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Study of Tensile and Flexural properties of hybrid nettle and glass fiber reinforced polymer composites.

Pankaj[1], Suman Kant[2], CS Jawalkar Kant[2], Sandeep Kumar Khatkar[3]
[1]*Research scholar, Production and Industrial Engineering, PEC Chandigarh*
[2] *Associate Professor, Production and Industrial Engineering, PEC Chandigarh*
[3]*Associate Professor, Production and Industrial Engineering, PEC Chandigarh*
[4]*Research scholar, Production and Industrial Engineering, PEC Chandigarh*

Abstract—Composite materials are getting attention of researcher day by day because of high tensile strength and high weight to strength ratio. New materials are being developed for different application. Polymers when reinforced with natural fibers give advantage like low weight, high strength, low specific weight and bio degradability. Synthetic fibers have widely used for fabricating polymer composites. Now a days to make synthetic fibers composites more applicable, synthetic fibers are mixed with natural fibers. In this study hybrid composite of nettle and glass fiber is fabricated and their tensile and flexural strength is evaluated. Specimen are prepared with hand layup technique. Results indicated that nettle fibers when hybridized with glass fibers increases tensile strength and flexural strength. Flexural strength of nettle and glass fiber hybrid composite is largest among all specimen.

Keywords— Composites, Hand layup, natural fibers.

I. INTRODUCTION

Glass fiber reinforced polymer composite are fabricated by reinforcing glass fibers in the matrix of polymer. To obtain specific results glass fibers are introduced into polymer either by woven form or randomly oriented form. Unidirectional properties are obtained when fibers are placed in one direction while woven fibers give bidirectional properties. As compare to carbon fiber glass fiber has inferior properties in stiffness and brittleness but glass fibers are less expensive [1]. Since natural fibers are ecofriendly their application is increasing day by day. Many researcher are working in this direction. In order to get combined properties of natural fibers and synthetic fibers hybrid composites were developed. Tensile and flexural properties of hybrid glass/natural fibers were studied to see the effect of reinforcement of flax fiber with glass fibers [2]. Natural fibers have some inferior properties compared to glass fibers but are cheap and lighter. Mechanical and thermal properties of jute and glass fiber based hybrid composites were studied and found impact and flexural properties were enhanced through hybridization [3]. They observed thermal resistance of composites increased by the addition of glass fibers with jute fibers. Tensile strength and elastic modulus of bamboo/glass hybrid was studied and enhancement in tensile strength and elastic modulus increased with aging [4]. Glass fibers when exposed to environment has adverse effect which can be reduced to some extent when reinforced with natural fibers. Natural fibers has limitation of moisture absorption which affect the interfacial bonding between fibers and matrix [5-9]. Lack of adhesiveness between fibers and matrix lead to decrease the mechanical performance of natural fiber based composites. Effect of moisture absorption on mechanical properties glass/sisal fibers hybrid was studied and found that presence of moisture decreased mechanical performance of developed composite [10]. This limitation of natural fibers can be overcome with modification of fibers. Effect of chemical treatment of Luffa cylindrical fiber reinforced into resorcinol-formaldehyde was evaluated and it concluded that fiber treatment like mercerization permanganate treatment decreases water absorption and mechanical properties of fabricated composite were enhanced [11]. Alkali treatment with NaOH was successfully used for the treatment of pineapple leaf fibers and found that mechanical properties of developed composites was increased [12]. Huge study on glass fiber based composite has been done and their overall strength depend upon the type of fiber used, type of matrix and composite fabrication technique. Many researcher studied the different parameter to cause a change in overall strength of composites [13-14]. Natural fibers are chosen as reinforcing material because it reduces tool wear, respiratory irritation. In present study tensile and flexural properties of glass/nettle hybrid composite is studied.

II. MATERIAL

In this study glass and nettle fibers are used for used for fabricating composite specimen. Glass fibers in randomly oriented sheet were obtained from Industrial area Chandigarh. General purpose polyester with catalyst methyl ethyl ketone peroxide is obtained from industrial area Chandigarh. Naphthalene is used as accelerator added as 1% with general purpose polyester.

III. FIBER TREATMENT AND SAMPLE PREPARATION

Glass tray is filled with water and 2% NaOH is added in it. Nettle fibers were soaked in this solution for 1 hour. During soaking some NaOH particles stick to the fiber surface therefore Nettle fibers were washed with distilled water. After that nettle fibers were placed on oven in order to remove moisture present in it. Hybrid composite of Glass/Nettle in this investigation is fabricated by hand layup process. Chopped fibers in the form of sheet as shown in Fig 1 is reinforced with GP polyester to fabricate composite. Hybrid composite of seven layers is fabricated. Glass fibers are placed at top and bottom, nettle fibers are placed after each layer of glass fibers. Mould made of stainless steel is used to fabricate composite. Heavy duty silicon spray is sprayed over the mould and GP impregnated glass fibers are placed in the mould, then nettle fibers are placed over the glass fibers. After nettle fibers are placed over glass fibers. After placing total seven layers of glass and nettle fibers load of 40 N is applied in order to obtain compatibility of fibers with resin. Load is applied for 2 hour. After unloading Specimen are allowed to cure at room temperature. Roller is used to distribute GP polyester uniformly.

IV. MECHANICAL TESTING

Tensile test: ASTM standard 679 is used test tensile properties of prepare GP polyester based composites. Required dimensions for tensile test were cut to specified dimensions with the help of cutter. Tensile test was performed on universal testing machine. Constant strain rate was taken to perform analysis. Three different type of specimen were prepared to conduct test. First specimen was reinforced with Glass fibers. Second specimen was reinforced with nettle fiber and third specimen was reinforced with nettle + glass fibers.

Flexural test: The flexural samples were prepared according to ASTM 790 standard. Specimen were placed at two support and load is applied at center until the fracture of composite material. This test give bending strength of material.

Glass fiber composite Glass and nettle fiber composite

Figure 1

V. RESULTS AND DISCUSSION

Tensile Test:

Tensile strength was performed on universal testing machine. Tensile strength of nettle fiber reinforced composite is less than from glass fiber reinforced composite. So, in order to enhance the tensile strength of nettle fiber composites these are mixed with glass fiber. Thus hybrid composite of nettle and glass fibers give intermediate properties of glass and nettle fiber composite. The ultimate tensile strength of glass fiber composite, nettle fiber composites and nettle +glass fiber composite is 80 MPa, 39.06 MPa and 64.96 MPa respectively. Stress strain curve plotted through universal testing machine is shown in figure 4, Figure 6 and Figure 9. From the results it can be concluded that hybrid composite incorporated with nettle and glass fibers gives intermediate tensile strength which lies between glass and nettle fiber composites.

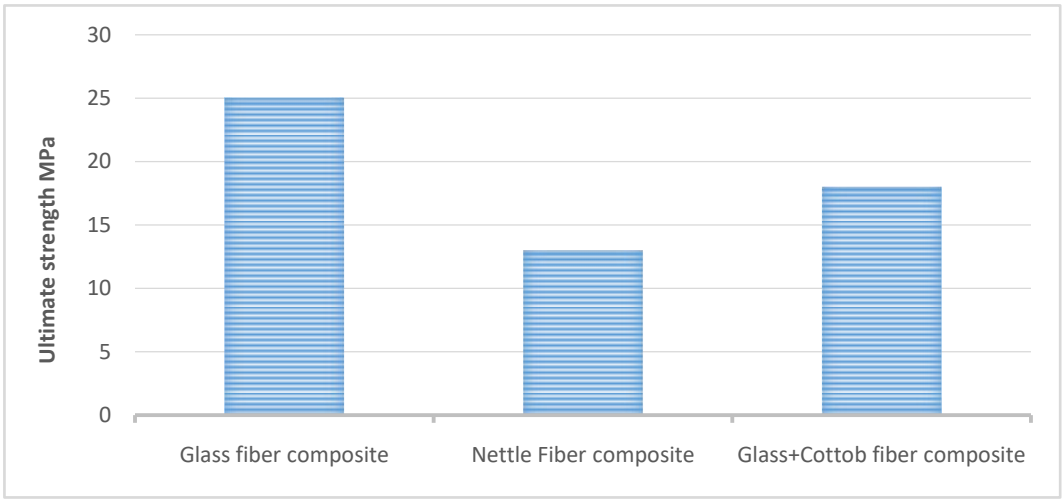

Figure 2 Ultimate strength for three type of composites

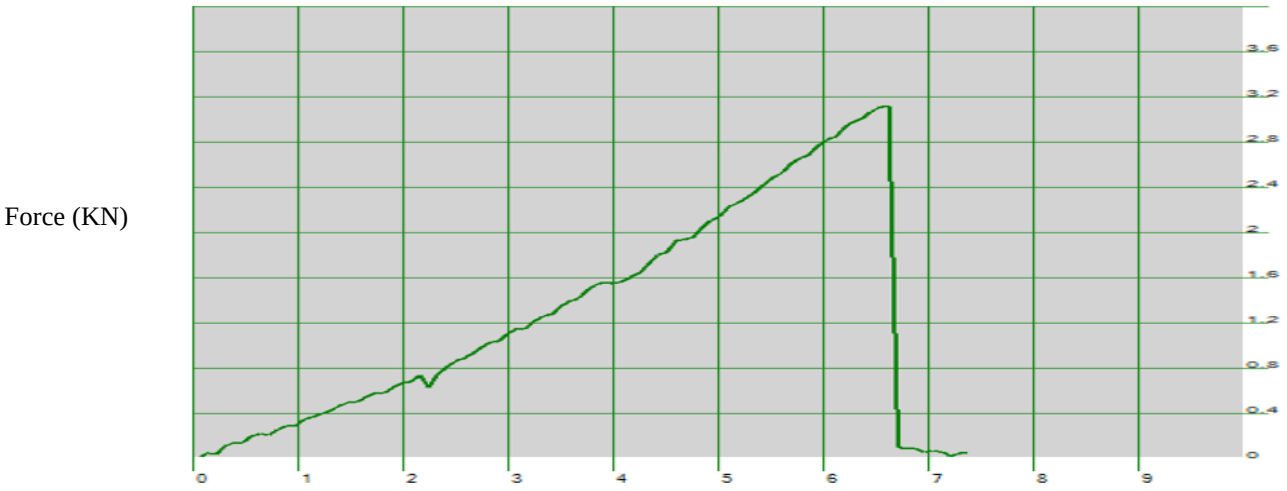

Figure 3 Force vs. Elongation graph for tensile test of glass and GP polyester composite

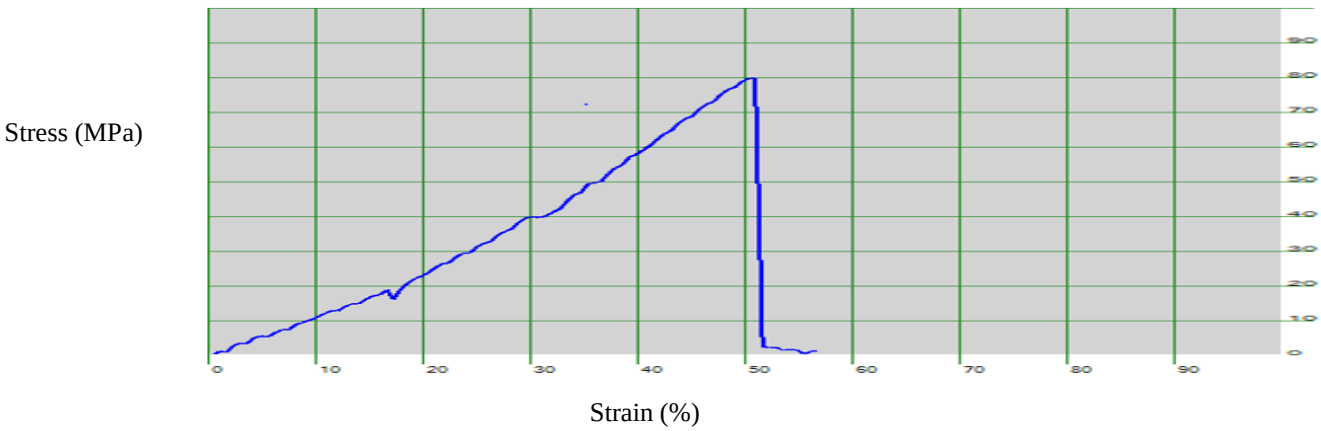

Figure 4 Stress vs strain graph for glass and GP polyester composite

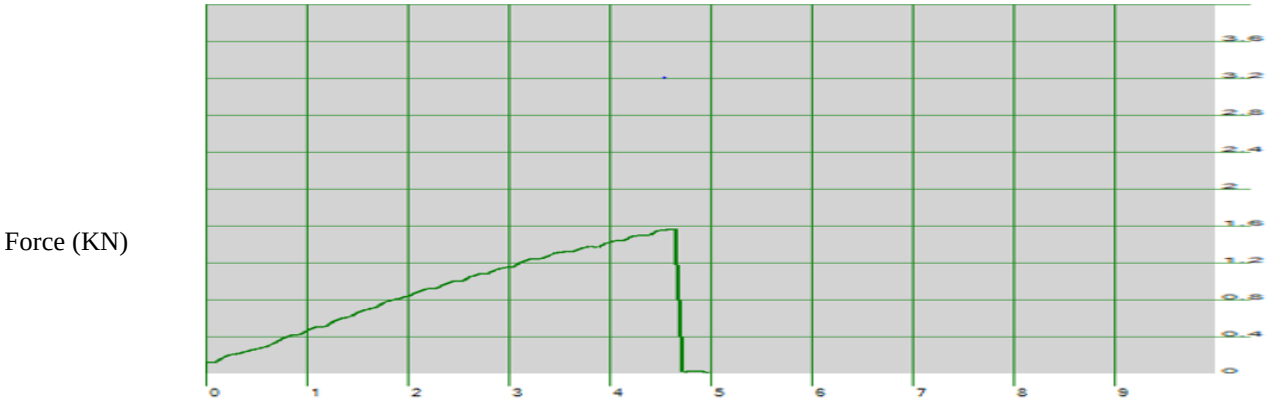

Figure 5 Elongation (mm)
Force vs. Elongation graph for tensile test for nettle fiber composite

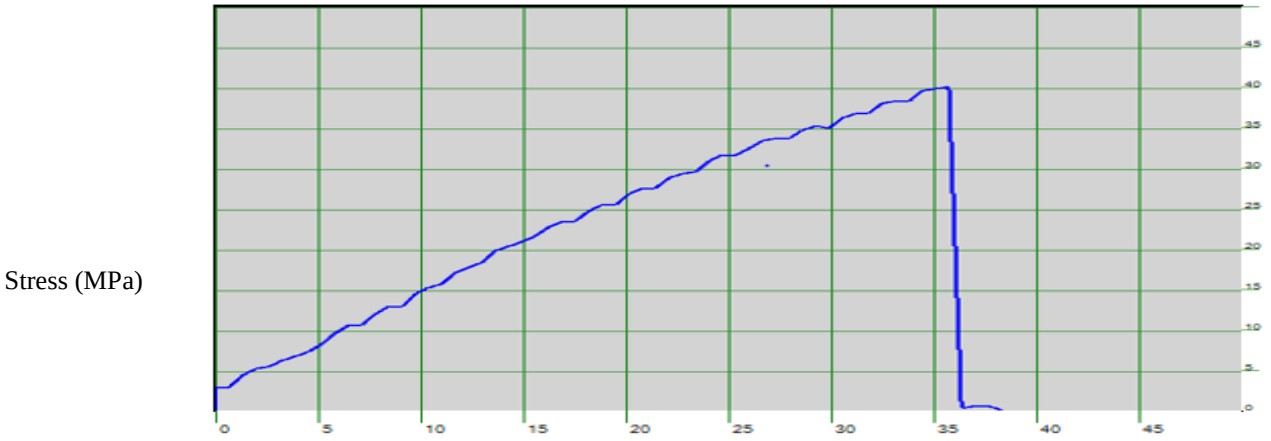

Figure 6 Stress vs strain graph for nettle fiber composite

Flexural strength:

Flexural strength properties are for Glass fiber, nettle fiber and glass + nettle fiber is shown in fig 7. The flexural strength of glass fiber composite, nettle fiber composites and nettle +glass fiber composite is 98.61 MPa, 75.31 MPa and 100.56 MPa respectively. From the results it can be concluded that hybrid composite incorporated with nettle and glass fibers gives better flexural strength compared to glass and nettle fiber composite. Overall mechanical properties of composites are summarized in table 1.

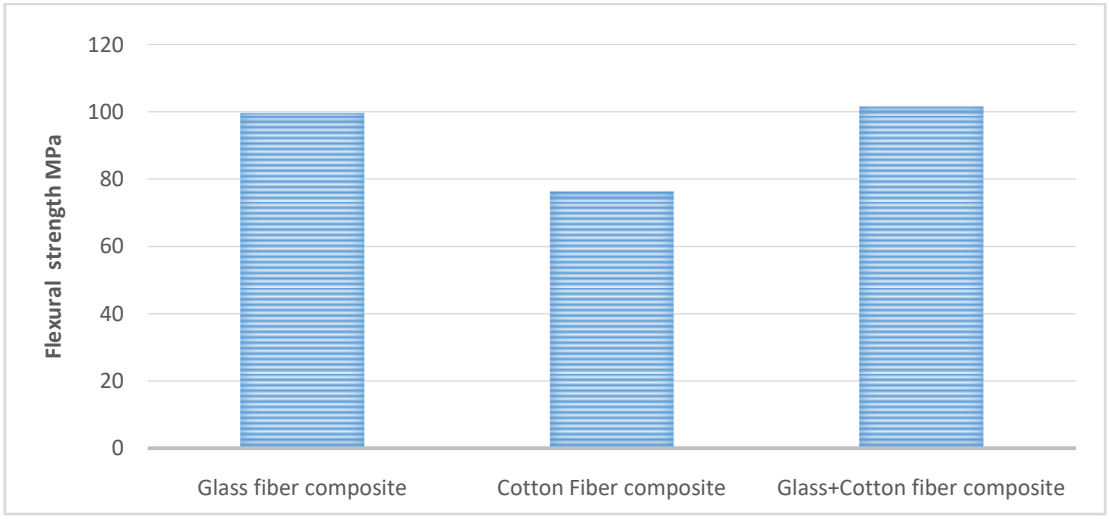

Figure 7 Flexural strength for different composites

Table 1. Mechanical properties for different composites.

Specimen	Peak load (KN)	Ultimate stress(MPa)	Flexural strength (MPa)	Displacement at peak load (mm)	Strain at ultimate stress (%)
Glass fiber composite	3.12	80	98.61	6.62	50.92
Nettle fiber composite	1.57	39.06	75.31	4.64	65.69
Glass + nettle fiber composite	2.56	64.96	100.56	6.65	51.15

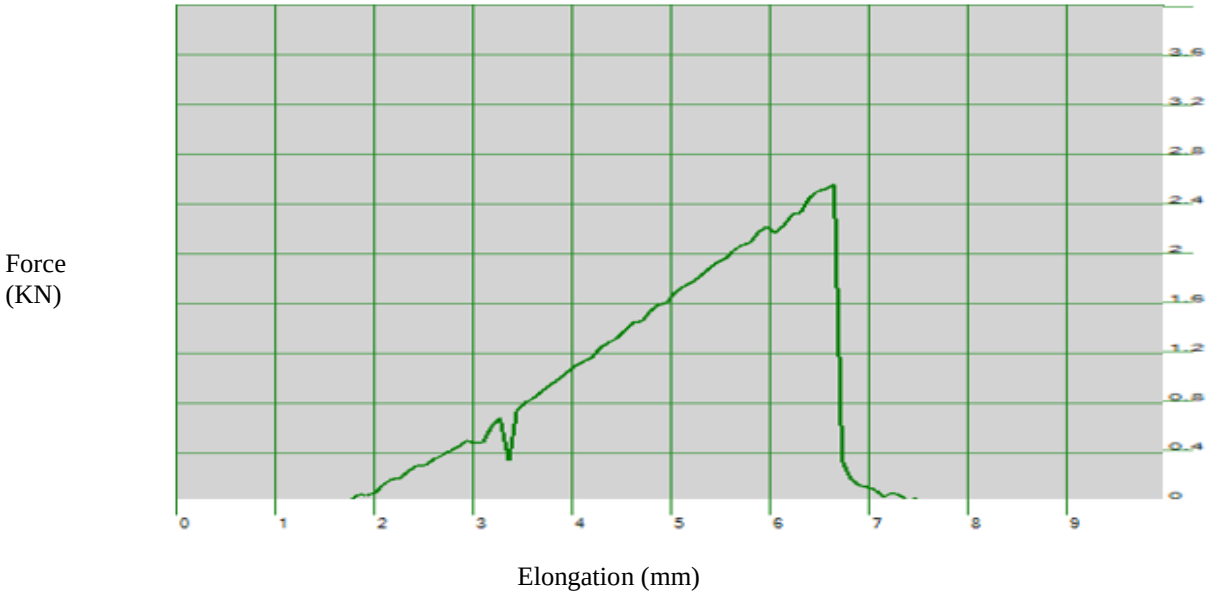

Figure 8 Force vs. Elongation graph for tensile test for Glass and nettle fiber composite

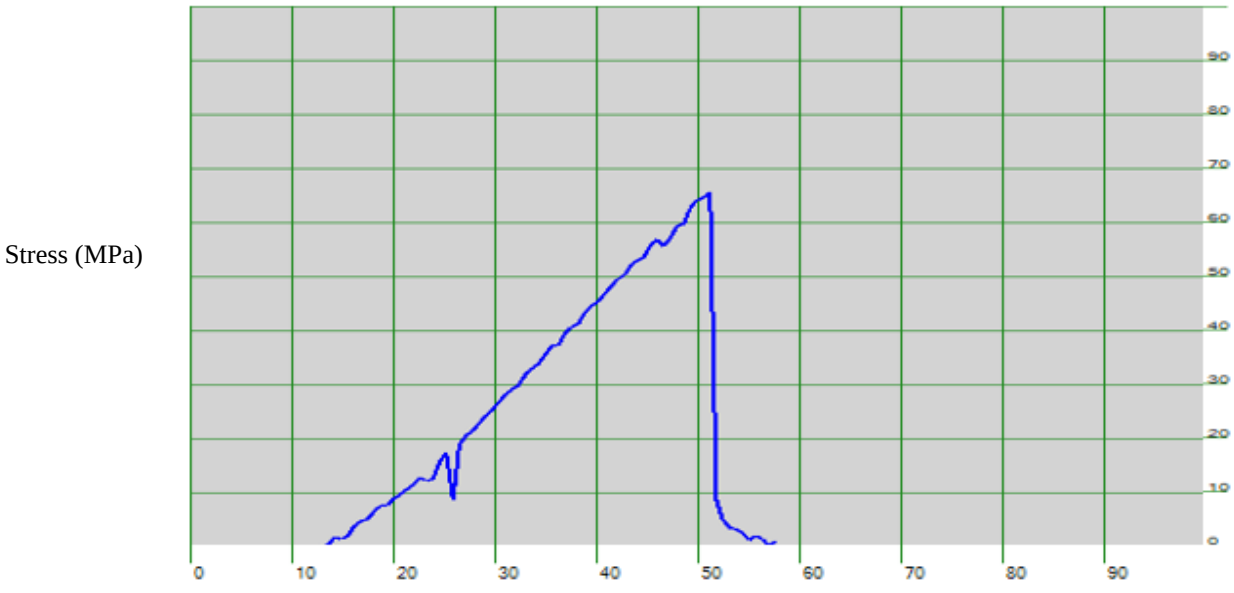

Figure 9 Stress vs strain graph for glass and nettle fiber composite

VI. CONCLUSIONS

Three type of composites Glass polyester, Nettle polyester and glass+nettle GP polyester are fabricated by hand layup technique. These composite are tested for tensile and flexural strength and their mechanical properties were found.

The result indicted that composite reinforced with glass fibbers shows maximum ultimate strength having value of 80 MPa. Glass and nettle hybrid composite hold maximum flexural strength of 100.56 MPa. Displacement at peak load is maximum for Glass and nettle hybrid composite up to 6.65mm.

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