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A study on a hybrid-composite prepared using Areca Nut Husk Fibre, Glass Fibre Cloth, and Epoxy Resin

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Abstract:- The demand for natural fibres has increased in recent years due to their low density, excellent biodegradability, stiffness, and cost-effectiveness. Natural fibre composites are widely used in various engineering applications, including the marine, construction, aerospace, and automotive industries. The present research work highlights the fabrication of natural composites by using areca nut husk and glass fibre dispersed in epoxy resin by the hand lay-up technique. The fabricated composites are then tested to determine the mechanical properties. The examined composites exhibited a hardness of 55 BHN and a porosity of 92.5%. The density of the composite ranges from 0.3808 to 0.4075 g/cm³.

Keywords*: Areca nut husk, glass fibres, epoxy resins, hardness, natural composites.*

1. Introduction

Composites are made up of two or more materials combined at the macroscopic scale. Matrix and reinforcement are the two important constituents of composite materials. The different forms of reinforcement are fibres, particulates, whiskers, etc. Metals, polymers, and ceramics are the most used matrix materials. The fibres used in composites can be either naturally available or synthetic. The demand for natural fibres is rising due to their lower cost, ease of availability, biodegradability, density, and properties when combined with other materials[1][2][3]. Natural fibres are environmentally friendly. Plants and animals are a basic source of natural fibres. Cellulose and hemicellulose are important constituents of plant fibres. The most commonly used plant fibres are coir, jute, sisal, cotton, bamboo, hemp, flax, banana, sugarcane, areca nut husk etc[4]. Areca is a mono-trunked plant that belongs to the family of Arecaceae / Palmae, which is a species of Areca catechu that originates in the Tropical Pacific, Asia, and East Africa[5]. The classification of the Arecaceae/Palmae family [6]. Areca catechu trees are commonly grown trees in India and Sri Lanka[6].

The fibres of areca can be extracted from the stem, fruit, and leaf, either from stalks and sheaths/fronds[6]. Areca husk fibre is largely composed of hemicelluloses. The contents of fibers include lignin of 12 to 24 %, hemicellulose of 40 to 64.8%, ash content of 4 % and water content of 7 to 25%[4]. 15–30% areca nut husk is present in the nut obtained from the areca nut palm. In a hybrid composite material, two or more fibres are hybridized in the same matrix. Glass fibres are also extensively used as reinforcement materials. The density of glass fiber is 2.50 g/cm3. Glass fibers are not biodegradable and are obtained from non-renewable sources[7]. Features such as high rigidity, stiffness, transparency, flexibility, adherence, and chemical resistance make them a potentially reinforcing material[4]. Epoxy resins are thermoset polymers that are universally used as matrix materials due to good mechanical properties, excellent adhesiveness, faster curing rates, chemical inertness, and water insolubility. Applications of epoxy-based composites are in the areas of marine, electrical insulators, automobiles, and the chemical industry[8].

2. Objectives

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3. Methods

The present research work highlights the fabrication of the hybrid bio-composite using areca nut husk fibres (ANHF) and glass fibres in epoxy resin matrix. Areca nut husks are collected from agricultural sources. The husk is thoroughly cleaned and dried at 75˚C for 2 days to remove the dirt and unwanted particles as shown in Fig.1.

Fig.1. a) Raw area husk before drying (b) Dried areca husk

The dried are soaked in 6% sodium hydroxide (NaOH) solution for 24 hours at room temperature. Post alkali treatment, the husks are washed with distilled water to remove traces of chemicals present on the fibre surface. The moisture content of the washed ANHF is removed by further drying the fibres in the sun. The extracted fibres are stored in airtight containers. Commercially available glass fibre cloth is cut into the required dimensions. Hybrid composites is prepared by mixing the epoxy resin and hardener in a 10:1 ratio by weight. LY556 resin and hardener of grade K6 are used. The resin mixture is applied onto the templates, and reinforcements are placed layer by layer. The hand layup technique is used to fabricate the composite. The synthesised composites are then tested to evaluate the hardness, density, and porosity of the material.

4. Results

The synthesised composites are later tested to determine the mechanical properties of the material. The Rockwell hardness test was carried out on the fabricated composite samples as per ASTM D 785 standard. A load of 100kgf was applied. The hardness of the composite was found to be about 55 RHN. Hardness of the composite is a function of the relative fiber volume and modulus [9].

The mechanical property of the composite is significantly affected by its density. The density of the composites was determined using Archimedes' principle. The average density of composites was found to be 0.39507g/cm3. The density and porosity values of fabricated samples are presented in Table.1.

Table 5.5: Density and Porosity Test

Sl.No	Density(g/Cm3)	Porosity (%)
1	0.4075	92.6
2	0.3808	93
3	0.3969	92.7

The porosity of the composite can be reduced by using a good resin that penetrates deeply into the reinforcement. Improper wetting of the reinforcement also leads to increased porosity in the composite, which further causes delamination[3].

5. Conclusion

The present research work highlights the feasibility of fabricating the hybrid composite using ANHF and glass fibre in an epoxy matrix. The results of the fabricated bio-composites show that their mechanical and physical properties vary significantly, highlighting areas that need improvement in the manufacturing process. From the hardness test, it is observed that the hardness of 55 demonstrates the promising potential of the material for high wear resistance applications. The low density of the composite is a direct outcome of the high porosity and the inherently lightweight nature of areca nut husk fibers.

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