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MECHANICAL CHARACTERISTICS AND TRIBOLOGICAL BEHAVIOUR STUDY ON NATURAL - GLASS FIBER REINFORCED POLYMER HYBRID COMPOSITES: A REVIEW

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**Abstract –*Natural fibers now attract the interests of researchers, Engineers and Scientists as an alternative reinforcement for fiber reinforced polymer composites. Natural fibers are not only strong and light weight but also relatively cheap and having properties like high specific strength, low weight, non-abrasive, eco-friendly and biodegradable. Generally used natural fibers are Jute, Sisal, Banana, Hemp, etc…, The glass fiber reinforced polymer are combined with natural fibers to enhance mechanical properties as well as particular technological applications. Now a days Sisal and Jute natural fibers are replacing the carbon and glass fibers owing their easily availability and cost. This study based on hybrid composites with the combination of Glass-Jute and Sisal with epoxy resin as binder Epoxy resin in the hybrid composite will result in the strong bond for the materials. Hybrid composites are usually used when a combination of properties of different types of fibers have to be achieved, or when longitudinal as well as lateral mechanical performances are required. By adding the filler to the composite material we can further improve the performance of composites. In this study the filler was Tungsten Carbide (WC), it improves erosion resistance and increase the strength*.

***Key Words*:** *Natural fibre; Natural fibre reinforced polymer composites(NFRPs); Glass fibre; Sisal Fibre; Jute Fibre; Tungsten Carbide; Epoxy Resin.*

1. INTRODUCTION

Composite material is a multi-phase system consisted of matrix material and reinforcing material. Matrix material is a continuous phase, and it includes metal matrix composite materials (MMC), inorganic non-metallic matrix composite materials and polymer matrix (PMC) composites by the different matrix materials. Reinforcing material is a dispersed phase, usually fibrous materials such as glass fiber, organic fiber like Jute, Sisal etc…, and so on. We only discuss polymer matrix with Glass and natural fibers.

Polymer matrix composite material is the one that uses organic polymer as matrix and fiber as reinforcement. Normally, strength and modulus of fiber are much higher than the matrix material. This makes the fibers element as main load-bearing component. However, there must be a matrix material with good adhesion properties to firmly bond fibers together. At the same time, the matrix material can serve to uniformly distribute the applied load, and transfer the loads to fiber. In addition, some properties of composite materials mainly depend on the characteristics of the matrix material.

Natural fibers, as reinforcement, have recently attracted the attention of researchers because of their advantages over other materials. They are environmentally friendly, biodegradable, abundantly available, and renewable. Natural fibers such as banana, cotton, sisal and jute have attracted the attention of scientists and engineers for application in consumer goods, low cost housing and other civil structures. It has been found that these natural fiber composites having better electrical resistance, better thermal and acoustic insulating properties and high resistance to fracture. They are also renewable and have relatively high strength and stiffness and cause no skin irritations. With these all advantages, there are also some disadvantages, such as absorption of moistures, quality variations and low thermal stability.

Generally used natural fibers are Jute and Sisal with the synthetic Glass fiber as Hybrid composites. Hybridization is done because getting required mechanical and other properties.Sisal/jute fiber composites are environment friendly and user-friendly materials and have very good elastic properties. Sisal fiber is the promising reinforcement because of low density, high specific strength, no health hazards and finding applications in making of ropes, mats, carpets, fancy articles etc.Jute fiber is biodegradable and eco-friendly. Jute products compare well with other fibers in terms of energy use, greenhouse gas emissions, eutrophication and acidification. The

chemical composition of jute fiber is as follows: Cellulose (61–71%), Hemicelluloses (13.6–20.4%), Lignin (12–13%), Ash (0.5–2%), Pectin (~0.2%), Wax (~0.5%), Moisture (~12.6%).

The performance of composites is further increased by adding the filler. In this study the filler was Tungsten Carbide (WC), it improves erosion resistance and increase the strength.

2. LITERATURE REVIEW

Vivek Mishra et al [1] studied the mechanical properties of bidirectional jute fiber reinforced epoxy composite. They found that void content decreases with increase in fiber loading, the hardness, tensile properties and impact strength of Jute-Epoxy composites increases with the increase in fiber loading.

Panthapulakkal and Sain et al [2] considered Hemp/Glass fiber – Polypropylene Composites material. They focused on mechanical and Thermal properties of these, They have noticed that due to hybridization of composite material enhance the flexural and impact properties.

TemesgenBerhanes et al [4] studied the Jute fiber composite by increasing the weight percentage of Jute, increased up-to 40%. The result exhibit that 40%Wt of jute with the polypropylene composite exhibit highest tensile strength. However, it decreases further increase in Jute Percentage. Also, flexural strength increases until 40%wt and then suddenly goes down with further more increases.Jute – Sisal mixture composite shows maximum flexural strength[3]

HimanshuBisaria et al [5] investigate the tensile, Flexural and Impact properties of randomly oriented short jute fiber reinforced epoxy composites. The result reveals that Tensile property of epoxy resin were not increased, whereas flexural and impact properties of epoxy resin were increased by reinforcement of Jute fiber.

R.A.Braga et al [6] investigate and compare mechanical, Thermal and water absorption properties of raw-jute and Glass fiber reinforced epoxy composites. The jute, Glass and Resin percentage varies 31-0-69 / 25-7-68 / 18-19-64. This study shows that addition of jute fiber and glass fiber in epoxy, increases density, the impact energy, tensile strength and flexural strength but decrease the temperature properties and water absorption rate.

Lin Xing Zhong et al [7] analyses the effect of raw Sisal and micro fibrillation Sisal in Sisal/Aramid fiber hybrid composites. The micro fibrillation improves cellulose fiber/resin interfacial adhesion in hybrid composites. Result reveals that surface micro-fibrillation significantly influenced on mechanical properties. It lessened the formation of cracks at fiber/resin interfaces to reduce fiber deboning. As a consequence the compression strength, Stability tensile strength, internal bonding strength and wear resistance were remarkably improved.

Hei-Lam Ma et al [8] study the glass fiber/epoxy composites at cryogenic environment; it helps in aerospace and aircraft application. They explained importance of epoxy resin and its temperatures with the experiments they concluded that the failure modes in low velocity impact event were matrix cracking delamination and fiber breaking. The final result reveals that post curing increased the energy absorption, reduced the damage depth.

Simma Maki et al [9] made experiment on obtaining of composite materials with epoxy resin matrixes and their behavior. They used different types of resins T19-38/500, T19-38/700, L50-54, A19 and two types of reinforcement's Kevlar pulp and glass fiber, from the results they have showed that glass fiber have high properties individually than those with Kevlar.

Khalil Ahmed et al [10] carried out experiments on Natural rubber (NR) hybrid composites reinforced with Silica, Marble sludge (MS), Rice Husk (RHS). The primary aim of this is to develop a production of low cost by easily available material as fillers. The result reveals the addition of silica and RHS in their corresponding hybrid NR composites improves significantly the tensile strength, modulus, tear strength and hardness.

Shamsiah awing ngah et al [11] conducted study on the fracture energies of Glass fiber (GF) composites with an anhydride-cured epoxy matrix modified using core-shell rubber (CSR) particles and silica nanoparticles. The use of CSR particles eliminates the incomplete phase separation that occur when using liquid rubber, finally they got results, the addition of CSR or NS particles increases the fracture toughness and bulk polymer and GF composites.

NazliGulsineOzdemir et al [12] investigate the effect of Nano carboxylic acrylonitrile butadiene rubber (CNBR-NP) and Nano acrylonitrile butadiene rubber (NBR-NP) on the interlinear shear strength and fracture toughness of

carbon fiber reinforced polymer composites (CFRP). The result show that the fracture toughness of the CFRP laminates improved significantly with the Nano rubber modification of the matrix, which was justified by the changed morphology of the resins. The elastomeric nature of the Nano rubbers cause a reduction in the inter-laminar shear strength, indicating an enhancement of the flexibility of the CFRP composite with dispersion of the Nano rubber.

ValterCarvelli et al [13] investigate the effect of hybrid epoxy resin filled with Micro-Fibrillated cellulose (MFC) and carboxylate nitrite-butadiene rubber particles (XNBR) by the help of inter-laminar shear strength test and tensile-tensile fatigue tests. A faster reduction of fatigue life was observed for composites containing hybrid matrixwith higher contents of MFC and XNBR that of the composites only MFC.

Crivelli Visconti et al [14] study the wear behavior of composite materials, sliding under dry condition against steel counter face. From the results they came to know that composite with the matrix filled with WC powder presented the highest value of wear resistance in more severe wear conditions. The present of different wear mechanisms has been analyzed SEM – Micrograph.

A.R.K Swamy et al [15] investigated the mechanical property of Al6061-Tungsten Carbide (WC) composite. The result of this study revealed that as the WC particle content increases there were significantly increases in the ultimate tensile strength, Hardness and Youngs Modulus but reduction in its ductility.

A.P Harisha et al [16] investigated the erosive wear resistance of unidirectional glass and carbon fiber epoxy composite and bidirectional E-Glass fabric reinforcement epoxy composites at normal incidences. Silica sand used to impact on the specimens, the result showed the bi-directional Glass fiber reinforced epoxy composite showed better wear resistance than unidirectional reinforced composites. The erosive behavior of epoxy composites is controlled by type of fiber and its arrangements. The steady-State erosion rate of epoxy ant its composites increased with increase in impact velocity from 25 to 60 m/sec.

M.Ivosevic et al [17] studied the erosion resistance by thermally functionally coating based on a polyamide matrix filed with varying fractions of WC-Co, to improve the erosion and oxidation resistance of polymers matrix composites. Coated and uncoated samples are experimented by four independent variable coating system, angle of incident of erodent, erosion temperature and erosion time. The result of erosion volume data clearly showed that coating system was relatively insensitive to the angle of erodent, incident from 20 to 90 degree and temperature increases from 20'C to 250'C

3. CONCLUSIONS

The above review showcased that the Natural fiber have more advantage than Synthetic fibers in terms of Strength and Environmental concern. The following review concluded that,

- The mechanical and physical property of natural fiber varies fiber to fiber.
- Hybridization of composite material enhances the flexural and impact properties and also found increase in thermal property.
- Sisal-Jute-Glass fiber reinforced polyester composite, there is some improvement in the properties; Jute composite have maximum tensile strength. Jute – Sisal mixture composite shows maximum flexural strength and maximum impact strength gained from the Sisal fiber composites.
- Flexural and impact properties of epoxy resin were increased by reinforcement of Jute fiber.
- Treatment of Sisal fiber with NaoH solution improves tensile strength but does not effectively influence the fatigue lives.
- Natural fiber exhibit superior mechanical properties such as flexibility, modulus and stiffness compared to glass-fiber.
- The combination of Glass/Jute,Glass/Sisal increases the tensile strength, Flexural and Impact strengths.
- The curing of Resin increased the energy absorption, reduced the damage depth.
- Incorporation of Natural Rubber to the Glass Fiber composites increases Tensile and Fracture toughness as well as flexibility.
- Addition of WC in GE composites improves erosion resistance.
- Bi-directional Glass fiber reinforced epoxy composite showed better wear resistance than unidirectional reinforced composites.
- Incorporation of natural fiber with GFRP can improve properties and used as an alternative material for other synthetic composites.

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