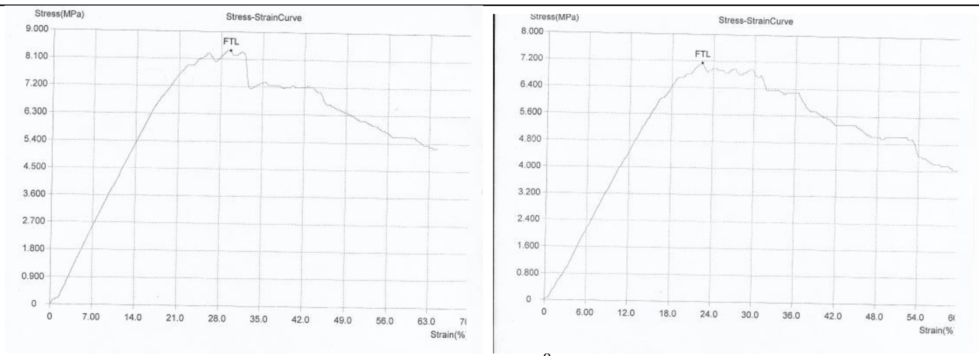

Fig17: Stress Vs Strain 0^0 (Flexural test)

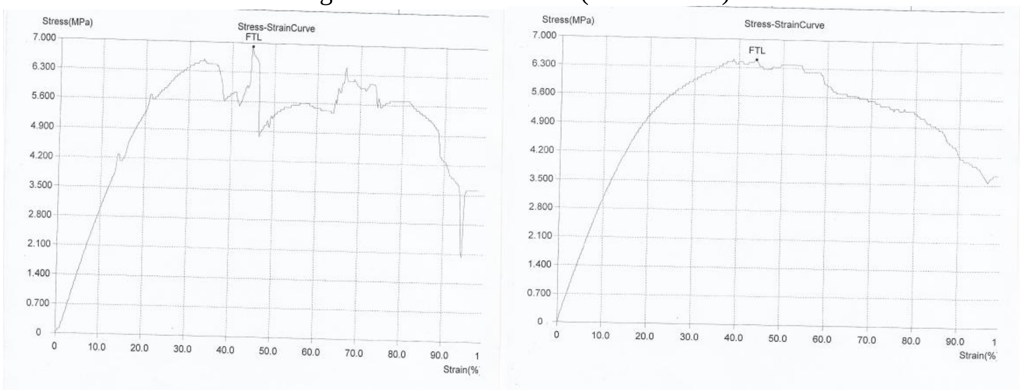

Fig18: Stress Vs Strain 30^0 (Flexural test)

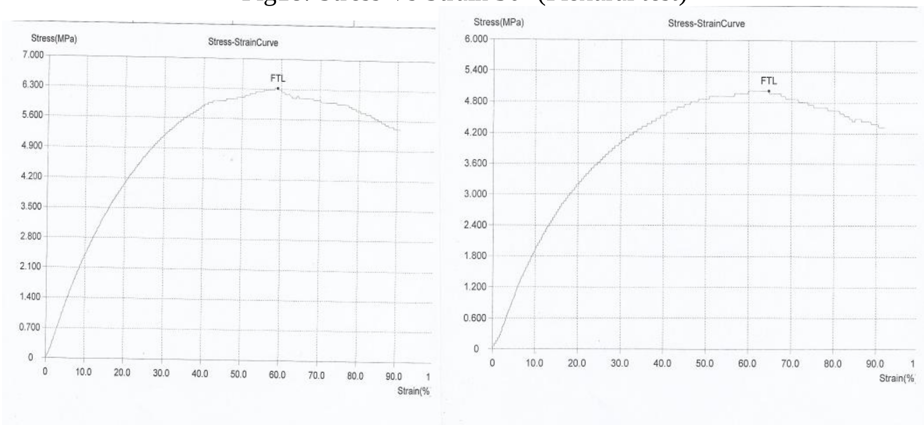

Fig19: Stress Vs Strain 45^0 (Flexural test)

3.5.2 Stress vs Strain Curves for hybrid fiber:

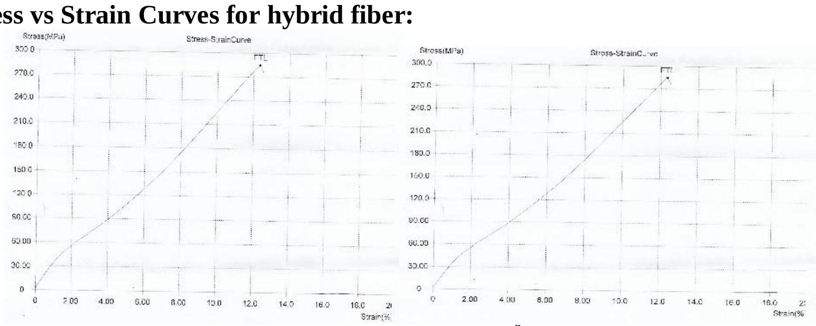

Fig20: Stress Vs Strain 0^0 (Tensile test)

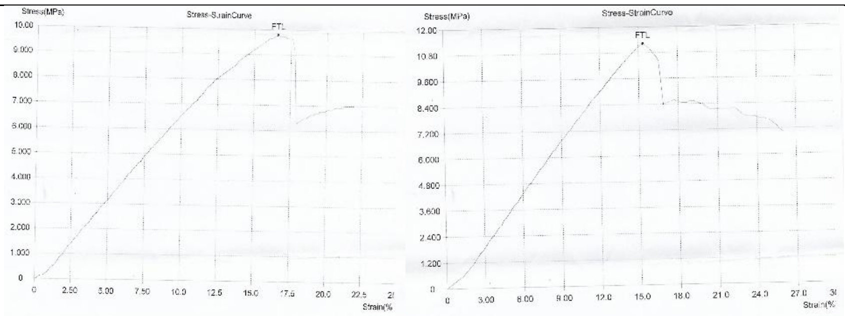

Fig21: Stress Vs Strain 0^0 (Flexural test)

3.5.3 Load vs Displacement Curves in gfrp:

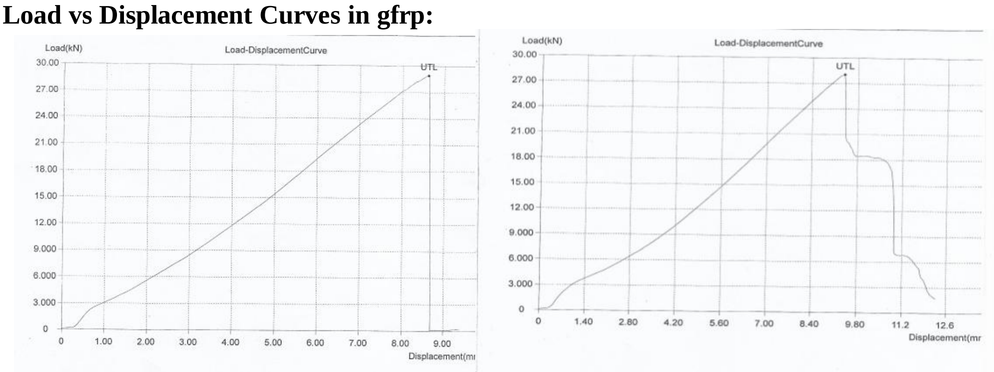

Fig22: Load Vs Displacement 0^0 (Tensile test)

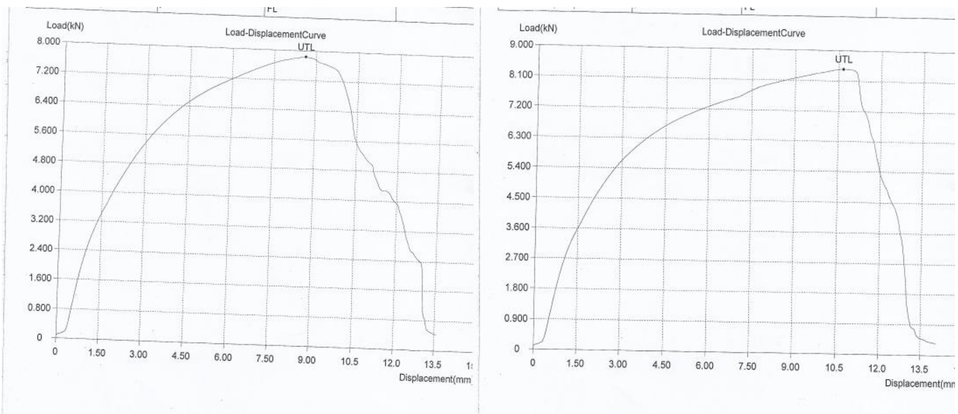

Fig23: Load Vs Displacement 30^0 (Tensile test)

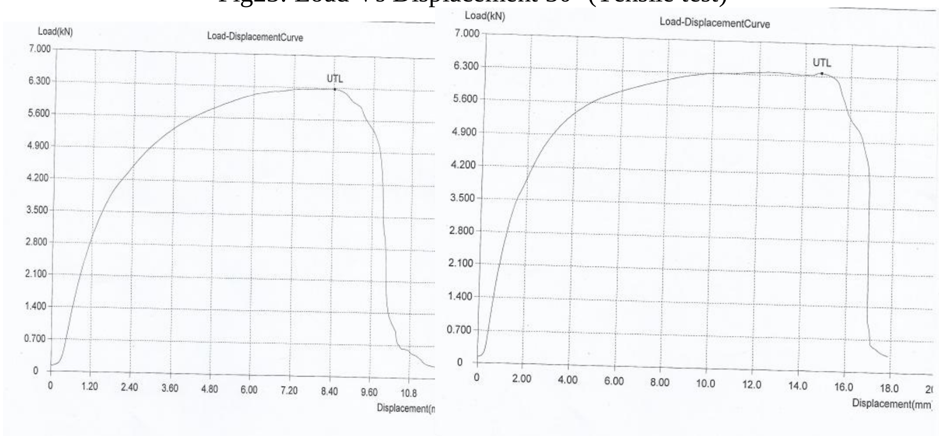

Fig24: Load Vs Displacement 45^0 (Tensile test)

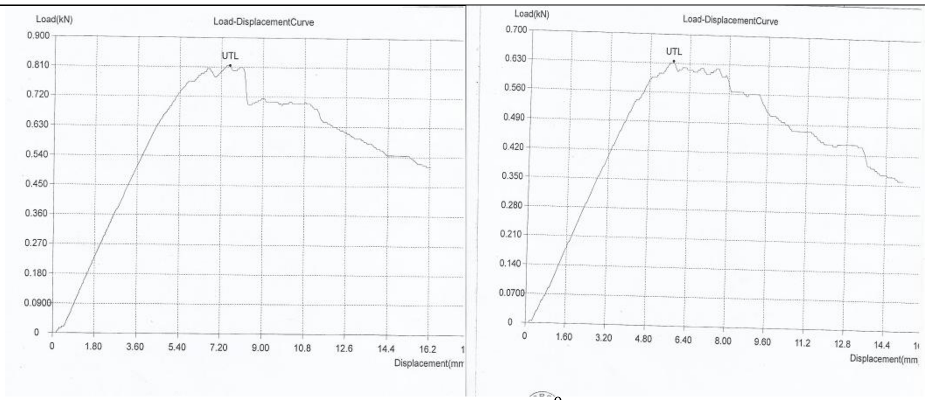

Fig25: Load Vs Displacement 0^0 (Flexural test)

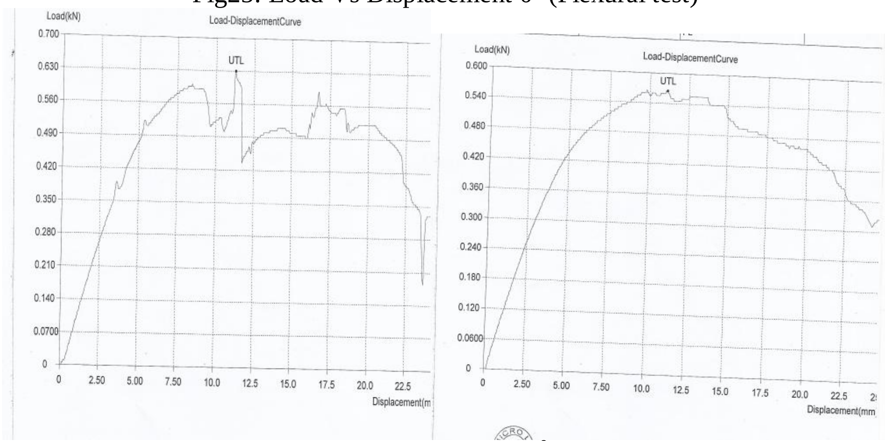

Fig26: Load Vs Displacement 30^0 (Flexural test)

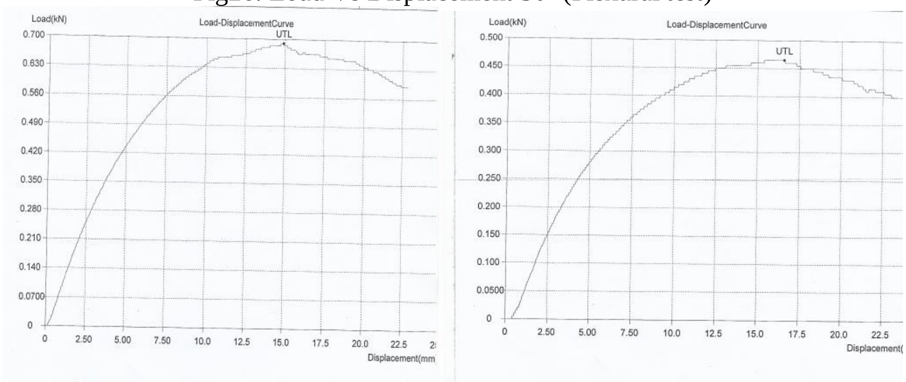

Fig27: Load Vs Displacement 45^0 (Flexural test)

3.5.4 Load vs Displacement Curves for hybrid fiber:

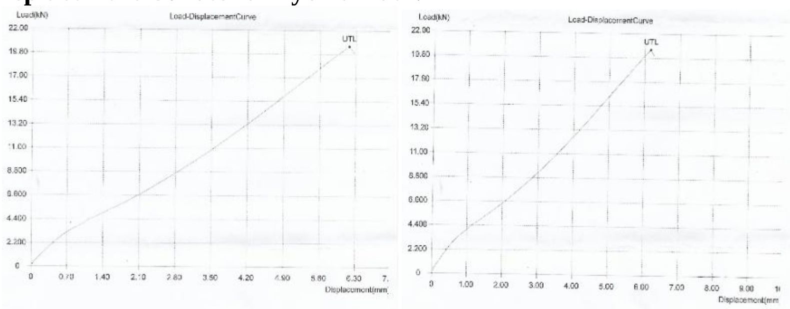

Fig28: Load Vs Displacement 0^0 (Tension test)

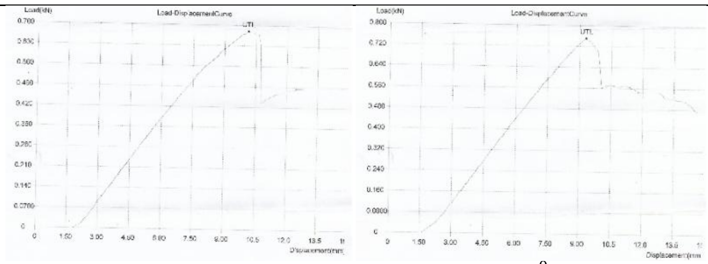

Fig29: Load Vs Displacement 0^0 (Flexural test)

3.5.5 Comparison charts for gfrp :

Tensile test

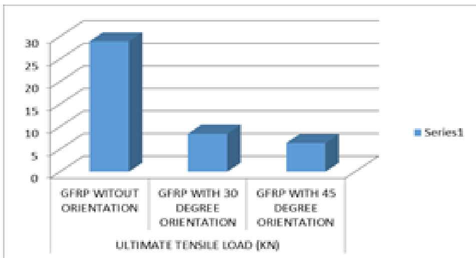

Chart 1:Ultimate tensile load

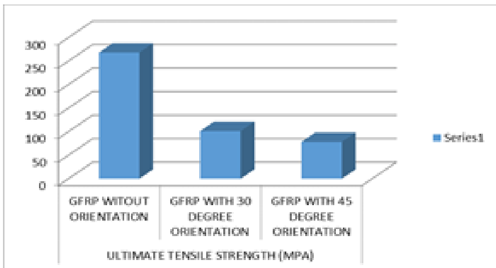

Chart 2:Ultimate tensile strength

Flexural test

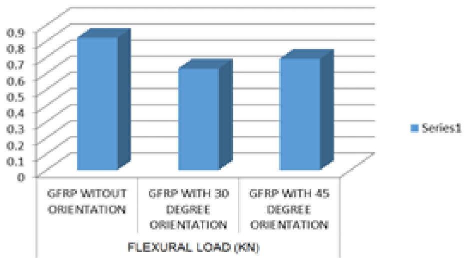

Chart 3:Flexural load

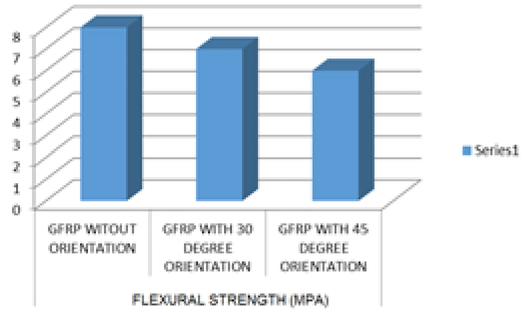

Chart 4:Flexural strength

3.5.6 Tensile properties of gfrp specimen:

3.5.6.1 The ultimate tensile strength is superior in case of$\pm 0^0$ orientation.

3.5.6.2 More force is required for fracture of glass fiber reinforced polymer composite in case of $\pm 0^0$orientation.

3.5.6.3 Maximum load is observed in case of $\pm 0^0$ orientation.

3.5.7 Tensile properties of hybrid composite :

3.5.7.1 The ultimate tensile strength is superior in hybrid composite when compared to both glass fiber reinforced composite and hybrid composite with $\pm 0^0$ orientation.

3.5.8 Flexural properties of gfrp:

3.5.8.1 The flexural strength is superior in case of $\pm 0^0$ orientation.

3.5.8.2 Maximum load is observed in case of $\pm 0^0$orientation.

3.5.9 Flexural properties of hybrid composite:

3.5.9.1 The flexural strength is superior in case ofin hybrid composite when compared to both glass fiber reinforced composite and hybrid composite with $\pm 0^0$ orientation.

3.5.10 Measurement of surface roughness after drilling:

The specimens are also drilled and surface roughness is calculated using roughness tester and a graph is directly generated. For $\pm 0^0$, $\pm 30^0$, $\pm 45^0$ orientations the surface roughness values are 3.552, 4.786, 4.525 µm respectively.

The surface roughness value after drilling the hybrid composite gave 0.952 µm, which was the best value compared to gfrp.

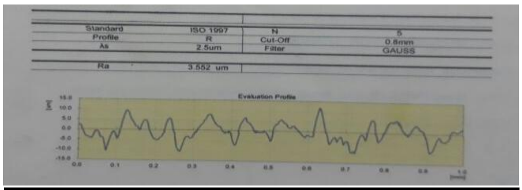

Fig 30:Average Surface Roughness value of 0^0 specimen (gfrp): 3.552 µm

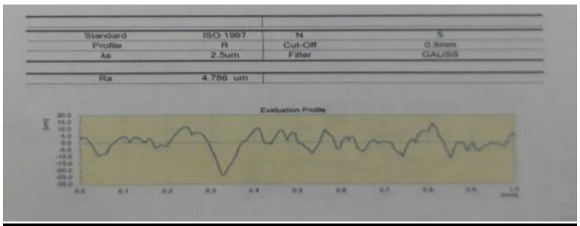

Fig 31:Average Surface Roughness value of 30^0 specimen (gfrp): 4.786 µm

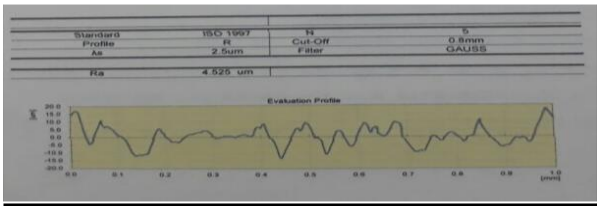

Fig 32:Average Surface Roughness value of45^0 specimen (gfrp): 4.525 µm

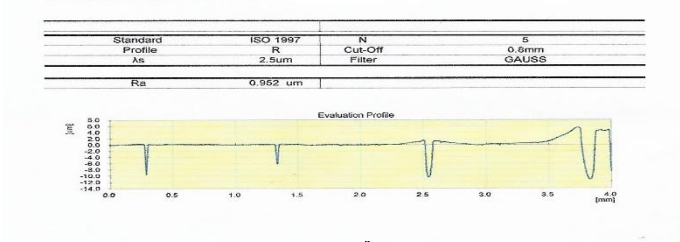

Fig 33:Average Surface Roughness value of0^0specimen (hybrid composite): 0.952µm

IV. CONCLUSION

The experimental investigations used to compare the analysis of tensile and flexural behavior of glass fiber reinforced polymer and hybrid composite leads to the following conclusions. In case of $\pm 0^0$ orientation the ultimate tensile strength is more in hybrid composite than in glass fiber reinforced composites. Even the displacement is more in case of hybrid composite than in glass fiber reinforced composite. So when used for any particular application of high strength hybrid composite can be used. And also hybrid composite gave better surface roughness value.

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