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Experimental Investigation of Comparison of Mechanical Properties of Natural Composites made of Bagasse, Coco-coir and Banana fiber

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Abstract: The recent advances in natural composite create a new era of composite used in different applications. These natural composites are highly biodegradable, environment-friendly, molded in varying shape, and can be recycled till it decomposes. In this experimental investigation Bagasse, Coco coir, and Banana fiber composites are prepared with the help of epoxy resin in the manufacturing laboratory of Seacom Engineering College, Dhulagarh, Howrah. The composites were prepared using the hand lay-up technique with a compressive load of twenty Kgf force. An open-type wooden mold was prepared to envelop the composite initially. The density of Composite made of Bagasse, Coco coir, and Banana fiber are measured as o.398gm/cm^3,o.373gm/ cm^{3}and 0.352ge/cm^3 respectively. Three different composites were made with each constituent of said fibers varying with fiber to resin ratio by weight. In each case, the tensile strength of bagasse fiber and coco coir composites was recorded as 70% and 34% higher values than the composite made of Banana fiber. Both the Hardness and Compressive strength of the composites are inversely proportional to the weight of the fibers used in the composites. Stress bearing capacity of the banana composite is the lowest among all three composites.

Keywords: Natural Fiber, Composites, Biodegradable, Coco-coir

I. INTRODUCTION

Composite is a product of two or more different materials combined to form something totally new than the original constituents [1]. Here raw materials are used to form the natural composites are shown in Fig. 1.1.

Fig.1.1 Natural fiber composite made of varying materials at the manufacturing lab.
Of Seacom Engineering College, Dhulagarh, Howrah.

Generally, a composite is made of with matrix that acts as the outer cover and a fiber which is the strengthening part/load-carrying member of the composite. Though a huge number of manmade composites are being used in varying applications of structural and decoration purposes few natural composites, such as wood, human bone and teeth, pearls, and a few shell structures are very important for human life and other purposes. The past literature reveals that amongst the hefty numbers of natural fibers, jute fiber shows good mechanical properties compared with other natural fibers, such as sisal, coir, and ramie [2]. A large many authors have reported that the jute fiber composites from different aspects, for example, mechanical properties [3], physical properties [4] and chemical properties, the effect of fiber treatments on mechanical properties [5], and dynamic mechanical properties [6] and so on.

II. THE RAW MATERIALS FOR COMPOSITE AND PROCESS OF PREPARATION

The different resources such as Bagasse, Coco coir, and Banana fiber are collected from different resources and Epoxy resin was collected to develop hardeners in the composite material. At first by manual isolation, all the different fibers were made fine and then the cleaning process was done thoroughly. The arrangement of Fibers was done in the form of layers so that these layers could

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be placed one by one with the combination of layers of resin. All the different types of fibers were placed and kept disjointedly to make their own layered composites. The weight percentage of fibers to resin was maintained to three different composites of fiber ratio of 0.2, 0.3, and 0.4 Wt. The weighted resin was applied over the fiber putting the fiber layer by layers. All the fibers are measured individually to maintain the proper ratio of materials to resin in definite percentages, after applying resin over one layer of fiber a soft roller was repeatedly rolled to make the surface even for the next layer, in this way, repeated layers of composite were prepared. After the initial preparation of the composite in the mold, a dead weight of 2.5 kg was placed overnight over the composite to remove trapped air/gases from the green sample and to get a uniform solid structure. The detail of the application of preparation of mold, weighing of different raw materials, and initial preparation of composite fiber is shown in Fig 1.2.

Fig. 1.2 (a) Preparation of wooden mould (b) weighing machine for measuring different raw materials used in composites and in (c) initial setup for composites is shown.

III. RESULT AND DISCUSSION

Different mechanical test of composite has been carried out in the material testing laboratories of Seacom Engineering College, Dhulagarh, Howrah. A similar test has been carried out thrice and an average of these three results is taken to check the accuracy of the result. Brinell hardness of three different composites of fiber ratio of 0.2, 0.3, and 0.4 Wt. The ratio of fiber to resin has been plotted in Fig. 2. The plot clearly describes that the lower weight ratio of fiber results in higher BHN of the composite. The density of Composite made of Bagasse, Coco coir, and Banana fiber are measured as o.398gm/cm^3, o.373gm/cm^3, and 0.352gm/cm^3 respectively when fiber to resin ratio is maintained as 0.4 in all three composites.

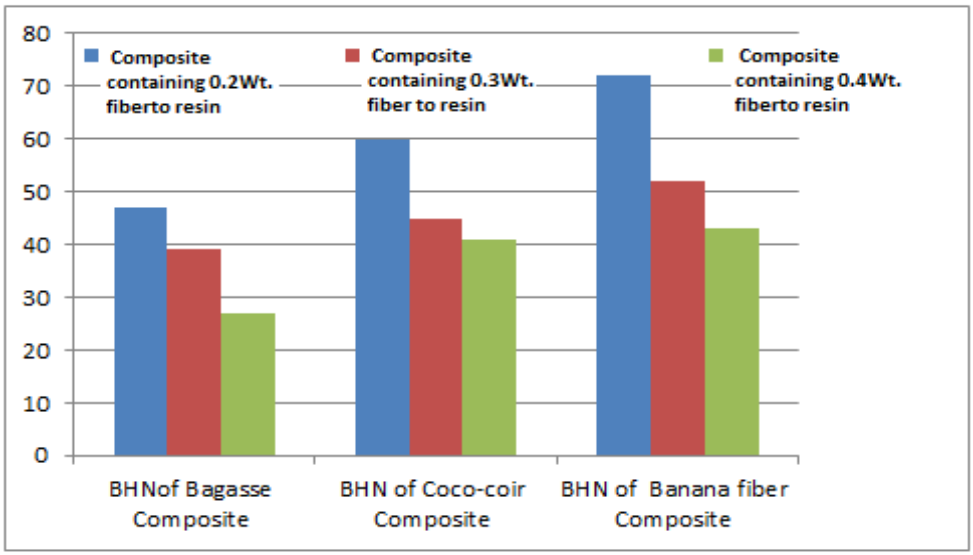

Fig. 2 The graphical representation of BHN of different composite fiber materials.

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The tensile test of three different composites of fiber ratio of 0.2, 0.3, and 0.4 Wt. The ratio of fiber to resin has been performed in the UTM machine and plotted in Fig.3. Samples were mounted in between the upper and lower crossbar of UTM as shown in Fig.3. The result represents that the value of tensile strength of Bagasse fiber composite has the highest value than the other two composite fibers, the Coco coir fiber composite has the medium value and the Banana fiber composite has the lowest value. The plot clearly describes that the lower weight ratio of fiber results in a lower Tensile strength of the composite. The density of Composite made of Bagasse, Coco coir, and Banana fiber are measured as o.398gm/cm^3, o.373gm/cm^3, and 0.352gm/cm^3 respectively when fiber to resin ratio is maintained as 0.4 in all three composites.

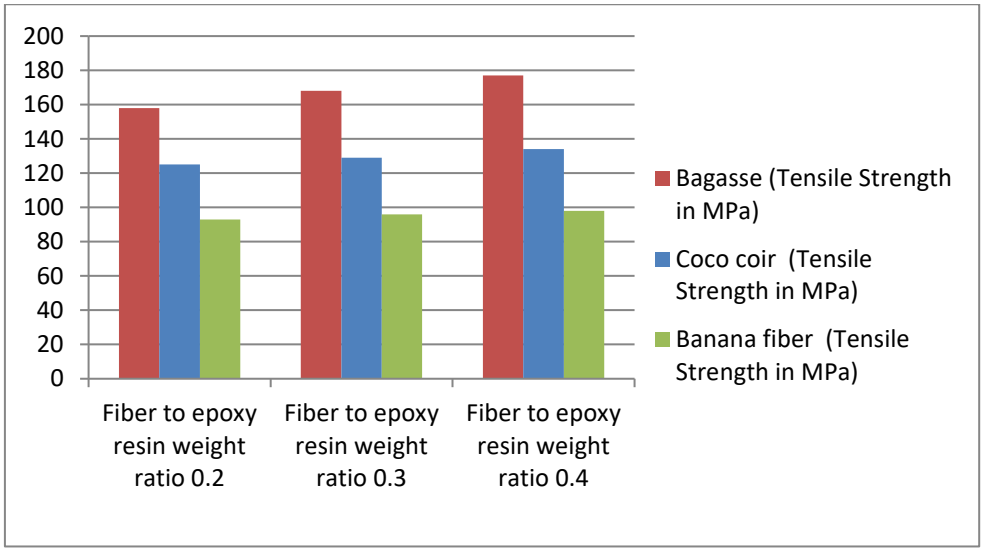

Fig. 3 The graphical representation of Tensile strength of different composite fiber materials.

In the shear strength result of three different composites of fiber ratio of 0.2, 0.3, and Wt. the ratio of fiber to resin has been plotted in Fig.4. In this test the Coco coir gave the highest value than the other two composite fibers, whereas the Bagasse composite fiber gave the medium value and Banana composite fiber gave the lowest value among the others. The plot clearly describes that the higher weight ratio of fiber results in higher shear strength of the composite. The density of Composite made of Bagasse, Coco coir, and Banana fiber are measured as o.398gm/cm^3, o.373gm/cm^3, and 0.352ge/cm^3 respectively when fiber to resin ratio is maintained as 0.4 in all three composites.

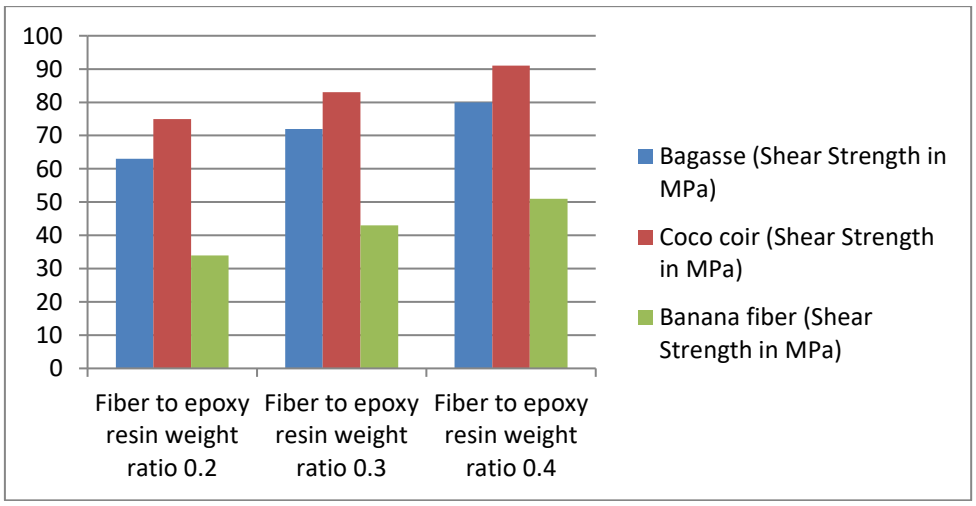

Fig. 4 The graphical representation of the Shear strength of different composite fiber materials.

When the compressive test was performed on three different composites of fiber ratio of 0.2, 0.3, and Wt. the ratio of fiber to resin no such difference had shown in the result like the Brinell hardness test performed, the graph plotted in Fig. 5. The plot clearly describe that the lower weight ratio of fiber result as the higher compressive strength of the composite.

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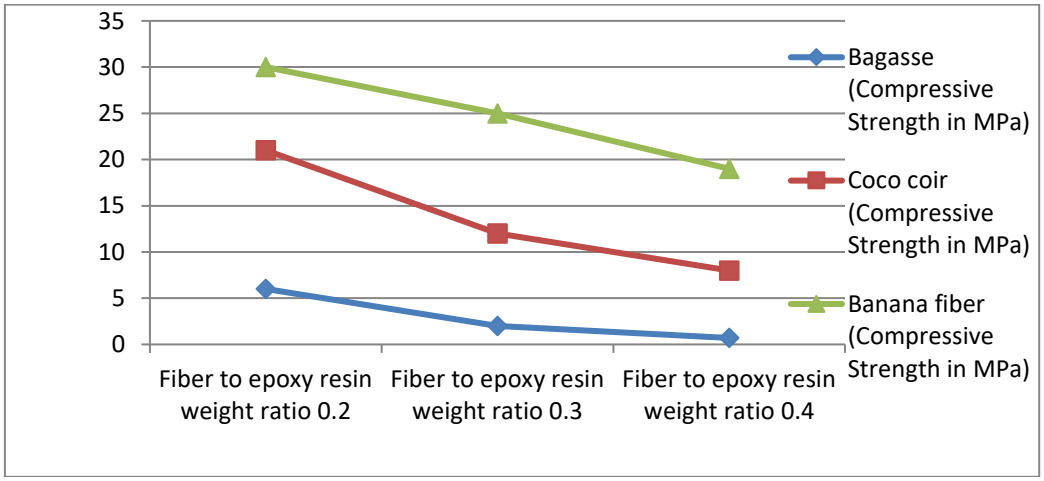

Fig. 5 The graphical representation of the Compressive strength of different composite fiber materials.

TABLE 1: EXPERIMENTAL DATA

Name of Composite Fiber	Fiber to epoxy resin weight ratio	Gauge length (mm)	Gauge Dia. (mm)	Tensile Strength (MPa)	Compressive Strength (MPa)	Shear Strength (MPa)	BHN Number
Bagasse	0.2	30	12	158	6	63	48
	0.3	30	12	168	2	72	39
	0.4	30	12	177	0.7	80	27
Coco coir	0.2	30	12	125	21	75	60
	0.3	30	12	129	12	83	45
	0.4	30	12	134	8	91	33
Banana fiber	0.2	30	12	93	30	34	71
	0.3	30	12	96	25	43	51
	0.4	30	12	98	19	51	42

IV. CONCLUSION

It has been observed that as the fiber weight ratio increases the tensile strength increases for every natural composite which are used in this case. The Bagasse has the highest tensile strength than Coco coir and Banana composite fibers. The result shows that Bagasse composite fiber has 32% more tensile strength than Coco coir composite fiber; and 80% more tensile strength than Banana fiber.

It has observed that as the fiber weight ratio increases the compressive stress is decreases for every composite which are used in this case. The results show that Banana composite fiber has the highest compressive strength among the other composite fibers. The shear stress shows that the Coco coir has the highest shear strength than other composite fibers.

It has 15% more shear strength than Bagasse composite fiber and 93% more shear strength than Banana composite fiber. The results show that the hardness is similar to the compressive strength i.e. the Banana composite fiber is harder than the other two composite fibers. The strength properties of natural composite depend on the individual fiber strength.

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