EXPERIMENTAL INVESTIGATION OF PROSOPIS JULIFLORA AND MANGO TREE
WITH EPOXY RESIN

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Abstract: Research on the development of composites has been going on long. But growing concerns about global warming, waste generation & management, increasing environmental awareness, increasing pressure on fossil fuel resources have led to the development of green composites. Even, there are some natural fibers where the properties can be good compared to the synthetic fibers which have contributed to this development. The work aims to develop a polymer composite with Prosopis juliflora and mango tree as reinforcements of a natural composite epoxy resin matrix. Composite plates were produced using a compression mold method with a composition ratio of 60:40, 65:35 and 70:30. The resin and hardener proportions were 10:1 respectively. The manufactured composites were tested following ASTM standards to assess mechanical characteristics such as tensile strength, compressive strength, flexural strength, impact strength, hardness value, and water absorption test.

Keywords: Prosopis juliflora, mango tree, natural fibers, fossil fuel, mechanical characteristics.

1. Introduction

A composite is an aggregate of materials, considered one of that is called the reinforcement stage, that's known as the strands, sheets, or debris, and is inserted into one of a kind materials known as the community level. Strengthening fabric and grid fabric may be metallic, clay, or polymer. Composites have a fibrous or molecular phase that is stiffer and more grounded than a coherent lattice section and fills because of the primary burden of transporting human beings. The network is going about as a heap pass medium between the filaments, and in less ideal situations in which the heaps are puzzling, the framework may additionally even want to endure masses transverse to the fiber pivot. The network is greater bendy than the strands and is therefore a source of composite energy. Also, the grid serves to defend the filaments from environmental harm previous to, in the course of and after composite processing. At the right time whilst scheduled, the sparkling attached cloth indicates the desired cost of normal materials. Composites are used for their auxiliary traits, however also for electrical, warm, tribological, and
ecological packages. Composites are multifunctional cloth frames that offer characteristics that are not possible from any discreet material. They are long-lasting systems produced by the physical integration of at least remarkable components, unique in layout and satisfactory, and occasionally in composition. Composites should not be regarded as essential as a combination of two materials. In an extra large centrality, the blend has its own unique houses. As some distance as the unity of safety from warmth or a few different appealing first-class is involved, it's far superior to both of the components by myself or no longer to the identical volume as both. Composites are compounds that differ from combinations in that the male or female additives nevertheless retain their traits and are so mixed into composites that they make the best use of their traits and not their inadequacies, he said, as a way of achieving advanced substances. Composite materials as heterogeneous substances, which include at the least powerful levels, that are in close touch with every other on a tiny scale. They also can be considered as homogeneous materials on a small scale, as any part of them may have the same bodily properties. Current work is directed in the direction of the manufacture of Prosopis juliflora and mango tree hybrid composites the use of an epoxy matrix. The versions in mechanical homes (Compression, Flexural, hardness, impact, and water absorption) are studied[6].

The study of mechanical properties of Kenaf and Fiberglass Hybrid Composite laminates by Hand layup method was investigated by Z. Salleh, et al. [16]. Short, Long fiber and powder fiber are used. Variation of the tensile strength of distinct kinds of fibers has been researched. Test findings show that the highest tensile strength and tensile modulus are found for long hybrid fiber composites. From the SEM assessment, the surface failure is due to the fracture of the matrix, the removal of the fiber, the debonding of the matrix, and the fracture of the fiber.

MohdSuhairilMeon, et al. [17] used high-density Polyethylene (PE) and polypropylene (PP) separately to prepare two sets of short kenaf composite. The kenaf fibers were treated with 3%, 6% & 9% of NaOH for a day and then dried for 24 hours at 80o C. The tensile properties of treated kenaf were improved when compared with the untreated kenaf fibers. Further coupling agents like MAPP, MAPE have amplified the tensile properties of both treated and untreated cases.

S Sivasaravanan, et al. [18] made an investigation on glass fiber/epoxy/nano clay composite by varying Nano clay from 1 to 5 wt% by hand layup process. E- Glass fiber is of bi-directional: 45o orientation is used. The average value of 5% wt of nano clay showed good impact results when compared to the other combinations used.

A. Atiqah, et al. [19] developed kenaf -glass reinforced unsaturated polyester hybrid composite. Kenaf and glass fibers are used in mat form. The kenaf fiber was treated with 6% NaOH using the Mercerization method for 3 hours. The test results showed that high tensile, flexural and impact strength were obtained using treated kenaf with 15/15 v/v kenaf/glass fibers. The adhesion between the matrix and surface of fiber was enhanced, which plays a key role in improving the mechanical properties of KG- UPE hybrid composites. The development of hybrid composite using jute and E- glass mats reinforced with epoxy (LY-556) resin and HY951 hardener is carried out by M. R. Sanjay, et al. [20]. Laminates were prepared by varying both mat layers. The test results show that hybrid composite has better mechanical properties and leads to an increase in the utilization of natural fibers in various applications.

2. Experimental

2.1 Material
The raw materials involved in the production were epoxy tar LY 556, Prosopis juliflora, and mango tree, Hardener HY 951. The Prosopis juliflora and the mango tree are arranged haphazardly in polymer lattice. Tests are to be organized with the soluble base of treated strands. Prosopis juliflora and mango tree were salt-treated in 1% NaOH response for 30 min expel any oily material and hemicellulose and then dried in daylight. The second fiber was used to make Prosopis juliflora and mango tree epoxy composites.

2.2 Material Preparation and Fabrication process

The shape is produced of wood in the measurements set out in the ASTM Standards for Preparathion Specimens. The OHP sheet is mounted and the discharging specialist is linked over it and equipped with the inside of the form, allowing it to dry. A glass container and a glass pole or stirrer shall be removed and well washed with running water and then with hot water. From that point on, the determined amount of epoxy tar and the deliberate amount of hardener (proportion 10:1) are added to the breaker and the mixture is mixed for almost 25 min. The reason for this mixing is to create a homogeneous mix. At that point, the determined amount of filaments (proportion 1:1) is included after the blending has been completed and the mixing procedure has proceeded for the following 45 min. At that stage, the mixture filled in the shape and softly pushed into a uniform settlement.

Fig.1. Fabricated plate

3. Characterizations of Composite Materials

3.1 Determination of Water Absorption Behavior of Composite

Water ingestion of Prosopis juliflora and mango tree fortified polymer composite was investigated by inundation in refined water at room temperature for 12, 24, 48, 72 hours. The sample instance size (5 mm X 5 mm) is set according to ASTMD-570 for the water retention test. The edges of the instance were attached to the polyester rubber. Tests were dried at 50oC for 24 hours. After 24 hours of testing, it was exactly weighed. Fixed examples were then immersed in refined water at room temperature for 12, 24, 48, 72 hours. Tests were expelled from the water after a lawful time and washed with tissue paper to remove surface water. Ingestion of clamminess in the composite was evaluated by the incidental inspection of the fabric between moments[ 13-14]. The volume of increase in the mass of the manual to the fundamental mass is indicated by the rate of clamminess ingestion.

The weight gain of the sample was measured as an increase in weight % using the formula.

$$\text{Increase in weight } \% = \left(\frac{\text{wet weight} - \text{sample weight}}{\text{sample weigh}}\right) \times 100$$
3.2 Tensile and compressive test

The ductile experiments were conducted by the ASTM D 3039 standard of the Mechanized Universal Testing Machine. The stacking course of action for the instance and the picture of the device used were shown in the figure. Examples with length measurements of 300 mm and a width of 25 mm have been used. The experiment was carried out at a crosshead velocity of 5 mm/min using a load cell of 10 kg. For each situation, 3 examples were used and the normal quality was taken into account. The compressive quality is usually obtained through the use of UTM compressive test techniques.

3.3 Flexural and Impact Test

The flexural quality of the composites was determined by the three-point twisting technique. It tends to be finished in the adapted UTM machine as per ASTM D790. The stacking course of action for the instance and the picture of the device used were shown in the figure. All the composite examples were of a rectangular shape with a length of 80 mm x 15 mm x 5 mm. Trials were conducted at a crosshead velocity of 0.5 mm / min. At that stage, the flexural quality was determined to use a straight forward minute outline of the fundamentally bolstered bar at the primary problem load. Effect quality was determined by the Izod Effect Test using examples of measurements.

4. Result and Discussion

4.1 Water Absorption behavior of Composite

Water absorption is one of the main issues in the use of natural fiber composites in many applications. Water absorption in hybrid composites rises at a pace of 1 %-5.5 % in 24 hours, maximum and minimum water uptake after 10 hours.

4.2 Impact strength

The variety of effect quality with the fiber content, if there should be an occurrence of Prosopis juliflora composite is displayed in the figure. For this situation, the Prosopis juliflora and mango tree composites displayed better sway properties. The effect quality increments with the expanding volume part of filaments, arriving at a most extreme incentive at 30%. Past 30%, the effect quality demonstrates a diminishing pattern. The most extreme effect quality of the composites fluctuates between 0.8 Joules to 2.3 Joules. Antacid treated Prosopis juliflora and mango tree indicated improved effect quality.

4.3 Compressive strength

The variety of compressive quality with the fiber content on the antacid treated composites has appeared in the figure. The Prosopis juliflora and mango tree composite material were tried and the compressive quality was determined. Three examples were tried, the normal compressive quality was accounted for. The compressive quality was expanding relentlessly up to 30% and past that, the change was negligible. The compressive quality of the Prosopis juliflora and mango tree from 19.77 MPa to 35.63 MPa.
Fiber substance and fiber quality are affecting parameters for the quality-related properties of the composite. Subsequently, the quality variety of fiber stacking demonstrated in an unexpected way. This variety in the ductile and flexural quality of the composites with 55%, 65%, and 75% of fiber substance has appeared in figures 9 and 10 separately. These figures obviously show rigidity and flexural quality for half and 60% fiber content. Anyway, there is a decline in both the pliable and flexural quality of the composite with 70% fiber content.
5. Conclusion

This whole project explains the mechanical property of the composite material (tensile test, compression, flexural test, impact test) while it can be both Prosopis Juliflora and mango trees. From the results of mechanical characteristics, 65:35 of composition shows a better value in the tensile test, compressive, flexural test and impact test. Parallel the test values are shows nearly to the synthetic fiber composite values from based the literature review. From the result it clearly indicates, synthetic fiber can be replaced by natural fiber.

Reference

[1] Furqan Ahmad, Heung Soap Choi, Myung Kyun Park, A review: natural fiber composites selection in view of mechanical, light weight, and economic properties, Macromol. Mater. Eng. 300 (1) (2015) 10–24.

[2] C.S. Boland, R. De Kleine, G.A. Keoleian, E.C. Lee, H.C. Kim, T.J. Wallington, Lifecycle impacts of natural fiber composites for automotive applications: effects of renewable energy content and light weighting, J. Ind. Ecol. 20 (1) (2016) 179–189.

[3] N. Saba, M. Jawaid, O.Y. Alothman, M.T. Paridah, A. Hassan, Recent advances in epoxy resin, natural fiber-reinforced epoxy composites and their applications, J. Rein. Plast. Compos. 35 (6) (2016) 447–470.

[4] D. Mohana Krishnudu, D. Sreeramulu, P.V. Reddy, Alkali treatment effect: Mechanical, thermal, morphological, and spectroscopy studies on abutilon indicum fiber-reinforced composites, J. Natural Fibers (2019) 1–10.

[5] D.M. Krishnudu, D. Sreeramulu, P.V. Reddy, H.R. Rao, Effect of alkali treatment on mechanical properties of prosopis juliflora hybrid composites, Int. J. Appl. Eng. Res. 13 (5) (2018) 2933–2935.
[6] Elayaraja.R, Saravanan.P, Experimental investigation of E-Glass and Kenaf fibre with epoxy resin, IRJET, Vol 6(11) (2019) 303–306.

[7] D.M. Krishnudu, D. Sreeramulu, P.V. Reddy, Optimization the mechanical properties of coir-luffa cylindrica filled hybrid composites by using Taguchi method, AIP Conference Proceedings vol. 1952 (2018).

[8] P.M. Borba, A. Tedesco, D.M. Lenz, Effect of reinforcement nano particles addition on mechanical properties of SBS/Curauá fiber composites, Mater. Res.17 (2) (2014) 412–419.

[9] N. Saba, M.T. Paridah, K. Abdan, N.A. Ibrahim, Effect of oil palm nano filler on mechanical and morphological properties of kenaf reinforced epoxy composites, Constr. Build. Mater. 123 (2016) 15–26.

[10] A. Shalwan, B.F. Yousif, Influence of date palm fibre and graphite filler on mechanical and wear characteristics of epoxy composites, Mater. Des. 59 (2014) 264–273.

[11] S. Biswas, A. Satapathy, A. Patnaik, Effect of ceramic fillers on mechanical properties of bamboo fiber reinforced epoxy composites: a comparative study, in: Advanced Materials Research, Trans Tech Publications, 2010, pp. 1031–1034.

[12] S. Dalbehera, S.K. Acharya, Effect of cenosphere addition on the mechanical properties of jute-glass fiber hybrid epoxy composites, J. Ind. Text. 46 (1) (2016) 177–188.

[13] B.C. Samata , T.Maity, S.Dalai, A.K.Banthia, Mechanical properties of modified epoxy: effect of chain length, Journal of Pigment and Resin technology, 35 (2006) 16-23.

[14] K.Sewda, S.N.maiti, Mechanical properties of teak wood flour reinforced HDPE composites. Journal of Applied Polymer Science, 18 (2009) 26 - 34.

[15] Elayaraja.R, Experimental investigation of natural composite with epoxy resin,International journal of Research and Analytical reviews,02 (2019) 458-464.

[16] Z. Salleh, M.N. Berhan, Koay Mei Hyie and D.H.Isaac, “Cold-pressed Kenaf and Fiber glass Hybrid Composites Laminates: Effect of Fibre Types”, International journal of chemical, Molecular, Nuclear and Metallurgical Engineering, Vol:6, No:11,2012.

[17] MohdSuhairilMeon, Muhamad Fauzi Othman, Hazaran Husain, Muhammad FairuzRemeli, MohdSyaharMohdSyawal, “Improving tensile properties of kenaf fibers treated with sodium hydroxide”, International Symposium on Robotics and Intelligent Sensors,Elsevier,2012,pp. 1587-1592.

[18] S.Sivasaravanan, V.K.Bupesh Raja, “Impact properties of epoxy/glass fiber/nano clay composite materials”,IOSR Journal of Mechanical and Civil Engineering, 2014,pp39-41.

[19] A. Atiqah, M.A. Maleque,M. Jawaid, M. Iqbal, “Development of kenaf-glass reinforced unsaturated polyester hybrid composite for structural applications”, Elsevier,2013,pp. 68-73.

[20] M. R. Sanjay, B. Yogesh, “Studies on Mechanical Properties of Jute/E-Glass Fiber Reinforced Epoxy Hybrid Composites”, Journal of Minerals and Materials Characterization and Engineering, 2016, Vol:4, pp. 15-25.