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Characterization and Mechanical Properties of Basalt / $CACO_3$ Reinforced Epoxy Hybrid Composite

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Abstract: This study is to investigate mechanical characterization of basalt/$CaCo_3$ reinforced Epoxy hybrid composite. To fabricate the hybrid composite by hand lay-up process. The effects of tensile and flexural properties of the composites will also be investigated. Dynamic mechanical analyses to be evaluate the damping behaviour of the composites. Using Scanning Electron Microscope(SEM) to analysis fracture surface of the composite.
Keywords*: *Tensile and flexural properties, basalt, $CaCo_3$, Epoxy, Hand lay-up, Hybrid composite.

I. INTRODUCTION

A composite is combination of two materials in which one of the materials, called the reinforcing phase, is in the form of fibres, sheets, or particles, and is embedded in the other materials called the matrix phase. The reinforcing material and the matrix material can be metal, ceramic, or polymer. Composite material can provide superior and unique mechanical and physical properties because it combines the most desirable properties of its constituents while suppressing their least desirable properties. At present composite materials play a key role in aerospace industry, automobile industry and other engineering applications as they exhibit outstanding strength to weight and modulus to weight ratio. High performance rigid composites made from glass, graphite, Kevlar, and boron or silicon carbide fibres in polymeric matrices have been studied extensively because of their application in aerospace and space vehicle technology.

II. LITERATURE REVIEW

K. Raj kumar in this work agricultural wastage such as sugarcane leaves and almond shell particles were reused as reinforcement in polymer material. This paper revealed the effect of sugarcane leaves, and almond shell particle on mechanical property of polymer composites. Sugarcane leaves were chopped to size of 50mm* 50mm and almond shell of average 1mm particle size were used to fabricate epoxy polymer composite by hand layup technique. Tensile, flexural and impact test were carried out to evaluate the mechanical property of the composite. Scanning electron microscopy study shows that uniform particle distribution and good bonding between particles and epoxy polymer.

III.RAW MATERIALS

This chapter describes the details of processing of the composites and the experimental procedures followed for their characterization and tri-biological evaluation. The raw materials used in this work are.

A. Epoxy

Epoxy LY 556, chemically belonging to the epoxies family which is used as the matrix material. The epoxy resin and the hardener are supplied by VasaviBala Resins (P) Ltd., Teynampet, Chennai. Normally it contains a high modulus fiber with low modulus fibre. The high-modulus fibre provides the stiffness and load bearing qualities, whereas the low-modulus fibre makes the composite more damage tolerant and keeps the material cost low.

B. Basalt Fibre

The influence of basalt powder addition on thermo mechanical properties of basalt fibre reinforced epoxy composites was investigated in this study. The dynamic mechanical thermal analysis was carried out in a torsion mode. The mechanical properties were evaluated by means of static tensile test and Charpy impact strength method.

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TABLE I
MECHANICAL AND PHYSICAL PROPERTIES OF BASALT FIBER

Properties	Continuous Basalt fiber	Glass fiber (Eglass)	Glass fiber (Sglass)	Carbon fiber
Breaking Strength (MPa)	3000-4840	3100-3800	4020-4650	3500-6000
Modulus of Elasticity (GPa)	79.3-93.1	72.5-75.5	83-86	230-600
Breaking Extension (%)	3.1	4.7	5.3	1.5~2.0
Fiber Diameter (μm)	6-21	6-21	6-21	5-15

C. Calcium Carbonate

Calcium carbonate is a chemical compound with the chemical formula $CaCO_3$. It is a common substance found in rock in all parts of the world, and is the main component of shells of marine organisms, snails, pearls, and eggshells. Calcium carbonate is the active ingredient in agricultural lime, and is usually the principal cause of hard water. It is commonly used medicinally as a calcium supplement or as an antacid, but high consumption can be hazardous.

IV. PROCESSING OF THE COMPOSITES

Basalt fibres are reinforced with epoxy, chemically belonging to the epoxies family which is used as the matrix material. The epoxy resin and the hardener are supplied by VasaviBala Resins (P) Ltd., Teynampet, Chennai. Epoxy resins has modulus of 3.42GPa and possess density 1100 kg/m^3. Composites of three different compositions i.e. 30wt%, 40wt% and 50wt% are made. Specimens of suitable dimension are cut for different tests.

TABLE II
Mechanical And Physical Properties Of Basalt Fiber

Hybrid Composite samples	Epoxy(Wt %)	$CaCo_3$(Wt %)
S1	60	0
S2	55	5
S3	50	10
S4	45	15

A. Hand Layup Technique

Hand lay-up technique is the simplest method of composite processing. The infrastructural requirement for this method is also minimal. The processing steps are quite simple. First of all, a release gel is sprayed on the mould surface to avoid the sticking of polymer to the surface. Thin plastic sheets are used at the top and bottom of the mould plate to get good surface finish of the product. Reinforcement are placed in the mould surface of mould after Perspex sheet. Then thermosetting polymer in liquid form is mixed thoroughly in suitable proportion with a prescribed hardener (curing agent) and poured onto the surface of reinforcement already placed in the mould.

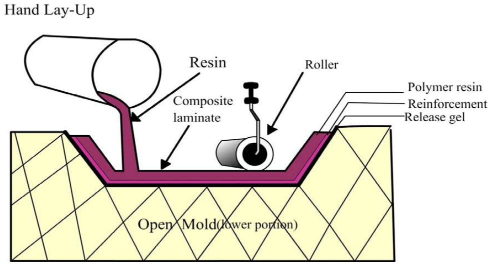

Fig. 1 Hand lay-up process

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V. MECHANICAL PROPERTIES

A. *Tensile strength*

The tensile test was carried out according to ASTM D-638 standard. The specimen dimensions were 165 mm x 19 mm x 4mm and load was applied on both the ends. The test was performed in the universal testing machine. Tensile strength decreases with increase in filler content this would be because of poor adhesion, direct contact of shell particles and void formation.

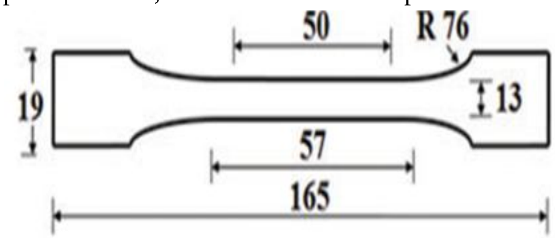

Fig. 2 Tensile specimen

B. *Flexural Strength*

The flexural strength was carried out according to ASTM D790. The three point bend test was conducted on all the composite samples in the universal testing machine. The dimension of each specimen was 125 mm x 13 mm x 4mm three identical test specimens were tested for calculating the flexural strength.

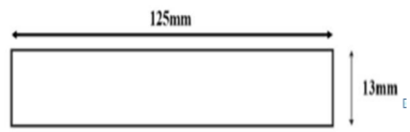

Fig. 3 Flexural specimen

C. *Scanning Electron Microscope*

Several composite samples were cut down to be used to photograph using a Scanning Electron Microscope (SEM). The samples dimensions were cut to roughly 11 mm x 3 mm x 3 mm. The samples were cleaned off with acetone. The SEM uses vacuum and it is important that the samples do not have any loose particles. The loose particles can damage the instrumentation. Because the knave composite is not conductive a piece of copper tape was adhered to the sample to help direct the electron beam

VI. RESULTS AND DISCUSSION

The mechanical properties of the Basalt fibre reinforced Epoxy composites with CaCo3 Fillers prepared for this present investigation. Details of processing of these composites and the tests conducted on them have been mark out in the previous chapter. The results of various characterization tests are reported here.

A. *Ultimate tensile strength*

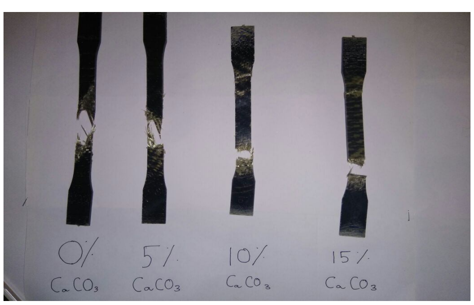

Fig. 4 Tensile fracture

It was observed that the tensile strength of all filled composites having higher values when compared with unfilled composite 15% of $CaCo_3$. This may be due to the restriction of the mobility and deformability of the matrix with the introduction of mechanical restraint and the filler particle size. Tensile strength decreases with increase in filler content this would be because of poor adhesion, direct contact of shell particles and void formation.

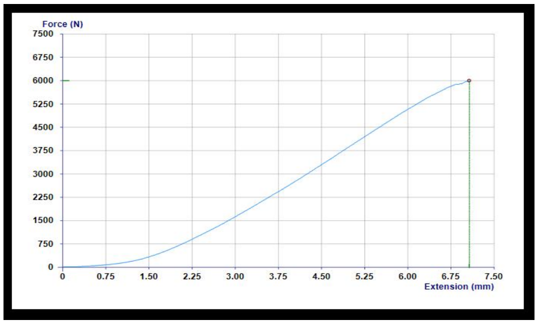

Fig. 5 Chart for tensile strength

B. Flexural strength

Flexural strength for composites with different filler volume fraction of hybrid composites were compared. Flexural properties of composites increased with increase filler content. The maximum flexural strength composite was observed in 15%. Unfilled composite was having higher flexural strength.

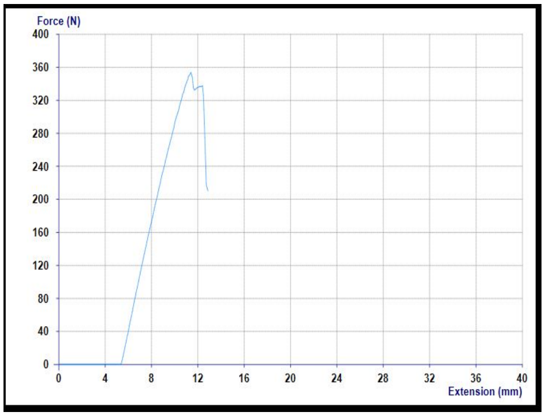

Fig. 6 Chart for flexural strength

C. Scanning Electron Microscope Image

The micrograph of fractured specimen of tensile, flexural of basalt / Calcium Carbonate reinforced epoxy hybrid composites. Fibre pull-out phenomena was observed for the hybrid composite. The SEM images clearly indicate that there was more breakage of fibres and few voids present due to fiber pull-out. This shows that there is a fibre–matrix interaction between the fibres and the polymer matrix. This results for better mechanical bonding between the fibre and polymer matrix.

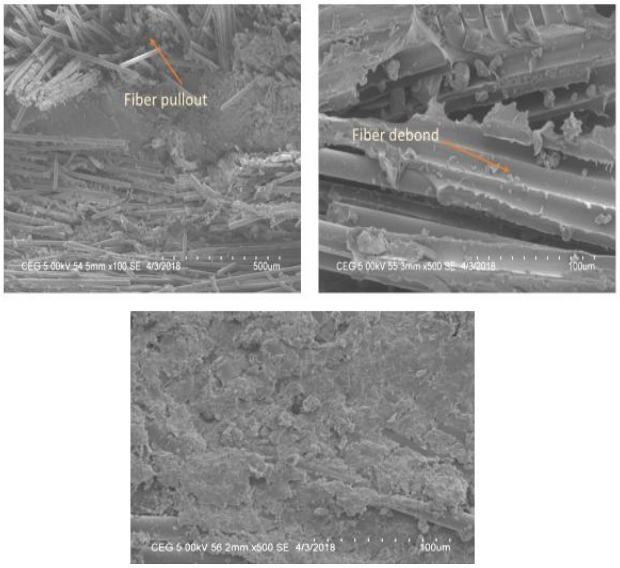

Fig. 7 SEM images

VII. CONCLUSION

Characterization And Mechanical Properties of Basalt / Caco3 Reinforced Epoxy Hybrid Composite was successfully fabricated in a hand layup technique.

A. The mechanical properties (tensile and flexural) were greatly influenced by the filler content.
B. The test result shows that composites filled by $CaCO_3$ powder increase the tensile strength linearly up to 15% particle addition.
C. The test result shows that addition of particles in the composite reduces the flexural strength.

SEM morphology of the fractured samples shows brittle mode of failure, and 15% particulate shows less fibre pull-out due to good interfacial strength between the particle and matrix.

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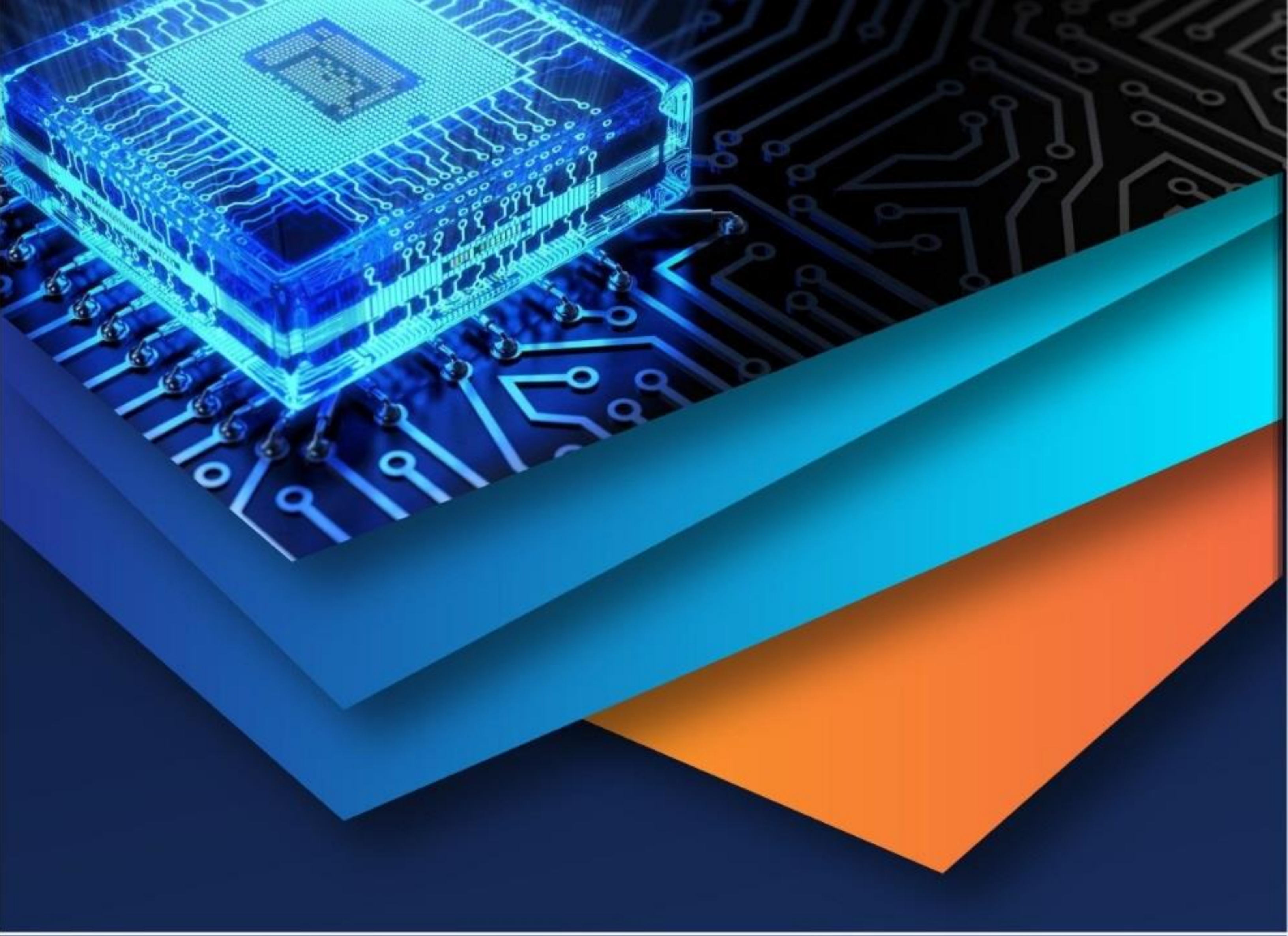

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