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A REVIEW ON MECHANICAL PROPERTIES OF NATURAL FIBER REINFORCED HYBRID COMPOSITES

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Abstract - *Development of the composites with natural fibers and fillers as a sustainable alternative material for some engineering applications, particularly in aerospace applications and automobile applications. Natural fiber composites are more attractive due to their highest specific strength, light weight and biodegradability and low cost. In this paper the hybrid composite are in the form of jute/glass fiber, sisal/glass fiber, natural rubber/glass fiber, natural rubber/jute fiber. The properties of the materials are discussed here. For the hybrid composite the epoxy resin is used as a binder. Epoxy resin in the hybrid composite will result in the strong bond for the materials. By adding the filler to the composite material we can further improve the performance of composites. The filler use in this paper is the silicon carbide.*

Key Words: Composite materials, Hybrid composites, Silicon carbide, Jute fiber, Sisal fiber, Natural rubber, Glass fibers, Epoxy.

1. INTRODUCTION

A composite is a structural material that consists of two or more combined constituents that are combined at a macroscopic level and are not soluble in each other. One constituents is called reinforcing phase and the one in which it is embedded is called the matrix. The reinforcing phase materials may be in the form of fibres, particles or flakes. The Matrix phase materials are continuous. The PMCs and MMCs are most commonly used. The polymer matrix composites consisting of polymer (e.g., epoxy, polyester) reinforced by fibres (e.g., graphite, aramids, boron). The metal matrix composites have a metal matrix. Metals are mainly reinforced to increase or decrease the properties. The glass is the most commonly fibre used in polymer matrix composites because of its high strength, low cost, high chemical resistance and easy available fibre.

1.1 Fiber

Natural fibres as an alternative reinforcement in polymer composites. These natural fibres include jute, sisal, banana and many others. Natural fibres exhibit superior mechanical properties such as flexibility, stiffness and modulus compared to glass fibres. Although glass fibres possess high specific strength, their fields of application are very limited because of their inherent higher cost of production. Natural fibres such as sisal and jute fibre composites materials are replacing the glass and carbon fibres due to their easy availability and cost. Natural fibres are lighter and cheaper, but they have low mechanical properties than glass fibres. The addition of natural fibre to the glass fibre can make the composite hybrid and glass fibre has high strength/weight ratio.

1.2 Resin

The resins that are used in fibre reinforced composites can also be referred to as polymers. All polymers exhibit an important common property in that they are composed of long chain-like molecules consisting of many simple repeating units. Man made polymers is generally called synthetic resins or simply resins. There are three types of resins used in the composite material industry i.e. Epoxy resin, polyester resin and vinyl ester resin. Most industrial applications of epoxy resins are in thermosetting, a process in which an epoxy resin reacts with a curing cross-link agent known as a hardener. Epoxy resins are most commonly used because of its better adhesive properties, mechanical properties like strength, stiffness etc.

1.3 Filler

Filler forms the addition strength to the mechanical properties of the composite materials. In this filler silicon carbide is the one of the fillers available. The silicon carbide when used as reinforcement it will increase the properties like tensile strength, young's modulus, ultimate tensile strength, hardness of the composite materials.

2 LITERATURE REVIEW

Hybrid composites are materials which are made by combining two or more different types of fibres in a

common matrix. Hybrid of fibres having same length and different diameter offer some advantage over the use of one type of fibres alone in a polymer matrix. They possess a good calorific value and they exhibit excellent mechanical properties, have low density and are inexpensive. Natural fibre composites are durable, have good maintenance, renewable and cost effective as compared to synthetic fibre composites.

Ajith Gopinath, Senthil Kumar.M, Elayaperumal A [1] made the experiment on mechanical properties of jute fibre reinforced composites with polyester and epoxy resin. In this study they revealed that the jute-epoxy exhibited better mechanical properties. The processing time required for jute-polyester composite is comparatively lesser time than jute-epoxy. The tensile strength and flexural properties for jute-epoxy is more than the jute-polyester, which makes it better suited for the automotive applications rather than jute-polyester composites.

M.R.Sanjay, B.Yogesha [2] has studied the hybrid effect of composites made of jute/E-Glass fibers are fabricated by hand layup method. It is found that the hybrid composite has better strength as compared to jute fibre composite fabricated separately with glass fiber. The incorporation of glass fibre in jute fibre composites enhances the mechanical properties and it leads to the increase of the utilization of natural fibers in various applications.

M.Ramesh, K.Palanikumar, K.HemachandraReddy [3] investigated the mechanical properties of sisal, jute and glass fiber reinforced polyester composites. They observed that the addition of glass fibre into jute fiber composites resulted in maximum tensile strength. In the same way they have observed that jute and sisal mixture composites sample is capable having maximum flexural strength and maximum impact strength was obtained for the sisal fiber composites.

Mohd Hafiz Zamri, Hazizan Md Akil, Azhar Abu Bakar, Zainal Arifin Mohd Ishak, Leong Wei Cheng [4] studied the mechanical properties of jute/glass reinforced polyester with water absorption condition. Composites are subjected to various water conditions and test were performed by immersing composite specimen in to three different water conditions, distilled water, sea water and acidic water and water was in room temperature for a period of three weeks and also effect of the various water environments on the flexural and compression characteristics were investigated in this study. It found out that the jute composite is not suitable for underwater applications.

C.Chaithanyan, H.Venkatasubramanian, Dr. S.Raghuraman, T. Panneerselvam [5] S. Raghuraman et al. [5] concluded that the composite with 50% sisal-glass fiber and 50% resin combination has maximum tensile strength. The breaking load of sisal-glass fiber reinforced composite is found as high. It is found that breaking load of sisal-glass fiber reinforced composite is 1.10 times higher than sisal-coir-glass fiber reinforced composite and 1.33 times higher than coir-glass fiber reinforced composite. The percentage elongation of coir-glass fiber reinforced composite is found as higher than the other composites and hence it may have more ductile property in nature. The hybrid with composite with 40% sisal- coir-glass fibers and 60% resin combination has high flexural strength and high impact strength.

Another research conducted by **V. Naga Prasad Naidu, G.Ramachandra Reddy[6]** the compressive strength and impact strength of unsaturated polyester based sisal/ glass hybrid composite have been studied as a function of fiber content. It is observed that the compressive and impact strength of sisal/glass fibre hybrid component is higher than sisal fibre reinforced composite, but lower than the glass reinforced composite. When the load is applied on sisal/glass fibre hybrid composite, first sisal fiber fails then the load is transferred to glass fibre. So that the presence of glass fibre in the sisal/ glass fibre hybrid composite causes to improve the impact and compressive strength. At the same time the presence of sisal fiber in hybrid composite the causes to decrease the compressive and impact strength than the glass fibre composite. The effect of chalk powder on compressive and impact strength of sisal/glass fibre hybrid composite has also been studied and it is observed that as the chalk powder quantity by weight of resin increases then the compressive and impact strengths decrease.

Kasama Jarukumjorn, Nitinat Suppakarn [7] the author studied the effect of glass fibre in hybrid composites. By the addition of glass fibre improves the thermal stability of the composites. Hybridization with glass fibers decreased water absorption of the sisal polypropylene composites. Tensile, flexural, impact properties of the sisal-polypropylene composites were increased by adding the glass fiber.

Hari Om Maurya, M.K. Gupta, R.K. Srivastava, H. Singh [8] the author tried to increase the mechanical properties of sisal fibre reinforced epoxy composites by varying the fibre length and keeping constant weight percent of sisal fibre content. Tensile strength of epoxy was not improved by the reinforcing of sisal fibre while tensile modulus, flexural and impact properties were improved. Impact properties of sisal composites were found maximum for the composites having more fibre length.

M Muthuvel, G Ranganath, K Janarthananand, K Srinivasan [9] the jute and glass fibre hybrid composite leads to the successful fabrication of glass, jute fiber and chopped fiber reinforced polyester composites with different fiber lengths is possible by simple hand lay-up technique. The mechanical properties of the composites

like tensile, flexural and impact strength of the composites are also greatly influenced by the fiber length.

Sanjay M R, Arpitha G R, B Yogesha [10] the author has been carried out a review to make use of natural fibers(such as sisal, jute, banana, bamboo etc). The mechanical and physical properties of natural fibers have varies from fiber to fiber. Natural fiber reinforced composites are used in engineering applications, because of its properties such as specific strength, low weight, low cost, non abrasive and bio- degradable characteristics. Incorporation of natural fibers with GFRP can improve the properties and use of an alternative material for glass fiber reinforced polymer composites.

Cristiane M. Becker, Teo A.Dick, Fernando Wypych [11] has studied the effect of epoxy resin in the composite material. The epoxy resin might have good mechanical properties but they lack the thermal properties. Under high temperature they will catch fire easily. This may results in the complete failure of the composite material. So it is mixed with LDH. This LDH will act as fire resistant in the epoxy resin. By this the fore problem of the epoxy cab be controlled.

Se Young Kim, In Sub Han, Sang Kuk Woo [12] the addition of filler consisting of a combination of silicon and carbon black powders decrease the negligible amount residual free silicon but increased the amount of internal reaction bonded SIC and filler reduced the flexural strength indicating damage to the fiber but it drastically improved the wear resistance characteristics of the composites.

Gaurav Agarwal, Amar Patnaik, Rajesh Kumar Sharma [13] as the percentage of SiC content increases, the area under the curve spreads across the wider range and the peak value shifts towards the higher temperature region resulting in the increase in elastic range of the composites. The mechanical properties such as hardness, tensile strength, interlaminar strength, flexural strength and impact strength increases with the increase in SiC filler content.

K.Devendra, T.Rangaswamy [14] experimental results indicated that SiC filled composites having high impact strength when compared with other filled composites this due to that good bonding strength between filler, matrix and fiber and flexibility of the interface molecular chain resulting in absorbs and disperses the more energy, and prevents the crack initiator effectively. The flexural strength results indicated that composites filled by SiC exhibited maximum flexural strength when compared with other filled composites but lower than the unfilled composites this is due to the good compatibility between filler and matrix.

Ritesh Kaundal, Amar Patnaik, Alok Satapathy [15] comparison between particulate filled and unfilled glass polyester composites were presented on the basis of mechanical and thermo-mechanical properties. It was noticed that, with an increase in the filler content, the mechanical properties (tensile strength and flexural strength) decreased. In the case of the unfilled composites, an increase in the fiber loading increased the mechanical properties simultaneously. However, in the case of dynamical mechanical analysis and thermal analysis, the particulate filled glass polyester composites showed better properties when compared to the unfilled glass polyester composites.

PruttipongPantamanatsopa,WaruneeAriyawiriyanan , Tawatchai Meekeaw [16] the effect of fibers content filled in natural rubber green composite on mechanical properties has been studied. The increasing in filler content tended to increased modulus and hardness but decreased tensile strength of the composite. The results showed that natural rubber/jute untreated can improve mechanical properties of composite more than natural rubber/jute treated. Which is due to distribution of fiber may effect to improve mechanical properties of composite in this study.

Hanafi Ismail, M.R. Edhyam, B. Wirjosentono [17] the author studied the properties of composites such as tensile strength, tensile modulus, elongation at break and hardness. Tensile modulus and hardness of composites increase with increasing filler loading and the presence of bonding agents. The adhesion between the bamboo fiber and natural rubber can be enhanced by use of a bonding agent.

S. Srisuwan, N. Prasoetsopha, N. Suppakarn, P. Chumsamrong [18] the flexural modulus of was higher than that of the blend and increased with increasing the amount of the fiber. When silanized sisal fiber was used, the composites showed further improvement in flexural modulus. The composite containing silanized sisal fiber showed an improvement on flexural strength compared to the composites prepared using alkalized sisal fiber.

A.M Viso, L.Calabrese, P.Cianciafara [19] the author studied the mechanical behaviour by immersing the composites in to sea water. The test is conducted before and after immersion in sea water. The composites containing isophthalic resin showed higher flexural and shear strength.

3. CONCLUSIONS

The following may be concluded based on this review.

- The combination of the useful properties of two different materials, make them as a versatile material in the field of engineering and technology.

- The hybrid composites of jute/E-glass fiber have better properties than that of the jute fiber.
- The hybrid composite has better strength as compared to the composite fabricated separately.
- The mixing of natural fiber with Glass-Fiber reinforced polymers are finding increased applications.
- Hybridization of natural fibers with synthetic fibers decreases the maximum absorption and increases the mechanical properties of the composites.
- Epoxy resin can be preferred first among the polyester resin and vinyl ester resin.
- SiC filled composites having high impact strength when compared with other filled composites.
- The mechanical properties such as hardness, tensile strength, interlaminar strength, flexural strength and impact strength increases with the increase in SiC filler content.
- The increasing in filler content tended to increased modulus and hardness but decreased tensile strength of the composite.
- Natural rubber/jute untreated can improve mechanical properties of composite more than natural rubber/jute treated.

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