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MECHANICAL BEHAVIOR OF FLY ASH IMPREGNATED NATURAL FIBRE REINFORCED POLYMER COMPOSITE

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ABSTRACT

A composite material is the combination of two or more materials, which are having different phases and the properties superior to the base material. The effect of the coir fiber and 75μm flyash particles on mechanical properties are going to be presented in this paper. The composites containing varying amounts of coir and fly ash were prepared using compression moulding method. The composites were systematically produced by applying high energy during a controlled dispersion process, in order to reduce the size of agglomerates and to gain a homogeneous distribution of individual particles within the epoxy resin. The fly ash impregnated coir fibre yields significant improvement in mechanical strength compared to the coir fibre composite material

KEYWORDS: Natural Fibre, Coir, Epoxy resin, Polymer Composites.

INTRODUCTION

A composite material is made by combining two or more materials to give a unique combination of properties, one of which is made up of stiff, long fibres and the other, a binder or 'matrix' which holds the fibres in place. Over a past few decades composites, plastics, ceramics have been the dominant engineering materials. The areas of applications of composite materials have grown rapidly and have even found new markets[1] . Modern day composite materials consist of many materials in day to day use and also being used in sophisticated applications while composites have already proven their worth as weight saving materials the current challenge is to make them durable in tough conditions to replace other materials and also to make them cost effective.This has resulted in development of many new techniques currently being used in the industry. The composite industry has begun to recognise the various applications in industry mainly in the transportation sector[2].

New polymer resin matrix materials with high performance fibres of glass, carbon and aramid which have been introduced recently have resulted in steady expansion in uses and volume of composites.High performance FRP are also found in many diverse applications such as composite armouring design to resist the impact of explosions, wind mill blades, industrial shafts, and fuel cylinders for natural gas vehicles paper making rollers and even support beams of bridges[3].

Beghezan defined as “The composites are compound materials which differ from alloys by the fact that the individual components retain their characteristics but are so incorporated into the composite as to take advantage only of their attributes and not of their short comings”, in order to obtain improved materials.Van Suchetclan explained composite materials as heterogeneous materials consisting of two or more solid phases, which are in intimate contact with each other on a microscopic scale. They can be also considered as homogeneous materials on a microscopic scale in the sense that any portion of it will have the same physical property**[4].**

Fly ash, an industrial waste, can be used as a potential filler material in polymer matrix composites because it is a mixture of oxide ceramics. It improves the physical and mechanical properties of the composites [5]. Reduction in filler size gives better enhancement in properties due to uniform distribution of particles in polymer matrix and increases degree of cross linking of matrix [6]. A mechanical property such as tensile strength, impact strength and hardness of PMC is enhanced with the addition of smaller size filler materials [7].Fly ash mainly consists of alumina and silica, which are expected to improve the composite properties. Fly ash also consists to some extent, hollow spherical particles (termed cenospheres) which aid in maintenance lower density values for the composite, a feature of considerable significance in weightspecific applications[8],[9].Composites involving low cost fillers of fly ash, considered to be an industrial waste product and pollutant, are among the newer entrants to the family of particulate filled polymer composites. The use of fly ash as a reinforcement in polymer matrices gets strong support from a discipline such as civil engineering [10].

EXPERIMENTAL

Materials

Commercially available epoxy resin is taken as matrix material in this study. Epoxy, also known as polyepoxide, is a thermosetting polymer formed from reaction of an epoxide "resin" with polyamine hardener. Epoxy has a wide range of applications, including fiber-reinforced plastic materials and general purpose adhesives. Reinforcement material used for processing of PMC is fly ash. Fly ash is one of the residues generated in combustion of coal in Thermal power plants and comprises the fine particles that rise with the flue gases. Fly ash is generally captured by electrostatic precipitators or other particle filtration equipment before the flue gases reach the chimneys of coal-fired power plants. The dimensions of the fly ash particle are in the range of 5 to 50µm and the color is grey in nature. Normally coir fiber was extracted from coconut tree. But the coir was not directly get from tree with the help of some process the coir was separated Fig . 1 ,Fig. 2 and Fig. 3 shows the photographic image of the epoxy resin , fly ash and coir fiber.

Fig1 Epoxy Resin

Fig2 Fly ash

Fig3 Coir Fiber

Characterization of Scanning Electron Microscope (SEM)

SEM is one of the best and most widely used techniques for the chemical and physical characterization of fly ash. A representative portion of fly ash particles was sprinkled onto double-sided carbon tape mounted on a SEM stub. This grain mount enable to determine the particle morphology, external surface structure and external elemental distribution of individual fly ash particles.

The morphology of a fly ash particle is controlled by combustion temperature and cooling rate. The majority of the particles ranged in size from approximately 1µm to 5 µm and consisted of solid spheres as showing in Fig.5. Agglomerated particles and irregularly shaped amorphous particles shown in fig 5 . The predominant elements in the fly ash samples were silicon, aluminum, oxygen and carbon in various compounds. Their weight percentages are Si-27.16, Al-10.76, O-51.57 and C-10.51 respectively as Listed in Table 1.

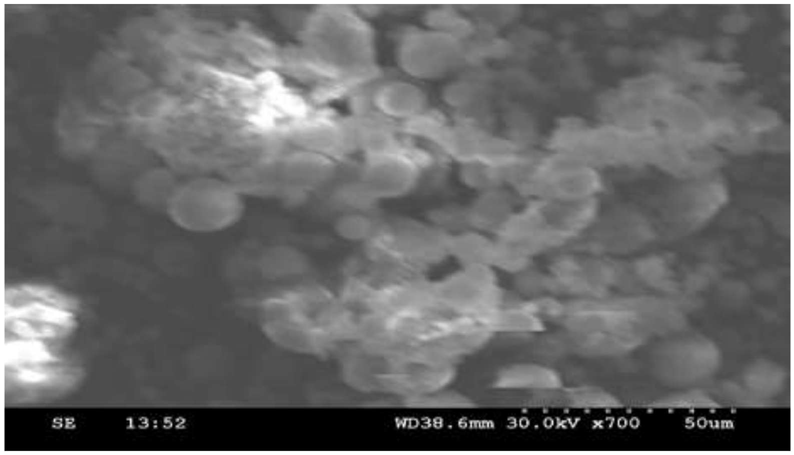

Fig 5 SEM image of fly ash

C.Table 1 Elements in the Fly ash

Composite	Compositions
C1	80% of epoxy resin+20% of coir fiber
C2	75% of epoxy resin + 25% of coir fiber(20 mm length)
C3	70% of epoxy resin + 30% of coir fiber(20mm length)
C4	75% 0f epoxy resin+15% of coir fiber +10% of fly ash(75 micron)
C5	65% 0f epoxy resin+25% of coir fiber +10% of fly ash(75 micron)
C6	70% 0f epoxy resin+20% of coir fiber +10% of fly ash(75 micron)

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COMPOSITES

WITHOUT FLY ASH

Fig1
80% of epoxy resin
20% of coir fiber

Fig2
75% of epoxy resin
25% of coir fiber

Fig3
70% of epoxy resin
30% of coir fiber

FLY ASH IMPREGNATED COMPOSITES

Fig 4
75% 0f epoxy resin
15% of coir fiber
10% of fly ash(75 micron)

Fig 5
65% 0f epoxy resin
25% of coir fiber
10% of fly ash(75 micron)

Fig 6
70% 0f epoxy resin
20% of coir fiber
10% of fly ash(75 micron)

RESULTS AND DISCUSSIONS

Mechanical Characteristics of Composites

The characterization of the composites reveals that the fiber length is having significant effect on the mechanical properties of composites. The properties of the composites with different fiber lengths under this investigation are presented in TABLE

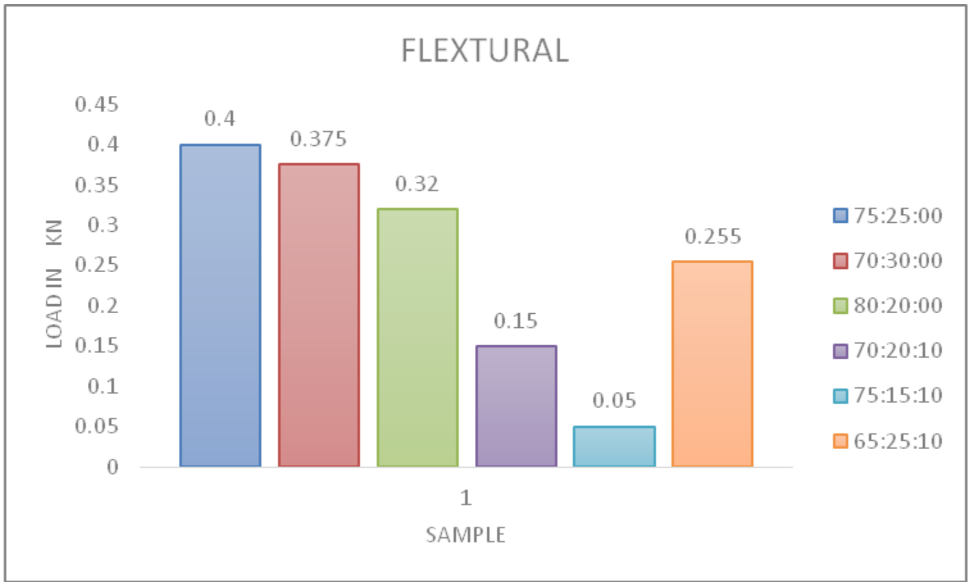
SAMPLE	IMPACT TEST (jouls)	FLUCTURAL TEST (KN)	TENSILE TEST (KN)	WATER ABSORPTION %
75-25 Flyash	0.26	0.400	2.100	5.36
70-30 Flyash	0.26	0.375	1.890	10.2
80-20 Flyash	0.26	0.320	1.070	6.42

70-20-10 Flyash	0.29	0.150	1.595	3.86
75-15-10 Flyash	0.34	0.050	1.245	2.11
65-25-10 Flyash	0.32	0.255	1.405	3.97

Mechanical properties of the composites

FLEXURAL TEST PROPERTIES

This chapter presents the mechanical properties of the coir fiber reinforced epoxy composites prepared for this present investigation. Details of processing of these composites and the tests conducted on them have been described in the previous chapter. The results of various characterization tests are reported here. This includes evaluation of tensile strength, flexural strength, impact strength has been studied and discussed. The interpretation of the results and the comparison among various composite samples are also presented.

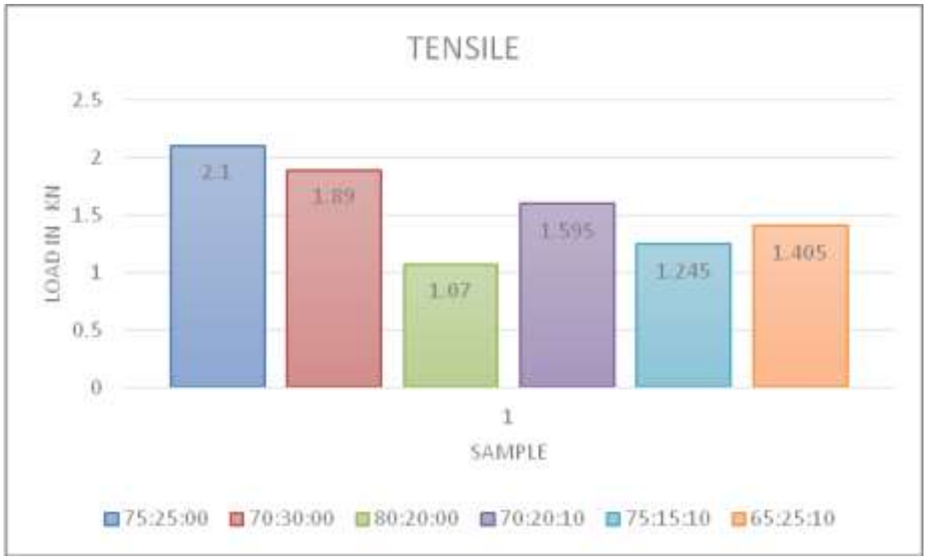


FLEXTURA TEST fig 17

TENSILE TEST PROPERTIES

EFFECT OF FIBER LENGTH ON TENSILE PROPERTIES

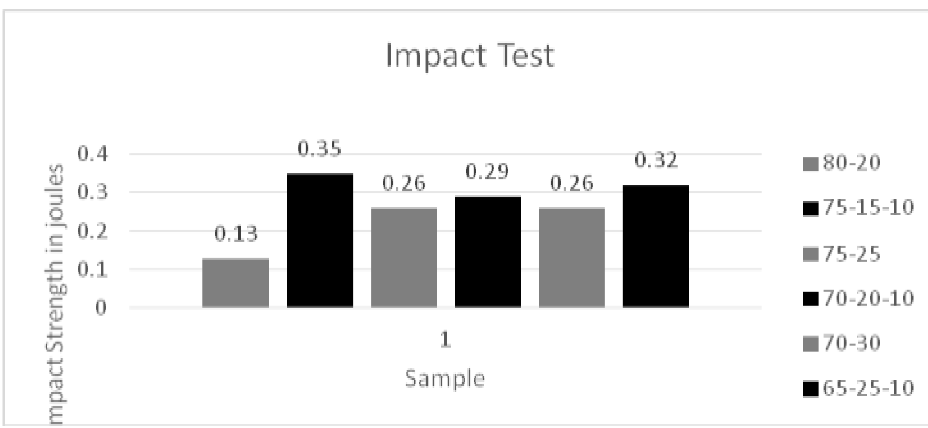
The test results for tensile strengths and moduli are shown in Figures 4.2 and4.3, respectively. It is seen that the tensile strength of the composite increases with increase in fiber length. There can be two reasons for this increase in the strength properties of these composites compared. One possibility is that the chemical reaction at the interface between the filler particles and the matrix may be too strong to transfer the tensile. From Figure 4.3 it is clear that with the increase in fiber length the tensile moduli of the coir fiber reinforced epoxy composites increases gradually.



TENSILE TEST fig 18

IMPACT TEST PROPERTIES

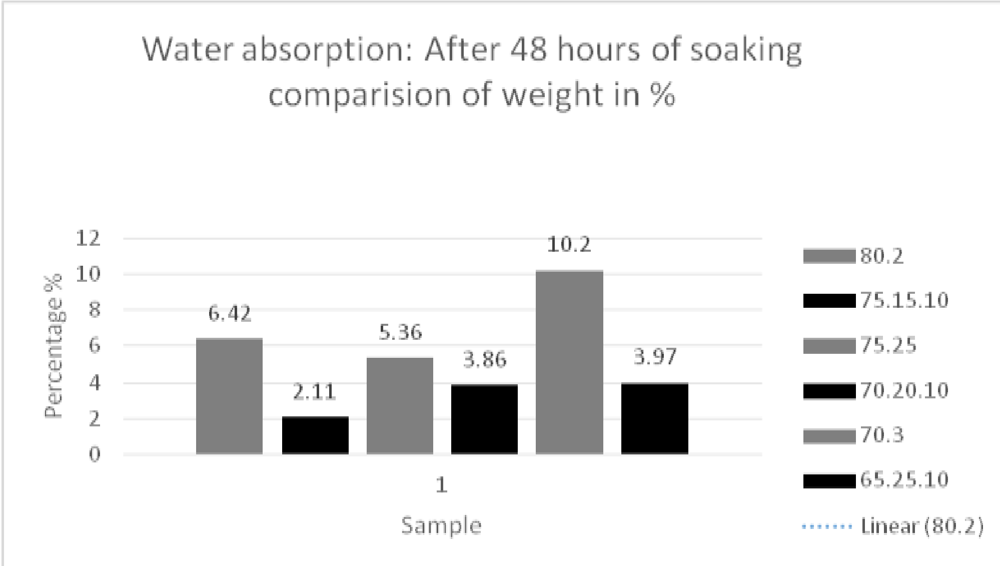
The impact energy values of different composites recorded during the impact tests are given in Table 4.1. It shows that the resistance to impact loading of coconut coir fiber reinforced epoxy composites improves with increase in fiber length as shown in Figure 4.5. High strain rates or impact loads may be expected in many engineering applications of composite materials. The suitability of a composite for such applications should therefore be determined not only by usual design parameters, but by its impact or energy absorbing properties.



IMPACT TEST RESULT CHART fig 19

WATER ABSORPTION TEST PROPERTIES

It is the absorption of water by roots with the help of metabolic energy generated by the root respiration.The force for water absorption originates from the cells of root due to root respiration.As the root cells actively take part in the process so it is called Active absorption. According to Renner, active absorption takes place in low transpiring and well-watered plants and 4% of total water absorption is carried out in this process. The active absorption is carried out by two theories which are, Active osmotic water absorption and Active non-osmotic water absorption.



WATER ABSORPTION TEST RESULT fig 20

CONCLUSIONS

This experimental investigation of mechanical behaviour of coconut coir reinforced epoxy composites leads to the following conclusions:

This work shows that successful fabrication of a coir fiber reinforced epoxy composites with different fiber lengths is possible by simple hand lay-up technique.

It has been noticed that the mechanical properties of the composites such as micro -hardness, tensile strength, flexural strength, impact strength etc of the composites are also greatly influenced by the fibre lengths.

The fracture surfaces study of coir fiber reinforced epoxy composite after the tensile test, flexural test and impact test has been done. From this study it has been concluded that the poor interfacial bonding is responsible for low mechanical properties.

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