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Applications of coir fibres in automotive industry

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Abstract: *The automobile sector is leading the way in the transition to a more environmentally friendly supply chain by using natural fibres as a foundation for parts like boot linings, door panels, spare tyres, and seat backs. More and more products with high energy consumption and synthetic fibres are being replaced with products made of natural fibres every year. The use of natural fibres like coir, sisal, jute, and others is gaining increased attention from scientists due to growing concerns about global warming and the depletion of petroleum sources. As a result, there is now greater awareness regarding the use of materials based on natural fibres, particularly composites. Over the last ten years, numerous attempts have been made to create composite materials as an alternative to petroleum and other non-biodegradable material-based products. Since natural fibres like coir are widely available in India, efforts have been focused on developing natural fibre composites, mainly to investigate opportunities for value-added applications. Due to its low cost, easy availability, low density, acceptable specific characteristics, ease of separation, better energy recovery, C02 neutrality, biodegradability, and natural recyclable nature, coir fibre reinforcement in composites has garnered interest recently. Commercial-use fibre-reinforced polymer composites can be made from agricultural waste. Despite having a high specific strength, glass and other synthetic fibre-reinforced polymers have very narrow applications due to their higher production costs. In this regard, research has been done to investigate the use of coir, a naturally occurring fibre that is widely accessible in India. The utilization of coir fibre and the state of research on it for the automotive sector are covered in this article. This review includes several citations to the most recent work on properties, processing, and application.*

Keywords: *Automotive industry, coir, Agricultural waste, global warming and polymer.*

1. INTRODUCTION :

Natural fibres are now widely used in vehicles by auto makers for a number of technological, financial, and environmental reasons. Chemicals indirectly lessen negative environmental effects, whereas the recyclable nature of natural fibres reduces environmental impact by doing away with the requirement for a set production period. In addition, they are inexpensive, recyclable, biodegradable, and ecologically beneficial goods. The ability of natural fibres to absorb sound comes from a variety of plants. A variety of sectors can reduce noise by utilizing sound-absorbing materials. The air's permeability and sound absorption coefficient are significantly impacted by the fibre mixture's ratio. As the ratio of increasing fibre in the blend of polyester, cotton, and bi components rises, the rate of sound absorption lowers. In a similar vein, multilayer nonwoven fibres prevent airflow more effectively than single-layer nonwoven fibres. The possibility of producing natural fibre-based sound-absorbing textiles is made possible by the health dangers connected to glass and mineral-based fibre products. Affordable and durable soundproofing materials for cars, home appliances, and architecture might be made from natural fibres with non-abrasive, porous, strong-insulating, and hygroscopic qualities. Natural fibres like jute, sisal, kenaf, and coir can be harvested twice or three times a year, but they are often harvested annually.

The noise, heat, and electrostatic charges produced by engines, exhaust systems, gears, and wheels can also be relieved by using natural fibres. Natural fibres are a suitable option for protection because they are not as abrasive as glass fibres and do not develop sharp edges when deformed. Many wealthy countries have moved towards manufacturing natural fibres, which has reduced environmental hazards and created jobs. There has been a recent trend in natural fibre degradation testing. By calculating the percentage weight of fibre reinforcement, researchers have found that the rate of deterioration can be improved through experiments on natural fibres. Natural fibres ability to bio degrade is thought to be one of their most important and intriguing properties when it comes to using them in polymeric materials.

Techniques for using bio material composites in automobile components are being developed as a result of the development of improved lightweight materials that can replace metals or conventional synthetic structures.

The car's fuel efficiency and carbon dioxide emissions can be significantly reduced by designing a combination of strong, lightweight composite panel construction. Lastly, because they are lightweight and environmentally friendly, they might enhance societal well-being and find widespread use in the creation of urban electric vehicles. Bio composites are used in the automobile industry for a variety of purposes, including the body shells of micro cars, e-bikes, fully electric cars, automotive interiors, and structural frame sections. Composites, polymers, and ceramics have dominated the engineering material market over the last few decades. Composite material uses have expanded quickly, even breaking into new markets. Modern composite materials are made of a variety of materials that are both used in sophisticated applications and everyday life. Although composites have already shown their value as materials that can reduce weight, the current challenge is to make them both cost-effective and durable enough to replace other materials in demanding environments.

As a result, numerous innovative approaches that are today employed in business were developed. The composites industry has started to acknowledge the numerous industrial applications, primarily in the transportation domain. One material, consisting of long, stiff fibres, and another, a binder or "matrix" that holds the fibres in place, are combined to create a composite material, which has a special set of qualities. Kelly made it extremely apparent that the composites were more complex than just two materials combined. Within a wider context, the amalgamation possesses unique characteristics of its own. It is either significantly different from any of the components alone or superior to both of them in terms of strength, resistance to heat, or some other desired attribute. A by-product of the coconut industry, coir fibres have excellent performance characteristics but are challenging to work with using traditional textile techniques. The review paper's goal is to determine whether coir's high-performance qualities can be processed to produce a composite good enough for automotive applications.

2. REVIEW OF LITERATURE:

2.1 COIR FIBRE

A natural fibre with many uses, coir is taken from the meso carp tissue, or husk, of the coconut fruit. The term "golden fibre" comes from the fact that fibre is often golden in colour after being removed from coconut husks and washed. The fibrous outer layer of a coconut is called coir. Because coir is hardy and inherently resistant to salt, the fruit is protected enough by it to withstand months of floating on ocean currents before being washed up on a sandy shore. There, with enough fresh water, it can sprout and grow into a tree because all the other nutrients it needs have been carried with the seed. Because of these qualities, the fibres are highly valuable in garden mulch, cordage and rope, aquarium filters, and floor and outdoor mats.

2.2 STRUCTURE OF COIR FIBRE

Each individual fibre cell is hollow, slender, and has thick cellulose walls. When they are young, they are pale, but as a layer of lignin deposits on their walls, they subsequently harden and turn yellow. Mature brown coir fibres are less flexible but stronger than fibres like flax and cotton because they contain less cellulose and more lignin. They consist of tiny threads that are between 10 and 20 micro meters in diameter and less than 0.05 inch (1.3 mm) in length. White fibre is weaker despite being finer and smoother. The only natural fibre that is resistant to being harmed by salt water is coir fibre, which is somewhat waterproof. The tender white fibres of green coconuts are collected after the plant has been in the ground for six to twelve months. When the coconut reaches full maturity and the nutrient layer surrounding the seed is ready to be processed into copra and desiccated coconut, brown fibre can be extracted. Next, the fruit is driven down onto a spike to split it, separating the fibrous layer from the hard shell (de-husking) by hand. These days, there are machines that crush the entire fruit to release the loose fibres.

2.3 CLASSIFICATION OF COIR FIBRE

2.3.1. BROWN FIBRE

To swell and soften the fibres, the fibrous husks are submerged in pits or nets in a slowly moving body of water. Wet-milling is the technique of separating the longer bristle fibres from the shorter mattress fibres beneath the nut's skin. After being cleaned of dirt and other debris, the mattress fibres are dried and bundled into bales. In order to maintain its suppleness for the creation of "twisted" fibres, some mattress fibre is permitted to retain additional moisture. The coir fibre maintains its curl as if it were permanently waved and is elastic enough to twist without breaking. To twist fibre, just form a rope out of the fibre's hank and twist it either by hand or using a machine. Before being tied into bundles or chunks, the longer bristle fibre is cleaned in clean water and allowed to dry. Steel combs may then be used to clean and "hackle" it in order to straighten the strands and get rid of any shorter fibre fragments. In order to create hanks of various colours, coir bristle fibre can also be bleached and colored.

2.3.2 WHITE FIBRE

For a maximum of 10 months, the young husks are left hanging in a river or a hole filled with water. In order to release the fibres during this period, micro organisms known as retting break down the plant tissues around the fibres. After the long fibres are removed by hand-beating sections of the husk, they are dried and cleaned. After fibre has been cleaned, it can be spun into yarn with a spinning wheel or a straightforward one-handed method. Sacking, doormats, mattresses, and brushes are all made of brown coir. A tiny portion is also turned into twine. Made by needle-felting, pads of coiled brown coir fibre are fashioned and sliced to fill mattresses and prevent erosion on hillsides and riverbanks. Rubberized coir, which is sprayed on a large percentage of brown coir pads to bond the fibres together for use as upholstery padding in European cars, is a product of this process. Additionally, packaging and insulation are made of this substance. The production of rope is the main application for white coir. Using hand or mechanized looms, the finer grades of bristle and white fibre are woven into mats of coir fibre. The use of coir is advised instead of milled peat moss due to its lack of bacterial and fungal spores.

2.4 EXTRACTION OF COIR FIBER Coir fibres are more durable than other natural fibres because of their higher lignin concentration, which makes them ideal for use in applications requiring progressive biodegradability. The two forms of coconut fibres are brown fibres from mature, ripe coconuts that are up to a year old and white fibres from unripe coconuts (from six months). According to Omoniyi and Ayodele (2020), correctly processing fibres to the necessary dimensions and then adding the matrix to make composites are necessary steps in the creation of natural fibre reinforced composite materials. They clarified that, among the many different types of natural fibre that are accessible, coir fibre is one of the hardest since it is difficult to separate or reduce in size for the creation of natural fibre composites. The husks of harvested coconuts from coconut trees in Eziora village, Adazi-ani in Aniocha Local Government of Anambra State, Nigeria, are soaked in water for a period of twelve months. This allows the husks to undergo anaerobic fermentation, which allows them to separate after softening. However, this process is time-consuming and laborious. The husks were pounded with mallets on hard surfaces, and the released fibres were then carefully cleaned and allowed to dry in the sun. According to Hasan et al. (2021), coir fibres require a longer period of up to 12 months for biological retting processes, in comparison to other natural fibres like jute. They made the observation that the flawlessly retted coconut husks are then separated from the less ideal husks and given a water wash to get rid of surface contaminants including mud, sand, and slime. The best white fibre quality is produced by the traditional extraction method, which involves retting over an extended period of time. However, in mechanical fibre extraction processes, the husks are only submerged in water for five days, after which the fibres are extracted using decorticating or de-fibering machines. Coir Board (2018) provided an explanation of the mechanical procedures involved in extracting coir fibre. Firstly, the husk is crushed in a decorticating machine to release the fibres. Next, the longer, coarser fibres are separated from the shorter, woody parts and the pith using rotating "drums." Finally, the stronger fibres are cleaned, dried, hacked, and finally combed.

2.5 CHEMICAL AND MECHANICAL PROPERTIES

The three main chemical components of plant-based fibres are cellulose, hemi celluloses, and lignin, according to Hassan et al. (2021). While lignin is a three-dimensional amorphous poly phenolic macromolecule made up of three different types of phenyl propane units, cellulose and hemi celluloses are polysaccharides. They observed that lignin, which is typically found at the surface of fibres, is amorphous, whereas celluloses, which make up the majority of natural fibres, are crystalline.

Water-soluble pectin and ash are some of the other chemical components of coir fibre in addition to lignin, cellulose, and hemi cellulose. 42.1% lignin, 35.3% cellulose, 6.2% hemi cellulose, 9.3% water-soluble, 4.1% pectin, and 3.0% ash are all present in coir fibre. Coir fibre is one of the most popular fibres for a variety of applications because of its high lignin concentration, which also increases its strength and rigidity. The main physical characteristics of coir fibres are density, modulus of elasticity, strength, and elongation at break. The coir fibre that was extracted had the following characteristics: density of 1.24 g/cm3, strength of 139 MPa, modulus of elasticity of 6.4 MPa, elongation at break of 28%, and saturation of water absorption of 132%.

2.6 APPLICATIONS OF COIR FIBERS REINFORCED COMPOSITES IN AUTOMOTIVE INDUSTRY

Because of their desired mechanical qualities and resistance to corrosion, coir fibre-reinforced composites have found extensive application throughout the years in a variety of fields. "Developed for industrial and socio-economic applications such as automotive interiors, panelling and roofing as building materials, storage tanks, packing materials, helmets and postboxes, mirror casing, paper weights, projector covers, as well as voltage stabilizer covers," claim Bongarde and Khot (2019) regarding coir fibre-reinforced polymer composites.

According to Ayrilmis et al. (2011), coir fibre has the potential to replace more costly and substantial glass fibres in the production of reinforced thermoplastic composites.

They pointed out that coir fibres can be used for non-structural applications, particularly in car door panels, because they can significantly improve the dimensional stability of composites.

The automotive industry is particularly interested in coir fibre because of its high hardness and hard-wearing quality (it is not as fragile as glass fibre), good acoustic resistance, moth resistance, non-toxicity, resistance to microbial and fungal degradation, and ease of combustibility, according to Nasif (2019). He made the point that, in comparison to other natural fibres, coir fibres are more moisture- and heat-resistant as well. Using a coconut fibre-reinforced polymer matrix, Natsa, Akindapo, and Garba (2015) successfully built a military helmet. After evaluating the mechanical properties of the manufactured helmet prototypes, they obtained a positive outcome. But they believed that as the coir fibre was raised to 8.733 N/mm2, the impact test—possibly the most important test of the investigation—showed a steady improvement. Because of their exceptional flexural strength and toughness, coir fibres have also been used as reinforcement in reasonably priced concrete constructions, primarily in earthquake-prone countries.

Satyanarayana, Kulkarni, and Rohatgi (1981) state that coir fibre is used in upholstery production in addition to being used in the manufacture of mats, carpets, brushes, and ropes. They pointed out that it is possible to find new uses for coir fibre, such as reinforcements in plastics, rubber, cement, and clay, thanks to our growing understanding of the fiber structure and properties. Santos da Luz et al. (2017) state that when epoxy composites are mixed with different fractions of coir fibre, they meet the necessary level for ballistic protection against the enhanced power of 7.62 ammunition.

3. CONCLUSION:

The automotive industry has recently shown interest in natural fibre-coir-based composite materials for a number of reasons, including increased vehicle fuel efficiency, more affordable and dependable building materials, and a growing public interest in ecological sustainability. Emerging technologies are currently exploring new composite constructions made of coir and other natural fibres, which have the potential to completely transform the field of biomaterial engineering and research. However, employing natural fibres raises a number of issues that need to be addressed, including poor fibre-matrix adhesion, moisture absorption, and durability. Furthermore, by generating jobs in rural and underdeveloped areas, the use of natural fibres will contribute to the nation's efforts to eradicate poverty, advance sustainable industrialization, build sustainable cities and societies, and practice responsible material production and consumption.

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5. CONFLICTS OF INTEREST

In light of this study paper's publication, I officially declare that I have no conflicts of interest. To the best of my knowledge and belief, this paper contains complete and accurate information. In the name of all contributing writers, I, the corresponding author, hereby proclaim this.

6. AUTHOR'S CONTRIBUTION

In terms of work and manuscript drafting, each author has contributed equally.

REFERENCES:

1. Kelly, A., The nature of Composite Material, Sci. Amer. Mag. 217 (B) (1967) 161.
2. Sustainable composites: Processing of coir fibres and application in hybrid-fibre composites Lucas Ciccarelli https://orcid.org/0000-0002-2539 8006.

3. Ayrilmis, N., Jarusombuti, S., Fueangvivat, V., Bauchongkol, P., and White, R. (2011), "Coir Fiber Reinforced Polypropylene Composite Panel for Automotive Interior Applications" Journal of Fibers and Polymers, vol. 12, issue. 7.
4. Bongarde, U., and Khot, B. (2019), "A Review on Coir Fiber Reinforced Polymer Composite" International Research Journal of Engineering and Technology, vol. 6, issue. 4.
5. Coir Board (2018), "Coir Processing – Technology and Machinery" [Online]. Accessed from http://coirboard.gov.in/?page id=64 on 19 May 2021.
6. Hasan, K., Horvath, P., Bak, M., and Alpar, T. (2021), "A State-of-the-art Review on Coir Fiber-Reinforced Bio composites" The Royal Society of Chemistry Journal, 2021, 11.
7. Nasif, R. (2019), "Effect of Coir Fiber Length and Content on Mechanical Properties of Unsaturated Polyester Composites" Iraqi Journal of Applied Physics, vol. 11, issue. 3.