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Effect on Compressive and Flexural Properties of Cow Dung/Glass Fiber Reinforced Polyester Hybrid Composites

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ABSTRACT
In this paper the Effect of Compressive and flexural properties of cow dung/glass fiber reinforced polyester hybrid composites were studied. In order to make pollution freely is very important to prepare eco-friendly composites. Two different hybrid composites such as treated and untreated cow dung fibers were fabricated and effect of alkali treatment of the cow dung fibers on these properties were also studied. It was observed that Compressive and flexural properties of the hybrid composites increase with increase of cow dung percentage of weight. These properties found to be higher when alkali treated cow dung fibers were used in the hybrid composites. The elimination of amorphous hemi-cellulose with alkali treatment leading to higher crystalline of the cow dung fibers with alkali treatment might responsible for these observations. The effect of alkali treatment on the bonding between glass / cow dung composites was also studied. Scanning electron microscope (SEM) were also conducted on the cross sections of fractured surfaces in order to rate the performance hybrid composites were also identified.

Keywords: *cow dung, Glass fiber, Hybrid composites, Compressive, flexural strength*

1. INTRODUCTION

Natural fibers exhibit many advantageous properties as reinforcement for composites. They are low-density materials, yielding relatively light weight composite with high specific properties. Natural fibers also offer significant cost advantages and benefits associated with processing, as compared to synthetic fibers such as glass, nylon, carbon, etc. However, mechanical properties of natural fiber composites are much lower than those of synthetic fiber composites. Another disadvantage of natural fiber composites which makes them less attractive is the poor resistance to moisture absorption. Hence use of natural fiber alone in polymer matrix is inadequate in satisfactorily tackling all the technical needs of a fiber reinforced composite. In an effort to develop a superior, but economical composite, a natural fiber can be combined with a synthetic fiber in the same matrix material so as to take the best advantage of the properties of both the fibers. This result in a hybrid composite evaluated the enhancement in the properties of coir-polyester composites by incorporating glass as intimate mix with coir.

Mohan and Kishore reported that jute provided a reasonable core material in jute-glass hybrid laminates. They evaluated flexural properties and compressive properties of the jute-glass reinforced epoxy laminates fabricated by filament winding technique using flat mandrel. Four different hybrid combinations were studied with different glass fiber volume fractionsand the results were compared with jute reinforced plastic. They found substantial increase in flexural and compressive properties with hybridization. The work of fracture determined by impact testing on sisal-glass hybrid composites with two arrangements, one with sisal shell and glass core and the other with glass shell and sisal core. They showed that the sisal shell laminate had the higher work of fracture compared with glass shell hybrid laminates of equivalent volume fraction of sisal and glass fibers. Studied the effect of glass fiber addition on tensile and flexural strength and izode impact strength of pine apple leaf fiber (PALF) and sisal fiber reinforced polyester composites. The unsaturated polyester based sisal glass composites were studied with 5% and 8% volume fraction and found a considerable enhancement in impact, compression, flexural and tensile properties [1-15].

Mathur synthesized with unsaturated polyester/epoxy resin the sisal, jute and coir fiber reinforced composites [16]. Some authors were discussed on extraction and process the newly identified elephant grass fiber, vakka fibers by manual and chemical methods. The result shows that the percentage of moisture absorption was higher in vakka fiber than the date and bamboo

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fiber [17-18]. Obi Reddy et al. prepared the composites by using the leaf sheath of the coconut tree and studied its significance with and without chemical treatment process [19]. The mechanical properties of the composites were strongly depends on the fiber volume fraction. The strength of the banana fiber reinforced composites with the help of soy protein resin [20]. By using Random orientation technique prepared natural fiber reinforced composites. The significance of the natural fiber composites by making it as a housing panel [21]. The different interior and exterior components of the automobiles can be replaced with the help of natural fiber reinforced composites [22]. Some other observed change in mechanical properties of kenaf natural fibers [23]. The structural stability and adhesion properties observed in the reinforced composite were improved by adopting the various chemical treatment processes [24]. The tensile strength of the various banana plant fibers and compared the results with and without chemical treatment processes [25].

Kline's study [27] reported an annual growth rate for natural fiber composites about 60% over the years 2000-2005. The major part of this growth was observed in building applications [26], where the wood fiber composites present a wide applicability. The automotive industry is also including some components in natural fibers reinforced thermoplastics as a way to serve the environment along with weight and cost savings. Applications of natural fibers in automotive applications have been limited to interior components and truck cabins [26,28] to replace the components previously made with glass fiber composites [29,30]. The hemp fibers were the world's largest agricultural crop in the early 19th century, but the interest in this material has declined with advances in the field of the synthetic fibers. Actually, the interest is returning due to the global environmental issues. These fibers have a strong applicability, for example, in the automotive industry in components like interior door trim panels, engine shields, gaskets, seat parts, etc. Bledzki et al. [31] presents the typical chemical composition and structure of hemp fibers. According to Van de Velde and Kiekens [32] the fiber properties are influenced by many factors such as: cultivation (variety, climate, harvest, maturity, retting degree), processing (decortications, disintegration) and fiber modification (textile and technical processes).

2. EXPERIMENTAL

2.1. Materials

Cow dung obtained from local sources and some of these fibers were soaked in 5% NaOH solution for 30 min. To remove any fatty material and hemi cellulose, washed thoroughly in distilled water and dried under the sun for one day. The glass chopped stand mat was used in making the hybrid composite percentage. The unsaturated polyester resin obtained from Sree Composites World.ltd, Secunderabad, A.P, India, Methyl Ethyl Ketone Peroxide as accelerator and Cobalt Naphthenate as catalyst, which are obtained from M/S Bakelite Hylam Hyderabad, A.P, India, were used.

2.2. Preparation of the Composite and test specimen

In this present work the composites were prepared by hand lay-up technique. The matrix of unsaturated polyester and monomer of styrene are mixed in the ratio of 100:25 parts by weight respectively. Later cow dung in powder form is mixed thoroughly and then the accelerator of methyl ethyl ketone peroxide 1% by weight and catalyst of cobalt naphthenate of 1% by weight were added to the mixture and mixed thoroughly. The releasing agent of silicon is sprayed to glass mould and the matrix mixture is poured in to the mould. The fiber is added to matrix mixture, which was poured in the glass mould. The excess resign was removed from the mould and glass plate was placed on the top the casting were allowed to cure for 24hrs at room temperature and then casting is placed at a temperature of 70^{o}C for 3 hrs. The composite were released from mould and are cut to prepare test specimens. The Instron Universal Testing Machine (UTM) (supplied by Instron Corporation, Series 9, automated testing machine) is used. The test specimens for compressive and flexural tests were cut as per American standard testing method (ASTM) D256 specifications. Six samples were tested in each case and average value is tabulated. For scanning electron microscope analysis the cryogenically cooled and fractured specimen surfaces were gold coated and the fractures surface was observed using scanning electron microscope.

2.3 Scanning Electron Microscopy Analysis:

A Joel JSM-6400 Japan scanning electron microscope (SEM) at 20 kV accelerating voltage equipped with energy dispersive spectroscopy (EDS) to identify the fractured surfaces were gold coated with a thin film to increase the conductance for SEM for analysis.

3. RESULTS AND DISCUSSIONS

3.1 Flexural and Compressive strength test

The flexural strength and compressive strength of cow dung fiber reinforced with polyester at constant glass fiber (untreated and treated short fiber) composites as a function of fiber content is presented in Fig 1 and 2, respectively. As can be seen in Fig. 1 and Fig.2, the flexural strength and compressive strength is increased with increased fiber content, in both untreated and treated fiber it would be seen there is high strength in treated composites over compare with untreated composites. The reason is in alkali treated fiber the hemicelluloses content is removed from it and this gives necessary strength. The reason for this may again be attributed to the increase of a population of fiber content and improvement seen in their interfacial bonding. As supported by the SEM micrograph (see Fig. 3 & 4). It is evident that flexural strength and compressive strength of the treated fiber composites was higher than that of the untreated fiber composites because of that treated fibers were well bonded with polyester.

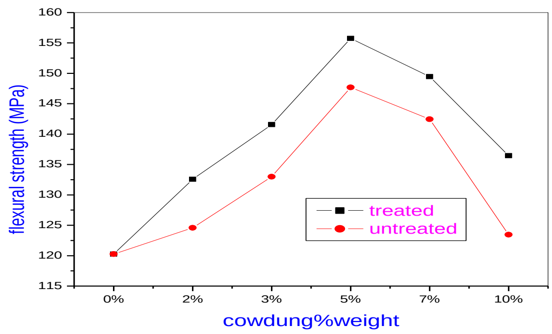

Figure 1: flexural strength of Untreated and Treated Cow dung % weight

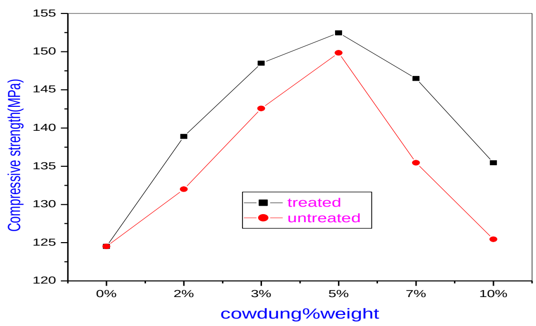

Figure 2: Compressive strength of Untreated and Treated Cow dung % weight.

Fig .1 & Fig.2 shows the variations in the flexural strength and compressive strength values over% increase in volume fractions. It is observed that the flexural strength values are gradually increased up to 5% Vf. Beyond 5% Vf of fiber in composite, the flexural strength is suddenly decreased. Then the increasing trend suddenly changes and the flexural strength gets drastically reduced when Vf of fiber in composite is 7%. During the composite preparation, if the fiber content is more than 5% Vf, it leads to excess of its fiber and less interact with matrix. 5% Vf composite have the maximum flexural strength of 147.68 MPa and 155.75 MPa for untreated and treated composite. The similar effect seen in Compressive strength also. It has significant change of 5% when the fiber content is varied. The maximum Compressive strength 5% Vf composite have 149.85 MPa and 152.45 MPa seen in untreated and treated composite. In this both flexural and compressive strength there is maximum strength is obtained due to the adding a constant glass fiber content, it is shown from Table 1 and Table 2.

3.2. Morphology Test on Cross Sections of Fractured Surfaces

To probe the bonding between the reinforcement and matrix, the scanning electron micrograms of fractured surfaces of glass/cow dung reinforced polyester hybrid composites were recorded. These micrograms were recorded at different magnifications and regions. The analysis of the micrograms of the composites prepared under different conditions is presented in the following paragraphs.

3.3.1 Untreated cow dung fiber

SEM micrograph analysis of fractured specimen Fig. 3 shows that the SEM micrograph of flexural fractured 5% Vf specimen. Due to the flexural load, the interphase delamination is found at the cross section of the composite. Due to the uniform compressive force applied during the manufacturing of the composite specimen, presence of voids in the specimen is found to be very minimal. Fiber pull-out is very much evident in the micrograph, as the bonding between the fiber and the matrix is very weak. Due to the fiber pull-out at the interphase, holes are created because of the poor interfacial wetting. More pull-out is observed in the compression region.

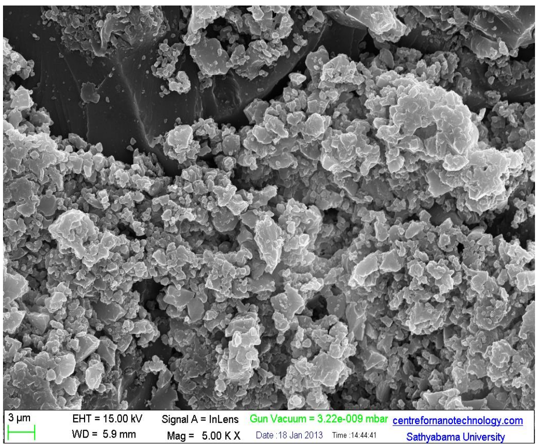

Figure 3: SEM micrograph of fractured surface of untreated cow dung polyester composite

3.3.2. Treated cow dung fiber

The micrograms of alkali treated cow dung fiber composites are presented in Fig 4. From these micrograms it is clearly evident that the surface of

Table 1: flexural strength of Untreated and Treated Cow dung % weight.

SNo	composite	Flexural strength(MPa) Cow dung % by weight of resin					
		0%	2%	3%	5%	7%	10%
1	**Untreated**	120.25	124.58	133	147.68	142.44	123.45
2	**Treated**	120.25	132.58	141.56	155.75	149.45	136.45

Table 2: Compressive strength of Untreated and Treated Cow dung % weight.

S.No	composite	Compressive strength(MPa) Cow dung % by weight of resin					
		0%	2%	3%	5%	7%	10%
1	**Untreated**	124.5	132	142.56	149.85	135.46	125.45
2	**Treated**	124.5	138.89	148.48	152.45	146.48	135.45

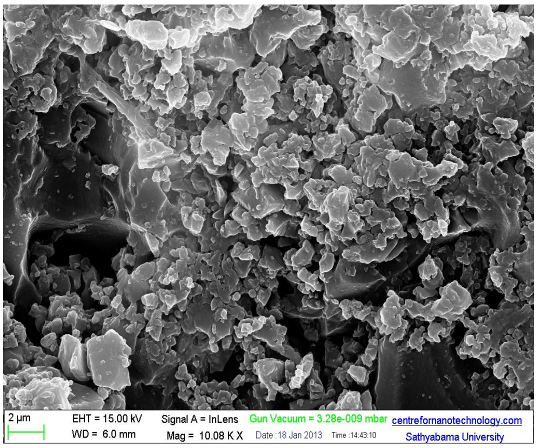

Figure 4: SEM micrograph of fractured surface of alkali treated cow dung polyester composite.

the fibers becomes rough on alkali treatment. The elimination of hemi-cellulose from the surface of the cow dung fiber may be responsible for the roughening of the surface. Here, however the bonding is improved, fiber pullout is reduced. Thus the alkali treatment improved the bonding.

4. CONCLUSIONS

In this present study it shows the clear evidence that cow dung is an alternative material can use instead of conventional materials because of good mechanical properties and available flexibly. The following conclusions are made based on the experimental study

1. Flexural and Compressive strengths are higher at 5% Vf of cow dung at constant glass fiber this supports to enhance the other properties of materials.
2. Beyond the 5% Vf it is seen gradual decrease in flexural and compressive strength in both treated and untreated composites.
3. When observed SEM Micrograph of fractured specimen of untreated composite a week interfacial bonding between fiber and matrix and also presence voids in it.
4. Due alkali treatment the hemi cellulose content is removed from the Cow dung and gives necessary strength to the composite material.
5. This is a evident of wile manufacturing of composite the volume fraction of material was plays a vital role. Cow dung is available flexibly in local resources and have good application in all areas.
6.

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