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Synthesis and characterization of treated banana fibers and selected jute fiber based hybrid composites

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ABSTRACT

The hybrid composite is obtained by compounding the natural fiber with artificial or synthetic fibers in the reinforcement phase. For the current work the NaOH treated banana fibers of selected length of 15 mm and selected length of 30 mm jute fibers are combined with glass fibers for various weight fractions. The specimens of treated banana/glass fiber with epoxy hybrid composites synthesized by hand layup method with reinforcement of treated banana fibers wt% of 30%, 40%, and 50%. Similarly jute/glass fiber with epoxy hybrid composites synthesized by hand layup method with Jute reinforcement wt% of 30%, 40%, and 50%. The synthesized composites characterized by tensile behaviors with help of computerized tensile tester. The interesting results were reported.

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1. Introduction

In new materials, the metal matrix composites and fibre matrix composites are two sides of the coin. In which the methods of preparing the nano-particles [1], reinforced metal matrix composites [2,3], optimizing the machining parameters [4,5], suggesting coated tools [6] analysing machined performances [7]. Etc are scope of the area. Nowadays the replacement of metal in to fibre composite is widely adapted [8], the delaminating properties of natural fibre composites was arrested by stitching method [9], tamarind seeds [10], Almond shells [11] are also recommended to fabricate the natural fibre composites. The natural fibre composites plays vital role in all fields. Some of the interesting results are motivates this research. The 20% banana fibres of 10 mm with polyester exhibited good harness property the same proportion was obtaining for jute fibre of 20% with Polyester [12]. Venkateshwaran and Perumal [13] recommended the length of 30 mm banana fibre with 16% content with epoxy yield better mechanical properties [14] reported that the Alkali treated banana fibre gives improved mechanical properties and less water absorption. Muthuvel et al. [15] recommend the glass woven fibre with jute fibre gives cost and weight reduction of 20% and 23% respectively for fibre weight fraction of 42%. Chaudhari et al. [16] recommends 15% of glass and 15% jute with polyester gives high flexural strength but less than the pure glass fibre composite. Boopalan et al. [17] reported that 50% weight fraction of jute with epoxy improved desirable properties in mechanical aspects. In this research explore the tensile behaviour of the jute epoxy composite with different weight fraction and treated banana epoxy composites. The tensile behavioural study helps to suite the composite to desired application.

2. Material and methods

2.1. Hybrid composite matrix materials

It is planned to synthesize two kinds of hybrid composites with use of treated banana fibres and jute fibres. Both the natural fibres are strong enough individually. With consideration of desirable properties like: best control over thickness, good weight to strength ratio, and other mechanical properties, electrical insulation capacity etc., the high dense (600 gsm) glass (woven fibre) fibre (refer Fig. 1(a)) is proposed to make strong composites. The

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Nomenclature

gsm	Grams per Square meter
NaoH	Sodium Hydroxide
ASTM	American Society for Testing and Materials

banana fibres collected with care (refer Fig. 1(b)) and tore them to minimal width (refer Fig. 1(c)). Those fibres are cut in 15 mm long (length of 10–15 mm long banana fibres already proved best strength in many banana based composites) and washed well. The washed fibres allowed to dry 2 to 3 h. The NaoH solution prepared with distilled water with ratio of 6:80 in volume percentage. The well dried banana fibres soaked into the solution for three hours. The hours of chocking are proportional to improving its

Fig. 1. Hybrid Composite Matrix materials: a) Glass fibre b) Raw banana fibre c) Treated Banana fibres d) Jute fibre e) epoxy f) Hardener.

Fig. 2. Synthesize of Hybrid Composite: a) cut of glass fiber to size b) prepared glass fiber c) weighing glass fiber to desired weight fraction d) weighing the epoxy and hardener e) first layer of composite f) second set of layer of composite g) prepared composite sample.

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strength. After 3 h the fibres took out form the NaoH solution and washed well with water again allow to dry for 3 to 4 h. Hence the treated banana fibres prepared. The eco friendly, affordable golden fibre i.e., Jute (refer Fig. 1(d)) was preferred to make another kind of hybrid fibre composites with selected length of 30 mm. The Epoxy and hardener (refer Fig. 1(e) and (f) respectively) employed

Table 1
Tensile properties, packing density and Classification of Hybrid Composites.

Wt% of Fiber Type Content	Composite Type	Packed Density of natural Fiber	Tensile Properties	
			Ultimate Stress (kN/mm^2)	Yield Stress (kN/mm^2)
30% Jute Fiber	C1	1.46	0.105	0.046
40% Jute Fiber	C2	1.46	0.113	0.105
50% Jute Fiber	C3	1.46	0.139	0.036
30% Banana Fiber	C4	1.426	0.139	0.139
40% Banana Fiber	C5	1.426	0.163	0.169
50% Banana Fiber	C6	1.426	0.204	0.204

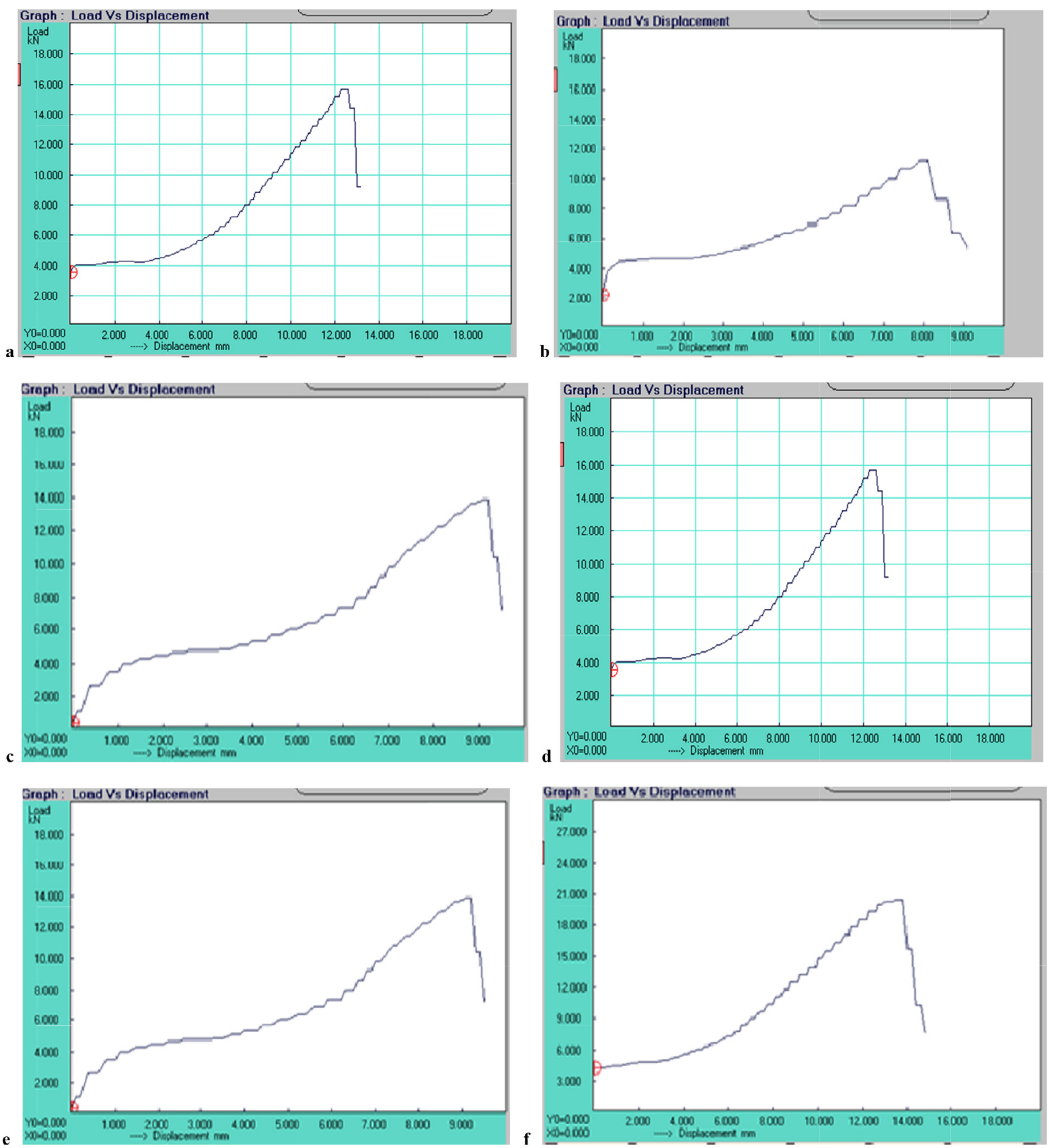

Fig. 3. Tensile Behavior of Hybrid Composites a) Type C1 and b) Type C2 c) Type C3 d) Type C4 e) Type C5 and f) Type C6.

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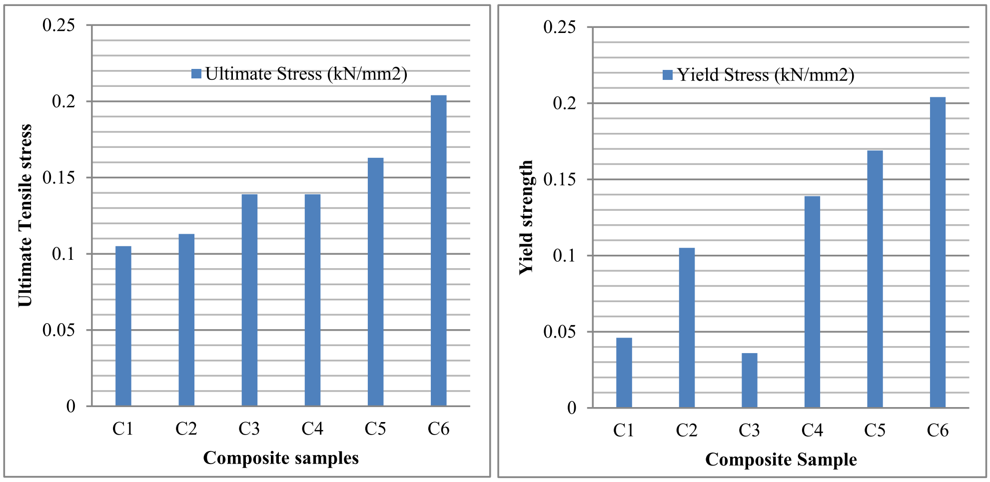

Fig. 4. Tensile strength of Hybrid composites a) Ultimate Tensile strength b) Yield strength.

with 10:1 ratio by weight fraction in the composite matrix. The weight fraction of the natural fibres varied in three levels as 30%, 40% and 50% and hence six different hybrid composites planned to synthesize for characterization.

2.2. Synthesize of hybrid composites

The sequential procedure of synthesizing hybrid composites, are depicted in Fig. 2. The hand layup method was preferred to fabricate the composites. The long Glass fibre sheets cut in to equal size of $30 \times 20\,cm^2$ (refer Fig. 2(a), (b)) so that weight fraction can be made easily. The natural fibres weight proportions used as 30%, 40% and 50%. The composite matrix materials weighed as per plan (Refer Fig. 2(c) and (d). The end layers are must be glass fibre, accordingly the weight of natural fibres were weighed and used. Hence the fabrication start glass fibre layer. The hardener mixed with epoxy with weight proportion of 1:10 and apply over the glass layer and filled with treated banana or Jute layer and covered the with glass layer. The natural and artificial fibres added in alternate fashion (Refer Fig. 2(e)–(g)).

2.3. Characterization of composites

The prepared composites were characterized by tensile properties. The ASTM D-3039 standard followed to prepare specimens and testing procedures. The sample size is $250 \times 2 \times 2.5$ mm. the tensile properties like ultimate tensile stress and yield stress were observed and consolidated in Table 1 for both kinds of hybrid composites. The tensile behaviours exhibit in Fig. 3(a). Fig. 3(b) and (c) for Jute fibre based hybrid composites of 30%, 40% and 50% respectively. Similarly the Fig. 3(d)–(f) exhibit the tensile behaviour of treated banana fibre based hybrid composites for the natural fibre composition of 30%, 40% and 50% respectively.

3. Results and discussions

The natural fibre fraction of 30% 40% and 50% is preferred in synthesizing the hybrid composites. The Hybrid composite type C1–C3 are belongs to Jute fibre based hybrid composites of 30%, 40% and 50% respectively and the types C4–C6 were made-up of treated banana fibres with weight fraction 30%, 40% and 50% respectively. The samples characterized by tensile behaviours and machine recorded graphs were shown in the Fig. 3. It was observed that in general increase of fibre composition that is weight fraction increases the ultimate tensile stress (refer Fig. 4a) in both cases and in particularly the treated banana fibre based hybrid composites shown more strong ultimate tensile values than jute fibre hybrid composites. But yield strength not showing order of variation for the jute fibre based hybrid composited but in treated banana fibre following same pattern of variation like ultimate tensile stress (refer Fig. 4b).

4. Conclusion

The synthesize of hybrid composite with treated banana fibre of length 15 mm and selected jute fibre length of 30 mm with epoxy at different weight fraction were discussed in detail. The choice of characterization here is tensile behaviour and its maximum values, which depicted in the Fig. 3. The graph ‘a’ depicts the tensile behaviour of composite type C1, similarly the graphs of ‘b’, ‘c’, ‘d’, ‘e’, and ‘f’ revel the composite samples of C2, C3, C4, C5 and C6 respectively. Hence the tensile behaviour revels that increase of jute fibre composition increases the high displacement with respect to tensile load refer b and c graphs in the Fig. 3. The same pattern was found for 405 wt fraction composite of treated Banana fibre hybrid composite. The 30% weight fraction of hybrid composites in both banana and jute fibre cases gives same pattern of tensile behaviour. The Fig. 4 shows that weight fraction of the selected length treated banana fibre increases, improves the tensile properties. Hence the user can select the appropriate choice of hybrid composite for their desired application.

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