FABRICATION AND TESTING OF MECHANICAL PROPERTIES OF BAGASSE NATURAL FIBER COMPOSITE

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Abstract

Fiber reinforced polymer composites have received widespread attention in the past four decades because of their high specific strength and modulus. In recent years, a significant amount of interest has been shown in the potential of natural fibres to replace glass fibre in composites. This is the alternative way which is more economical and can be very cost effective than using synthetic fibres. Although these fibres may not be as strong as carbon and aramid, their main advantages are low cost and biodegradability. The present research work has been carried out to make use of Bagasse natural fibres. The aim of this work is to describe the development and characterization of new set of hybrid natural fibre composites. Hybrid composites were prepared using bagasse fibres of pure epoxy compared with 1wt%, 2wt%, 3wt%, and 4wt% weight fraction ratios. Tensile testing at room temperature revealed that 3wt% of bagasse yielded maximum strength of 25.5 MPa other than 0 wt.% of bagasse. Hardness at room temperature revealed that 4wt% of bagasse composite shows maximum 67 HRB compared to other compositions. The reason may be the natural fibre distributed and dispersed uniformly across the epoxy.

Keywords: polymer composite, bagasse fibre, magnetic stirring, tensile strength and hardness

1. Introduction

Bagasse is the fibrous residue which remains after sugarcane stalks are crushed to extract their juice. It is mainly used as a burning raw material in the sugar mill furnaces. The low caloric power of bagasse makes this a low efficiency process. Also, the sugarcane mill management encounters problems regarding regulations of clean air from the Environmental Protection Agency, due to the quality of the smoke released in the atmosphere. Presently 85% of bagasse production is burnt. Even so, there is an excess of bagasse. Usually this excess is deposited on empty fields altering the landscape. Approximately 9% of bagasse is used in alcohol (ethanol) production. Ethanol is not just a good replacement for the fossil fuels, but it is also an environmental friendly fuel.

Y. Cao [1] studied the mechanical properties of bagasse fibre composite with and without alkali treatments. He used the biodegradable aliphatic polyester (Randy CP-300) as matrix and Noah is used as alkali for the treatment of his fibre composite. His conclusions were that both the tensile and impact strength of the untreated bagasse fibre composites increased with increase in fibre content to an optimum fibre content of 65% only. The NaOH (1%) treated fibre composites showed maximum improvement in tensile, flexural and impact strengths, compared with the Na OH (3, 5%) treated fibre composites. SEM micrographs of the fracture surface indicated that the fibres after the alkali treatment became finer due to the dissolution of the hemicellulose and increased aspect ratio, which resulted in a better fibre–matrix adhesion. After 1% Noah treatment an average improvement of 13% in tensile strength, 14% in flexural strength and 30% in impact strength, respectively, were observed.

PankajTripathi, Beira, Dharmendrakumar, Bhavneshkumar [2] studied on the mechanical behavior of sugarcane bagasse fibre reinforced polymer matrix composites . In their journal they took bagasse in volume fractions and specimens are specimens and graphs are drawn to identify the optimum composition of bagasse. (i) Tensile strength found to be maximum with 60MPa when 20% volume percentage of bagasse is added . (ii)Flexural strength is found maximum with 60MPa with 20% bagasse concentration. (iii)Rockwell macro hardness is found to be maximum with 100HRL with 30% bagasse concentration. The conclusion was that the optimum for select performance for tensile, flexural and macro hardness testing at 20% of fibre content. Maneesh Tewari, V. K. Singh, P. C. Gape and Arum K. Chaudhary worked on the Evaluation of Mechanical Properties of Bagasse-Glass Fibre Reinforced Composite [3]. P Siva raj, G Rajesh Kumar predicted the Mechanical Properties of Hybrid Fibber Reinforced Polymer Composites [4]. In their investigation the coir and bagasse fibres were taken to reinforce with the polyester resin. After the fibres were collected, the coir was allowed to undergo with the chemical treatment by using the 6-8% of Noah with the distilled water. This treatment was used to remove the lignin content in the fibre. The lignin content may affect the Young's modulus of the fibre. So, the fibre was treated by using the Noah. To prepare the composite, polyester resin was used as matrix material. The chopped coir and bagasse fibres hybrid composite sheets were manufactured by simple hand lay-up process in a mould. The mould was prepared to fabricate the test specimen. The dimensions of the mould were 300mmx200mmx3mm. Nine hybrid composites with different combinations of coir fibre content (10, 20 and 30 wt. %) and bagasse fibre content (10, 20 and 30 wt. %) were designed and produced. After the curing process, test samples were cut according to the sizes of ASTM standards. Daniella R. Molinari [5] prepared bagasse cellulose composite in which Sugarcane bagasse cellulose and sugarcane bagasse cellulose modified with zirconium oxchloride were mixed with the polymeric matrix (HDPE) in a thermo kinetic mixer, model MH-50H, with speed rate maintained at 5250 rpm, in which fibres were responsible for 5 wt.% in the composition. After the mixture, composites were dried and ground in mill, model RONE. The mechanical strength of sugarcane bagasse cellulose modified and non-modified reinforced HDPE composites was determined using an INSTRON universal-testing machine (model 8801). Tests were carried out according to ASTM standards D638 with 10 mm min1 crosshead speed. Tensile strength and modulus values are average results of five tested specimens. Fibres insertion can contribute to the modulus increase, because the Young's modulus of the fibres is higher than the thermoplastic modulus. However, to obtain a significant increase, a good interfacial bond between fibre and matrix is necessary. The tensile strength exhibited a good interaction between fibre and matrix, with increases of 24.1% and 31.8%, respectively, in relation to the high density polyethylene

2. Experimental Details

2.1 Materials

For fabricating the pure epoxy composite, AralditeAW106 type epoxy resin with HV 953 IN as hardener were used which are supplied from local industry in Vishakhapatnam, Andhra Pradesh. The sugar cane bagasse is a residue widely generated in high proportions in the agro-industry. It is a fibrous residue of cane stalks left over after the crushing and extraction of juice from the sugar cane. Bagasse is generally grey-yellow to pale green in color. It is bulky and quite non uniform in particle size. The sugar cane residue bagasse is an underutilized, renewable agricultural material that consists of two distinct cellular constituents. The first is a thick walled, relatively long, fibrous fraction derived from the rind and fibro-vascular bundles dispersed throughout the interior of the stalk.

2.2 Fabrication of Samples

2.2.1 Fabrication of Plain Epoxy Sample

The test specimens in this study were prepared by using GI sheets. These sheets prepared as rectangular shape with 5 mm thickness. Measured required amount of epoxy and add 10% of hardener in epoxy for curing purpose. Now blend of epoxy and hardener poured into rectangular sheet mould curing at room temperature for 24 hrs. After 24 hrs the blend gets solidified. Cut the composite by hacksaw as per ASTM D638 standards.

2.2.2 Fabrication of Bagasse Incorporated Neat composite

Bagasse fibres are purchased from Bhimasinghi Sugarcane Factory, Vizianagaram. The fibres are cleaned with water and then dried. Then the segregations are gently dispersed with hand sitting. After drying at the room temperature, fibres were sieved several times further separate the fibres in to individual state. Fibres are measured for proper weight and length. The required weight proportion of bagasse is taken i.e., 1 wt%, 2wt%, 3wt%, and 4 wt.%. Usually in the received condition from industry, the bagasse present in agglomerated form to reduce their surface energy. Thus to deagglomerated the existing bagasse agglomerate, required amount of bagasse was dispersed in 150 ml acetone which was magnetically stirred at 1000 rpm for 30mins. Acid treatment is done to bagasse to increase the strength of fibre. 100gm of epoxy (AW106) is taken in a conical flask and made to heat and stirred at 70°C & 500rpm for 10 minutes on Hot plate magnetic stirrer. The collective weight of conical flask, epoxy, fibre and magnetic bead is noted. Acetone-fibre mixture is poured in conical flask containing epoxy and it is stirred on an electromagnetic stirrer at 70°C &1000rpm until acetone gets evaporated. For this, weight is calculated at frequent intervals. Once the Acetone get evaporated, 80gm of hardener (HV 953 IN) [6] is added and stirred. Stirring should not exceed the duration of two minute as it is a room temperature hardener. The final mixture of epoxy, hardener and fibre is poured in to the mould. Once the mixture was solidified the samples were cut by hacksaw blade. The ASTM standards for tensile testing are followed by surface finish. The schematic of whole procedure is shown in fig1.

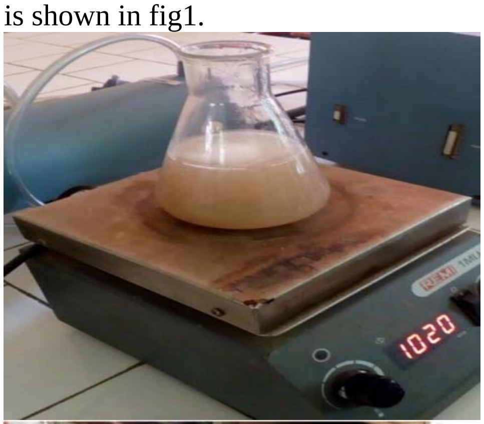

Fig1: Fabrication procedure of bagasse embedded epoxy composite

Fig2: Sample for tensile testing

2.3 **Material characterization**

For getting information on the tensile properties of the materials Tensile Test (as per ASTM D638) was performed. The tensile properties of epoxy with various bagasse content were evaluated by using universal testing machine (UTM). These properties were measured at room temperature. The hardness properties of the neat epoxy with various Bagasse loading were also evaluated using Rockwell hardness Apparatus.

3. Results and Discussion

3.1 Tensile Test

The tensile strength of a material is the maximum amount of tensile stress that it can take before failure. The commonly used specimen for tensile test is the dog-bone type. During the test a uniaxial load is applied through both the ends of the specimen. The dimension of specimen is (165x19x3) mm. The tensile test is performed by universal testing machine (UTM).and results were analyzed to calculate the Tensile Strength of composite samples. Tensile test on UTM machine in sample loaded condition is shown in the following Figure 3.

Fig3: Specimen loaded for testing on UTM

Figure 4 represents stress verses strain relationship for all bagasse compositions .From Figure 4 (b) it is clear that 3w t % of fibre will get max tensile strength 25.5 MPa. The tensile strength increases with increase in concentration of fibre upto certain limit, later it decreases. The optimum level of tensile strength is obtained due to proper distribution and dispersion of fibre in the matrix. With the increase in fibre content result in rapid decrement in tensile strength because of agglomeration effect. This agglomeration causes the stress riser inside the composite chance to failure easily

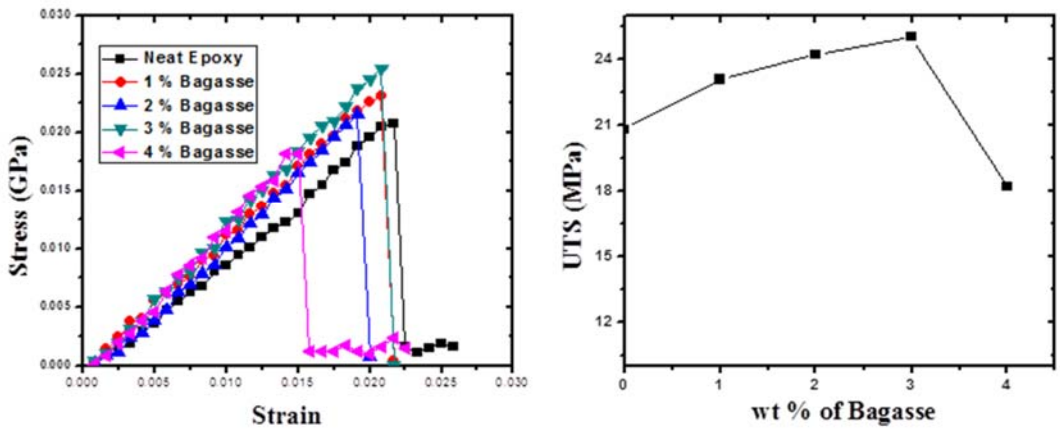

Fig 4: Stress vs. strain diagram for different bagasse composition composite and variation of Ultimate tensile strength for various composition of Bagasse.

3.2 Hardness Test:

Rockwell hardness apparatus is used to measure the hardness shows figure 5. Type of indenter and the test load determine the hardness scale (A, B, C, etc.) is used to measure hardness. The value of hardness can directly measure by indenter scale attached to the machine.

Fig 5: Hardness test on Rockwell Hardness Apparatus

Figure 6 represents that hardness verses w t % of bagasse. From that graph with increase concentration of fibre content hardness of the composite increases. The maximum hardness obtained at 4 wt% of bagasse. But increase hardness rate between 2 &3 grams the value is higher when compared to other compositions. The reason could be fibre uniformly distributed and dispersed in epoxy so the shows maximum rate of hardness at 3wt % of bagasse added to epoxy. .

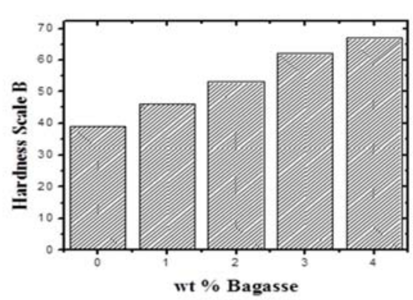

Fig 6: Hardness vs. wt% of bagasse

Conclusion

Evaluation of mechanical properties on tensile and hardness performance of neat epoxy and Bagasse Epoxy composite was carried out for various compositions of Bagasse. Present study suggest that concentration of bagasse has a strong impact on the mechanical behavior of conventional composites as well as bagasse embedded composites. In their Fabricated condition 3 wt.% bagasse epoxy composite showed the highest tensile strength among all other composites. Further dropped down to 18.2% when increased to 4wt.% of bagasse embedded into epoxy. This rapid decrement is due to localized bagasse caused internal stress at the bagasse epoxy interface. In fabricated condition 4wt.% of bagasse epoxy composite showed the maximum hardness value compared to other compositions. But from the figure 6 it is observed that the rate of hardness highest in case of 3wt.% of bagasse embedded to epoxy.

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