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Natural Fiber Reinforced Composites: A Review

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Abstract - *Over recent years, in the field of research, engineering and science, natural fibers with polymer composites are also useful as an alternative reinforcement for traditional composite. Not only are natural fibers strong and light, but they are also relatively cheap and have properties such as high specific strength, low weight, non-abrasive, environmentally friendly and biodegradable. Usually used natural fibers such as Jute, Sisal, Banana, Hemp, etc., polymer reinforcement of waste natural fiber is a sustainable option for the environment. The materials of the polymer matrix together with the correct and suitable filler and better filler / matrix create a strong connection between traditional and modern methods or approaches. It allows the production of polymeric composites showing great potential applications in the construction, automotive, aerospace and packaging industries. Due to the larger surface area and greater aspect ratio, polymer composite displays significant applications in different fields with fascinating properties.*

Being environmentally friendly, polymer composite applications offer new technology and business opportunities for a number of industries, including aerospace, automotive, electronics, and biotechnology. Hybrid polymer composites in a reinforced polymer-based composite harness the synergy between natural fibers. It leads together with the green appeal to develop the estate. In addition to fiber-matrix interface bond strength, the mechanical properties of a natural fiber-reinforced polymer composite depend on parameters such as fiber density, fiber size, chemical treatment and orientation. The purpose of this review article is to clarify research and development in improving the mechanical properties of natural fiber reinforced polymer composites along with end applications.

***Key Words*: Natural Fibre, Jute, Basalt, Kenaf, Matrix**

1. INTRODUCTION

A composite is a mixture of two materials in which one of the materials, called the reinforcement phase, is in the form of fibers, sheets, or particles and is installed in various materials called the Matrix phase. The substance that has been extracted from two or more different materials with mostly different physical and chemical properties leading to individual components. The components will be individual. Composites are currently exploring application in products ranging from simple PC sheets and vehicle parts, such as skis and bicycles, to elite athletic hardware. An interest in new, simple, fantastic production procedures has also been generated as composite material applications have grown in scope. Current assembly methods include prepreg shaping, pultrusion, gum shaping, fiber winding, pressure trimming, and hand lay-up. Such methods refer to a wide range as far as price and value of products are concerned. Resin Transfer Molding (RTM) has demonstrated its ability to deliver great items at a moderately minimal effort as a guarantee. In decreased volatile outflows and geometric adaptability, it also has favorable circumstances. A comprehensive study has been done on natural fibres through the years. Roger. M, et.al. (1997), studied that Composite materials are used for building and construction of bridges, structures such as boat hulls, swimming pool panels, race car bodies, shower stalls, bathtubs, storage tanks, imitation granite, and cultured marble sinks and countertops [1]. Paul Wambua, et.al. (2003), The outline of this study states that the execution of regular fibre strengthened composites can be equivalent to that of the engineered fibre-based composites, yet with lower explicit weight and cost. The benefits of regular fibre composites are their 'great dimensional security' and 'sturdiness' against wood-based composites [2].

According to Hoi-yan Cheung et. al. (2009), the study was on different natural fibres and their development in engineering components and domestic components. Properties like mechanical and thermal were also evaluated in depth. The discussion was about reinforcing animal fibre on plant fibre. The study concluded that it exhibits better thermal properties in comparison to only polymers [3]. Jawaida et. al. (2011), This study examined the quality under tensile and flexural behavior of' tri-layer oil palm EFB / woven Jute fiber reinforced epoxy hybrid composites.' The tensile and flexural properties of hybrid composites were found to be higher than those of EFB composite, but less than woven jute composite [4]. Bapi Sarker, et.al. (2011), The material used in this study was found to have low thickness, higher quality, and modulus than plastic, which is why it is a decent substitute for customary strands for greater part of the time. Broadly utilized regular strands are cotton, jute, sisal, corn, coir, hemp, banana, pineapple, etc. These filaments are biodegradable and furthermore natural neighborly [5]. Ku H, et. al. (2011), Observations were made on the tensile properties of a material made of polymer composite strengthened by natural fiber [6]. Rafeeq et.al. (2013), the mechanical properties of the epoxy matrix have been studied to create natural fibers such as stiffness, impact, flexural and thermal properties. By holding the filler percentage constant,

composite was manufactured by hand lay-up system. Concluded that it is possible to use composites in low-cost applications [7]. Saba N, et. al. (2014), the study was on hybrid composites and it was concluded that the properties of the material can be different and can be improved with different fiber lengths, orientation, fiber content and fiber arrangement. Hybrid materials do not exist in nature they are prepared by adding two or more than two materials these are unique materials. In this work the combination of polymer matrices and naturally available fibers were considered [8].

1.1 A Study on Jute Fibre

According to Mubarak A, et. al. (2004), the study has observed that from the few past decades, we have been worrying about the green condition, and in this way our real examinations have been centered around to make contamination free conditions. It is viewed that non-degradable materials are exclusively in charge of natural contamination [9]. M.Z.Abedin Abdullah-Al-Kafi, et.al. (2006), Natural strands, according to the study, add to the simple degradation of the composites. These strands also have a less ecological effect on their creation than glass filaments and polymers, as they require less vitality and produce less emanation [10]. S. Mukhopadhyay, et. al. (2015), this study makes some interesting observations referring that Natural fibres require only a low degree of industrialization for their processing, and in comparison with an equivalent weight of the most common synthetic reinforcing fibres, the energy required for their production is small and hence the cost of fabricating these composites is also relatively low. Another observation is that Jute fibres, as a natural reinforcing agent, are about seven times lighter than steel and high tensile strength values with a suitable low-cost [11].

Mubarak A. Khan, et.al. (2015), The study summarizes that Jute products are equally good with different strands in terms of use of vitality, emanation of ozone depleting material (GHG), eutrophication, and fermentation. One hectare of jute plants retain huge amounts of CO2 from the climate and during their 120-day life expectancy infuse nearly 11 tons of O2. In addition, decayed leaves and underlying foundations of jute plants enhance dirt maturity and decrease the cost of manure. The production of 1 Kg of jute shopping packs texture saves 80 MJ of vitality, as opposed to 1 Kg of poly hydroxyl alkanoid. Jute Hessian material devours less vitality and radiates irrelevant measurements of 'GHG contrasting and thermoplastic polymers' [12]. Md Sahadat Hossain, et. al. (2017), This study observes that tightly integrating sensing, actuation, and computation into composites could enable a new generation of truly smart material systems that can change their appearance and shape autonomously. Applications for such materials include airfoils that change their aerodynamic profile, vehicles with camouflage abilities, bridges that detect and repair damage, or robotic skins and prosthetics with a realistic sense of touch [13].

Sharfun N. Arju, et.al. (2015), Mubarak A. Khan, et.al. (2009), J.E. Riccieri, et.al. (1999), According to these studies, extraordinary non-degradable composite materials are directly and generally utilized rather than metals. Non-degradable materials are exposed to be supplanted by degradable ones so as to make contamination free condition. In this way, common fibre composites are picked up to make biodegradable materials [14, 15, 16].Jochen Gassan, et.al. (1999), M Mushfequr Rahman, et.al. (2012), Siva Bhasker Rao Devireddy, et.al. (2016), An impressive observation made in this study was that, among all the normal filaments, jute gives off an impression of being a promising material, since it is moderately economical and industrially accessible in tropical nations [17,18,19]. Sharfun N. Arju, et.al. (2015), the summary of this study says that eventually in time, various non-degradable composite materials are generally utilized, rather than metals. Non-degradable materials are exposed to be supplanted by degradable ones so as to make contamination free condition. Consequently, normal fibre composites are picked up to make biodegradable materials [20]. Km Idriss Ali, et.al. (1994), A K Mohanty, et.al. (2000), These studies report that the presentation of common fibre fortified composites can be similar to that of the manufactured fibre-based composites. However, with lower explicit weight and cost, the benefits of normal fibre composites are their 'great dimensional security' and 'toughness' against wood-based composites [21, 22, 23].

1.2 A Study on Kenaf Fibre

According to study made by Juliana .A, et. al. (2012), investigations were made on kenaf plant and its production in this study. It was concluded that kenaf maintains an average height of 4 to 6 mm stem diameter, and ranges from 25 to 35 mm within a period of 4-5 months [24]. Imtiaz Ali et. al. (2014), investigated on different factors of resin, to determine the physio-mechanical properties of medium density fibreboard (MDF) panels which were made from kenaf bast fibres. The other objective was to reduce the number of experimental runs using Taguchi method. The investigation concluded that 'there is a significant effect on mechanical properties with respect to the changes in type of resin and moisture content'. It was also observed that physio-mechanical properties are superior with MUF resin at 12% resin content and 12% mat moisture content. The complete study led to a suggestion that wood can be replaced by Kenaf fibres for MDF manufacturing 25].

H.O. Maurya et. al. (2015), in this study, the mechanical and thermal properties of Kenaf short fibres were determined after they were subjected to different temperatures and climatic conditions. The study concluded that 'the mechanical and thermal properties of natural fibres will change with respect to environmental conditions'; which is not same throughout the world [26]. N. Saba et. al. (2015), made observations on 'kenaf reinforced polymer material' for the past few years. It was mentioned in the study that since 'kenaf reinforcement' had superior mechanical

properties, it can be used as material for building and construction. According to Rajneesh Verma, et.al. (2018), the effects of fibre loading with different weight percentages on flexural and tensile properties were evaluated. The test samples, with and without alkali treatment, were taken. Further reinforcing behaviour of kenaf fibre was observed with Dynamic mechanical analysis [27]. Alvid Devadas, et. al. (2018), the investigation of mechanical and tribological properties found that the strength of kenaf particles improved with the reinforcement of neat epoxy. Furthermore, there is an improvement in bending, overall load distribution and flexibility of the material. It was also concluded that Ws and friction coefficient improved significantly with the reinforcement of neat epoxy with kenaf particles. It was also seen that under different loading conditions, the optimal fibre particle loading condition is 15% [28].

1.3 A Study on Basalt Fibre

Fiore V, et.al. (2015), discussed about basalt fiber production technology and contrasted with glass fiber production technology. It was concluded that basalt production process in comparison with glass fiber is non-hazardous and environmentally friendly. Moreover, basalt consumes less energy than glass fiber has been said [29]. In the study by V. Fiore, et. al. (2016), Composites strengthened jute and basalt were manufactured and accelerated aging of hygrothermal stress and UV radiation was done. Each specimen is tested for 14 days, 28 days, 56 days and 84 days. Mechanical tests were carried out in accordance with the ASTM standard, such as quasi-static flexural tests, charpy impact tests and dynamic mechanical tests. It was concluded that the hybrid composite has better impact, more flexural properties with superior resistance to aging than just jute [30]. In another study by Bulut M (2017), Observations were made on the influence on mechanical properties such as tensile, flexural and impact of graphene pellets with different weight percentages. It was concluded that the bonding strength of composite laminate was improved by 0.1% of graphene pellets. Also presented were further failure characteristics of the laminates prepared and tested [31].

2. CONCLUSION

Humanity has recently realized that, unless the ecosystem is preserved, it will itself be endangered by over-consumption of natural resources and a substantial reduction in the world's fresh air. The use of renewable resources such as plant-based and animal-based polymeric composites has become an important design criterion for the design and manufacture of components for all industrial products. In the last decade's work on natural materials (animal, vegetable) has increased rapidly with the growing interest over sustainable solutions in product design. In recent years, several studies have been carried out with the aim of obtaining polymer composites that are eco-friendly, biodegradable, low-cost lightweight natural fiber. Current research has been undertaken to explore the potential of natural fibers for various applications. The study focuses on reinforcing various chopped and continuous fibers, as well as on resins and filler materials affecting reinforcement and strength. And also on thermal properties, characteristics of materials.

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