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A REVIEW- Mechanical Properties of Polymer Matrix Composite

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***Abstract*— The composite manufacturing has been a wide area of research and it is the preferred choice due to its superior properties like low density, stiffness, light weight and possesses better mechanical properties. This has found its wide applications in aerospace, automotive, marine and sporting industries. Polymer matrix composite material is the one that uses organic polymer as matrix and fiber as reinforcement. Strength and modulus of fiber are much higher than the matrix material normally. The Present study deals with effect of aspect ratio, modular ratio, fiber loading on output response tensile test, flexural test, and impact test. Fabrication of different composite like banana-epoxy, banana-polyester will be carried out using full factorial design of experiment technique to determine the effect of parameter on the output responses.**

***Index Terms*— fibers, Glass fibers, Polymer Composites, tensile test, flexural test, impact test.**

I. INTRODUCTION

Composite materials are among the oldest and newest of structural materials. The older concept of composite is simply the mixing of two or more materials to rectify some shortcoming of particular useful component in modern technology. The concept of combining two dissimilar materials has acquired a broader significance: the combination has its own distinctive properties in terms of strength or resistance to heat or some other desirable properties. The principle attraction of modern composite material is that they are lighter, stiffer and stronger than anything made before [12]. The term composite can simply define as a combination of two or more dissimilar materials having a distinct interface between them such that the properties of the resulting material are superior to the individual constituting components [11]. Composite materials are materials made from two or more constituent materials with significantly different physical or chemical properties, that when combined, produce a material with characteristics different from the individual components. Composite structures, used to meet the demand for lightweight, high strength/stiffness and corrosion-resistant materials in domestic appliances, aircraft industries and fields of engineering composites, have been one of the materials used for repairing the existing structures owing to its superior mechanical properties. Applications of composite materials have been extended to various fields, including aerospace structures, automobiles and robot systems [1]. As composite material made of basically two material fiber and matrix, it is not homogeneous. Their properties are dependent on many factors, the most important of which are the type of fiber, quantity of fiber (as volume fraction) and the configuration of the reinforcement. They are generally completely elastic up to failure and exhibit neither a yield point nor a region of plasticity. The properties of composites are dependent on the properties of the fiber and the matrix, the proportion of each and the configuration of the fibers. If all the fibers are aligned in one direction then the composite relatively stiff and strong in that direction, but in the transverse direction it has low modulus and low strength. When a unidirectional composite is tested at a small angle from the fiber axis, there is a considerable reduction in strength. A similar but less significant effect occurs with the tensile modulus [1]. Fiber reinforced composites materials offer a combination of strength and elasticity that are better than conventional metallic materials. Composites are superior because of their low specific-gravities, strength-weight ratios. Structural materials such as steel and aluminum alloys are considered isotropic since they exhibit nearly equal properties irrespective of the direction of measurement. Composites consist of two or more phases that are usually processed separately and then bonded, resulting in properties that are different from those of either of the component materials.

II. LITERATURE SURVEY

1. Ajith Gopinath et al, has investigate on Experimental Investigations on Mechanical Properties Of Jute Fiber Reinforced Composites with Polyester and Epoxy Resin Matrices The jute-epoxy and jute-polyester composite specimens prepared as per ASTM standards subjected to mechanical characterization results were analyzed and compared. The results revealed that the jute epoxy exhibited better mechanical properties. The jute contains a fairly high proportion of stiff natural cellulose amongst the other lingo cellulosic fibers. The mechanical properties of jute fibers tend to be controlled by the cellulose content and micro fibril angle based on the morphology and fiber composition.

2.Joseph Seena et al, has investigate on Mechanical Properties and Water Sorption behaviour of Phenol–Formaldehyde Hybrid Composites Reinforced with Banana Fiber and Glass Fiber. From single fibre pull out tests, the interfacial shear strength (ISS) values are calculated for banana fibre and glass fibre. These values show that ISS is higher in banana fibre embedded in PF than for glass fibre in PF indicating a strong adhesion between the ligno cellulosic banana fibre and PF resoles. The tensile stress–strain behaviour reveals that the neat PF is brittle.

3.Kumar Ashwani et, has investigate on Development of Glass/Banana Fibers Reinforced Epoxy Composite. He has invegestigate GFREC had more Tensile Strength, Flexural Strength and Impact Resistance than BFREC. The Hybridization of Glass Fibers and Banana Fiber at varying wt. percentage of both fibers within the matrix had greater Tensile Strength, Flexural Strength and Impact strength than both GFREC and BFREC. It has been noticed that by adding a small wt. percentage of Banana Fiber in GFREC enhance its properties to a great extent. The Hybridization of Banana Fiber and Glass Fiber not only improve the mechanical properties of FRP composite but also reduce its cost and make it Eco Friendly composite.

4.M. Ramesh,et al The maximum flexural strength and maximum tensile strength is hold by the 50% banana fiber and 50% epoxy resin combination of the composite samples. From the experimental study it can be suggested that, the 50% banana fiber and 50% epoxy resin composite materials can withstand the higher loads when compared to the other combinations and used as an alternate materials for conventional fiber reinforced polymer composites.

5.Maiju Hietala, et al has investigate on The effect of pre-softened wood chips on wood fibre aspect ratio and mechanical properties of wood–polymer composites. The use of undried wood chips resulted in improved flexural strength in comparison with the composites with dried wood chips, but the flexural modulus was decreased. Study of the aspect ratios of wood particles showed that the use of pre-treated and undried wood chips resulted in the highest aspect ratio after compounding. In general, aspect ratios were considerably higher when undried wood chips were used as raw material instead of dried wood chips. The overall results are promising. The study shows that it is possible to use wood chips as raw material for the production wood– polymer composites and that the wood chips can be defibrated during the composite manufacturing process. When a simple chemical pre-treatment is used to soften the wood a more defibrated wood structure can be achieved.

6. Mohammed Abduls attar, et al has investigate on Mechanical Behaviour for Polymer Matrix Composite Reinforced By Copper Powder that increasing the weight fraction of copper powder to epoxy for different particle sizes leads to an increase in modulus of elasticity (E), modulus of rigidity (G), tensile yield stress and ultimate tensile strength but at the same time will decrease the compression yield stress, fracture energy and the impact strength. The modulus of elasticity is increased according to the increase in weight fraction for each particle size due to increase the number of copper particles in unit volume and then decreased the movement of particles (i.e. decreasing strain in specimen) which leads to increase modulus of elasticity.

7.Mortazavian Seyyedvahid et al, has investigate on Fatigue behaviour and modelling of short fiber reinforced polymer composites. As the fiber aspect ratio increases, fatigue strength also increases until it reaches a plateau at a particular fiber aspect ratio. The effect of fiber length this typically different and more pronounced in LCF, as compared with HCF, and in bending versus axial loading. The interface between fiber and matrix is an important factor influencing fatigue behaviour.

8.Naguib Hamdy M. et al**,** has investigate on Effect of fiber loading on the mechanical and physical properties of “green” bagassee polyester composite. Alkali treatment of bagasse, enhanced mechanical behaviour was achieved especially at 5 and 10% loadings. This improvement can be attributed to high strength, increasing of bagasse content leaded to increasing of water absorption percentage for the prepared composites within room temperature. Bagasse filler to polyester matrix began to enhance both of flexural strength and Young's modulus compared to untreated bagasse fiber. The chemical treatment of bagasse leaded to stronger interaction at fiber matrix interface compared to untreated fibers getting more uniform dispersion of applied stress and more energy for debonding of bagasse polyester interface.

9.**Palanikumar K.** et al, has investigate on Mechanical property evaluation of sisal–jute–glass fiber reinforced polyester composites results indicated that jute–GFRP specimen gives better tensile strength then the other two types of composites considered. The addition of sisal fibers shows comparatively low tensile strength than the other composites considered. The sisal–jute– GFRP hybrid composites perform better than the sisal fibers. The impact test carried out for the present investigation is Charpy impact test. The energy loss is found out on the reading obtained from the Charpy impact machine. The impact response in jute–GFRP composites reflects a failure process involving crack initiation and growth in the resin matrix, fiber breakage and pullout, delaminating and disbanding.

10.Paul Sherely Annie, et al has investigated on process parameter Effect of fiber loading and chemical treatments on thermo physical properties of banana fiber/polypropylene. When the fiber loading increases, due to the hollow cellular structure of the fibers, they act as an insulator, which causes a decrease of conductivity. Thus, the addition of banana fiber in the PP matrix decreases the heat transport in the composite. However, density increases with the increase of the fiber loading while the thermal diffusivity behaviour is similar to that of the thermal conductivity, I.e. decreases with the increase of the fiber loading.

11.Paul Shouha et al, has investigate on effect of fiber aspect ratio and volume loading on the flexural properties of flow able dental composite .This study shows that short and very short glass fibers can significantly reinforce flow able dental composite. The fiber’s aspect ratio was shown to be more important than volume loading for flexural strength. It appears possible to produce a light cured short glass fiber reinforced flow able material with superior flexural properties compared to conventional universal composites. Within the parameters studied the fiber aspect ratios of 68and 640 resulted in significant ($p < 0.05$ and $p < 0.001$) improvements to the flexural strength of flow able controls even with relatively small volume load. All low aspect ratio samples though had a negative effect and fiber volume loading was not significant for strength. As expected with regards to flexural modulus the presence of any volume of stiffer fiber led to a significant increase($p < 0.05$) in stiffness even if it weakened the composite (low aspect ratio). Fiber aspect ratio was not significant for modulus.

12.Pothan Laly A. et al, has investigate on Tensile and Impact Properties of Banana Fibre/Glass Fibre Hybrid Polyester Composites. Study concludes that the tensile strength of banana –glass hybrid composites shows a linear increase as the volume fraction of glass is increased. The geometry or the layering of the fibres affects the mechanical properties of the composites. Tensile strength shows the maximum value in intimately mixed composite at low volume fraction of glass. However when high volume fraction of glass is used, an interleaving arrangement of glass and banana shows a marginal increase in tensile strength of the composite. The impact strength of the hybrid composite increases when the glass volume fraction is increased up to 0.11. A further increase in glass volume fraction lowers the impact strength slightly.

13.Sanjay M R et al, has investigate on Investigation on Mechanical Property Evaluation of Jute - Glass Fiber Reinforced Polyester. In this work hand lay-up process is used to fabricate Jute, glass fiber reinforced polyester composites. Specimen preparation and testing was carried out as per ASTM standards. Composites were prepared using Jute - glass fibers of 50/50, 40/60 and 30/70 Weight fraction ratios and mechanical properties like tensile, impact and flexural strength of Jute-glass fiber reinforced polyester were evaluated. The results shows that tensile strength and impact Strength of 50% Jute-50% glass fiber composition is found to be better than the other two compositions and the flexural strength of 40% Jute-60% glass fiber composition is found to be better than the remaining two compositions. It has been noticed that the mechanical properties of the composites such as tensile strength, flexural strength, impact strength of the composites are also greatly influenced by the fiber composition.

14. Velmurugan R. et al, has investigate on Mechanical properties of Palmyra/glass fiber hybrid composites. Maximum strength is achieved when the length of the fiber in the laminate is equal to the critical fiber length. The strength of short fiber composites depends on the type of fiber, matrix, fiber length, fiber orientation, fiber concentration and the bonding between the fiber and matrix. Composites are prepared by varying the fiber length and the fiber content. Tensile, flexural and shear specimens are cut from the composite plates as per ASTM standards and tested in Instron universal testing machine.

III. CONCLUSION

Various mechanical properties like tensile strength, flexural strength, impact strength etc.

Of a natural composite depend on various factors like:

(a) Type of fiber

(b) Volume Fractional of Fiber

(c) Fiber Loading.

Fibers are more significant effect on mechanical properties of natural composites. Outcome from Literature Survey reported that the For the short fiber reinforced polymer composite as the aspect ratio increase fatigue strength also increase and having the higher tensile strength. Results of glass, banana fiber and epoxy resin having higher tensile strength, flexural strength compare to jute polyester composite and also having good automotive application.

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