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PRODUCTION OF HYBRID COMPOSITE USING WASTE GLASS PARTICLES TO ANALYZE ITS MECHANICAL CHARACTERIZATION.

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Abstract: According to a study, glass bottles are four times more harmful to the environment than plastic bottles. It has been argued that glass bottles demand significantly more energy and natural resources to manufacture. To address this issue, we are creating a new composite material out of waste glass bottle powder that is reinforced with Ramie fiber. Following the fabrication of the composite, we conduct tensile and flexural tests on the material to determine its mechanical properties and characterization

***Keywords* - Glass Powder, Ramie fiber, Epoxy resin, Tensile and flexural test.**

I. INTRODUCTION

Glass is formed by melting a mixture of elements such as silica, soda ash, and CaCO3 at high temperatures, then cooling the mixture to solidify without crystallization. Glass is utilized in a variety of ways in our daily lives, including windows glass, bottles, kitchenware, and vacuum tubing. Glass has become indispensable to man's life because of its pliability to easily adapt to any shape, its gleaming surface, abrasion resistance, safety, and durability. The amount of waste glass produced by glass utility ranges increases. Waste glass can be recycled and used to manufacture new glass. However, not all used glass can be recycled into new glass due to impurities, pricing, or mixed colors. When it comes to solid waste disposal, non - recyclable waste glass is a challenge in many cities. Non - recyclable glass is still disposed of in landfills in large quantities. Glass is not biodegradable; thus land-fills are not an environmentally friendly option. [1]. To recycle waste glass, we are turning it into fine powder and manufacturing it with natural fibers(Ramie).

Natural fibers have recently piqued the interest of researchers due to their low cost, availability, ease of manufacture, and potential environmental friendliness as reinforcing agents in composites [2]. As ramie fibre is the strongest natural fibre currently accessible, we employed it as reinforcement in our investigation. When wet, ramie fibre shows even more strength. Ramie fibre is renowned for its capacity to maintain form, lessen wrinkling, and provide a smooth shine to the look of the cloth. Because it is not as strong as other fibres, it is frequently blended with other fibres like cotton or wool. In terms of density, absorbency, and microscopic appearance, it is comparable to flax. But it won't take dye as well as cotton. Ramie lacks resilience and has limited elasticity and elongation potential because to its high molecular crystallinity, making it stiff and brittle and breaking if folded repeatedly in the same spot [3].

II. EXPERIMENTAL PROCEDURE

2.1 Materials

In this research, the unidirectional ramie fiber mat used as reinforcement for the composite was supplied by Fiber region, Chennai, India. The epoxy resin employed was Epoxy L556 with HY951 slow hardener. Fiber mat of Ramie and Epoxy shown in Figure 2.10.

Fig. 2.1: ramie fiber and epoxy

According to the datasheet provided, the epoxy and hardener were mixed in a 10:1 ratio. The material mechanical properties of the Ramie fiber, Glass powder and epoxy resin used in this research are listed in Table 2.11.

Table 2.11: Mechanical properties

Materials	Young's Modulus(GPa)	Poisson's ratio	Density(Kg/m3)
Ramie fiber	31.8	0.30	1500
Glass powder	70	0.22	2500
Epoxy resin	3.47	0.35	1200

2.2. Preparation of glass powder

Prior to being introduced into the crusher machine for crushing, the glass powder is cleaned with ordinary tap water to remove pollutants. The crushed glass was then filtered through a 600 µm sieve to remove large glass particles. To guarantee that the nanoparticles were formed successfully, the sieved glass was ground for three hours in a glass ball mill machine to get 53 µm particles. To verify, the final glass particle size is examined using a scanning electron microscope.

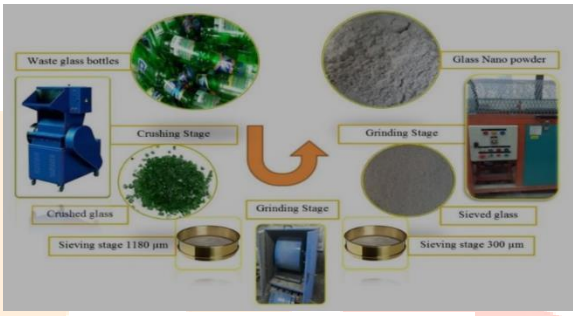

Fig. 2.2: glass powder processing

2.3. Fabrication of the composite

The hand lay-up approach was used to create a laminated composite made up of numerous layers of ramie fiber mat. The composite is made with total fiber loading of 50 wt% and epoxy glass powder mixture of 50 wt% with glass powder varying percentage of 10%, 20% and 30%. as shown on composition table 2.3. Throughout the curing process, a 50-bar pressure is supplied to the mold using hydraulic press as shown in Figure 2.3. The composite is allowed to cure at room temperature for 24 hours. The cured composite is removed and cut according to ASTM standards for tensile and flexural testing.

Table 2.3: Composition table for tensile and flexural test.

Sample *ID*	Glass Powder %wt	Epoxy %wt	Fiber %wt
S1	10	40	50
S2	20	30	50
S3	30	20	50

Fig. 2.3: hydraulic press.

III. Characterization of Composite

3.1 Tensile Testing

The tensile testing was performed according to the ASTM D 638 type IV standard, using the facility in the Konkan testing facility, Mangalore. The dimensions of the sample are 115 mm×19 mm×3.4 mm for the length, width, thickness and gauge length 33 mm, respectively. A sample is tested according to the standard. The tensile jig held the samples and tugged them until they failed at room temperature. The crosshead was set to a speed of 2 mm / min.

Fig. 3.1: schematic diagram showing the standard size of tensile test specimen and its testing set-up in mm as per ASTM D-638 standard.

3.2. Flexural Testing

The flexural testing was carried out in accordance with the ASTM D790 standard. The length, width, and thickness of the sample were 126 mm x 12.5 mm x 4 mm, respectively. The velocity of mm x 12.5 mm x 4 mm, respectively. The velocity of the cross head is 1.5 mm/min.

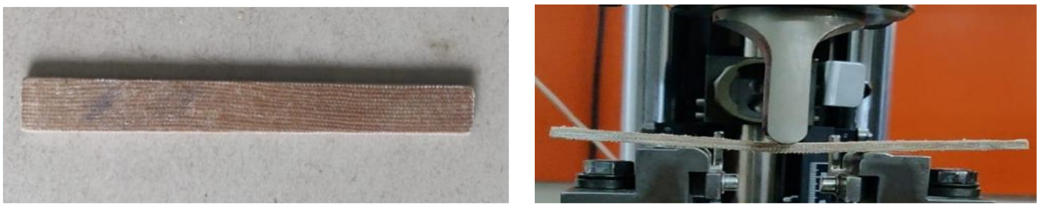

Fig. 3.2: schematic diagram showing the standard size for flexural test specimen and its testing setup in mm as per ASTM D-790 standard.

IV. Result and Discussion

4.1 Tensile Properties

The prepared composite specimens S1, S2, and S3 as discussed in Table 02 are subjected for tensile loading. The values of load and displacement for corresponding samples were obtained from the post processor of UTM machine. The values of load were noted down to calculate stress values. Similarly, in order to get the corresponding strain values, displacement with respect to gauge length were also recorded.

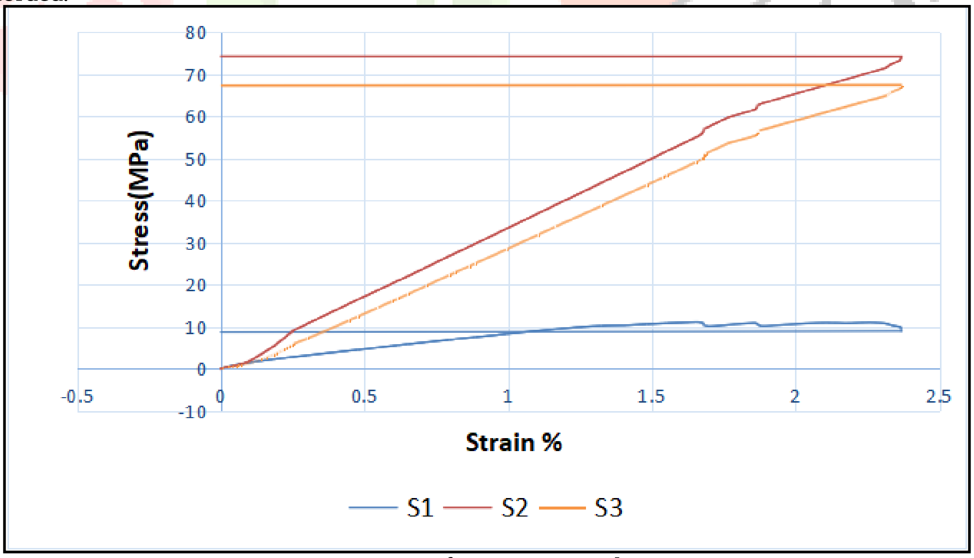

Fig. 4.1: stress v/s strain for various tensile test specimens

The Fig. 4.1 shows that the stress increases linearly with respect to strain for all composites. The tensile strength of S2 specimen having 20 % glass powder, 30% epoxy, 50% fiber was found to maximum when compared to other test specimens.

4.2 Flexural Test.

A three-point bending test with a span length of 48mm is performed on the same three specimens and graph is plotted against stress and strain.

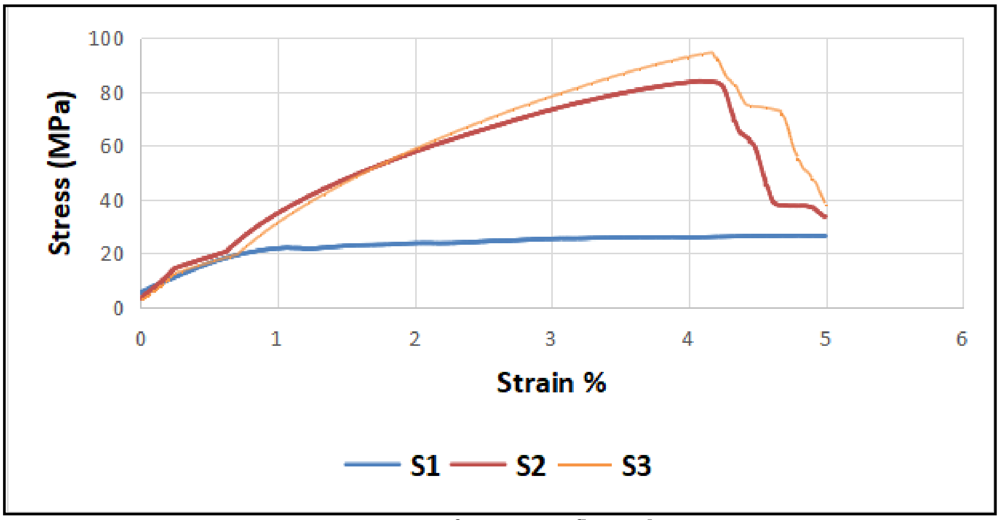

Fig. 4.2: stress v/s strain for various flexural test specimens

The Fig. 4.2 shows that the stress increases linearly with respect to strain for all composites. The Flexural strength of S3 specimen having 30 % glass powder, 20% epoxy, 50% fiber was found to maximum when compared to other test specimens.

4.3 Validating the results by FEM (Finite element method).

Table 4.3: Comparing experimental and ansys result

Composition	Tensile strength(MPa)		Flexural strength(MPa)	
	Experimental	Ansys value	Experimental	Ansys value
S1	11.1	12.7	26.7	25.5
S2	74.3	73.5	84.1	83.2
S3	67.5	67.5	94.7	93.3

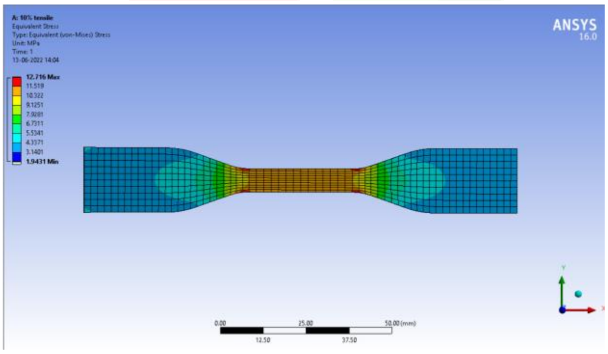

Fig. 4.3.1: tensile analysis of S1

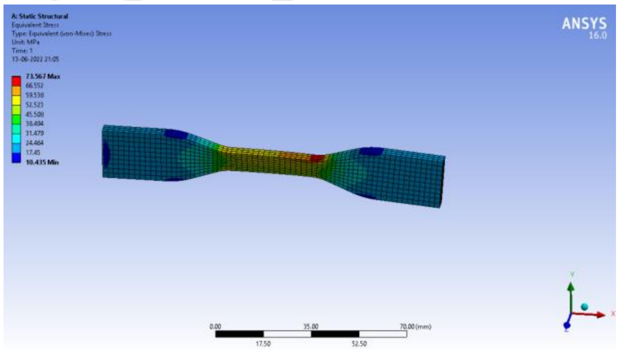

Fig. 4.3.2: tensile analysis of S2

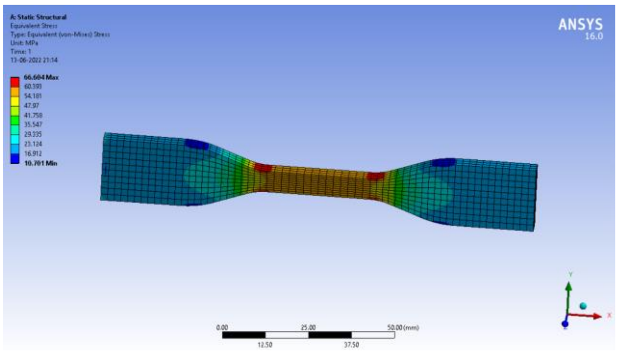

Fig. 4.3.3: tensile analysis of S3

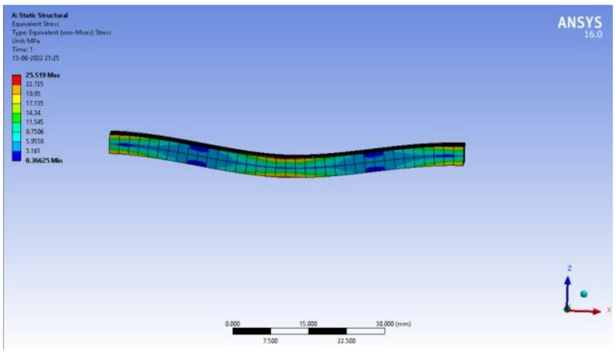

Fig. 4.3.4: flexural analysis of S1

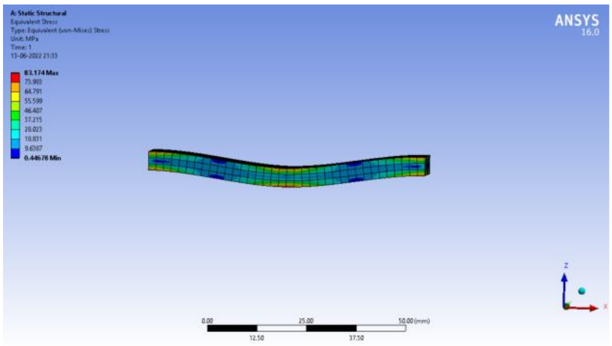

Fig 4.3.5: flexural analysis of S2

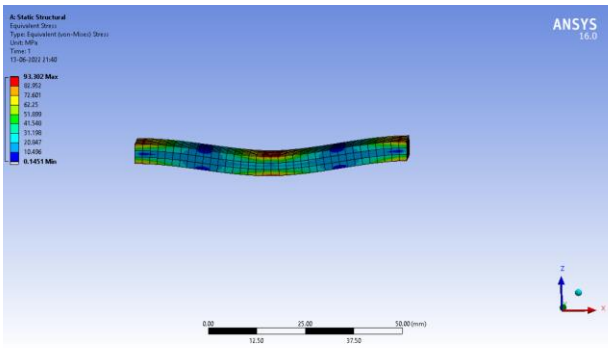

Fig. 4.3.6: flexural analysis of S3

V. CONCLUSION

The most important conclusions that have been reached by this study are:

1. The hybrid composite of Ramie fibre and glass particle using epoxy resin and hardener was effectively made and the mechanical property was examined and results were established.
2. Tensile test was found as per the standard ASTM D-638 and the obtained tensile strength and modulus of 20% glass powder fibre reinforced polymer composite is 74.3MPA and 545MPa respectively. These values are more than the rest of the specimens. So 20% glass powder specimen possess better tensile properties.
3. Flexural strength was measured according to the ASTM D-790. The flexural strength of 30% glass powder specimen was obtained as 94.7 MPa which is higher than the rest of the specimens.
4. The comparison between experimental and numerical investigation shows a fair agreement between the results.
5. Finally, it can be concluded that 20% of glass powder along with the ramie fiber reinforced hybrid composite material with 74.3 MPa tensile strength and 94.7 flexural strength can be suited for structural and non-structural application based on both experimental and numerical analysis(FEM).

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