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MECHANICAL PROPERTIES OF JUTE AND HEMP REINFORCED EPOXY/POLYESTER HYBRID COMPOSITES

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ABSTRACT

The mechanical properties of epoxy and polyester matrix composites reinforced with Jute/Hemp fibres were evaluated. In this research the mechanical properties like impact strength, tensile strength and flexural strength were studied. These fibres were placed with matrix resin in different orientation (30%, 45%, and 90%) by using simple hand lay-up technique. The evaluation of the results show that the mechanical properties are higher in the 90^0 oriented hybrid composite than in 45^0 and 30^0orientation. There are indications that by the incorporation of both fibres the polyester resin will stabilize mechanical properties than epoxy resin.

KEYWORDS: Epoxy, Hand Lay-up, Hybrid Fibres, Polyester

INTRODUCTION

A composite material is a 'material system' composed of a combination of two or more micro or macro constituents that differ in form, chemical composition and which are essentially insoluble in each other. Composites are one of the most advanced and adaptable engineering materials. Progress in the field of materials science and technology has given birth to these fascinating and wonderful materials. A composite material can provide superior and unique mechanical and physical properties, because it combines the most desirable properties of its constituents while suppressing their least desirable properties. At present composite materials play a key role in aerospace industry, automobile industry and other engineering applications as they exhibit outstanding strength to weight and modulus to weight ratio.

Glass, carbon, boron and Kevlar reinforced polymeric composites are expensive which find justifiable application in aerospace industries. Therefore, natural fibres have attracted the attention of scientists and engineers for application in consumer industries. It is observed that the natural fibre reinforced composites provide better electrical, thermal and acoustic insulation while they offer higher resistance to fracture. Most of the natural fibres are relatively cheat and commercially available in plenty in the required form. Many researchers have studied the effect of various natural fibre reinforcement different properties of the composites. Mechanical properties of untreated jute fibre reinforced polyester composites have been studied [1]. Moisture absorption characteristics of sisal fibre reinforced polypropylene composites have been established [2]. Environmental, mechanical and structural behaviour of various bio composites have been studied by number of investigators [3-6].

The present investigation is aimed at synthesis and characterization of jute and hemp reinforced epoxy and polyester hybrid composite.

EXPERIMENTAL PROCEDURE

Lapox L-12 epoxy with hardener K-6 and polyester resins with catalyst and accelerator were used as matrix materials. Some important properties of epoxy and polyester resins are given in table 1. Natural jute fibres and hemp fibres are used as reinforcement in place of the traditional glass fibres. Jute and hemp fibres along with the plants from which they are extracted are shown in figure 1. The composite plates were fabricated by placing fibres in different orientations by the traditional hand layup technique. This is a very popular method of composite fabrication, limited by its ability to produce intricate shapes. Few important stages of fabrication of this composite are shown in figure 2. Plate specimens consisting of epoxy resin or polyester resin with jute fibre and hemp fibre reinforcement was fabricated. The plate was made up of 55% fibre and 45% resin by weight. Tensile specimens are prepared according to ASTM D-638 standard and tested with a pre load of 0KN and 5mm/min speed. Flexural samples are cut according to ASTM D-790 standard and tested with pre load of 50KN. Charpy impact specimens were cut and tested according to ASTM D-256 standard. These test results are tabulated in table 2.

(a) **(b)**

Figure 1: (a) Jute Plant and Fibre, (b) Hemp Plant and Fibre

Table 1: Properties of Epoxy and Polyester Resins

Properties	Epoxy	Polyester
Viscosity at 250μ(cP)	12000-13000	250-350
Density ρ (g.cm^{-3})	1.16	1.09
Heat distortion temperature HDT (ºC)	100	85
Modulus of elasticity E (GPa)	5.0	3.3
Flexural strength (MPa)	60	45
Tensile Strength (Mpa)	73	40
Maximum elongation (٪)	4	1

Figure 2: Different Stages of Composite Fabrication

RESULTS AND DISCUSSIONS

Figure 3 shows the value of tensile strength of anepoxy and polyester matrix specimens. It is clear that polyester based composite exhibits maximum UTS value. Also it is observed that from $0/90^0$ (jute/hemp) orientation gives maximum UTS values in both epoxy and polyester matrix composites. Whereas, very low UTS values were obtained from $0/45^0$ and $0/30^0$ orientation.

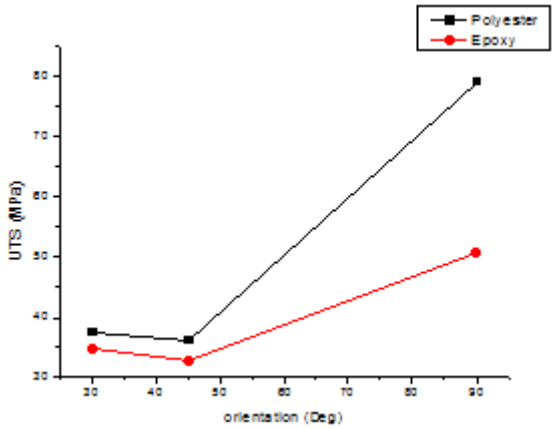

Figure 3: Tensile Properties of Polyester and Epoxy Based Composites

Figure 4 shows the value of flexural strength of a hybrid composite. Flexural strength is maximum in $0/90^0$ (jute/hemp) orientation for both polyester and epoxy based composites. It is also observed from the figure that the epoxy resin based composites yields lesser flexural strength compared to polyester based composite for all orientations of the reinforcement. The flexural strength of both the composites was observed to be minimum for fibre orientation of $0/45^0$.

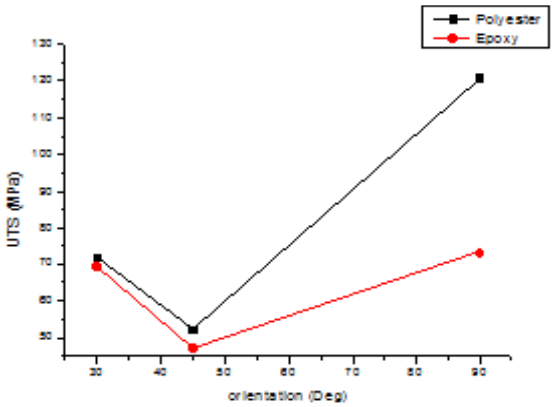

Figure 4: Flexural Strength of Polyester and Epoxy Based Composites

Figure 5 shows the results of the impact test conducted on both types of composites. From the obtained values it is observed that that impact strength of $0/90^0$ oriented hybrid polyester composite shows higher value than remaining two orientations. It is also observed that the impact strength drastically reduces at $0/45^0$ fire orientation.

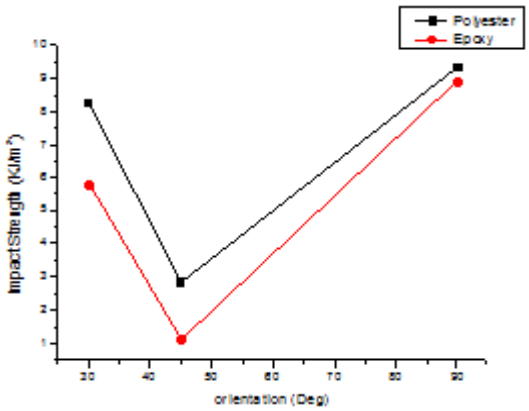

Figure 5: Impact Strength of Polyester and Epoxy Based Composites

Table 2: Test Results of Different Composite Material

Material	UTS (Mpa)	Flexural Strength (Mpa)	Charpy Impact Strength (KJ/m^2)
0/90° Polyester	79.13	120.06	9.33
0/90° Epoxy	50.83	73.39	8.91
0/30° Polyester	37.64	71.89	8.26
0/30° Epoxy	34.43	69.18	5.78
0/45° Polyester	35.95	52.18	2.84
0/45° Epoxy	32.46	47.39	1.13

CONCLUSIONS

The experiments are carried out to determine tensile, flexural and impact properties of jute and hemp reinforced epoxy and polyester hybrid composites for 30^0, 45^0 and 90^0fibre orientations. From the obtained results the following conclusions can be drawn.

- Composites with polyester resin as matrix give more tensile, flexural and impact strength than epoxy based hybrid composites.
- The tensile, flexural and impact strength is observed to be maximum at 90^0 orientations in both epoxy and polyester based composites.
- Diagonal inclinations of the reinforcing fibres gives poor mechanical properties as observed in 30^0, 45^0 oriented composites.

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