Development and Mechanical characterization of Epoxy based Bio-Composite with Sugarcane Trash as Reinforcement

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Abstract - *Composites are replacing traditional materials due to their high strength, low thermal expansion, and low weight. New polymer composite materials are being developed daily. Composite materials make up the majority of engineering materials and are used in everything from household items to automobiles. The automotive industry requires renewable and/or biodegradable composites. Natural filler reinforcement instead of synthetic fibre in thermosetting matrices like epoxy resin reduces weight, density, and cost. Compression molding was used to create epoxy/ sugar cane trash composites. The plate-shaped composite samples were made. The weight percent of sugar cane trash in the sample ranged from 10% to 22%. The fabricated plates were profiled to ASTM standards. Mechanical properties like tensile, flexural, and impact strength are assessed.*

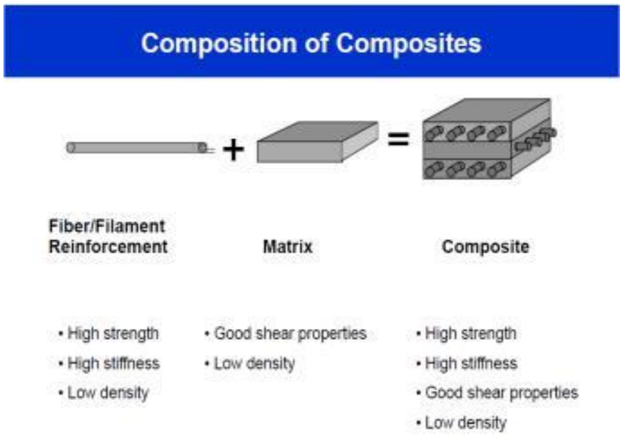
***Key Words*: Epoxy, Sugarcane trash, ASTM D-638, ASTM D-256, Araldite HY951, TGMDA**

1. INTRODUCTION

Fiber-reinforced composites have long attracted attention for their superior properties and applications. The addition of fibres to various polymers improves the mechanical properties of composites. Glass and carbon fibres are commonly used in polymer reinforcement in the aerospace and automotive industries. However, recycling these composites is difficult due to component separation issues. However, when disposed of or burned, these composites pollute the environment. Eco-friendly bio-composites must reduce environmental impact in order to replace petroleum-based non-renewable resource composites.

2. MATERIAL SELECTION

Growing concern for the environment has led to an increase in the use of natural fillers as reinforcement materials in reinforced polymer matrix composites (RPMC). Using natural fillers, which are biodegradable, plentiful, low-cost, and high-specific strength, composite materials may be made that have enhanced performance and usage in their applications. As a bonus, because of its low density, it helps to lower the overall bulk of the composite, which is advantageous.



2.1 Epoxy selection:

Epoxies are the most often encountered thermosetting polymers, which are formed by the reaction of two or more chemical ingredients. Epoxy resins are used in consumer and industrial applications due to their chemical resistance, good adherence, and durability.

The phrase "epoxy" or "epoxide" is a generic term that refers to a broad class of reactive chemicals. They are distinguished by the presence of an oxirane or epoxy ring, such as -epoxy, 1, 2-epoxy, and so on. It is represented as a three-member ring with an oxygen atom that is bonded to two carbon atoms in a unique way.

As a result, the presence of a "epoxy" group in a chemical implies that the molecular base of the compound may change greatly, resulting in a diverse spectrum of epoxy resins.

TGMDA (Tetraglycidyl methylene dianiline**)** resins have good mechanical characteristics and a high glass transition temperature, making them ideal for advanced composites in aerospace. Epichlorohydrin reacts with an amine to produce aromatic amines that are appropriate for use at high temperatures.

2.2 Hardeners:

Hardeners, which are chemicals added to help in the curing of the composite, are used to harden polymers. Hardeners are used to increase the adhesion and impact strength of epoxy resins as well as modify the viscosity of the polymer matrix. Hardeners are used in a wide range of situations. Hardeners contribute to the extension of the product's shelf life by decreasing the exothermic process. We are selecting **Araldite HY-951** because it is available easily in market and also used for industrial purposes.

2.3 Reinforcement:

Fillers are added to materials in order to reduce the amount of expensive binder material that is consumed. The characteristics of mixed materials are improved by the addition of filler particles. Sugarcane, rice husk, wheat husk, and other natural fillers are examples of this.

Sugarcane trash is a readily available waste material that can be used as a natural filler material in reinforced polymer matrix composites. Aside from that, it's a resource that can be harvested again. It is made from agricultural waste and, because of its high density, it may be used as a filler material in a variety of applications. It is made by crushing and extracting the juice from sugarcane, and then converting the waste left behind in the form of fibre into particle form, which is often grey-yellow to pale green in hue.

3. METHODOLOGY

1 Epoxy treatment with hardener
2 Filler mixing to form composite paste
3 Preparation of pure epoxy resin
4 Preparation of composite specimen
5 Mould preparation
6 Cutting of samples into desired dimensions
7 Design calculation for mould
8 Testing

- Tensile test
- Elongation test
- Flexural test
- Impact test

9 Testing results and graph plotting

3.1 Mould Preparation:

- First, the composite mould is made. Preparation of 250 x 200 x 4 mm moulds for the required composite.
- A clean smooth-surfaced hardwood board is carefully washed. A non-reactive thin plastic layer covers the wooden board.
- Then the glass of the same size (thickness 3 mm) is taken.
- We set the glass on the board. 8mm squares are trimmed to size and stapled around the glass.
- These should be fastened so no polymer leaks out during casting. The parts are securely nailed so that the glass does not move and damage the mould's dimensions.
- The glass is removed after fastening the parts, leaving the mould behind.
- Then, we cut each laminate using a rack saw blade for various experiments.

4. TESTING

ASTM standards regarding bio-composite specimen:
For tensile, elongation and flexural test, ASTM D-638 is used.
Length = 17 cm
Width = 2 cm
Thickness = 3 to 5 mm
Gauge length = 9 cm

For impact test, ASTM D-256 is used.
Length = 6.4 cm
Width = 1.27 cm
Thickness = 3.2 to 4.6 mm
Depth under the notch= 10.2mm

Following tests are performed:

- Tensile strength- UTM
- Elongation test- UTM
- Flexural strength test- UTM (by 3- point bending test method)
- Impact strength test- Impact testing machine(by Izod method)

Table- 4.1: Tensile strength tests results(in MPa)

Filler content	Specimen 1	Specimen2	Specimen 3	**Result**
10%	19.85	24.59	37.05	27.16
14%	29.36	30.61	38.30	32.75
18%	30.75	32.16	28.05	30.32
22%	24.29	22.40	24.50	23.63

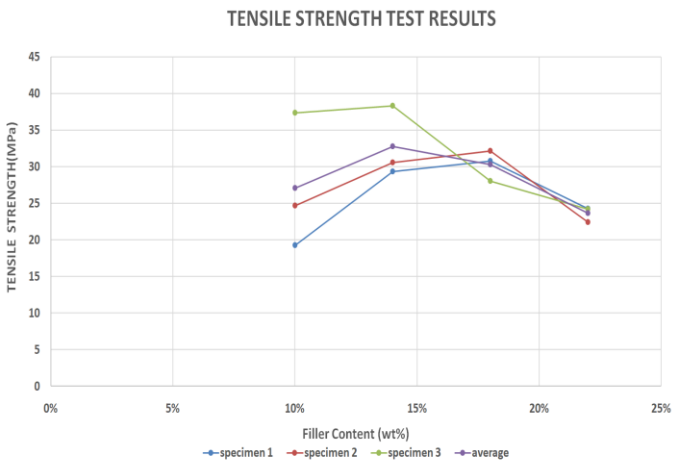


Table 4.2: Elongation tests results

Filler content	Specimen 1	Specimen2	Specimen 3	**RESULT**
10%	1.26	1.57	1.92	1.58

14%	1.40	1.47	1.40	1.42
18%	1.21	1.48	1.23	1.30
22%	1.20	1.35	1.25	1.26

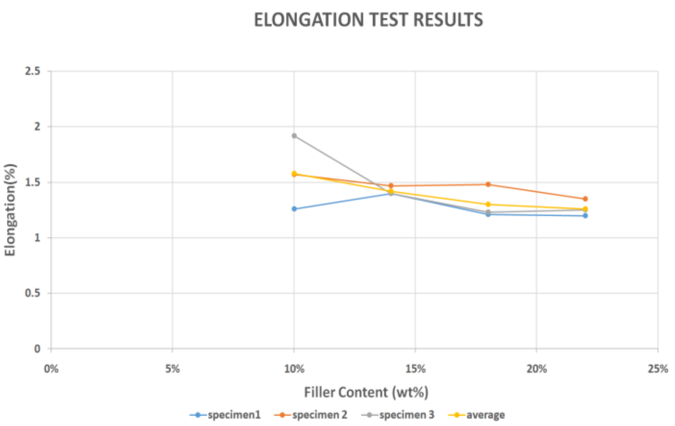


Table 4.3: Flexural strength tests results(in MPa)

Filler content	Specimen 1	Specimen2	Specimen 3	RESULT
10%	59.00	41.61	65.0	55.2
14%	47.00	39.62	57.12	47.91
18%	42.98	39.95	56.39	46.45
22%	44.71	40.09	56.21	49.81

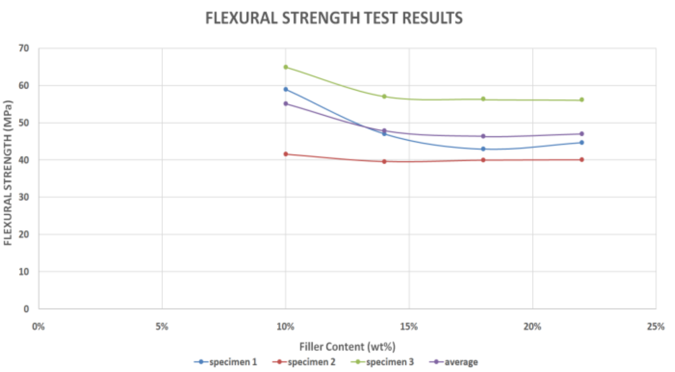
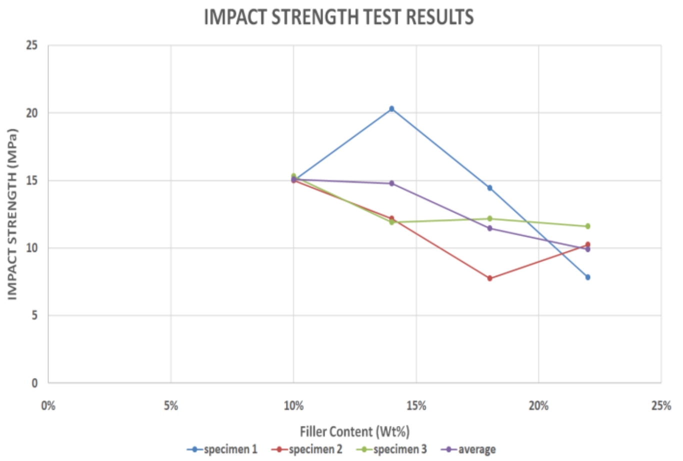


Table 4.4: Impact strength test results(in MPa)

Filler content	Specimen 1	Specimen2	Specimen 3	RESULT
10%	15	15	15.3	15.1
14%	20.3	12.2	11.9	14.8
18%	14.45	7.75	12.2	11.46
22%	7.85	10.27	11.62	9.91



5. CONCLUSIONS

I. A series of polymer composites material has been successfully developed by varying % of sugar cane trash filler.

II. Developed composite having 14% filler is showing good results in tensile test.

III. Developed composite having 10% filler by weight is showing good results in elongation.

IV. It is observed that when percentage sugarcane trash increases, tensile strength of the specimen increases up to 14% and then it shows decline.

V. The elongation% decreases as the percentage of sugarcane trash increases.

VI. The flexural strength comes out to be maximum at 10% filler content and then it starts decreasing when the percentage of filler content increases.

VII. The impact strength comes out to be maximum at 10% filler content and then it declines as the percentage of sugarcane trash increases.

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Biographical note- Presently pursuing Bachelor of Technology from M.E. department of JSS Academy of Technical Education, NOIDA, U.P. I am also doing final year project on epoxy based bio-composite reinforced with sugarcane trash. My interests are including Composite Materials, Designing on Solidworks, Ion drive engine and Braking systems. I am hopeful that this research paper shall be very helpful in the development of epoxy based bio-composites at industrial level.