COMPARISON OF MECHANICAL PROPERTIES FOR HYBRID PALM/GLASS/RARE EARTH FILLER REINFORCED POLYMER COMPOSITE

Pradeep P. and Edwin Raja Dhas J.
Department of Mechanical Engineering, Noorul Islam University, Kumaracoil, Tamil Nadu, India
E-Mail: pspradeep2006@rediffmail.com

ABSTRACT
The tensile, flexural and impact properties of Hybrid palm leaf stalk fiber/fruit fiber/rare earth sand filler/ sandwiched with glass fiber reinforced in polyester matrix were described for the first time in this work. The natural fibers were taken from palm leaf stalk and fruit portion of the palm tree. The extracted palm fibers were treated with potassium permanganate solution to enhance their properties. For experimentation three combinations of natural fibers, the first one with palm leaf stalk fiber, the second one with palm fruit fiber and the third one with hybrids of both palm leaf stalk/fruit fibers were sandwiched inside glass fibers acts as reinforcements. The polyester resin/rare earth sand filler was blend into uniform mixture acts as matrix. Compression moulding method was adopted to manufacture these in form of composite plates. Specimens are cut from the sandwiched composite plates according to the ASTM standards for testing mechanical characters. Experimental results on comparison reveal that the Hybridized palm leaf stalk/palm fruit fiber/rare earth sand filler/ sandwiched with glass possessed superior values than the others. Hence the developed composite can be recommended for fabrication of automobile parts like car bumpers, under body shield, etc.

Keywords: natural fibers, polymer composites, palm fiber, natural filler, fiber treatment.

1. INTRODUCTION
Natural fibers reinforced polymer composites represent one of today’s fastest growing industries. Natural fibers having comparable mechanical properties are alternates to manmade fibers such as carbon and glass fibers in reinforcement with composites. Natural fibers are bio-degradable in nature and are widely used in many applications [1-3]. It is difficult to compromise the properties of natural fiber reinforced composite in analogous with synthetic fibers as they possess extreme values closer to other metals. Development of bio-based polymer composite based products using natural fibers are basic interest among researchers due to their great advantages like high strength to weight ratio, low cost, easily available and fiber matrix adhesion. Eco-friendly composites are alternatives for plastic fiber composites [4-6]. Some natural fibers, like henequen [7], sisal [8], coconut fiber [9], jute [10], bamboo [11], date palm [12], wood [13], basalt [14], and banana [15] were common reinforcement agents in different thermosetting and thermoplastic resins. Many researchers manufactured composites with and without chemical treatment [16-18]. Fillers are added to natural fibers in preparation of composites for high strength [19-20]. Increase in percentage of coconut shell filler content usually increases the tensile strength. Limited research was done in using palm as natural composites. Palm fibers residues when added with coupling agent in preparation of composites enhanced the composite characters [21]. Palmyra fruit fiber chemically treated with NaOH whose tensile properties were analysed using FEA [22]. Hybrid Oil Palm Empty Fruit Bunch composites exhibited good mechanical properties and water absorption behavior [23]. The Sugar Palm Fibers showed high tensile properties and impact strength [24]. Oil palm empty fruit bunch natural fibers with Copper nano particles revealed biodegradability [25]. Asbestos based automotive brake pads can be replaced with palm kernel fiber composites [26]. Long palmyra palm petiole fiber based polymer composites holds good mechanical strength [27]. The influence of date palm fibers and graphite filler on mechanical and wear characteristics of epoxy composites showed appreciable results [28]. The effect of alkali pretreatments on hybrid oil palm empty fruit bunch (EFB) and kenaf core fibers showed hybridization improved strength [29]. Hybrid composites prepared with jute and oil palm fibers using hand lay-up technique finds application in automotive industry [30].

This paper addresses the development of Hybridized palm leaf stalk/palm fruit fiber/rare earth sand filled/ sandwiched with glass fiber and reinforced in polyester to form composites. Results shows hybrid fiber is superior.

2. EXPERIMENTATION

2.1. Materials
The materials used to develop the sandwiched composites are naturally available fibers extracted from the leaf stalk and fruit portions of the palm tree figure1. To enhance the properties of these fibers 8% KMnO₄ solution was used.
Three combinations of natural fibers were required, the first one with palm leaf stalk fiber, the second one with palm fruit fiber and the third one with hybrids of both palm leaf stalk/fruit fibers. All the three combinations of natural fibers were sandwiched inside commercially available E glass fiber for reinforcement. Polyester (resin), cobalt napthanate (hardener), methyl ethyl ketone peroxide (catalyst), were blend with rare earth sand filler into uniform mixture that acts as matrix. Wax polish as mould releasing agent was used for mould box surface coating.

2.1. Preparation of specimen

The Table-1 shows the combinations of Polyester resin, fibers and filler materials in weight percentage. The composite plates A, B and C were fabricated in these combinations.

<table>
<thead>
<tr>
<th>Specimen</th>
<th>Combinations</th>
<th>Weight % gm</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Polyester resin + 8% KMnO₄ treated Palm leaf stalk fiber mat + E-glass fiber mat + Rare earth sand filler</td>
<td>70 1050</td>
</tr>
<tr>
<td>B</td>
<td>Polyester resin + 8% KMnO₄ treated Palm fruit fiber mat + E-glass fiber mat + Rare earth sand filler</td>
<td>70 1050</td>
</tr>
<tr>
<td>C</td>
<td>Polyester resin + 8% KMnO₄ treated Hybrid Palm leaf stalk and Palm fruit fiber mat + E-glass fiber mat + Rare earth sand filler</td>
<td>70 1050</td>
</tr>
</tbody>
</table>

2.3. Fabrication of Composites for testing

Compression moulding method was adopted for fabricating all the composites A, B and C as plates using a moulding box of size 300mm × 200mm × 10mm. All the composite plates are allowed to dry at room temperature for 24 hours. Finally the composite plates were taken out from the moulding box. The composite plates fabricated in this combination were cut as per ASTM D standard specimen for performing various tests to find tensile, flexural, impact and hardness properties.

3. MECHANICAL STUDY

3.1. Tensile strength

The samples of each material were tested on a computerized servo controlled Universal Testing Machine with specimen standard ASTM D 638. The samples are placed in the grips of the UTM, the gauge length and cross head speeds are fixed to 50mm and 2mm/min respectively and pulled apart for measuring strength and elongation until the specimen got fractured.

3.2 Flexural strength

Flexural test was conducted on all these samples with specimen standard ASTM D 790 using the same computerized UTM with a special attachment. The speed of test was set as 2mm/min at room temperature.

3.3 Impact strength

The impact strength of all composites was measured using a charpy impact tester with specimen standards ASTM D 6110. The energy absorbed by each specimen during the test was recorded.

3.4 Hardness value

Rockwell hardness test was conducted on these specimens prepared as per ASTM D 785 standard in a Rockwell hardness tester. A constant load was applied for 15 seconds and the hardness was measured.

4. RESULTS AND DISCUSSIONS

Alkali treatment caused fibrillation i.e., breaking of fiber bundles into smaller fibers which increased the effective surface area available for wetting by the matrix material and yielded a better fiber-matrix interface.
adhesion. The addition of filler material got filled on the gaps and considerably decreased the voids formation during polymerization.

4.1 Stress Vs Strain
Figure-2 shows the stress-strain plot of specimen combinations, it can be seen that the hybrid composite (specimen C) holds maximum value.

4.2 Specimen Vs UTS
Figure-3 illustrates the plot of Ultimate Tensile Strength (UTS) in N/mm² versus specimen combinations, it can be seen that the hybrid composite (specimen C) has maximum value of UTS.

4.3 Specimen Vs Flexural strength
The variation of flexural strength for the specimen combinations were shown in Figure-4. The hybrid composite (specimen C) recorded increase in flexural strength than the other specimens. This was due to high fiber-matrix compatibility, good fiber-matrix interaction and wetting.

4.4 Specimen Vs Impact strength
The variation of impact strength for the specimen combinations were shown in Figure-5.

The hybrid composite (specimen C) recorded increase in impact strength than the other specimens, which results in obtaining the enhanced impact properties.

4.5 Specimen Vs Hardness
The variation of hardness for the specimen combinations were shown in Figure-6. The hybrid composite (specimen C) recorded increase in hardness than the other specimens.
5. CONCLUSIONS

The successful fabrication of sandwiched polymer composite using the less utilized palm fibers was completed. The various mechanical tests reveal that the mechanical properties of Hybrid palm leaf stalk fiber/fruit fiber/rare earth sand filler/sandwiched with glass fiber reinforced polymer composite (specimen C) were superior to other composites.

REFERENCES


