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# Mechanical Behavior of Hybrid Composites Moulding

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***Abstract*** **- Polymers and their composites are one of the most advanced and adaptable engineering materials. The strength of any composite depends upon number of factors such as volume/weight fraction of reinforcement, types of fibers, orientation angles, chemical treatment of reinforcement, and many others**

**The present work focuses on the analysis of mechanical properties (tensile and flexural) Hybrid Composite made up of natural fiber (Coconut Coir, Egg Shell) and Glass Fiber -reinforced with epoxy composites. An attempt is made to reduce the usage of full synthetic glass fibers by adding natural fibers such that the resultant composite (Hybrid Composite) shows increased strength when compared with both natural fibers (natural fibre & Egg Shell fibers) and Synthetic Fiber(Glass Fiber). The test specimens were prepared and tested according to ASTM standards. Experimental results revealed that reinforcement of natural fibers with Synthetic Fiber up to some extent increases the mechanical properties and reduces the overall cost of fabrication of synthetic fiber composites and Eco Friendly.**

*Keywords* - Polymers, composites, hybrid materials, Egg shell and coconut coir.

## INTRODUCTION

- Natural fiber reinforced composite materials are considered as one of the new class of engineering materials. Interest in this area is rapidly growing both in terms of their industrial applications and fundamental research as they are renewable, cheap, completely or partially recyclable, and biodegradable. Among all the natural fiber reinforcing materials, jute appears to be a promising material because it is relatively inexpensive and commercially available in the required form.
- Modern composite materials constitute a significant proportion of the engineered materials market ranging from everyday products to sophisticated niche applications .Research on plastics and cement reinforced with natural fibers such as jute, sisal, coir, pineapple leaf, banana, sun hemp, straw, broom, and wood fibers are done. Although natural fibers reinforced in the polymer matrix are environment friendly, they suffer from lower modulus, lower strength, and relatively low moisture resistance compared to synthetic fiber reinforced composites such as glass fiber reinforced composites.

## SELECTION OF SYSTEMS

Selected materials for composites

- Resins: Any, e.g. epoxy
- Natural fiber: Coconut Coir , Egg Shell
- Synthetic Fiber: Glass Fiber (E – Glass Fiber)

These materials are the required ones needed to developed a hybrid composite. It is replacement of metals in industries. These hybrid materials possess same properties where metals have.

*A. Requirements*

As a first step, we have to list the requirements for making the desirable composite to design it. The following requirements are the needs and which is suitable for making our required component.


Figure 1.1

*Fabrication Requirements*

- Composite fabrication processes typically involve some form of molding, to shape the resin and reinforcement.
- A mold tool is required to give the unformed resin/fiber combination its shape prior to and during cure.

*2)* Chemical Treatment requirements

- Coconut fiber in this experiment was obtained by separating the fiber from coconut husk and corks.
- Chemical solution for fiber surface treatment was prepared by dissolving sodium hydroxide (NaOH) in distilled water with the composition of 5%, 10%, 15%, and 20%; hydrogen peroxide (H2O2) with the same composition, and the potassium permanganate (KMnO4) with 0.25%, 0.5%, 0.75%, and 1% as tabulated in Table 1.

*Experiment Details*

- Gel coat is first applied to the mold using a spray gun for a high-quality surface. When the gel coat has cured sufficiently, roll stock fiberglass reinforcement is manually placed on the mold.
- The laminating resin is applied by pouring, brushing, spraying, or using a paint roller. FRP rollers, paint rollers, or squeegees are used to consolidate the laminate, thoroughly wetting the reinforcement and removing entrapped air.

Subsequent layers of fiberglass reinforcement are added to build laminate thickness. Low density core materials such as end-grain balsa, foam, and honeycomb, are commonly used to stiffen the laminate. This is known as sandwich construction

MOLDS :

Simple, single cavity molds of fiberglass composites construction are generally used. Molds can range from small to very large and are low cost in the spectrum of composites molds.

*ADHESIVE BONDING*

- The primary reason for epoxy's popularity is its superb mechanical strength.
- Welding is often the only alternative. Epoxy is nearly always cheaper and faster than welding.
- Epoxy also has excellent resistance to chemicals.
- After setting, there is no worry of a chemical reaction that will weaken the seal. It also resists heat.
- That resistance makes it ideal for electronics and electrical systems and other industrial applications.
- Those who use epoxy are aware of the superb mechanical strength and low curing contraction.
- They also know the epoxy resins are well-balanced industrial materials and suited to a broad range of applications.
- Engineers are faced with concerns about heat dissipation, electrical insulation, adhering dissimilar substrates, light weighting, sound dampening, vibration, and reduction corrosion.
- Appearance has to be considered, as well as, assembling costs. Epoxy is an adhesive formulation that meets all of those concerns.
- Its thermal and electrical properties, strength, and durability are what epoxy is noted for.
- Those properties along with the resistance to immersion and hostile chemical vapor are the reason epoxy often is chosen by engineers.

*Preparation*

- Two mold plates were taken and a template of 200 x 100 x 7 mm size which is the size of the composite was readied within their boundaries.
- The composite was made by collecting hair from various sources and making them into beds of minute thickness by hand rolling in such a way that the follicles are interlocked.
- Taking approximately 20gms of hair 20 grms of Coconut coir and 10 grms of Egg shell .
- The epoxy resin was made with a composition of Araldite LY556 to HY951 hardener in the ratio of (10:1) and mixed wel.
- First to take the resins are (hardener and softener) mixing uniformly.
- They are mixing ratios 1:3 only. Next to take the Coconut Coir, EGG shell and Glass Fiber as per required size cut and the resins both are mixed well.

Figure 1.2

- Mixed materials are (not dry or wet stage) in between the solidification.
- Before poured the materials to apply the wax provided all the areas, due to get good surface finish . Next already prepared the mixed material poured in to the core.
- At the time of bonding, material and resins bonding each other remove the blow holes or avoid the blow holes and also uniform flowability.
- Improve the stiffness, and strength of the composite beam. After The bonding still 3 to 4 hours maintained the atmosphere (air) cooling done completely.
- Again the composites was put in the same process for next fibre. Apply the force to gradually compress the die.
- In this condition still maintained the load up to 8 hours. (Normally) After 8 hours was completed, the composites was ready.

- After 8 hours the composite is dried by leaving it to atmosperical air the final material would look like as follows


Figure 1.3

*TESTING OF SPECIMEN*

*Specimen Dimensions*

- Specimen prepared by hand lay-up process is cut into required dimensions. 1Tensile
  2.Flexural and
  3.shore hardness test
- specimens are obtained according to ASTM standards. Tensile Test Specimen is prepared into Dog Bone shape of dimensions 165x19x7 mm according to ASTM D638 standard. Flexural Test Specimen is prepared into the Flat shape of dimensions 80x15x7 mm3 according to ASTM D790 standard.

*TENSILE TEST*

- According to ASTM D-638 standard the tension test can be performed. This test is done by universal testing machine type (LARYEE) with cross-head speed.

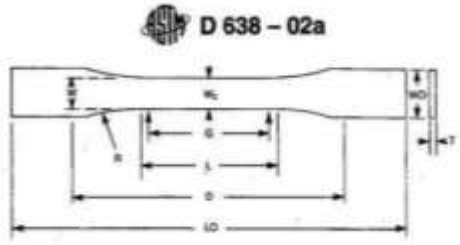


Figure1.4

The mechanical properties of composite are depending on numerous variables like fiber loading and fiber length. According to ASTM D3039-76 test models the tensile test of composites is carried out utilizing Universal Testing Machine Instron 1195. A load was connected to the both sides of composite samples for the testing. The experimental set up and specimen for tensile test is shown in Figure and respectively.

| Test parameters | Observed values |
|---|---|
| Sample ID | T1 |
| Gauge Width (mm) | 13.24 |
| Gauge Thickness (mm) | 6.11 |
| Original Cross Sectional Area(mm2) | 80.90 |
| Ultimate Tensile Load | 0.449 |
| Ultimate Tensile Strength(N/mm2 or Mpa) | 6 |

*FLEXURAL STRENGTH*

- The flexural test of composites is also carried out utilizing Universal Testing Machine Instron 1195. The findings of flexural strength should be the critical characterization of a composites material. For the testing, the cross head rate is kept as 2 mm per min and a span of 60 mm is kept up. The loading arrangement for flexural test is presented in The impact tests are carried out as per ASTM D 256 using an impact tester. The experimental set up for impact test

Figure1.5

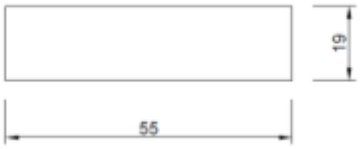


Figure 1.6

| TEST PARAMETERS | OBSERVED VALUES |
|---|---|
| Sample ID | F1 |
| Flexural Strength | 23.38 |

*SHORE HARDNESS TEST*

- Shore hardness is tested with an instrument called Durometer. Durometer utilizes an indenter loaded by a calibrated spring. The measured hardness is determined by the penetration depth of the indenter under the load
- Shore Hardness is a measure of the resistance a material has to indentation. There are different Shore Hardness scales for measuring the hardness of different materials (soft rubbers, rigid plastics, and supersoft gels, for example).
- The measured hardness is determined by the penetration depth of the indenter under the load

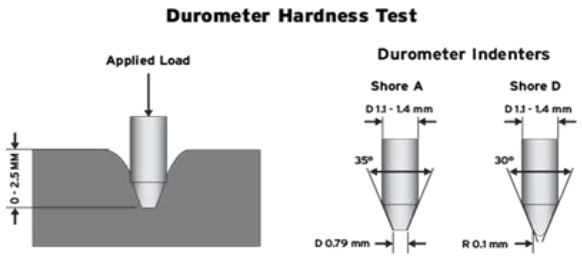


Figure 1.7

Figure 1.8

| TEST PARAMETER | OBSERVED VALUES |
|---|---|
| Shore'D'Hardness | 78.80 |

## CONCLUSION

- The mechanical properties of the Hybrid composites using Glass, Coconut Coir and Egg shell reinforced epoxy resin composites were studied in this work.
- The composites were fabricated by hand layup technique and tested according to ASTM standard. From the experiment the following conclusions have been drawn.
- It has been observed that the various properties of the composites are greatly influenced by the fibre loading and fibre length. From the ASTM mechanical property tests of tensile, Flexural, shore hardness "D" can be observed from composites in the strength properties.
- The hardness value and ultimate tensile strength in Hybrid composites compared with Glass fibre enhanced value are More or less equivalent to glass fibre. Material Suggested to light weight interior works instead of glass fibre.

## REFERENCES

[1] Cao Y., Shibata S., Fukumoto I., (2006). Mechanical properties of biodegradable composites reinforced with bagasse fibre before and after alkali treatments, Composites: Part A 37, pp. 423–429.

[2] Pervaiz M., Sain M.M., (2003). Carbon storage potential in natural fiber composites, Resource, Conservation and Recycling 39, pp. 139- 325.

[3] Satyanarayana K.G., Sukumaran K., Mukherjee P.S., Pavithran C., Pillai S.G.K., (1990). Natural Fiber-Polymer Composites, Cement and Concrete Composites 12 (2), pp. 117-136.

[4] Satyanarayana K.G., Sukumaran K., Kulkarni A.G., Pillai S.G.K., Rohatgi P.K., (1986). Fabrication and Properties of Natural Fiber-Reinforced Polyester Composites, Composites 17(4), pp. 329-333.

[5] Mansur M.A., Aziz M. A. (1983), Study of Bamboo-Mesh Reinforced Cement Composites, International Journal of Cement Composites and Lightweight Concrete 5(3), pp.165- 171.

[6] Popescu C. and Hocker H. (2007). Hair the most sophisticated biological composite material, Chemical Society Reviews 37(8), pp.1282–1291.

[7] Volkin D. B. and Klibanov A. M., (1987). Thermal destruction processes in proteins involving cystine residues, The Journal of Biological Chemistry 262(7), pp.2945-2950.

[8] Thompson R.M., (2010). Hair based composite, U.S. Patent US 12/304,777.

[9] Jain D. and Kothari A. (2012). Hair Fibre Reinforced Concrete, Research Journal of Recent Sciences, Vol. 1, pp.128-133.

[10] Hu X., Cebe P., Weiss A.S., Omenetto F., Kaplan D.L., (2012), Protein-based composite materials, Materials Today 15(5), pp. 208–215.

[11] Gupta A. (2009), Human Hair "Waste" and Its Utilization: Gaps and Possibilities, International Journal of Refractory Metals & Hard Materials 27, pp. 892–899.

[12] Hernandez A.L.M., Santos C.V., (2012). Keratin Fibers from Chicken Feathers: Structure and Advances in Polymer Composites, In: Keratin: Structure, Properties and Applications, Nova Science Publishers, pp.149-211.

[13] Babu R.P., Connor K.O. and Seeram R., (2013). Current progress on bio-based polymers and their future trends, Progress in Biomaterials, DOI: 10.1186/2194-0517-2-8