Experimental Study of Natural Fiber Reinforced Polymer Composite

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Abstract:

Natural fibers are the centre of attraction between researchers and people from academia due to eco friendly nature. The objective of this study is to analyze the mechanical behavior of Nettle, Sun hemp and Hemp fire reinforced polymer composite. Mechanical properties of composites changes with the change in shape, size and type of fibers. Chemical treatment of fibers was done using NAOH. Fiber loading was varied so as to measure the contribution of fibers in the mechanical properties of the composite. Bonding between fibers and epoxy is greatly increased due to chemical treatment which leads to better mechanical strength. Results shows that Nettle fiber polymer composites have better tensile and flexural properties as compared to Sun hemp and hemp polymer composite.

IndexTerms **– Natural fibers, Composite, Reinforcement, Polymer, Mechanical Strength.**

INTRODUCTION

Community awareness regarding environmental issues has increased all over the world. The use of environmental friendly materials has gain importance. Conventional materials like wood are getting replaced by natural fiber or biomass reinforced polymer composites. Use of natural fibers in the composite industry is at boom.[1] Natural fiber reinforced polymer composite industry will grow with an estimated rate of 10% worldwide. Natural fibers are naturally obtained fibers and are quite different than manmade artificial fibers in appearance and properties. Natural fibers like Abaca, Coir, Cotton, Flax, Hemp, Jute, Ramie, Sisal etc. can be derived from fibrous plants and Animal fibers like wool from sheep, alpaca fiber and mohair fiber from goats.[2-3] These fibers have numerous mechanical properties. Natural fibers have gained popularity in the last decade. Natural fibers have dozens of superior properties than manmade fibers. Natural fibers are degradable in nature and have good mechanical property, lighter in weight, cheap and easily available, durability, best surface properties of finished composites, eco-friendly, non toxic and many more. Natural fibers are blended easily with any polymer either thermosetting or thermoplastic.[4-5] The chemical structure of thermoplastic is such that it have one or two dimensional moleculars, it increase high temperature bearing capacity. Thermoset polymer are cross-linked polymers can be cured by light or heat or pressure.[6]

Combination of natural fibers and polymers is like giving birth to all new material. A limitation in fibers because of presence of cellulose, lignin and other sticky substances leads to water absorption. Water absorption is a threat to the stability and mechanical strength of composite. Fibers can absorb moisture from surroundings it may penetrate the adhesive bond between the fiber and polymer matrix.[7-8] Chemical Treatment of natural fibers prior to mixing with polymers is a well adopted practice. Scientists observed that there is a loss of hydroxyl groups because of chemical treatments of fibers due and this can reduce the hydrophilic nature of the fibers resulting in enhanced mechanical properties and dimensional stability. Chemical treatments like alkali treatment, silane, acetylation treatment, benzoylation treatment, acrylation treatment were used by scientists. Chemical Treatment of the fibers can be done by using NaOH, CH_3COOH, etc can be used.[9] Fiber modification is a new technique used to treat fibers with reagents in order to reduce water absorption and it results in better bonding between polymer and fiber. Natural fiber reinforced polymer composite are used in automotive industries, aviation industries, sports industries, construction industries etc.
The aim of this study is to analyze the mechanical behavior of nettle, sun hemp and hemp fiber reinforced polymer composite.[10]

2. EXPERIMENTAL

2.1 Materials

Three different kind of natural fibers are taken for this study sun hemp, nettle and hemp. The Fibers were purchased by Chandra Prakash and Company Limited Jaipur. The fibers are shown in fig 2.1,2.2 and 2.3. Epoxy LY 556 and hardener HY 951 was purchased from Savita Chemicals Jaipur. The properties of fibers are given in Table 2.1

Table 2.1. Properties of fibres

Properties	Dimension	hemp	Sun hemp	Nettle
Density	g/m^3	1.47	1.45	1.25
Diameter	Mm	25	60	40-50
Cellulose content	%	67-75	59-71	85.93
Hemicellulose Content	%	16-18	12-13	6.8
Lignin Content	%	2.8-3.3	11.8-12.9	5.49
Microfibrillar Angle	Deg	6.2	7-9	7.5-12
Tensile Strength	Mpa	368-800	400-800	560-1600
Young's Modulus	Gpa	17-70	10-30	24.5-87
Elongation at Break	%	1.6	1.16-1.8	2.1-2.5

Fig 2.1 Sun Hemp Fiber

Fig 2.2 Nettle Fiber

Fig 2.3 Hemp Fiber

2.2 Composite Preparation

Fibers were cut in 20 cm long strips. Natural fibers were chemically treated by using 5% NaOH and then thoroughly rinsed by distilled water. The fibers were then dried in an oven at 30ºC for about 4 hours. Thermoset polymer was used in composite prepearation. Epoxy LY 556 and hardener HY 951 was taken in ratio 1/10. Teflon sheet was kept in the mould and wax is applied to ensure easy removal of composite form the mould. In the first step a thin layer of epoxy was spread at the bottom of the mould. Then the fibers were placed and rest of the epoxy was poured in the mould. Weight is kept on the mould to put pressure. The sample was kept at room temperature for 24 hours.

Fig. 2.3 Sun Hemp Fiber Composite

Fig. 2.4 Nettle Fiber Composite

Fig. 2.5 Plane Epoxy

Fig. 2.6 Hemp Fiber Composite

3. RESULTS AND DISCUSSION

The composites were subjected to tensile and flexural testing as per ASTM standards.

3.1 Effect of variation of fiber loading on the tensile strength

Fig 3.1 shows the tensile behavior of sunn hem, nettle and hemp composite. It is clear that the nettle fiber exhibit highest tensile strength. The tensile strength increases with fiber loading and highest at 20% fiber loading. Tensile strength greatly depends on the adhesive forces between fiber and the polymer.

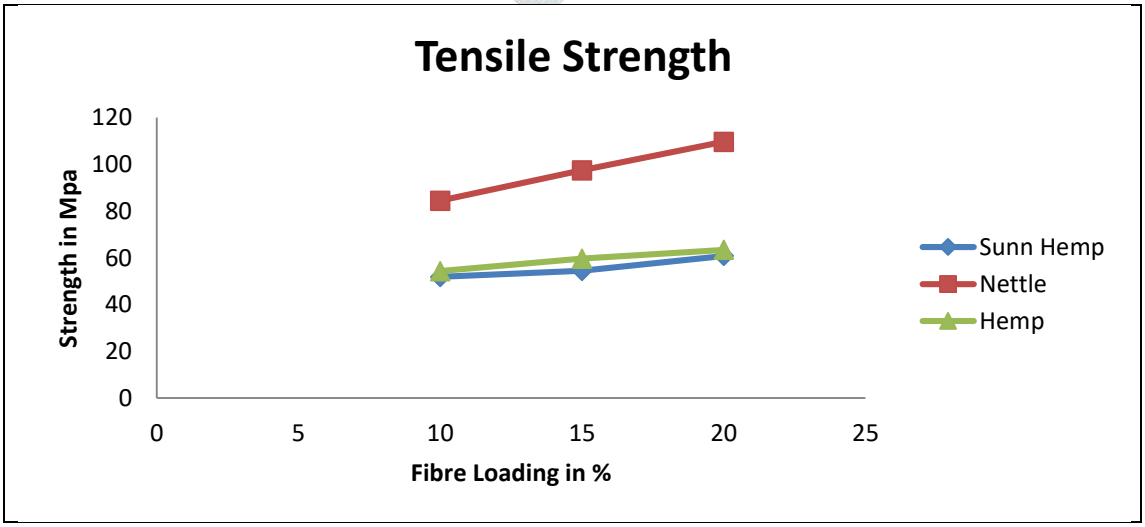

Fig 3.1 Tensile Strength vs Fiber Loading for Sun Hemp, Nettle and Hemp Fiber.

3.2 Effect of variation of fiber loading on the flexural strength

Result of fiber loading on flexural properties of sun hemp/nettle/ and hemp epoxy composites with different fiber loading is shown in Fig. 3.2. It is clear that the flexural properties increase with fiber loading. Like tensile strength Nettle fiber exhibit highest flexural strength among all the fiber.

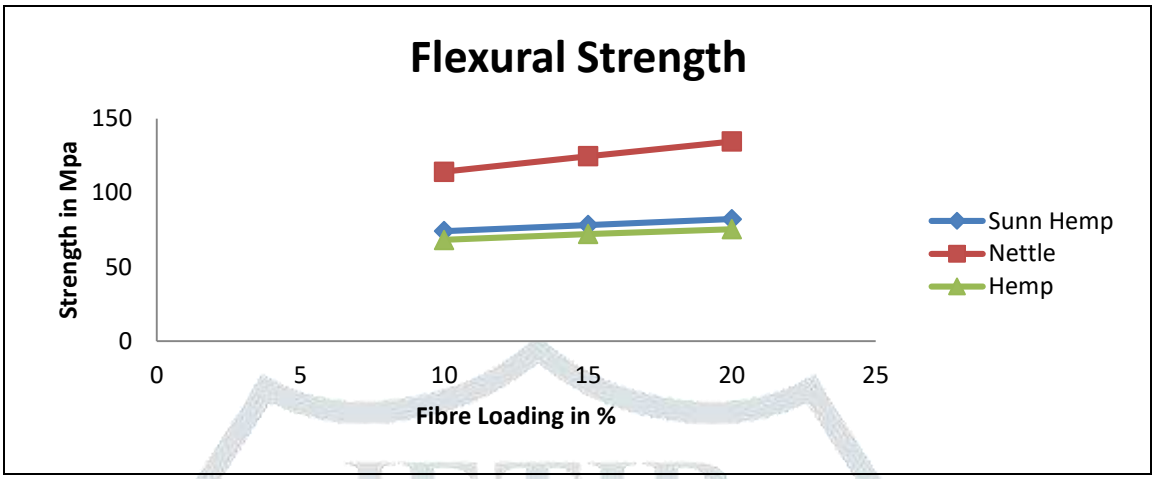

Fig. 3.2 Flexural Strength vs Fiber Loading for Sun Hemp, Nettle and Hemp Fiber.

4. CONCLUSION

A detail study has been conducted on the mechanical behaviour of hemp/sun hemp/nettle/epoxy composite. The fibre loading was kept same concentration and fibre length was altered lead to the conclusions

- In tensile testing, as fibre loading increases, tensile strength of composite increases and nettle fibre have maximum tensile strength at 20% fibre concentration which is highest among all the composites.
- In flexural testing similar behaviour were also obtained. Flexural strength increases with fibre concentration. Maximum flexural strength was achieved at 20% fibre loading in Nettle fibre composites which is highest among all the composites.

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