Comparison of Heat Deflection Behaviour of Alkali Treated and Untreated Hybrid Fiber Reinforced Composites

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Abstract*: Natural Fiber reinforced composites finds place in many applications as they have the advantages of being light, strong, cheap and more environmental friendly. This study aimed to determine the effect of alkali treatment on natural fiber and its impact on the heat deflection behaviour of the natural and glass fiber reinforced hybrid composites ,in this work two type of hybrid composite are made with glass, sisal and flax fiber ,the hybrid fiber reinforced composite laminates were fabricated by hand lay-up method. Specimens are cut from the fabricated laminates and their heat deflection behaviour was tested according to ASTM D648 standard. From the result it is understood that the alkaline treatment has improved the heat withstanding capacity of sisal/glass hybrid composite by 20C in average and don't have much effect on flax /glass hybrid composite.

Index Terms: Alkali Treatment, Heat Deflection Behaviour, Hybrid composites

I. INTRODUCTION

Polymeric matrix composites with different reinforcements found application in many of the industries. [1].,Due to their high strength to stiffness and weight to stiffness ratio [2, 3]. The main reasons for the interest of researchers in replacing the reinforcements from synthetic fibers like glass fibers to natural fibers in polymeric matrix composites are their low environmental impact, low cost, and high flexural strength, which supports their potential across a wide range of applications [4]. Also natural fibers has competitive mechanical properties such as flexibility, stiffness and modulus compared to glass fibers. In the recent days natural fibers such as sisal and flax fibers are replacing the glass and carbon fibers owing to their easy availability and cost [5]. Currently there are many researches in polymeric composite filed combining different resin and fibers [6]. The flexural strength values of the hybrid fiber composites are good and also Sisal/Glass fiber composite is performing well with the tensile load [7].Properties like bonding between the fibers and the matrix, the fiber volume fraction, the fiber aspect ratio, fiber orientation, determines the performance of fiber-reinforced composites [8]. Darshil U.Shah et al., found that natural fiber flax is a suitable structural replacement to E-glass in small wind turbine blade applications [9]. Flax fibers in particular possess a Young's modulus comparable to glass fibers[10].whereas tensile strength and stiffness of flax fibers reported to be as high as 1500 MPa and 90 GPa, respectively[11]. Flax has complex internal structure that results in anisotropic elastic properties. Such features of the fibers can also be allowed for in the orientation averaging approach [12]. A. Belaadi et al,[13] studied the energy dissipation of the sisal fibers. Sisal fiber's thermal stability increases by 10°C through mercerization as compared to untreated fibers [14]. The mechanical properties of polymer composites can be improved by chemical treatments as it enhance the interfacial bond between fiber and matrix [15]. This study aimed to determine and compare the heat deflection temperature of Glass Sisal Glass treated (GSG-T), Glass Sisal Glass untreated (GSG-UT) and Glass Flax Glass treated (GFG-T) & Glass Flax Glass untreated (GFG-UT) hybrid fiber reinforced composites. Here sisal and flax are treated with NaOH for improving the bonding strength between fiber and matrix.

II. MATERIAL AND METHOD

A.Material

Using Epoxy resin (LY 556) and the Araldite hardener HY-951, in the ratio of 10:1 and natural fibers flax and sisal fibers and glass fiber (600 Gsm) in the form of biaxial mats four different types of composite laminates are prepared.

B.Alkali Treatment

The mechanical strength of the composites depends on the interfacial bonding between the fiber and the matrix. The poor wetting of the fiber in the resin will result in lower strength of the composites [16].In this work, mercerization, a chemical process to enhance the roughness of the fiber surface, is carried out on the flax and the sisal fiber to improve the adhesion. Actually, all the natural fibers are lignin-cellulose based fibers, the presence of hemicellulose material on the outer surface prevents the proper bonding between matrix and the fiber[17].

The fiber surface is treated as follows:[18]

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1. Flax and sisal fiber mat were washed with distilled water and dried.
2. Then the dried fiber mats were treated with 10% NaOH solution for 1hr at room temperature in a separate tray.
3. The treated fibers
4. were washed with distilled water again to remove excess NaOH adhered to the fiber mat
5. The washed mats were sun-dried for 8 hr and were then oven dried at 50°C for 2 hr.

Figure 1: NaOH treatment of Flax and sisal Fiber

C.Fabrication

Hand layup method is used for composite laminate preparation [7], Epoxy and Hardener mixed in the ratio of 10:1. and the Glass, natural fiber mats are cut into 300 X 300 mm sizes, Four types of laminates are prepared with the combination of Glass-Flax-Glass (treated with NaOH & Untreated), Glass-Sisal-Glass (treated with NaOH & Untreated).the process has been done carefully to get homogeneous laminates of 300X300X3 mm. The 3 mm thickness is achieved using the fiber layers

III.EXPERIMENTATION

The composites ability to bear a given load at elevated temperature can be found out using heat deflection temperature test. This testing procedure will determine the temperature at which the deformation will occurs when specimens are subjected to prescribed testing conditions. The dimension of the sample are 63.0 mm × 12.8 mm × 3.2 mm (length × width × thickness).The heat deflection temperature was measured using the HDT Tester, according to ASTM D648–01 standard, with the loading pressure of 0.455 MPa, and 2°C/min rise in temperature. Test results are based on average value of four samples. The test setup, tested and untested samples are shown in Figure 2, 3, 4 respectively.

Figure 2: Heat deflection temperature test

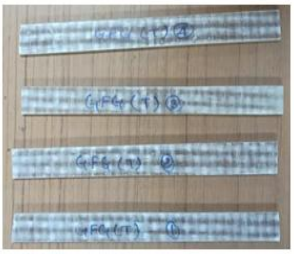

Figure 3: specimen before test **Figure 4**: specimen after test

IV.RESULTS AND DISCUSSION

Heat deflection temperature analysis is important for industrial applications using thermoplastics. In figure 5, specimen 1 to specimen 4, all treated fiber shows better heat deflection temperature compare to untreated fiber. In figure 6, specimen 1 and specimen 2 of treated and untreated fiber shows same result. But in specimen 3, heat deflection temperature of treated fiber is higher compare to untreated, whereas in specimen 4, surprisingly heat deflection temperature value of untreated fiber is higher compare to treated fiber. So, overall performance of treated and untreated glass flax glass fiber shows same result.

Thus, in Figure 5, heat deflection temperature value of GSG-Treated shows better result compare to GSG-Untreated, whereas in Figure 6,both the GFG Treated and untreated shows the similar result in most of the samples.

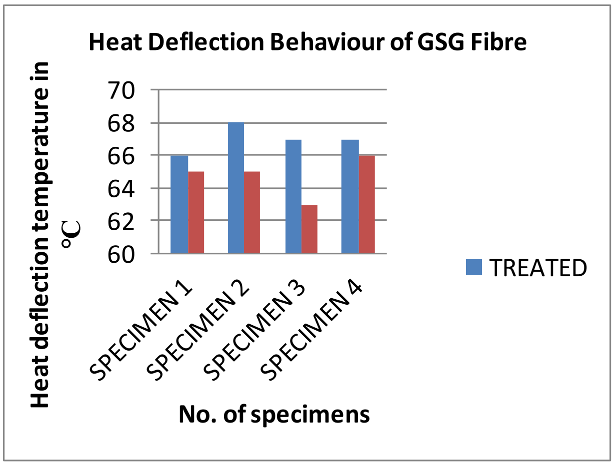

Figure 5: Heat deflection temperature comparison of GSG-T & GSG-UT.

IV.CONCLUSION

Thus the following conclusion drawn from the study of heat deflection behaviour.

- Glass Sisal Glass Treated Shows better result compare to Glass Sisal Glass Untreated the heatwithstanding capacity increases by 2^0C
- Heat deflection behaviour of both Glass Flax Glass Treated and Untreated remain the same.

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Further this work can be extended to by doing more comparative study between mechanical behaviour like tensile, compression strength of alkali treated and untreated natural fiber composite to understand completely about the advantages of alkali treatment on natural fibers and their influence on composite bonding strength.

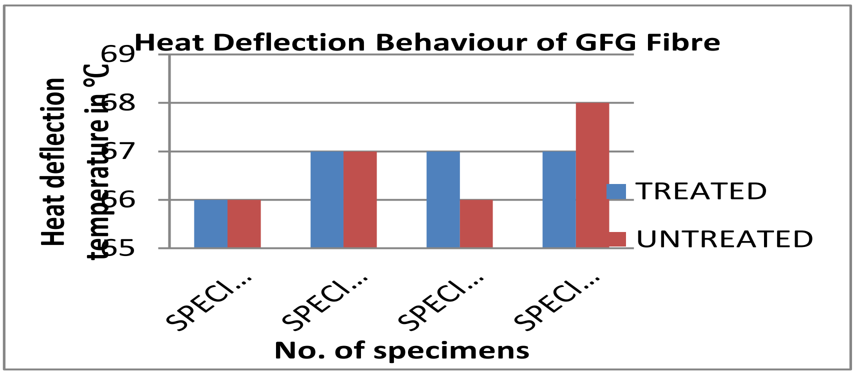

Figure 6: Heat deflection temperature comparison of GFG-T & GFG-UT

Table 1: Heat deflection temperature of hybrid composites

S.NO.	SPECIMEN	GFG Treated with NaOH	GFG Untreated	GSG Treated with NaOH	GSG Untreated
1	1	66°C	66°C	66°C	65°C
2	2	67°C	67°C	68°C	65°C
3	3	67°C	66°C	67°C	63°C
4	4	67°C	68°C	67°C	66°C

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