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Experimental Investigation of Mechanical and Flexural Properties of Coconut Shell Powder Reinforced with Epoxy

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ABSTRACT
The present work deals with the study of mechanical properties of epoxy filled with coconut shell powder and egg shell powder. Epoxy with coconut spell powder and egg shell powder composite was prepared with different filler concentration using hand lay-up technique. Specimens were cut according to the ASTM standards for different experiments, such as flexural test, vickers hardness test and water absorption test. It is observed that at 10 wt% of filler content, coconut shell powder gives the best results for Vickers hardness, flexural strength and flexural modulus. In water absorption test 20% C.S.P absorbs more water compared to other samples.

Introduction

Composite materials are replacing conventional materials in many fields due to easy processing and light weight. composite material are engineered material made from two or more constituent materials with significantly different physical or chemical properties and which remain separate and distinct on a macroscopic level within the finished structure[1]. Polymer composites are promising in mechanical applications due to the possibility of tailoring their properties with special filler such as sisal fiber, coconut fiber, jute fiber, egg shell powder[2,3].

The main objective of this work is to prepare a PMC using coconut shell powder as reinforcement and epoxy as matrix material and to study its mechanical properties and flexural properties. Out of the available manufacturing procedures we have adopted the hand lay-up technique to prepare the PMC[4,5]. Different volume % of filler of coconut shell powder has been mixed with the matrix material and specimens were prepared for mechanical studies.

Materials and Methods

Epoxy resin (araldite AW106) is used as matrix material and coconut shell powder of 150µm is used as filler materials to prepare composite material. The material is prepared using the hand lay-up technique; composite used in present study is listed in table 1

Table 1. List of composite samples

Sample	Epoxy (% volume)	Filler (% volume)	
		Coconut Spell Powder (CSP)	Egg Shell Powder (ESP)
E1	100	0	0
E2	90	10	0
E3	80	20	0
E4	90	5	5
E5	80	10	10

Preparation of Coconut Powder

The coconut were procured from a nearby local stores and temples.Break the coconuts to remove the water and sundry it for easy removal of meat from inner shell. The fibers on the outer shells were also scraped and cleaned[6]. Emery or sand paper were used to clean the outer shells, cut the coconut to small pieces using hammer. Use grinding machine to powder the shells. Then the powder was them sieved using shieve shaker machine to a size of 150µm.

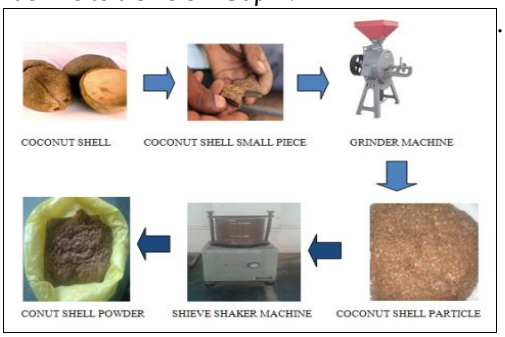

Figure 1. Preparation of coconut powder

Mould Preparation

A wooden mould is used for casting the composite. First we have taken a square wooden plyboard and kept a thin glass sheet on the upper surface of the board[7]. Now we fix wooden bits of 7mm thickness on the glass sheet with the help of adhesive and nails. We make the cavity of 170mmX80mmX07mm. Now the mould is ready for further process.

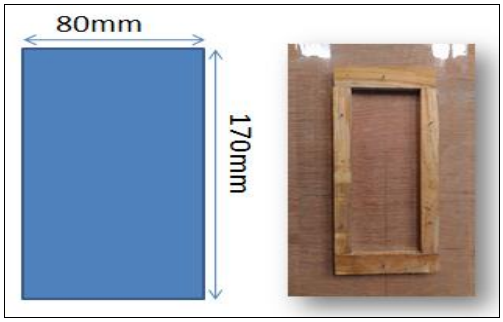

Figure 2. Mould Dimension

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Preparation of Composite Specimen

Prepare the solution then poured into the wooden mould cavity is allowed to cool at room temperature for 72 hrs. After 72 hrs the sample is taken out of the mould with proper care and kept in air tight container for further experimentation.

Figure 3. Specimen Preparation

Flexural Strength

Flexural strength is ability of the composite material to withstand bending forces applied perpendicular to its longitudinal axis[8]. Flexural test were performed using 3-point bending method according to ASTM D2344-84 standard procedure. The loading arrangement in the specimen was shown in figure below.

Figure 4. Universal Testing Machine

The flexural strength was calculated by the Equation 1:

$$\sigma_{max} = \frac{3 P_{max} L}{b h^2} \quad (1)$$

The flexural modulus was determined by the Equation 2:

$$E = \frac{FL^3}{4bt^3 d} \quad (2)$$

Vickers-Hardness Test

Hardness is a mechanical property which represents the resistance of the material to penetration and scratching, it is measured by the distance of indentation and recovery that occurs when the indenter is pressed into the surface under constant load. vickers micro-hardness tester was used for Hardness measurement. This tester had a diamond indenter, in the form a right pyramid with a square base and an angle 136° between opposite faces, is forced in to the material under a load ranging from 5kg to 129kg..

Vickers hardness test is determined by the given Equation (3):

$$V.H.N = \frac{2 F \sin(\alpha/2)}{d^2} \quad (3)$$

Water-Absorption Test

In this test the specimen is immersed in the water to determine the absorption behavior of the composites. The composite sample was placed in a container with water at room temperature.at the end of 24hours one of the sample is removed from the water at a time[9], all surface water wiped off with a dry cloth and weighed immediately and then replaced in the water and this procedure was repeated at every 24 hours till 7 days and the data was recorded. The percentage increase in weight was calculated by using equation 4 as follows-

$$\text{Increase in weight } \% = \frac{\text{Wet weight} - \text{Initial weight}}{\text{Initial weight}} \times 100 \quad (4)$$

Result and Discussions

Flexural Strength

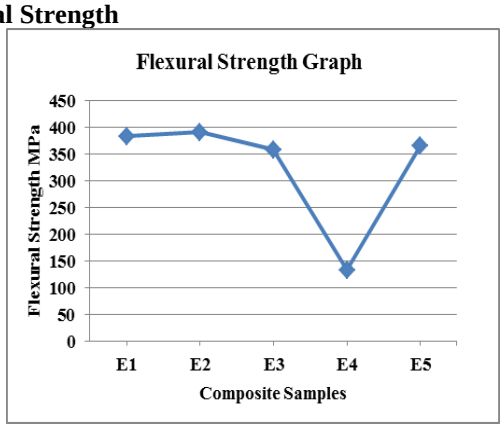

Figure 5. Flexural strength graph

From the above graph of flexural strength versus volume % of filler, in case of neat epoxy flexural strength increases sharply till 10% of filler abd then decreases with further increase in volume % of filler till 20%. While going through hybrid of coconut shell powder and egg shell powder also shows similar behavior with increase in flexural strength till 20% of hybrid filler at its best. Coconut shell powder of volume 10% gives highest flexural strength comparison to remaining all.

Vickers hardness test

Hardness test was carried out in Vickers hardness machine. The load selected for testing was 5kg.

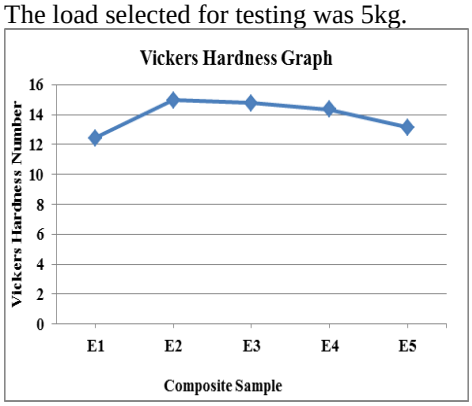

Figure 6. Vickers hardness graph

From the above graph of Vickers hardness test vs volume % of fillers the hardness number increase from neat epoxy to 10% of fillers and gradually decrease with increase in the filler content till 20% filler content, C.S.P of 10% has better hardness value compared to other composite sample.

Water Absorption Test

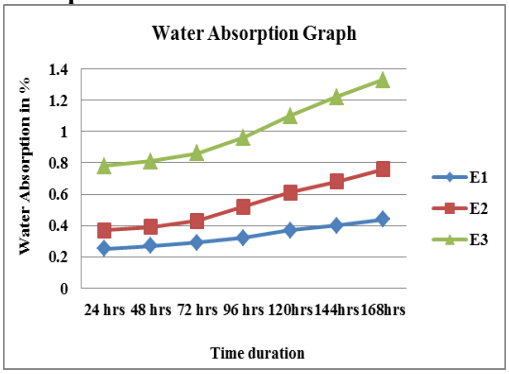

Figure 7. Water absorption test graph

From the above graph of water absorption % vs time duration, we can observe that there is increase in water abosption with increase filler content in epoxy. The neat epoxy absorbs less water compared to the 10% C.S.P composite material and water absorption is more in 20% C.S.P composite compared to other composite sample.

Conclusion

The investigation of mechanical behavior of coconut shell powder and egg shell powder with epoxy lead to the following conclusion:

- The mechanical properties of the composite are greatly influenced by the filler content.
- Composite with 10% volume coconut shell powder exhibited better Flexural strength.
- Composite with 10% volume coconut shell powder exhibited better hardness number then other sample.
- Composite with 20% volume coconut shell powder absorbs more water, water absorption increases with filler content in epoxy.

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