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Fabrication and Abrasive Water Jet Machining of Fly Ash Particulate and Basalt Fiber Reinforced Vinyl Ester Composite

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Abstract: A recent increase in the use of eco friendly, natural fibres as reinforcement for the fabrication of lightweight and low cost polymer composites can be seen globally. One such material of interest currently being extensively used is basalt fibre (BF), which is cost-effective and offers exceptional properties over glass fibres. Unsaturated vinyl ester (VE) based polymer composites were developed by reinforcing basalt fabric using the hand layup technique at room temperature. This study describes BF reinforced unsaturated VE composites (BF5, BF10 and BF15) without acid and alkali treatments of the BF. This research work focus on the study of mechanical properties like tensile strength, flexural strengths and hardness. Variations in mechanical properties such as the tensile strength, flexural strengths and hardness of various specimens were calculated using a computer-assisted universal testing machine (UTM). Scanning Electron Microscope (SEM) was used to observed of the fracture surface of the composites which showed transition brittle to mixed brittle-ductile mode when increase in BF. This work confirms the applicability of BF as a reinforcing agent in polymer composites. The abrasive water jet machining (AWJM) was proven to be more effective and a preferable technique in machining of fiber-reinforced composite material. The machining characteristic of basalt fiber 15% composition was studied using AWJM and ANOVA Analysis was used to find, the major influence factor of machining composite

Keywords: Abrasive Water Jet Machining, basalt, Fly ash, Epoxy, Hybrid composite, Hand lay-up.

I. INTRODUCTION

Composites are a class of materials which are made up of two or more different materials which are combined or bonded together to form an entirely new material exhibiting properties of all the constituent materials. In general, a composite has two phases the matrix and reinforcement. The matrix phase helps in load transfer and also holds together the fibers, it also offers protection to the fibres. The reinforcement phase is used to add strength to the existing matrix. Without the reinforcement the matrix will be useless. The new material may be preferred for many reasons which include materials which are stronger, lighter, or less expensive when compared to traditional materials. Composites are combinations of two or more materials in which one of the materials, called the matrix and, the other materials called as fibres or fillers. Matrix is the main core of the composites that transfer stresses between the reinforcing fibres/fillers and enhance the mechanical and/or physical damage.

II. LITERATURE REVIEW

AlaaM. Rashadet al. (2016) conducted a study on the development of new binders, as an alternative to Portland cement (PC), by alkaline activation, is a current researcher's interest. Alkali-activated fly ash (AAFA) binder is obtained by a manufacturing process less energy-intensive than PC and involves lower greenhouse gasses emission. Utilizing AAFA system as binder material can limit the consumption of virgin materials (limestone and sand) required in PC manufacture. AAFA belongs to be prospective material in the field of Civil Engineering where it can resist aggressive acids, resist sulphate attacks, resist aggregate alkali reaction, and resist elevated temperatures.

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. Fly Ash

Fly ash is a fine gray powder consisting mostly of spherical, glassy particles that are produced as a by-product in coal-fired power stations. Fly ash has pozzolanic properties, meaning that it reacts with lime to form cementitious compounds. It is commonly known as a supplementary cementitious material.

Fly ash is suitable for a wide variety of applications and uses, including:
1) Concrete
2) Dams
3) Flowable fill
4) Mines
5) Landfills
6) Geopolymer concrete

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.

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. Vinyl Ester Resin

Vinyl ester oligomers diluted with styrene are important matrix resins for thermosetting polymer composites. A major objective of this work has been to study the chemistry and kinetics of the cure reactions of vinyl ester resins at elevated curing temperatures, which are consistent with typical composite processing conditions. The cross linking reaction of vinyl ester resins was studied by FTIR and the loss of the carbon-carbon double bonds of the methacrylates (943 cm-1) and styrene (910 cm-1) were followed independently. A small background absorbance overlapping the absorbance at 943 cm-1 was subtracted from all spectra collected as a function of reaction time to quantify conversions. Copolymerization reactivity ratios of styrene and terminal methacrylates on vinyl ester oligomers were calculated to be rs = 0.36 Â± 0.05 and rm = 0.24 Â± 0.1 from early conversion data obtained at 140Â°C on a series of resins with systematically increasing levels of styrene. The composition data were analysed using the integrated form of the copolymerization equation and assuming a terminal reactivity model to predict copolymer compositions throughout the reactions. These curves agreed well with the experimental data even at high conversion levels. Another important part of this research was to study structure-property relationships of vinyl ester resins. Characteristics of vinyl ester resins and networks such as shrinkage, viscosity, crosslink density, glass transition temperature, gel swelling, and toughness have been studied. The shrinkage of vinyl ester resins during cure was calculated according to density measurements to be 4% - 10% depending on styrene content. It was found that the chain length of vinyl ester oligomers strongly affects the properties of the networks. For vinyl ester resins with longer lengths (Mn = 1000 g/mole), cross linked networks have higher fracture toughness values and lower Tg's.

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IV. PROCESSING OF THE COMPOSITES

Basalt fibres are reinforced with vinyl ester composite, chemically belonging to the ester family which is used as the matrix material. The vinyl ester and the hardener are supplied by VasaviBala Resins (P) Ltd., Teynampet, and Chennai. The shrinkage of vinyl ester resins during cure was calculated according to density measurements to be 4% - 10% depending on styrene content. Composites of three different compositions i.e. 55wt%, 50wt% and 45wt% are made. Specimens of suitable dimension are cut for different tests.

TABLE II
Mechanical And Physical Properties Of Basalt Fiber

S.no.	% of flax fiber (by weight)	% of vinyl ester resin (by weight)	% of fly ash (by weight)
11	40	55	5
22	40	50	10
33	40	45	15

A. Hand Layup Technique

Hand lay-up technique is the easiest method of composite processing. The infrastructural requirement for this type is also minimal. The processing steps are easy. 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 is 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.

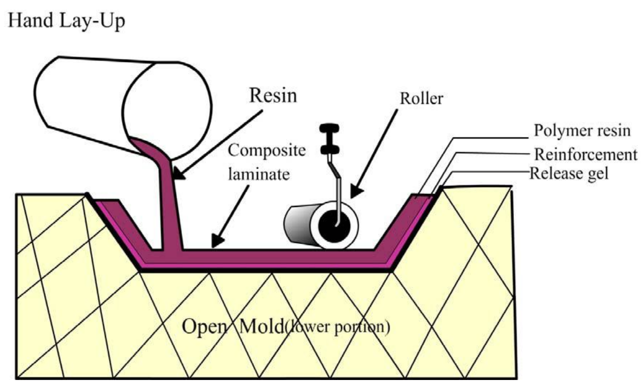

Fig. 1 Hand lay-up process

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

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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 10 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.

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

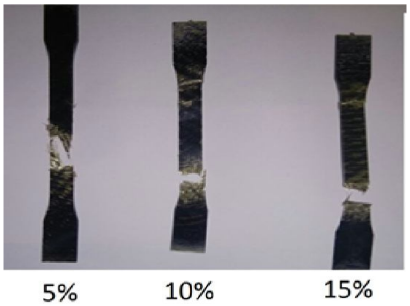


Fig. 4 Tensile fracture

From the Fig 5 it was observed that the tensile strength of all filled composites having higher values when compared with unfilled composite 15% of Fly ash. 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

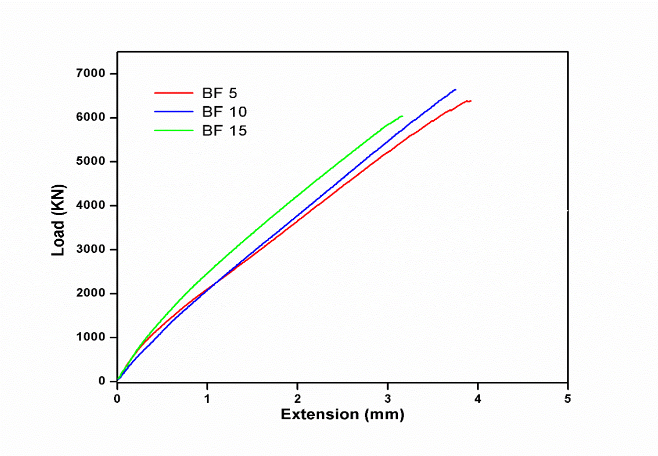


Fig. 5 Chart for tensile strength

B. Flexural strength

Flexural properties of composites increased with increase filler content. The maximum flexural strength composite was observed in 15%. Unfilled composite was having higher flexural strength.

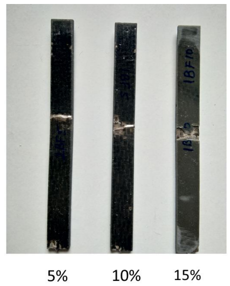


Fig. 6 Chart for flexural strength

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.

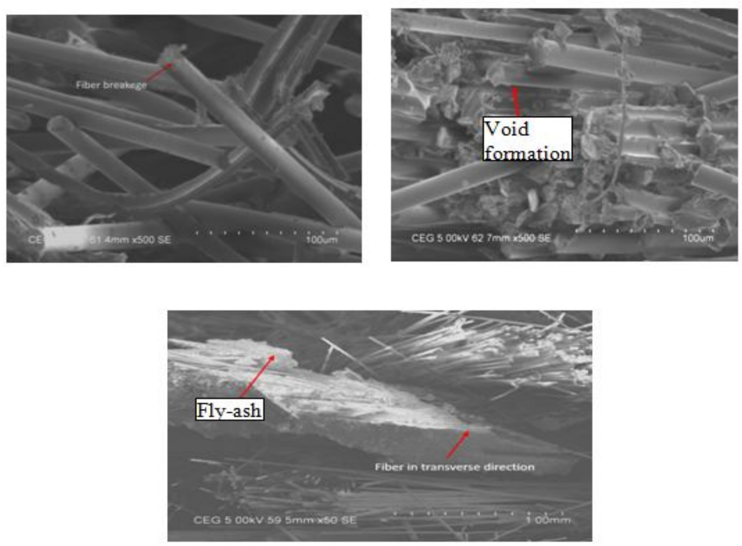


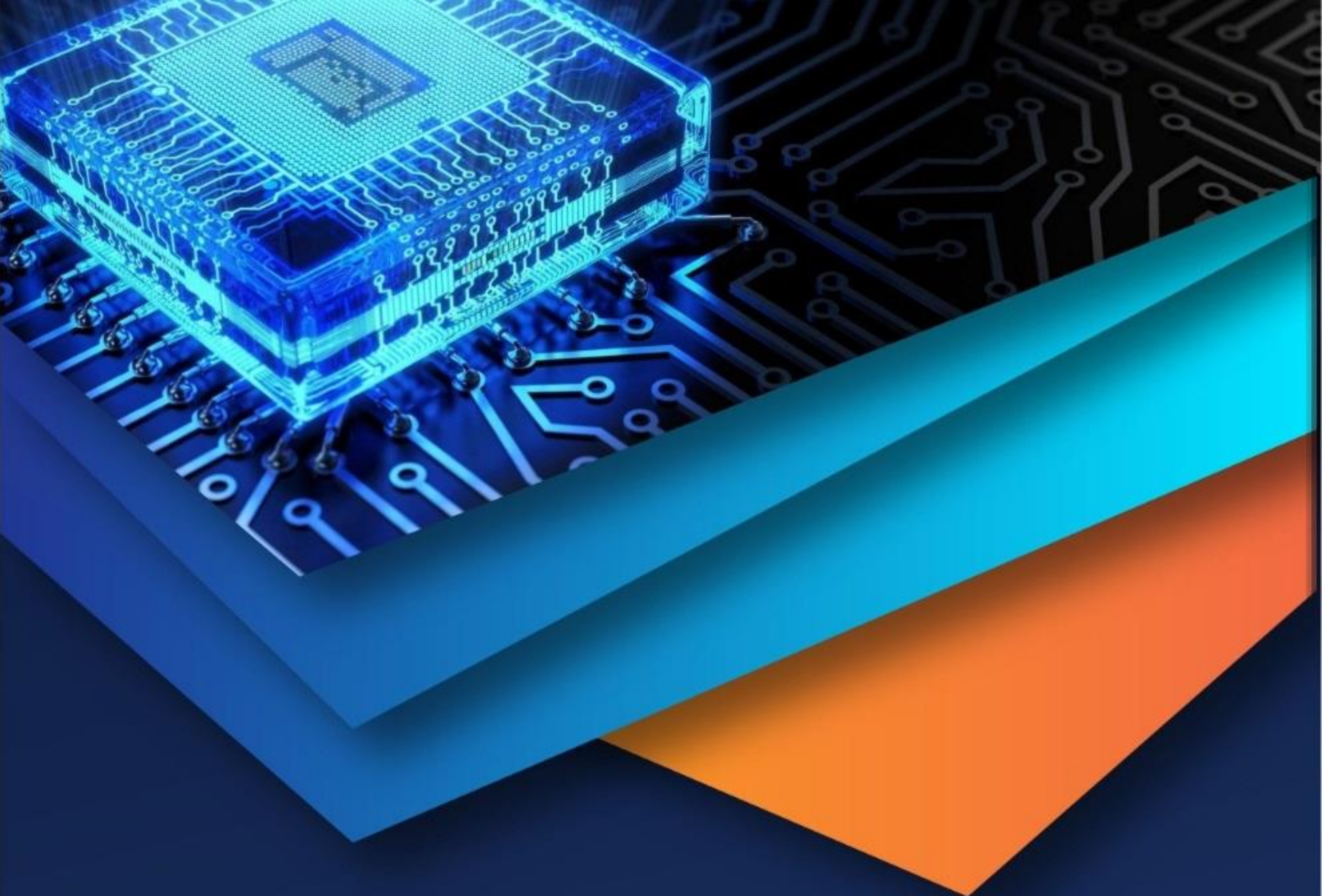
Fig. 7 SEM images

VII. CONCLUSION

A. The mechanical properties tensile, flexural and hardness were greatly influenced by the filler content.
B. The performance of basalt fibber reinforced composites with vinyl ester was superior to the basalt fibber reinforced composites. The tensile tests showed that basalt fibres rein-forced composite had higher tensile strength values.
C. The test result shows that composites filled by fly ash powder increase the tensile strength linearly up to 15% particle addition.
D. 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. .
E. Surface quality of the machined composites depends on various parameters; a combined input response is essential in achieving better surface quality.
F. Surface roughness can be reduced by reducing the SOD and increasing the water pressure and abrasive mass flow rate.
G. Further increase in the SOD and the transverse. Further increase in the SOD and the transverse speed will increase the surface roughness. Striation on the cut surface can be reduced by working at moderate transverse speed, higher jet pressure, and larger abrasive particles at high flow rate

REFERENCES

[1] Pragatheeswaran, R. and Kumaran, S.S., 2015. Mechanical behaviour of groundnut shell powder/calcium carbonate/epoxy composite. Date: 8th March 2015 Gujarat, p.50.
[2] Matykiewicz, D., Barczewski, M., Knapski, D. and Skorczewska, K., 2017. Hybrid effects of basalt fibers and basalt powder on thermomechanical properties of epoxy composites. Composites Part B: Engineering, 125, pp.157-164.
[3] .Lapčík, L., Maňas, D., Vašina, M., Lapčíková, B., Řezníček, M. and Zádrapa, P., 2017. High density poly (ethylene)/CaCO3 hollow spheres composites for technical applications. Composites Part B: Engineering, 113, pp.218-224.
[4] Liang, J.Z., 2007. Evaluation of dispersion of nano-CaCO3 particles in polypropylene matrix based on fractal method. Composites Part A: Applied Science and Manufacturing, 38(6), pp.1502-1506.



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