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ANALYSIS OF MECHANICAL BEHAVIOUR IN FIBER REINFORCED POLYMER COMPOSITES.

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Abstract - The main aim of the project is to describe the experimental development and characterization of new set of hybrid fiber reinforced composites. Recently, Fiber reinforced polymer composites (FRPCs) has becoming attractive material which possess good mechanical properties, eco-friendly and biodegradable characteristics. The fabrication of composites are made by reinforcing both natural and synthetic fibers like Sisal\E-glass\Bamboo with epoxy resin as polymer with different percentage ratios such as 22.5% of fibers with 77.5 % resin and 30% of fibers with 70% of resin. Hybrid fiber reinforced composites were manufactured according to ASTM standards by using hand layup method. The mechanical properties such as tensile, flexural and impact properties were determined for two different composite specimens and compared their values. From the result and discussion, we have to conclude the composite specimen 1 (22.5% of fibers with 77.5 % resin) have better tensile, flexural and impact strength value compared with other specimen.

Keywords : Bamboo , Sisal , E- glass , epoxy , Hand layup , Tensile , Flexural , Impact

1. INTRODUCTION

Over the last thirty years composite materials, plastics and ceramics have been the dominant emerging materials. The volume and number of applications of composite materials have grown steadily, penetrating and conquering new markets relentlessly. Modern composite materials constitute a significant proportion of the engineered materials market ranging from everyday products to sophisticated niche applications. While composites have already proven their worth as weight-saving materials, the current challenge is to make them cost effective. The efforts to produce economically attractive composite components have resulted in several innovative manufacturing techniques currently being used in the composites industry. It is obvious, especially for composites, that the improvement in manufacturing technology alone is not enough to overcome the cost hurdle. It is essential that there be an integrated effort in design, material, process, tooling, quality assurance, manufacturing, and even program management for composites to become competitive with metals.

A composite material consists of two or more physically and/or chemically distinct, suitably arranged or distributed phases, with an interface separating them. It has characteristics that are not depicted by any of the components in isolation. Most commonly, composite materials have a bulk phase, which is continuous, called the matrix, and one dispersed, noncontinuous, phase called the reinforcement, which is usually harder and stronger.

2.INTRODUCTION

S.Srineevasalu et al., studied that "Many of our modern technologies demand materials with unusual combination of properties such as high strength to weight ratio, high stiffness, high corrosion resistance, high fatigue strength, high dimensional stability etc., these can't be met by the conventional metal alloys. Polymeric materials reinforced with synthetic fiber such as glass, carbon and aramid provide advantages of high stiffness and strength to weight ratio as compared to conventional construction materials, i.e. wood, concrete, and steel. Therefore, the present project work is to evaluate the Mechanical properties such as Tensile strength (TS), Flexural strength (FS) of short bamboo fiber reinforced composites with and without Alumina (Al2O3) as a reinforced material".

S.M.Darshan et al., concluded that "Natural fibers have recently become attractive to researchers, engineers and scientists as an alternative reinforcement for fiber reinforced polymer composites (FRPCs). Due to their low cost, fairly good mechanical properties, high specific strength/modulus, nonabrasive, ecofriendly, and biodegradability characteristics, they are exploited as a replacement for the synthetic fiber, such as glass, aramid, and carbon. Characterization challenges associated with the waste silk fiber reinforced thermoplastic and thermoset composites productions were also examined. Thus, the findings of this research review can be used as a data base for further inquiring into the waste silk FRPCs in a view to enhance the development of the automotive sector".

3.MATERIALS AND METHODOLOGY

3.1 Materials used

3.1.1 Bamboo fiber

In the present project work, short bamboo fiber is taken as the reinforcement in the polyester matrix to fabricate composites. In this work, short bamboo fiber is used as the reinforcement in the composites. The average thickness of each bamboo fiber is about 2 mm.

Fig 3.1 Bamboo fiber extraction process

3.1.2 Sisal fiber

Sisal produces sturdy and strong fibres. Sisal fibre is one of the prospective reinforcing materials that its use has been more experiential than technical until now. The fibres of Sisal are made of elementary fibres of 4 to 12 μm diameter that are aggregated by natural bound forming small cells of 1 to 2 μm.

Fig 3.2 Sisal fiber extraction process

3.1.3 E – glass fiber

Among all the synthetic fibers, glass fibers are being used widely due to their low cost and comparatively better physico-mechanical properties. E-glass (54.3SiO2–15.2Al2O3–17.2CaO–4.7MgO–8.0BO–0.6Na2O) is the most widely used glass fiber and it can maintain its properties up to 815°C.

3.1.4 Epoxy resin

Epoxy resins are available in liquid and solid forms and are cured into the finished plastics by a catalyst. They are cured at room temperatures as well as elevated temperatures of about 275°C. The erosion resin of grade LY-556 was used of density 1.1-1.2 gm/cc at 298 K.

3.2 Method – Hand lay up method

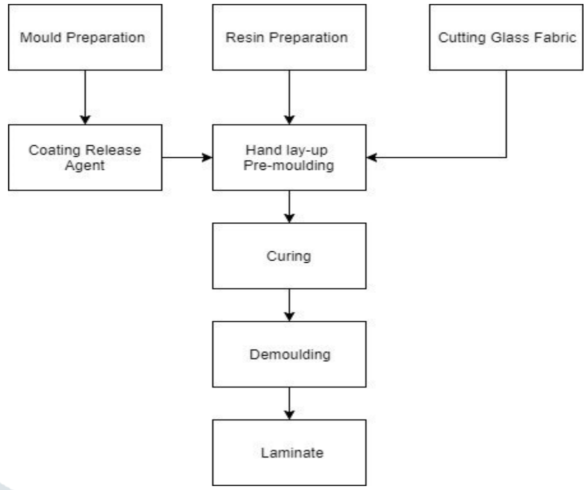

Fig 3.3 Hand lay up process

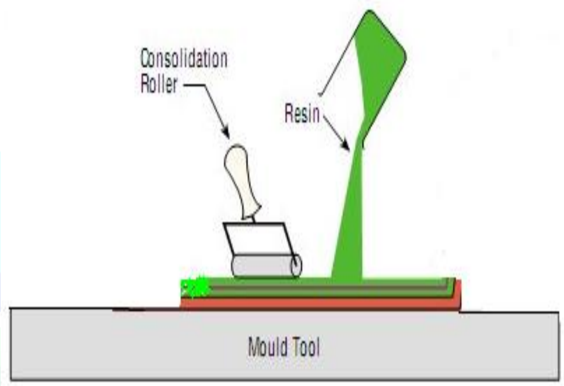

Fig 3.4 Experimental method

4.EXPERIMENTAL TESTING

Utilization of materials has always been supported by testing activities, which have developed over the centuries from crude tests of the fitness-for-purpose of service items to the modern science-based procedures that support all aspects of the science and technology of materials and their utilization.

4.1 DETERMINATION OF TENSILE STRENGTH

Fig 4.1 Universal Testing machines

The force measurement is used to calculate the engineering stress, σ, using the following equation.

$$\sigma = F/A$$

where F is the Tensile force , A is the nominal cross section of the specimen.

4.2 DETERMINATON OF FLEXURAL STRENGTH

For a rectangular sample under a load in a three-point bending setup:

$$\sigma = 3FL / 2bd^2$$

Where F is the load (force) at the fracture point (N),*L* is the length of the support span, *b* is width and *d* is thickness

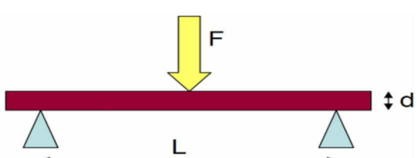

Fig 4.2 Flexural Testing

4.3 DETERMINATION OF IMPACT STRENGTH

Fig 4.3 Impact testing machines

4.4 PICTOGRAPHY OF TESTING SPECIMEN

Fig 4.4 Sample Testing Preparation

5.RESULTS AND DISCUSSION

Details of processing of these composites and the tests conducted on Bamboo, Sisal and E-Glass composite material have been described in the previous chapter.

5 .1 TENSILE STRENGTH RESULT

Fig 5.1 Testing Specimen of sample1(load vs displacement)

Fig 5.2 Testing Specimen of sample2(load vs displacement)

5.2 FLEXURAL STRENGTH

Fig 5.3 Flexural Test Specimen 1

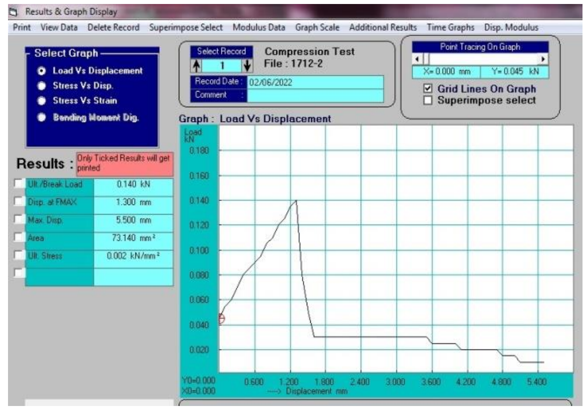

Fig 5.4 Flexural Test Specimen 2

5.4 IMPACT STRENGTH RESULT

Composite Material	Ultimate Impact Strength (J)
Sample 1 (30% Fiber & 70% Resin)	0.26
Sample 2 (22.5% Fiber & 77.5 % Resin)	0.2

6. CONCLUSION

Hybrid fiber reinforcement composite (Bamboo + Sisal + E-Glass) with epoxy resin have been successfully fabricated using hand lay – up technique

1.Composite sample 1 is holding the maximum flexural strength of 3 kN/mm^2 higher than the other sample 2 composite material.

2. Sample 1 composite possess good tensile strength and can withstand the strength up to 25 kN/mm^2. From the result it observed that the tensile strength increased with increasing resin volume fraction.

3. The impact strength was found that sample 1has highest value of 2.6 joules compared with other composite samples.

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