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Fabrication and Mechanical Characterization of Coconut Fiber and Glass Fiber Epoxy Reinforced Hybrid Composite

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Abstract— The present work deals with the Mechanical Characterization of coconut and glass fiber reinforced hybrid composite. The Mechanical test for Tensile, flexural & Impact strength was performed at UTM. The sample comprises coconut and glass fiber with epoxy resin ARALDITE LY556 with hardener HY951. The composite has different orientations and volume fractions of its constituents. The fabrication process for sample preparation is the Hand layup method, and considerable precautions taken to ensure homogeneity. The composite sample comprises 50% epoxy resin, 25% glass fiber, 25% coconut fiber, and 50% epoxy resin, 35% coconut fiber, 15% glass fiber. Testing of sample for tensile test at UTM ASTM-D638, for flexural ASTM-D790 and for Charpy Impact test ASTM-D4812 was performed. The effect of volume fraction & orientation of fiber was analyzed. The result shows the significant strength of this hybrid composite. Tensile test show peak stress of 33.25 MPa and 18 MPa, which decreases on the increasing coconut fiber content. Flexural test show Peak stress of 60 MPa, & 72 MPa, which show on reducing coconut fiber %, the peak flexural stress rises. Impact Charpy test had strength 92 kJ/m^2 & 44 kJ/m^2, which show decreases on increasing in coconut fiber %. This study evaluated more interest in Natural Hybrid Composite for future aspects. Further, more research needs to examine the effect of fiber content, fiber orientation & load etc

Keyword: *Hybrid Composite, Glass fiber, Coconut fiber, Epoxy resin, Mechanical characterization.*

INTRODUCTION

In this fast growing world demands of new materials increases rapidly. Composites are one which taking places. Natural Hybrid Composite find suitable to replacing traditional existing materials, it possess good mechanical properties which can fulfill current scenario requirement [1]. Natural hybrid composite has biggest advantages i.e. environmental friendly, lightweight and high performance with easily availability in nature [2]. It has some drawbacks such as high production cost & polluting environment during it production and disposal [3]. Different research suggests that hybridization of different fibers reduces limitations & increases mechanical properties of the composites [4]. Composite with different orientations and volume fractions were used to prepare using basic Hand lay-up method and compression mold technique [5]. The Mechanical properties such as Tensile, Flexural and Impact strength of coconut fiber and glass fiber reinforced with polymer epoxy & hardener are analyzed.

MATERIALS AND METHODS

The composite consists of randomly oriented glass fiber and coconut fiber reinforced with epoxy resin with hardener (10:1). Coconut fiber is extracted from raw coconut manually [6], purchased from a local shop, and randomly oriented glass fiber sheet is purchase from FUNIQUE COMPOSITES PRIVATE LIMITED Delhi. To enhance the adhesion of fiber, raw coconut fiber was treated with a 10% concentration of NaOH Solution for 24 hours, and then fiber was treated with water to reduce the environmental reaction [7]. Furthermore, these fibers were dry in sunlight for one week. Fabrication of the sample performed by Hand lay-up techniques.

Glass Fiber

Glass fiber used is of 0.7 mm thickness and density 1.97gm/cc is reinforced with epoxy ARALDITE LY 556 with hardener HY 951 procured from FUNIQUE COMPOSITES PRIVATE LIMITED Delhi. Glass fiber possess various good mechanical properties and less costly [8]. One disadvantages of glass fiber is that they break on subjected to tensile load [9].

Coconut Fiber

Coconut fiber used has density 1.2gm/cc is procured from raw coconut purchase from local shop. Chemical treatment performed to reduce environmental reactivity [10]. Coconut fiber is sustainable and eco-friendly also it is easily renewable and biodegradable. It has a good weight-to-strength ratio [11]. It is also resistant to saltwater and can withstand high temperatures; coconut fiber is a versatile and useful material with a wide range of applications [12].

Epoxy Resin

Araldite LY 556 is a medium-viscosity, unmodified epoxy resin based on bisphenol-A [13]. It has outstanding mechanical qualities and chemical resistance, and it may be changed to a large extent by employing various hardeners and fillers [14]. The matrix material used is epoxy resin ARALDITE LY556 with hardener HY 951 purchased from FUNIQUE COMPOSITES PRIVATE LIMITED Delhi. Epoxy resin has viscosity at (25℃) is 10000-12000 mPa s, density at (25℃) is 1.15-1.20 gm/cc and colour is clear white liquid [15].

Experimental Design

The fabrication of composite was done to considering both volume variation and orientation of fibers [16]. Matrix have 50% epoxy with (10:1) hardener and reinforcement were 25% coconut fiber , 25% glass fiber and 15% glass fiber , 35% coconut fiber. Orientation of fiber is [GCGCGCG] & [GCCCCCG]. G denoted glass fiber and C denote coconut fiber.

Preparation of composite samples

Composite is prepared by conventional Hand layup method and compression molding technique [17]. The composite is prepared by seven piles of fiber. 10:1 Epoxy resin with hardener was mixed well with stir and painted layer by layer to bind the fibers [18]. First, silicon gel as mold releasing agent was spread on plastic foil and placed on the iron plate for a good clean surface of a sample [19]. Then epoxy resin spread, fibers are over placed one by one and painted up to the last layer. Then the prepared sample was compressed by a Hydraulic press with a pressure of 5 tones to eliminated air trapped inside and the void present inside the sample. The sample was placed on a hydraulic press for 24 hours.

Fig. 1: Sample of rndomaly oriented glass fiber & coconut fiber

3. MECHANICAL PROPERTIES CHARACTERIZATIONS

After sample preparation, the tensile, flexural (three-point) and Impact Charpy tests were conducted at UTM at 1mm/min speed of the machine.

Tensile test: Sample tested at ASTM D638 standard for the tensile test [20]. The test was performed at UTM. Specimen geometry is 6 mm × 21.5 mm × 170 mm, and the gauge length is 50 mm. The test was performed to determine the tensile strength of the composite.

Flexural test: Sample tested at ASTM D790 standard for the three-point flexural test [21]. It determines the ability of a material to withstand bending. The gauge length is 100 mm, and the specimen geometry is 125 mm × 12 mm × 7 mm.

Impact test: Sample tested at ASTM D4812 standard for the Impact Charpy test [22]. It determines the ability of materials to absorb energy without breaking (rupture) is called the Impact test. Specimen geometry is 15 mm × 5 mm × 65 mm.

Fig. 2: Setup of test, tensile, flexural & Impact Charpy test

4. RESULTS

4.1 Tensile Strength

Tensile strength of a fabricated composite sample of different orientations and volume fractions obtained as a test performed on a Universal testing machine. The tensile strength of the composite decreases with increasing the coconut fibre %. The below table 1, tensile strength shows as:

Table 1: Tensile strength of sample

Comppposite (% wt)	Orientation of fiber	Peak Load (kN)	Tensile Strength (MPa)
Epoxy (50%), Coconut fiber (25%), Glass fiber (25%0	GCGCGCG	4.28	33.24
Epoxy (50%), Coconut fiber (35%), Glass fiber (15%)	GCCCCCG	3.15	18

4.2 Impact Strength

Fabricated sample when subjected to Charpy Impact test, on increasing coconut fiber %, the Impact strength decreases. Data shows sample having 25% glass fiber & 25 % coconut fiber with 50% epoxy have 91.24 kJ/m^2 of Impact strength. And sample with 35% coconut fiber & 15% glass fiber with

50% epoxy have 43.8 kJ/m^2 of Impact strength.As shown in table 2:

Table 2. Impact strength of sample

Comppposite (% wt)	Orientation of fiber	Impact Strength (kJ/m²)
Epoxy (50%), Coconut fiber (25%), Glass fiber (25%0	GCGCGCG	91.24
Epoxy (50%), Coconut fiber (35%), Glass fiber (15%)	GCCCCCG	43.8

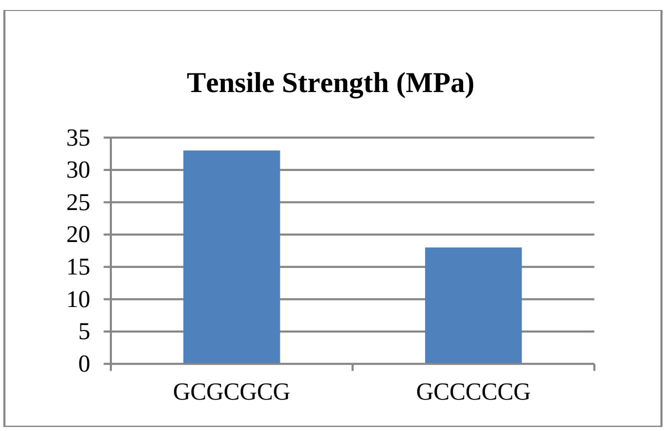
4.3 Flexural Strength

Fabricated sample when subjected to three-point Flexural test, the flexural strength increases on increasing coconut fiber % as .Data Shown in table 3 as:

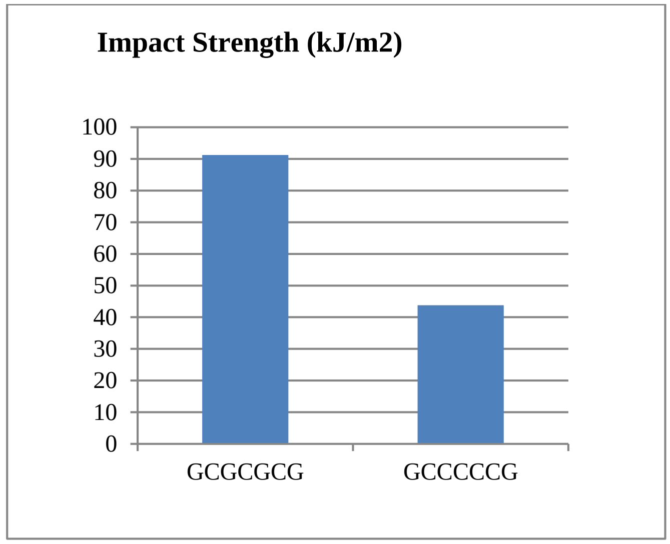
Table 3: Flexural strength of sample

Comppposite (% wt)	Orientation of fiber	Peak Load (kN)	Flexural Stress (MPa)
Epoxy (50%), Coconut fiber (25%), Glass fiber (25%0	GCGCGCG	0.23	60
Epoxy (50%), Coconut fiber (35%), Glass fiber (15%)	GCCCCCG	0.28	72

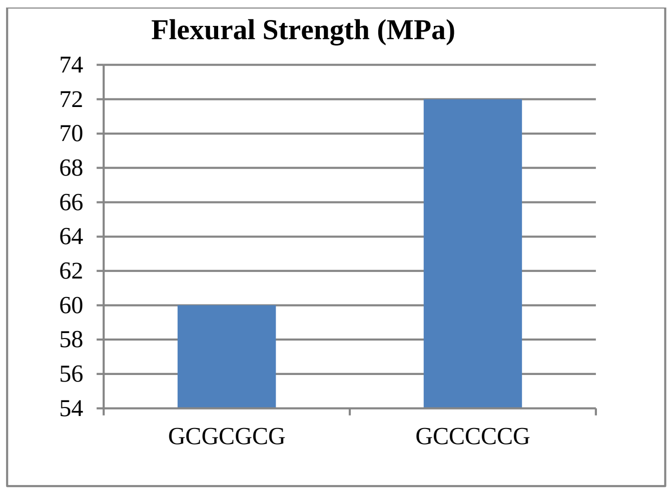
Graph shows tensile, Impact & Flexural strength of fiber having composition of (50% epoxy + 25% glass fiber + 25% coconut fiber) & (50% epoxy +15% glass fibr + 35% cocnut fiber) with orientation {GCGCGCG] & [GCCCCCG] respectivily. G denote as Glass fiber & C as Coconut fiber.



In above graph , tensile strength of sample decreases on increasing coconut fiber % by weight.



In above graph, Impact strength of fabricated sample decreases on increasing coconut fiber % by weight.



Above graph shows that on increasing coconut fiber %, the flexural strength increases.

5. CONCLUSION

The study on mechanical characteristics of 25% wt of coconut fiber , 25% wt glass fiber reinforced with 50% epoxy . And 15% wt glass fiber & 35% wt coconut fiber reinforced with 50% epoxy. On comparison of results tensile test decreases from on increasing coconut fiber.In flexural test, on decreasing coconut fiber % the peak flexural stress increases.In Charpy test, on increasing coconut fiber % the Impact strength decreases.

6. FUTURE SCOPE

The future scope of coconut fiber and glass fiber-reinforced epoxy composite is vast and has great potential to revolutionize various fields. It is a promising material in the field of composite due to its excellent mechanical properties, low cost and environmental friendliness. Some potential future use is in structural, aerospace, automotive, marine and sustainable development.

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