Study of Mechanical Properties of Hybrid Epoxy Composites Reinforced with Glass Fibers & chopped glass fibers

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Abstract: Now-a-days, the glass fibers are potential fibers as a reinforcing material for polymer composites compared to the natural fibers. Among several fibers, glass fibers are most widely used fiber due to easy obtainable, low production cost, low density and having good mechanical properties. For a composite material, its mechanical behavior depends upon on many variables such as parentage fiber content, orientation of fibers, types, its length etc. In present research work efforts have been made to investigate the effect of weight fraction fiber on the physical and mechanical behavior of glass fiber reinforced epoxy hybrid composite. A hybrid composite consists of several different types of fibers in which one fiber balance the deficiency of another fiber.

It has been observed that there is an influential effect of fiber percentage on the performance of glass fiber reinforced epoxy hybrid composites. The fabricated hybrid composites undergo different kinds of tests such as Hardness, Flexural, and Tensile. The obtained results indicates hybrid composites having good stiffness and strength

1. 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 commonly accepted materials for structural & non-structural applications. The main reason for the interest in FRP is due to their high stiffness and high strength as compared to conventional materials. However, these materials have some limitations such as renewability, recyclability, disposal and cost expensive.

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

Epoxy resin is one among the 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 several 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 enhanced before they can be considered for many end-use applications. One among the successful methods of improving the toughness of epoxy resin is by the addition of fibers and fillers. Even though natural fiber mechanical properties are lower than glass fibers there specific properties, especially stiffness are comparable to the stated values of glass fibers. But the natural fibers are about 50% lighter than glass fibers and they are cheaper in cost.

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

1.1 Literature survey:

Several works on the application of natural fillers and fibers in composites like sisal, coconut coir, palm, jute, cotton, rice husk, bamboo and wood as reinforcements in composites have been reported in literature. Paul Wambuna, Ivens investigated the tensile strength and modulus on various natural fibers. It is observed from the experiment that tensile and modulus enhances with enhancing fiber weight fraction. The properties of natural fiber composites were in some cases better than those of glass fiber. This shows that composites of natural fibers have potential to replace glass fiber in many applications that do not require very high load bearing capability. Harini M & Sapaun S M investigated the mechanical properties of epoxy/coconut shell filler particle composites. They observed that th flexural & Tensile strengths enhances with the increasing filler content. J.Giridhar and Kishore investigated the moisture absorption characteristics of natural fibers. They observed that the fillers absorb less moisture than fibers. Munikenche Gowda T, A.C.B. Naidu, Raj put Chhaya have investigated the mechanical properties of untreated jute fabric-reinforced polymer composites. They observed that jute reinforced polyester composites are stronger than wood composites. A.C. Albuquerque and Kurvilla Joseph has carried out 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 observed that the flexural & tensile strength and modulus of longitudinal composites enhances 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 estimate the tensile, flexural and moisture properties of natural composites without fiber reinforcement and results were compared with the fiber reinforced composites. The experiment work is carried out as follows:

- Selecting the material like
  Fiber; E-glass
  Filler material: maize powder filler, chopped glass
  Matrix; epoxy resin (Lapox L12)
  Hardener; K6
- Preparation of natural composite specimen (as per ASTM standards) for various 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 test specimens are prepared in batches and tested in room temperature.

3. INVESTIGATION METHODOLOGY:

3.1 Procurement of materials

The experiment begins with the procurement of maize powder, glass fiber, resin, hardener and mold. Maize was ground to form a powder with the dia of 50-200 micrometer using grinding machines. Epoxy and hardener were obtained 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 experiment were made from ply wood sheets. They were open molds. Every mold has a space to accommodate the composite samples. The dimensions and shapes of cavities were made as per the ASTM standards. D 3039 for tensile testing, ASTM standard D 2344 for flexural testing.

Epoxy and hardener were mixed in a vessel and stirred well for 5-7mins then by adding the maize filler particles and chopped glass fibers again stirred for 5mins. Before the mixture was placed inside the mold, the mold has initially polished with a waxing agent (Vaseline) to prevent the composites from adhering on to the mold upon removal. Finally the mixture is poured into the mold and leaves it to room temperature for 8 hours until the mixture was hardened. When the composite was solidifies, it was carefully removed from the mold.

For laminates with reinforcement of glass fiber, the 360 gsm glass fibers are selected and weighed for required proportion. Those fibers are immersed in a vessel where the epoxy, filler particles and hardener were mixed. Then the wetted fibers are uniformly placed in a mold along the length, the mold has applied with a releasing agent. The mixture of epoxy resin, chopped glass fiber and maize powder filler is poured in the mold and leave it to room temperature for 4-8 hours until the mixture was solidifies. Then it was extracted from the mold.

3.3 Mechanical Testing:

3.3.1 Tensile Testing

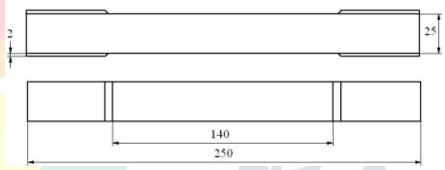

Fig. 1 Tensile test specimen

From the laminate Specimens were cut precisely for tensile test and finished to accurate size according to ASTM D 3039. The dimensions of the test specimen are shown is fig 1. For proper gripping the end tabs of specimen were bonded with Glass fiber reinforced composite end tabs were bonded to the specimen and to ensure failure in gauge length while the tensile test were carried out using universal testing machine for different weight fractions filler, fiber and epoxy weight fractions namely 80:20 and 90:10 (without fiber content) . 80:10:10 and 90:5:5 (with fiber content). The standard test specimen was held 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 increases, load readings and corresponding displacement are recorded until the failure of the specimen occurs.

3.3.2 Flexural testing

Flexural test were carried out as per ASTM D 2344 standards. The specimen were precisely cut from the laminate and finished to accurate shape & size. The dimensions of the specimen are shown in fig 2. The test were carried out on the same machine, the flexural stress in a three point bending test is shown in fig. 3

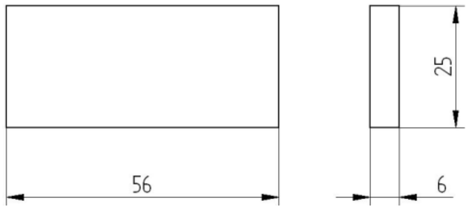

Fig. 2 Flexural test specimen

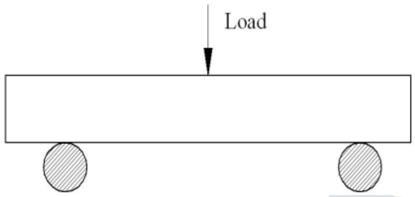

Fig. 3 Three point bending

The specimens are tested and results are plotted.

3.3.3 Moisture absorption testing

The test specimen are cut as per the ASTM standards the dimensions of the specimen is shown in fig. 4 the specimens are placed in a tray containing distilled water up to 7 days. Regularly Readings were noted down at intervals of 24 hours. The Difference between initial and final weight shows the amount of moisture absorption by the each specimen for various ratios.

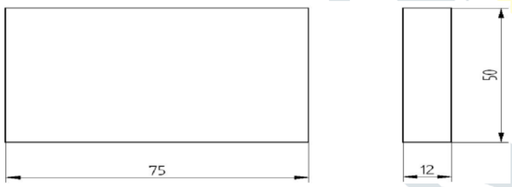

Fig. 4 Moisture test specimen

4. RESULTS AND DISCUSSION

4.1 Tensile testing

Mechanical properties of natural fiber composites depends on various factors such as stress –strain behaviors of fibers and matrix phases, the phase weight fractions, Fiber concentration, Distribution and orientation of fibers and filler with respect to one another Fig 5 Represents the typical tensile stress Vs strain curves for maize powder & chopped glass filler epoxy composite and fig 6 shows the typical tensile stress Vs strain curves for maize powder and chopped glass filler, Glass fiber and epoxy composites for different weight fractions. The effect of maize powder and chopped glass filler and glass fiber content is shown in fig 4 & 5 . The increase in the filler and fiber content results in enhancement of tensile strength

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

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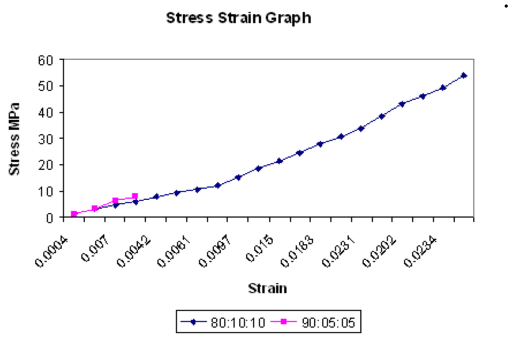


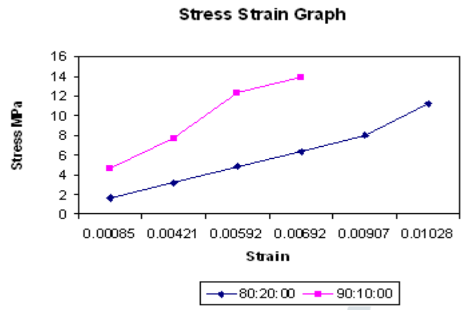


Fig. 6 Tensile stress versus strain for various weight fractions with reinforcement of fiber

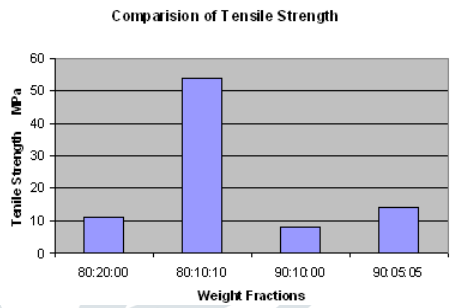


Fig 7: Comparison of Tensile strength of composite specimen with and without fiber reinforcement.

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 various weight fraction of maize powder & chopped glass filler, Glass fiber and epoxy resin composites. The flexural stress enhances 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 exhibits slightly non linear behavior. Fig 8 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 composites with weight fractions 90:5:5 and 80:10:10 respectively

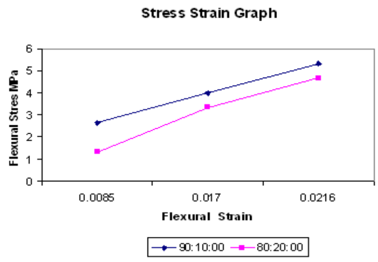


Fig 8: Flexural stress versus strain for various weight fractions without reinforcement of fiber.

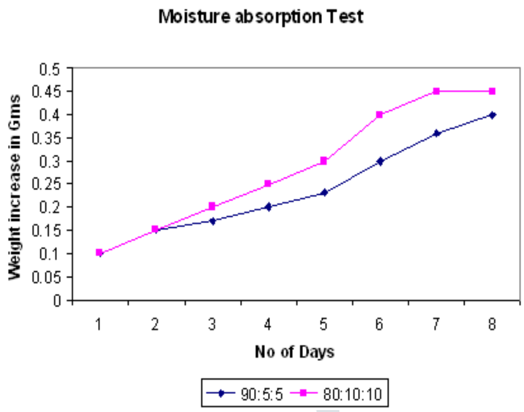


Fig 9: Flexural stress versus strain for different weight fractions with reinforcement of fiber

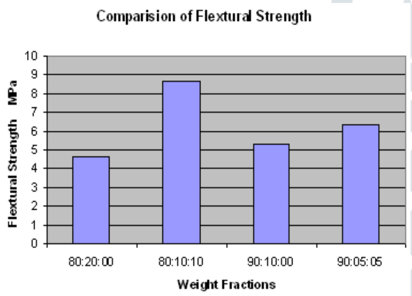
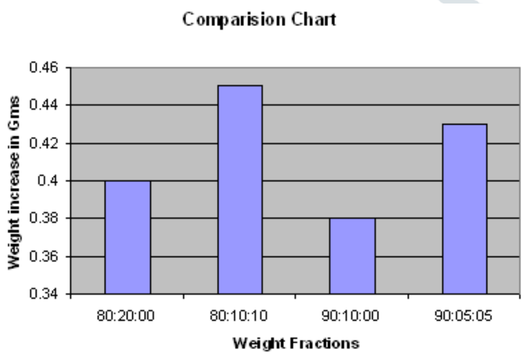


Fig 10: Comparison of Flexural strength of



composite specimen with and without reinforcement.

4.3 Moisture absorption test

Comparative study was made between the moisture absorption behaviors of composite specimens made up various weight fractions of maize powder & chopped glass fiber filler , glass fiber and epoxy resin . fig 11&12 shows typical weight increase Vs no. of days. It is found that moisture absorption enhances with the increase in filler content. From fig11.shows that specimen with 80:10:10 weight ratios absorb more moisture than others

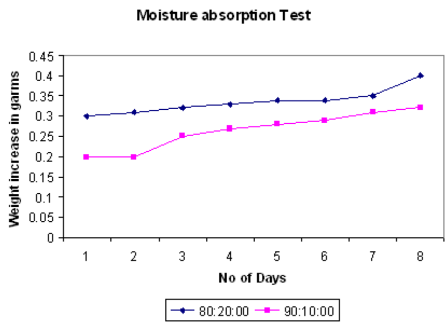


Fig11: Moisture absorption test graph for various weight fractions without fiber reinforcements.

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

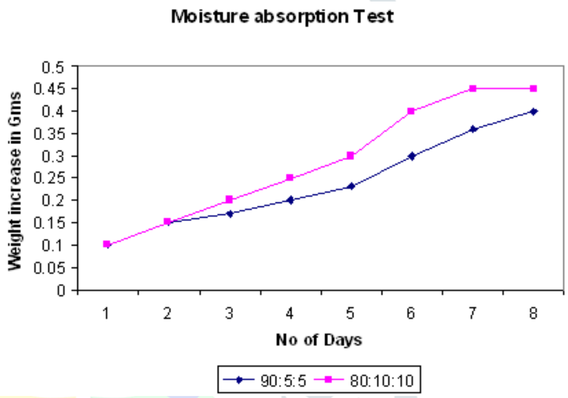


Fig13: Moisture absorption test graph for various weight fractions without fiber reinforcement

5. CONCLUSIONS.

The tensile, flexural and moisture absorption properties of specimens prepared with epoxy maize powder and chopped glass filler particles of several 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 glass fiber to epoxy maize powder and chopped glass filler of several weight fractions of 80:10:10 and 90:5:5 yields higher tensile strength than weight fractions of 80:20 and 90:10 of the specimens prepared without reinforcement of glass fibers to epoxy coconut shell filler. The more the fiber content, the higher tensile strength.

[2] In flexural test it is found that the weight fraction of 80:10:10 and 90:5:5 shows higher flexural strength than the weight fraction of 80:20 and 90:10 because to the reinforcement of glass fibers.

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

6. REFERENCES

[1] S.M. Sapaun and M.Harini, 2003, Mechanical properties of epoxy /coconut shell filler particle composites, The Arabian journal for science and engineering, vol 28, number 2B

[2] Paul Wambua, Jam Ivens, Ignaas Verpoest, 2003, Natural fibers can they replace glass in fiber reinforced plastics, Composites science and technology, 63, 1259 -1264

[3] A.C. dc Albuquerque, Kurruvilla Joseph, Laura Hecker de carvallo, 2000, Effect of wet ability and ageing conditions on the physical and mechanical properties of uniaxially oriented jute-roving-reinforced polyester composites, Composites science and technology, 60, 833 - 844

[4] J.C.Giridhar, Kishore and V.G. Rao, 1985, Moisture absorption characteristics of natural fiber composites, journal of reinforced plastics and composites, vol 15

[5] T. Munikenche Gowda, A.C.B. Naidu, Rajput Chhaya, 1998, some mechanical properties of untreated jute fabric-reinforced polyester composites, Composites: part A 30, 277 – 284

[6] K. Sabeel Ahmed , S. Vijayarangan , 2008 , Tensile , flexural and interlaminar shear properties of woven jute and jute-glass fabric reinforced polyester composites , Journal of materials processing technology , 207 , 330-335

[7] Moe Thwe, Kin Liao, 2003, Durability of bamboo-glass fiber reinforced polymer matrix hybrid composites, Composites science and technology, 63, 375-387

[8] Seung-Hwan Lee, Siqun wang, 2005, Biodegradable polymers/ bamboo fiber biocomposite with bio-based coupling agent, Composites: Part A 37, 80-91

[9] Ariel Stocchi, Bernd Lauke, Analia Vazquez, Celina Bernal, A novel fiber treatment applied to woven jute fabric/vinylester laminates, 2006, Composites: Part A 38, 1337-1343

[10] R.C. Prasad, P. Ramakrishna, 2000, “Composites science and technology”, New age international publishers, New Delhi