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FABRICATION AND MECHANICAL PROPERTIES EVALUATION OF GLASS FIBRE REINFORCED MONO SKIN (GFRMS) CELLULAR EPOXY COMPOSITE PANEL

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ABSTRACT

Fibre-reinforced composite materials contain fibres of high strength and modulus embedded in or bonded to a matrix with distinct interfaces between them. In this form, both fibres and matrix retain their physical and chemical characters; however, they create a mixture of properties that cannot be attained with individual elements acting alone. This paper contains information about Glass Fiber Reinforced Mono skin (GFRMS) cellular Epoxy composite panel made by mixing, epoxy (resin and hardener), polystyrene (thermocol) macro balls and glass fibre in 15 %, 70% and 15 % by volume percentage respectively. Macro balls were 2mm in diameter and the length of glass fibre was 10 mm. The muddle was poured in the desired mould and left for 24 hrs for primary curing. Then the sheet was removed from the mould and kept in a hot air oven for secondary curing. Thereafter the sheet was machined to get the preferred size. Tensile, compression and flexural tests were conducted with triplication in each case on the UTM machine. The tensile, compressive, flexural strength obtained were 2.2781MPa, 5.9106MPa and 3.3882MPa respectively. The material's density was evaluated as 0.2812g/cc. GFRMS fabrication achieved the advantage of using the waste thermocol obtained from packing of different items such as TV, radio etc. Secondly, it can replace wood made table tops thus saving trees.

Keywords: *GFRMS, Flexural strength, Tensile strength, Compressive strength, Muddle.*

I. INTRODUCTION

Many fiber-reinforced polymers offer a combination of strength and modulus that are either comparable to or better than many traditional materials. Because of their low density materials, the strength-weight ratios and modulus-weight ratios of these composite materials are markedly superior to those of metallic materials. The use of fiber-reinforced polymer as the skin material and a lightweight core, such as aluminium honeycomb, plastic foam, metal foam, and balsa wood, to build a sandwich beam, plate, or shell provides another degree of design flexibility that is not easily achievable with metals. Such sandwich construction can produce high stiffness with very little, increase in weight. In general, fibers are the principal load-carrying members, while the surrounding matrix keeps them in the desired location, acts as a load transfer medium between them, and defends them from environmental harms due to elevated temperatures and humidity. Even though the fibers provide reinforcement for the matrix, the latter also serves a number of useful functions in a fiber reinforced composite material. This paper is related to making of Glass Fibre Reinforced Mono Skin (GFRMS) cellular Epoxy Composite Pannel in which Epoxy acts as a matrix and glass fibre mixed with thermocol as the reinforced material.

II. MANUFACTURING OF COMPOSITE PANNEL

A composite is made of two phases one is called the matrix phase and the other is called dispersed phase In the present work rigid, cellular, glass fiber reinforced mono skin panel is prepared and tested for evaluating mechanical properties. The proposed material could be used as structural component for interior of a building and other low load capacity structures. Presented manufacturing technique could shrink the initial production cost and manufacturing problems while improving performance. The material of proposed panel consists of three key components, epoxy resin as matrix phase, macro balls of polystyrene and glass fiber as filler. Following steps are involved in the manufacturing of the GFRMS cellular epoxy composite panel.

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a.) Development of the Matrix Phase:

In order to develop the composite the matrix phase is first manufactured using a epoxy resins. Epoxy resins are low molecular weight pre-polymers or higher molecular weight polymers which normally contain at least two epoxide groups. The epoxide group is also sometimes referred to as a glycidyl or oxidize group. Epoxy resins are polymeric or semi-polymeric materials, and as such rarely exist as pure substances, since variable chain length results from the polymerization reaction used to produce them. A wide range of epoxy resins are produced industrially.

b.) Development of Dispersed Phase

Dispersed phase is made by two materials namely polystyrene and the glass fiber. **Polystyrene** is made by stringing together, or polymerizing, styrene, a building-block chemical used in the manufacture of many products. Styrene also occurs naturally in foods such as strawberries, cinnamon, coffee and beef. The example of the polystyrene is thermocol. Polystyrene also is made into a foam material, called expanded polystyrene (EPS) or extruded polystyrene (XPS), which is valued for its insulating and cushioning properties. Foam polystyrene can be more than 95 per cent air.

Glass fibre filler is a blue-green glass fiber paste used for bridging holes, deep filling scratches etc and is suitable for metal or fiberglass. Impervious to water, it contains high tensile glass fiber strands for extra strength. It has a working time of 8 min, a curing time of 20 min and has a max. Temperature resistance on steel of +160°C.

c.) Mixing of Epoxy, polystyrene(thermocol) & Glass fibre

Panel is produced by mixing, epoxy (resin and hardener), polystyrene (thermocol) macro balls and glass fiber in 15 %, 70% and 15 % by volume fraction respectively. Macro balls are 2 mm in diameter and glass fiber has length of 10 mm. the muddle is poured in the desired mould and left for 24 hrs for primary curing. Then sheet is removed from the mould and kept in hot air oven for secondary curing. Sheet is then machined to get preferred size.

III. MECHANICAL TESTING ON UNIVERSAL TESTING MACHINE

In this work a GFRMS rigid cellular material is developed and then mechanical properties are evaluated by conducting tensile, compression and flexural testson Universal Testing Machine.

Figure 1(a) Front View of INSTRON 1195

Figure 1(b) Close View of INSTRON 1195

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Type of Machine	Screw driven
Maximum Capacity	100kN
Minimum Load can be tested	1gm
Types of Test can be performed	Tensile, Compression, 3-pt bend,4-pt bend, Loading-Unloading and Oil dip tensile(upto 400℃ in silicon oil)
Types of the materials can be tested	Metallic, plastic, Ceramic, Rubber and fiber
Available Load cells	Tensile or Compression : 200N,800N ,2kN,100kN Tensile only 50gm Compression only : 50kg ,2kg
Types of sample can be tested	Round, Flat , Sheet , Wire , Rod or Tubular
Crosshead Speed (Strain Rate)	Max – 40mm/min Min – 0.005mm/min
Crosshead Displacement	Max – 700mm
Type of test control	Stroke, Load and strain
Type of Extensometers	GL 25mm (travel 2.5mm), GL25mm (travel 25mm),COD -10mm and Transverse – 12.5mm

Figure 1: Universal Testing Machine

IV. TENSILE TEST

Fabrication of Tensile test specimen

To conduct tensile test for the material, ASTM D 638-03 standard is referred. According to this standard the specimen has the following specifications as shown in figure

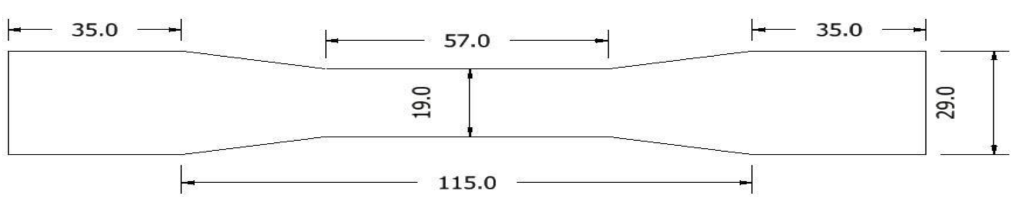

Figure 2: Specification of Tensile Test Specimen

Tensile test using UTM

Tensile test carried out in triplication on INSTRON-1195 as per ASTM standard as ASTM D638-03 with cross head speed of 1.3 mm/min.

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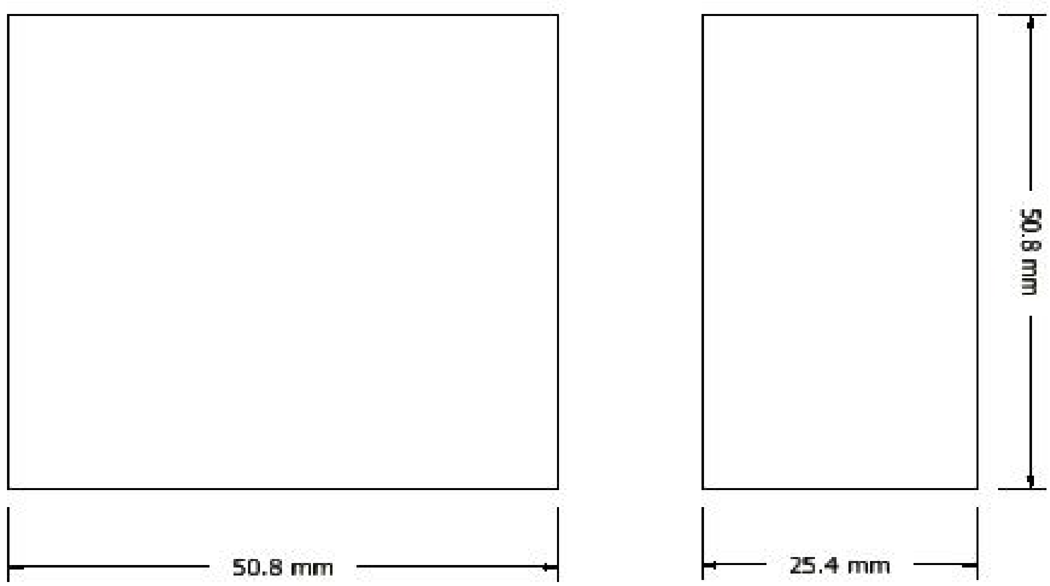
V. COMPRESSION TEST

Fabrication of Compression test specimen

To conduct compression test for the developed material, ASTM D 1621-00 standard is referred. According to this



standard the specimen size is 50.8 x50.8 x 25.4 mm^3, shown in figure 3.

Figure 3: Specification of compression test specimen

Compression test using three samples

Compression test carried out is triplication on Instron-1195 as per ASTM D 1621-00 with cross head speed of 2.5 mm/min. The specimen is compressed up to 13% of its original thickness.

VI. FLEXURAL TEST

Flexural test specimen

To conduct three point bend test for the core material (rigid cellular epoxy) ASTM D 790-02 standard is referred. According to this standard the specimen has the following specifications as shown in figure 4

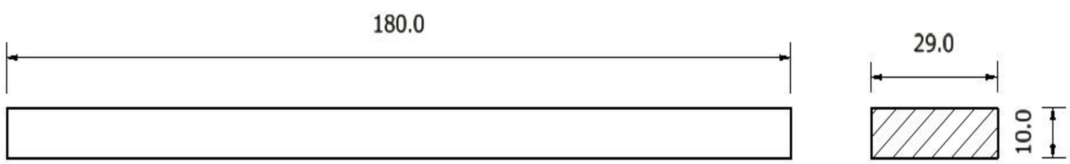


Figure 4: Specification for Flexural Test Specimen

Flexural test using three samples

Flexural test carried out is triplication on Instron-1195 as per ASTM D 790-02 with cross head speed of 2.5 mm / minute.

Density Test specimen

To evaluate the density of the material (rigid cellular epoxy) ASTM D 1622-8 [13] standard is referred. According to this standard the specimen has the size of 25.4x 25.4x25.4mm^3.The test is carried out with the three samples and the average value of these three gives the final density of the material.

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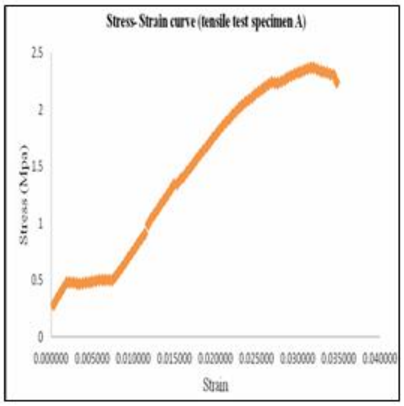
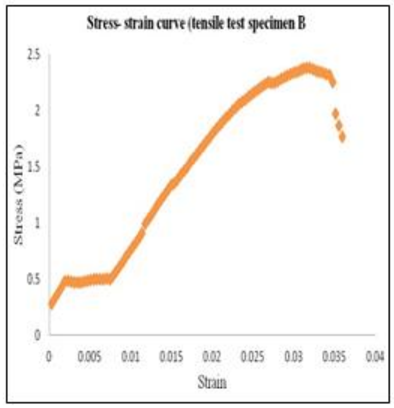
VII. EXPERIMENTAL RESULTS AND DISCUSSIONS

The obtained test results are tabulated below:

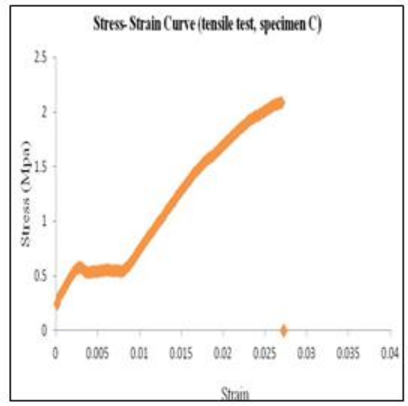
Stress-strain curves for the tensile test



(a)Stress-Strain curve for specimen A

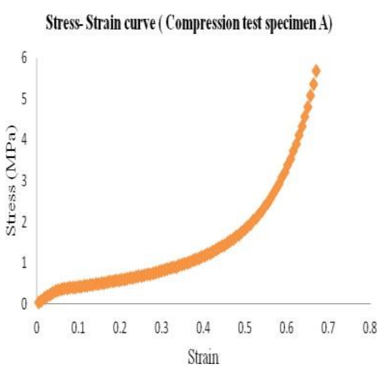


(b)Stress-strain curve for specimen B

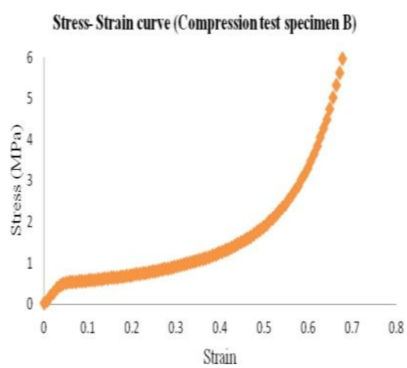


c.)Stress-Strain curve for specimen C

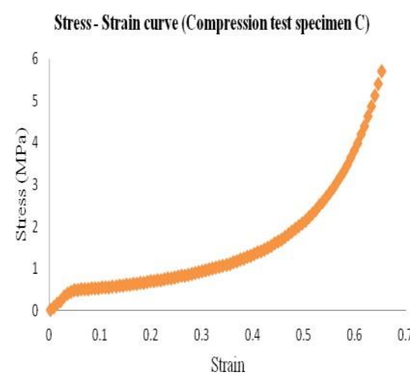
Stress-Strain curves for the compression test



g) Stress-Strain curve for specimen A



e.) Stress-Strain curve for specimen B



f.) Stress-Strain curve for specimen C

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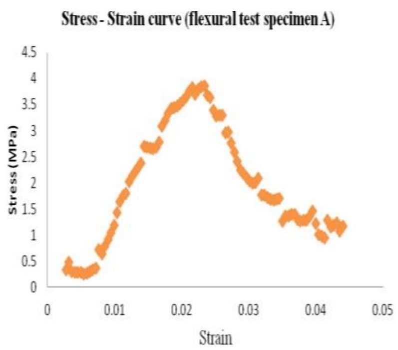
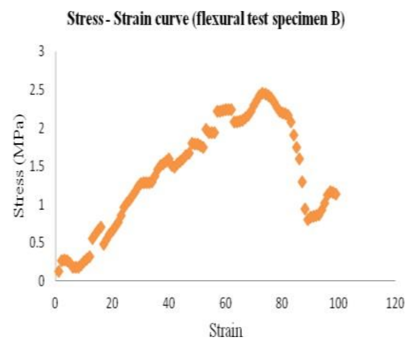
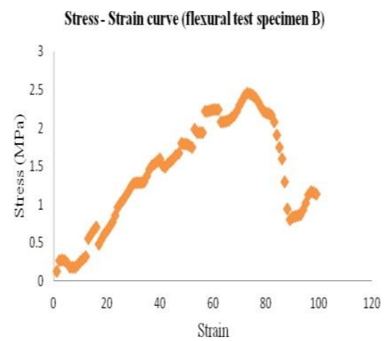
Stress-Strain Curves Obtained from conduction of the Flexural Test



g.) Stress-Strain curve for specimen A



h.) Stress-Strain curve for specimen B



i.) Stress-Strain curve for specimen C

Result for tensile strength

S. No.	Specimen	Ultimate Tensile strength (MPa)	Average ultimate tensile strength (MPa)
1	A	2.3671	2.2781
2	B	2.3796	
3	C	2.0877	

Result for Compressive strength

S. No.	Specimen	Ultimate compressive strength (MPa)	Average ultimate compressive strength (MPa)
1	A	5.6844	5.9106
2	B	6.3421	
3	C	5.7053	

Result for Flexural strength

S. No.	Specimen	Ultimate flexural strength (MPa)	Average flexural strength (MPa)
1	A	3.8597	3.3882
2	B	2.4606	
3	C	3.8443	

Density Test

S. No.	Specimen No.	Density (g/cc)	Average Density (g/cc)
1	A	0.2772	

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2	B	0.3023	0.2812
3	C	0.2641	

Fractographic Study

Fractographic study is been carried on the fractured surface of the specimen. The fractured specimen images are given in the figure below

(a) Fractured specimen on Tensile test *(b) Fractured specimen on Compression test* *(c) Fractured specimen on Flexural Test*

Figure 6

VIII. CONCLUSION

Thus we see that a composite material named Glass Fibre Reinforced Mono Skin (GFRMS) Cellular Epoxy Composite Panel is manufactured and the test were successfully conducted on the material. From the three test i.e tensile, compression and flexural test were conducted in triplication. The stress strain curve were were obtained from the tests. It is obtained that the lowest value of the strength was obtained was that of the tensile strength i.e 2.2781 MPa. Therefore keeping this value of tensile strength into consideration any product such as table top and almirah's shelf etc can be manufactured and thereby utilising the waste thermocol and preventing it from harming the environment.

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