Evaluation of Mechanical Behaviour of Bamboo/Cotton Fabric Reinforced Epoxy Composites

Bhuvaneshwaran M[1], Vasanth K[2]*

[1]Assistant Professor, Department of Mechanical Engineering, K.S.R. College of Engineering, Tiruchengode – 637 215, Tamil Nadu, India.

[2]P.G. Scholar, Department of Mechanical Engineering, K.S.R. College of Engineering, Tiruchengode – 637 215, Tamil Nadu, India.

Abstract: *This work is concerned with the evaluation of the effect of fiber content on the mechanical properties of composites. Composites were fabricated using Cotton & Bamboo woven fabric /epoxy with varying fiber loadings. Cotton fiber reinforced epoxy composites were fabricated with varying fiber loading (30, 35, 40, 45 and 50 wt %). Cotton/epoxy composites are fabricated using hand lay-up technique followed by compression mounding method. The results showed that tensile, flexural, impact and compression properties of the composite increased with increasing fiber content up to 45wt% for Cotton & bamboo epoxy composite. After that the result is decreased because of poor bonding between fiber and matrix.*

Key word: Cotton & Bamboo, Fabric, Compression Moulding, Mechanical Properties.

1. INTRODUCTION

Ever since the global market to move towards energy reduction and energy conservation, the natural fiber composites had high demand. These fibers are used mostly in the engineering section because of the characteristics they exhibit compared to other fibers. These natural fibers are eco-friendly products and meet various applications in automotive construction and manufacturing fields. For numerous reasons the production of composite materials based on natural and renewable sources are raising swiftly. Due to various properties the importance of plant fiber composites increased [1-3]. Because other eco- friendly natural fibers, replace the other conventional fibers such as carbon, aramid and glass fibers. Natural fiber also has many drawbacks such as poor adhesion to polymers, poor strength, and high water sensitivity. Many studies were conducted to increase the strength by chemical treating with alkali, silane etc., which increases the bonding between matrix and fiber exponentially. If the alkali concentrations are high, the fiber surface will be damaged which leads to decrease in mechanical properties [4-7].

Due to the extraordinary characteristics of nanoclay composite their research and aflention is increased. The chemical treatment with NaOH for one hour were performed on Coccinia indica fiber to eliminate the unwanted hemicellulose, amorphous and lignin phase of the fiber [8-9]. NaOH treatment were performed to overcome the disadvantages of natural fiber.The main objective of this study is merge nanoclay into alkali treated coccinia indica fiber reinforced epoxy composites and study its mechanical properties. Nanoclay infusion in fiber and matrix enhance the property of natural fiber reinforced composties [10]. The addition of small concentration of nanoclay improves the mechanical properties of prepared reinforced polymer composites. The novel aspect of this research is introduction of nanoclay into novel natural reinforcing material.

2. MATERIALS AND PREPARATION

2.1 Bamboo fiber

Bamboo is from a group of woody perennial evergreen plant in the true grass family poacoae and sub family bambusuae and it is one of the fastest growing plants in the world. Generally, bamboo has two patterns during growth namely clumping and running. The clumping bamboo species tends to grow and spread slowly as the pattern of the rhizhomes is to simply expand the root mass gradually similar to ornamental grass while the running bamboo needs care even during cultivation due to its potential and aggressive behaviour. The bamboo steam as shown in Figure.3.1

Figure 3.1 Bamboo steam

2.2 Cotton fiber

The fiber king cotton is a single-cell fiber obtained from the seeds of cotton plants belonging to the Malvaceae family. Cotton is the backbone of textile applications. Cotton is a soft white fibrous substance and is a natural fibre known for its comfort and durability. Leaf and best fibres are very important but they can't be compared with textile fibres, seed fibres and cotton. As cotton has some unique structure, it can absorb water up to 2.7 times of its weight. India stand second in producing cotton after china.Out of the total cultivated area, cotton grown area occupies 3% in the world. India has its own unique position in producing cotton and is also one of the main exports of cotton yarn and garments. cotton plaut has flowers in white and the flowers turn purple after two days of blooming while its length ranges from 3/8" to 2" (Figure. 3.2)

Figure 3.2 Cotton plant

2. 3 Preparation of epoxy and hardener

Epoxy remains as one category of thermoset polymer available in the form of liquid and is a matrix material for preparation of woven fabric reinforced composite. The cross-linking of epoxy is performed by adding hardner to cure epoxy. The ratio of epoxy and harner weight is 10:1 while epoxy type is LY556 with a density value of 1.5-1.2g/cm^3 and harder of HY951 of density 0.98 g/cm^3 are used for the present work.

2.4 Fabrication of Composites

Plain woven fabric and resin were taken separately in correct proportion and the harder and epoxy resins were mixed in a jar using glass stirring rod. So that it can be mixed without air bubbles and pore in the mixture. Before starting the fabrication process, the top and the bottom surface were cleaned and waxed. The plain woven fabric was stacked on the bottom die surface and using Hydraulic operated Compression Moulding Machine (HCMM), the pressure was applied between moulded plates upto 110bar. The mould plates were then opened at room temperature under atmospheric air condition. Further, the temperature was gradually increased to 80º C and it was kept for 30 minutes.

2.5 Mechanical Testing

After fabrication the test specimens were subjected to various mechanical testing as per ASTM standards. The mechanical tests that carried out are tensile test, flexural test, impact test. The specimen size and shape for corresponding tests are as follows. ASTM D3039, ASTM D790, and ASTM D256 standards are used to conduct the tensile, flexural and impact tests respectively.

3. RESULTS AND DISCUSSIONS

3.1 Tensile Test

Tensile testing of specimen prepared according to ASTM D 3039 type IV sample was carried out, using electronic tensile testing machine with cross head speed of 2mm/min and a gauge length of 150 mm.

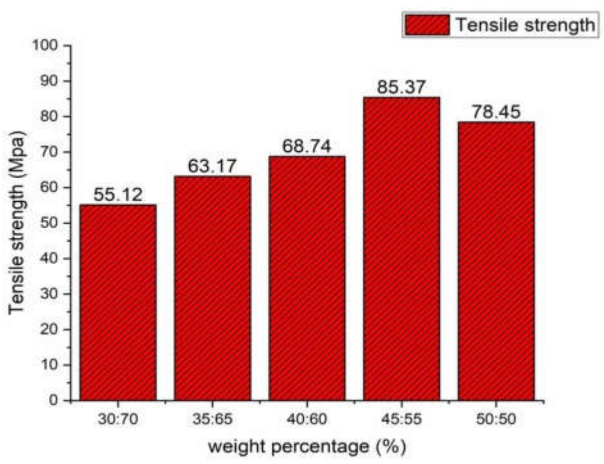

Fig. 3.1 Tensile strength of cotton & bamboo epoxy composite

Four specimens were tested for each set of samples and mean values were reported. Fig 3.1 shows the cotton bamboo composite experiences increase in tensile strength of 85 Mpa at 45 wt. % of fiber loading since the bamboo fiber has higher load carrying capacity than cotton fiber; the result of difference in tensile strength shows cotton bamboo composite has enhanced property.

3.2 Flexural Test

The flexural test was performed by the three point bending method according to ASTM D 790, and cross head speed of 1 mm/min. Four specimens were tested, and the average was calculated. As such, flexural strength has enhanced with increase in fiber loading up to a critical point of 45 wt. %. But, it starts to decrease when there is increase in fiber loading since the flexural strength of the composite is also influenced by the strength of the fiber. The fig 3.2 shows cotton/bamboo exhibited higher flexural strength at 107.02 Map at 45 wt%.

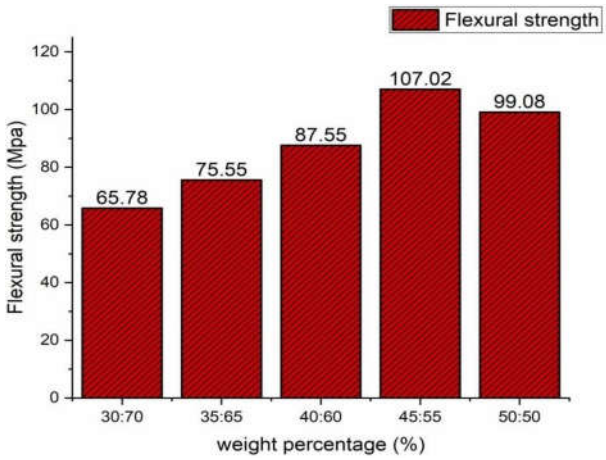

Fig. 3.2 Flexural strength of cotton & bamboo epoxy composite

3.3 Impact Test

The capability of material to resist fracture under the sudden applied load at same velocity (or) speed is called impact strength. The impact properties of laminated composites are based on the factors like fracture toughness, fiber pull out on friction force, inter laminar and interfacial strength between fiber and matrix. The cotton/bamboo composite laminate strength increases up to 45 wt. % as 32.3 kJ/m^2. In the woven pattern, the impact strength of laminates with different types of fiber influences parameter interface between fiber, matrix and dimension of composite laminates.

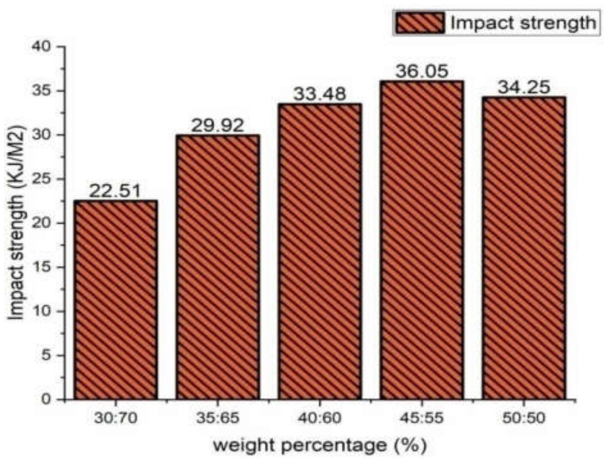

Fig. 3.3 Impact strength of cotton & bamboo epoxy composite

4. CONLUSION

The single yarn strength, tenacity, and elongation of (100%) cotton yarn are low but (100%) bamboo yarn has more and at the same time, blended yarns have low strength, tenacity, and elongation. The tensile, flexural and compression strength of cotton & bamboo woven fabric /epoxy composite improved by increasing fiber loading up to 45wt.% and deceased by higher loading. The Impact strength of cotton & bamboo woven fabric /epoxy composite improved by increasing fiber loading up to 45wt.% and deceased by higher loading. Addition of bamboo fiber in weft direction increasing the mechanical properties of composites.

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