Influence Of Fiber/Filler Particles Reinforcement On Epoxy Composites

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Abstract

This paper presents the study of tensile, flexural & moisture absorption properties of composites made from areca fibers, maize powder filler particles & epoxy resin. The specimens are prepared using hand lay-up techniques as per ASTM standard for different weight fractions of fiber, filler & matrix material. The specimens were tested as per ASTM standards. Experimental results showed that tensile and flexural properties of the composites increased with increase of filler particle content and fiber content. The relation between stress & strain found to be linear the moisture absorption increases with the fiber, filler content and duration of immersion in water

Key words: *Weight fractions, Filler, Fiber, Flexural strength, Hand lay-up*

INTRODUCTION:

In the past few decades, research & engineering interest has been shifting from monolithic materials to reinforced materials .the glass, carbon and Kevlar fibers are being used as reinforced materials in reinforced plastics (FRP). Which have been widely accepted as materials for structural & non-structural applications. The main reason for the interest in FRP is due to their high stiffness to weight ratio and high strength to weight ratio compared to conventional materials. However, these materials have some drawbacks such as renew ability, recyclability, disposal and expensive.

Therefore natural fibers (sisal, areca etc) have attracted the attention of scientists & technologists for application in consumer goods, low cost housing and other civil structures. It has been found that these natural fiber composites posses' good mechanical properties with low specific mass, better electrical resistance, good thermal & acoustic insulating properties. Despite the attractiveness of natural fiber reinforced polymer matrix composites they suffer from lower modulus, lower strength & relatively poor moisture resistance compared to synthetic fiber reinforced composites such as glass fiber reinforced plastics.

Epoxy resin is one of the most important classes of thermosetting polymers. Which are widely used as matrices for fiber reinforced composite material. They are amorphous, highly cross-linked polymers and this structure results in these materials processing various desirable properties such as high tensile strength & modulus, good thermal and chemical resistance and dimensional stability. However, it leads to low toughness and poor crack resistance, which should be upgraded before they can be considered for many end-use applications. One of the most successful methods of improving the toughness of epoxy resin is by the addition of fillers and fibers. Though natural fiber mechanical properties are lower than glass fibers there specific properties, especially stiffness are comparable to the stated values of glass fibers. Moreover natural fibers are about 50% lighter than glass fibers and they are cheaper.

The present study involves the study of hybrid composite made up of maize powder filler particle, areca fiber and epoxy resin matrix. The objective of this paper is to study the tensile, flexural and moisture absorption properties of epoxy composites based on maize powder filler particle and areca fiber.

Literature survey:

Various works on the application of natural fillers and fibers in composites like sisal, coconut coin, jute, palm, cotton, rice husk, bamboo and wood as reinforcements in composites have been reported in literature. Paul Wambuna, Ivens studied the tensile strength and modulus on various natural fibers. It is noted from the experiment that tensile and modulus increases with increasing fiber volume fraction. The specific properties of natural fiber composites were in some cases better than those of glass fiber. This suggests that natural fiber composites have potential to replace glass fiber in many applications that do not require very high load bearing capability. S.M.Sapaun and M.Harini studied the mechanical properties of epoxy/coconut shell filler particle composites. They found that the tensile and flexural strengths increase with the increasing filler content. J.Giridhar and Kishore studied the moisture absorption characteristics of natural fibers. They found that the fillers absorb less moisture than fibers. T.Munikenche Gowda, A.C.B. Naidu, Rajput Chhaya have studied the mechanical properties of untreated jute fabric-reinforced polyester composites. They found that jute reinforced polyester composites have better strength than wood composites. A.C.Albuquerque and Kurvilla Joseph has conducted the experiment on effect of wettability and ageing conditions on the physical and mechanical properties of uniaxially oriented jute-roving reinforced polymer composites. It is found that the tensile and flexural strength and modulus of longitudinal composites increased with the fiber content. The impact strength also increased linearly with the fiber loading.

2. PROBLEM FORMULATION:

Based on above literature, the present work is formulated in order to evaluate the tensile, flexural and moisture properties of natural composites without fiber reinforcement and results were compared with the fiber reinforcement composites. The experiment work is carried out as follows:

- Selecting the material

Fiber; areca
Filler material: maize powder filler
Matrix; epoxy resin (Lapox L12)
Hardener; K6

- Preparation of natural composite specimen (as per ASTM standards) for different weight fractions using Hand lay-up method and cured at room temperature.

The different weight fractions of epoxy resin, filler and fiber for composites are 90(epoxy resin): 10(filler) and 80:20 for composites without fiber additions and 90(epoxy resin): 5(filler): 5(fiber) and 80(epoxy resin):10(filler):10(fiber) for composite with fiber addition, as per the weight fractions the specimens are prepared in batches and tested in room temperature.

3. INVESTIGATION METHODOLOGY:

3.1 Procurement of materials

The experiment started with the procurement of maize powder, areca fiber, resin, hardener and mold. Maize was ground to form a powder with the dia of 50-200 micrometer using grinding machines. Areca fibers are procured from local supplier. Epoxy and hardener were procured from Atul India Ltd., the resin used was epoxy (Lapox-L12) with the density of 1.1 g/cc and the hardener used is K6. The weight ratio of resin and hardener is 100:10.

3.2 Preparation of composite samples

Molds used in this study were made from wooden sheets. They were open molds. Each mold has a cavity to accommodate the composite samples. The dimensions and shapes of cavities were made according to the ASTM standards. D 3039 for tensile testing, ASTM standard D 2344 for flexural testing. Epoxy and hardener were mixed in a container and stirred well for 5-7mins then by adding the maize filler particles again stirred for 5mins. Before the mixture was placed inside the mold, the mold has initially polished with a releasing agent (Vaseline) to prevent the composites from sticking on to the mold upon removal. Finally the mixture is poured into the mold and left at room temperature for 8 hours until the mixture was hardened. When the composite was hardened, it was removed from the mold.

For laminates with reinforcement of fiber, the required length of the areca fibers are selected and weighed for required proportion. Those fibers are dipped in a container where the epoxy, coconut shell filler particles and hardener were mixed. Then the wetted fibers are placed uniformly in a mold along the length, the mold has initially polished with a releasing agent. The mixture of epoxy resin and maize powder filler is poured in the mold and left at room temperature for 4-8 hours until the mixture was hardened. Then it was removed from the mold.

3.3 Mechanical Testing:

3.3.1 Tensile Testing

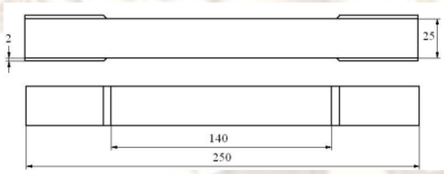

Fig. 1 Tensile test specimen

Specimen for tensile test were carefully cut from the laminate and finished to accurate size according to ASTM D 3039. The geometry of the test specimen is shown is fig 1. Glass fiber reinforced composite end tabs were bonded to the specimen for proper griping and to ensure failure in gauge length the tensile test were carried out using universal testing machine for different filler, fiber and epoxy weight ratios namely 80:20 and 90:10 (without fiber content) . 80:10:10 and 90:5:5 (with fiber content). The standard specimen was mounted by its ends into the holding grips of the testing apparatus.. Gradually increasing the load until the failure is approach. As the loading of the specimen progresses, load readings and corresponding displacement are recorded until the failure of the specimen occurs.

3.3.2 Flexural testing

Flexural test was conducted as per ASTM D 2344 standards. The specimen were carefully cut from the laminate and finished to accurate size. The geometry of the specimen is shown in fig 2. The test was conducted on the same machine; the flexural stress in a three point bending test is shown in fig. 3

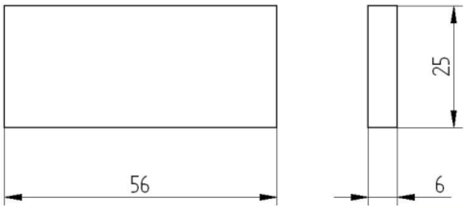

Fig. 2 Flexural test specimen

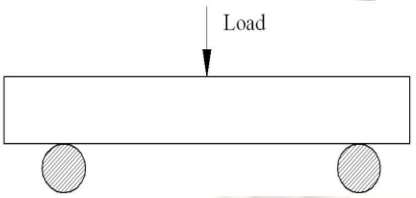

Fig. 3 Three point bending

The specimens are tested and results are obtained.

3.3.3 Moisture absorption testing

The test specimen are made according to ASTM standards the geometry of the specimen is shown in fig. 4 the specimens are placed in a tray containing distilled water up to 7 days. Readings are taken at regular intervals of 24 hours. Difference between initial and final weight shows the amount of moisture absorption by the individual specimen of different ratios.

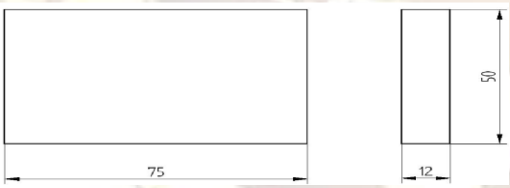

Fig. 4 Moisture test specimen

4. RESULTS AND DISCUSSION

4.1 Tensile testing

Mechanical properties of natural fiber composites depends on several factors such as stress – strain behaviors of fibers and matrix phases, The phase volume fractions, The fiber concentration, The distribution and orientation of fibers and filler relative to one another.

Fig 5 shows the typical tensile stress Vs strain curves for maizen powder filler epoxy composite and fig 6 shows the typical tensile stress Vs strain curves for maize powder filler, areca fiber and epoxy composites for different weight fractions. The effect of maize powder filler and areca fiber content is shown in fig 4 & 5 . The increase in the filler and fiber content results in increase in tensile strength.

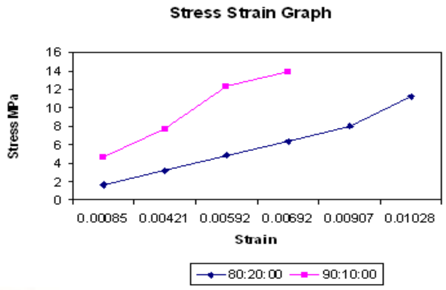

Fig. 5 Tensile stress versus strain for various weight fractions without reinforcement of fiber.

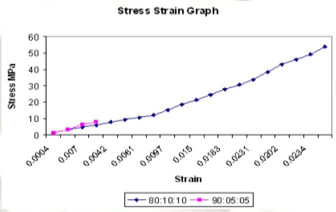

Fig. 6 Tensile stress versus strain for various weight fractions with reinforcement of fiber

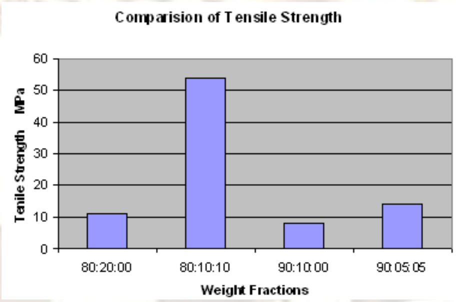

Fig 7: Comparison of Tensile strength of composite specimen with fiber reinforcement and without fiber reinforcement.

4.2 Flexural Test

Stress at the fracture from bend or is known as flexural test. The figure 8 & 9 shows the typical flexural stress Vs strain for different weight fraction of maize powder filler, areca fiber and epoxy resin composites. The flexural stress increase with the increase in filler and fiber content, the maximum flexural strength for 10 % fiber and 10 % filler composites at lower concentrations of filler & fiber material, specimen demonstrated slightly non linear behavior. Fig shows the comparison between the results obtained from composites without reinforcement and with reinforcement. It shows that there is 3 % and 5 % increase in flexural strength for laminates with weight fractions 90:5:5 and 80:10:10 respectively

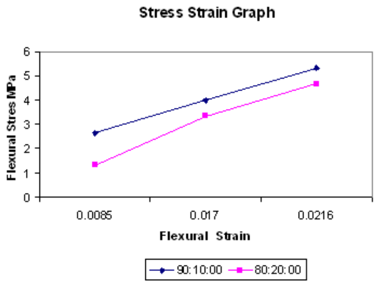

Fig 8: Flexural stress versus strain for various weight fractions without reinforcement of fiber

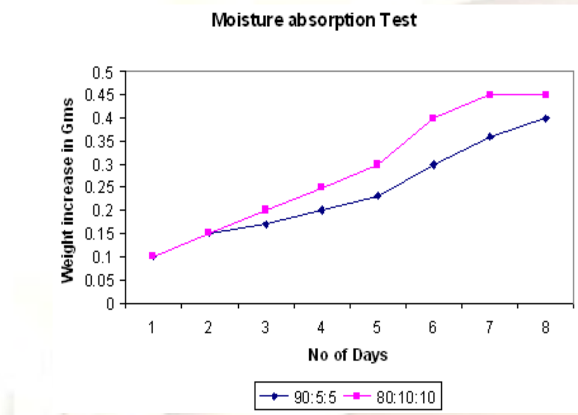

Fig 9: Flexural stress versus strain for various weight fractions with reinforcement of fiber

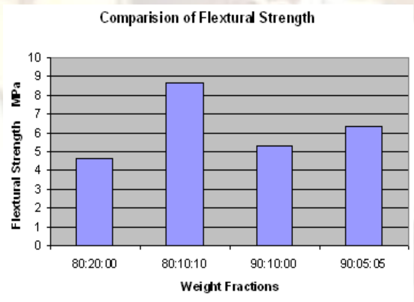

Fig 10: Comparison of Flexural strength of composite specimen with fiber reinforcement and without fiber reinforcement.

4.3 Moisture absorption test

Comparative study was made between the moisture absorption behaviors of composite specimens made up different weight fractions of maize powder filler , areca fiber and epoxy resin . fig 11&12 shows typical weight increase Vs no. of days. It is observed that moisture absorption increases with the increase in filler and fiber content. From fig shows that specimen with 80:10:10 weight ratios absorbs more moisture than others

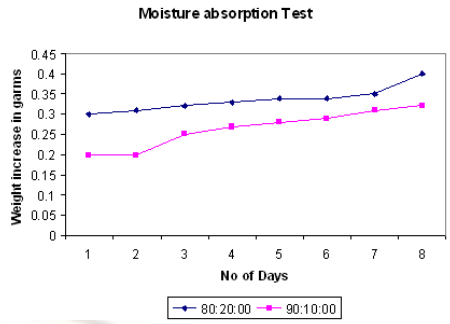

Fig11: Moisture absorption test graph for various weight fractions without fiber reinforcement

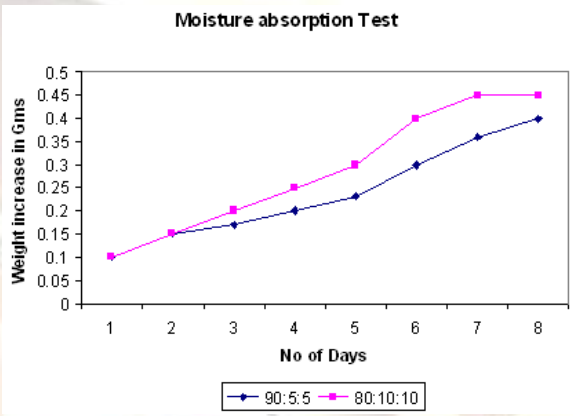

Fig12: Moisture absorption test graph for various weight fractions with fiber reinforcement

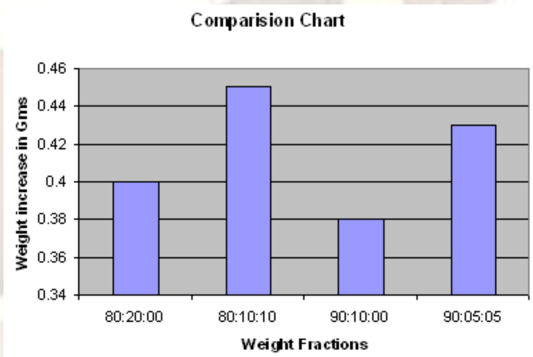

Fig13: Moisture absorption test graph for various weight fractions without fiber reinforcement

5. CONCLUSIONS.

The tensile, flexural and moisture absorption properties of specimens prepared with epoxy maize powder filler particles of different weight fractions have been studied. From the result of this study, the following conclusions are drawn.

[1] It is noted from the tensile test that the specimens prepared with reinforcement of areca fiber to epoxy maize powder filler of different

weight fractions of 80:10:10 and 90:5:5 gives higher tensile strength than weight fractions of 80:20 and 90:10 of the specimens prepared without reinforcement of areca fibers to epoxy coconut shell filler. The more the fiber content, the higher tensile strength.

[2] In flexural test it is observed that the weight fraction of 80:10:10 and 90:5:5 gives higher flexural strength than the weight fraction of 80:20 and 90:10 due to the reinforcement of areca fibers.

[3] The moisture absorption test shows that the weight fraction of 80:10:10 and 90:5:5 absorbs higher amount of moisture than the weight fraction of 80:20 and 90:10

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