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A Review on Natural Fibers; Its Properties and Application Over Synthetic Fibers

Ms. G. Parasakthibala[1], Mrs. A.S. Monisha[2]
Department of Home Science, Gandhigram Rural Institute Deemed to be University

Abstract: ***Fibre is a long, thin strand or thread of material made by weaving or knitting threads together. Fibre is a hair like strand of material. A fibre is the smallest visible unit of any textile product. Fibres are flexible and may be spun into yarn and made into fabric. Natural fibres are taken from animals, vegetables or mineral sources. A few examples of widely used natural fibres include animal fibre such as wool and silk vegetables fibres, especially cotton and flax and asbestos, a mineral. Natural fibers are more important part in our human environment. Natural fibers are ecofriendly and inexpensive which are readily available in nature. In this chapter we discuss about the overview of natural fiber and their characteristic. this paper also deals with the impact of natural fibers over the synthetic fibers and also the application of natural fiber in various fields.***
Keywords: Fiber, Natural fiber, Synthetic fiber, Impact of natural fiber.

I. INTRODUCTION

A fibre is commonly understood to be a long hair like object and this notion serves for all ordinary purposes; but the user of fibres requires a clean definition. No material is more common in the world than fibre; it is the form of all vegetable and most animal substances. Life is supreme and original weaver. Flesh is fibre; skin is fibre; muscles are bundles of fibre; leaves, flowers, fruits, stems of grass and bark and wood of tress are all fibres [1].

Fibre is a class of materials that are continuous filaments are in discrete elongated pieces, similar to lengths of threads. They are very important in the biology of both plants and animals, for holding tissues together. They can be spun into filaments, string or rope used as a component of composite or matted into sheets to make products such as paper or felt [2].

Natural fibres are those that are not synthetic or manmade [3]. Natural fibres can be obtained from plant fibres such as sisal, hemp, bamboo, coir, flax, kenaf, jute, ramie, oil palm, pineapple, banana, cotton etc., as well as from animal source, e.g., wool, silk and chicken feather fibres [4].

A. Classification of natural fibres

1) *Vegetable Fibre:* The basic material of all plant life is cellulose. Cellulose is formed of linear chains of glucose units bound to each other like beads in a necklace. The constituent elements in cellulose are carbon, hydrogen and oxygen. All the cellulose fibres have many similar basic properties but do suffer from each other with respect to others [5]. These can be subdivided according to the part of the plant that produces the fibre. Thus, there exist the categories of seed hair fibres, bast or stem fibres and miscellaneous category [6].
2) *Animal fibres:* The fibres are obtained from animals are called as animal fibres. The fibres are mainly made up of protein molecules. The basic element of a protein molecule is carbon, nitrogen, hydrogen, oxygen. Wool (Hair fibres obtained from the animals) & silk fibres are common examples of animal fibres. The fibres obtained from the sheep are referred as wool fibres, in the way the hair of the horse, camel, goat is also obtained as fibre. 90% of hair fibres are wool fibres used various applications. Silk is very delicate filament. It is obtained from silkworms. Silk formation takes place by the secretion of proteinous molecules in liquid form through the glands of the silkworm, It is located on the head of the worm. This liquid proteinous material gets converted into the solid filament. During this secretion process, the worm forms cocoons from which silk is extracted. The sericulture of the silkworm is called as the rearing of the silkworm [7].
3) *Mineral fibre:* Mineral fibres are inorganic materials shaped into fibres and are mainly used in the fire proof fabrics. Examples of mineral fibres are asbestos, graphite and glass. Asbestos occurs naturally as fibres. Asbestos is the only natural fibre obtained from varieties of rocks. It is fibrous form of silicate of magnesium and calcium containing iron and aluminium and other materials. It can be largely used in fire resistance substances. Graphite is the low cast naturally available mineral fibres. They have higher stiffness and reasonable mechanical properties. It will be having higher thermal conductivity. Glass mineral fibres are light weight easily installed and provides outstanding thermal insulation as well as exceptional acoustic performance [8].

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B. Types Of Plant Based Natural Fibres

1) *Bast fibre*: Bast fibres are usually extracted from the outer bark of plant stems. Some examples of bast fibres are jute (Corchorus olitorius/ Corchorus capsularis), flax (Linumusitatissimum), abaca (Musa textiles), and kenaf (Hibiscus cannabinus). Retting is the process through which these bast fibres are extracted, and is accomplished through biological or chemical degradation of cut plant stems.
2) *Leaf fibre*: Leaf fibres are coarse and hard fibres obtained from leaf tissues by hand scraping after beating/ retting process or mechanical extraction. Owing to the relatively high strength, leaf fibres are typically used for the production of ropes, fabrics, carpets and mats. Examples of leaf fibres are sisal, caroa, henequen and pineapple.
3) *Seed fibre:* Coir fibre is a typical example of seed fibre, and it is extracted from the coconut husk. These lightweight and strong fibres are mainly used in the production of ropes, mats, sacks, brush, geotextile and etc. Another set of seed fibres are also extracted from the pod or boll of some plant seeds. Examples are cotton and kapok.
4) *Stalk fibre:* These are fibres from plant stalks, and are typically extracted from plants such as sugarcane, corn, eggplant, sunflower, wood and the straw of various grain crops such as barley, wheat, rice and etc. Pulp from some of these fibres has been utilized in paper and paper board products.
5) *Grass and other fibre crop residue:* Widely available tall grasses such as ryegrass (Loliumperenne), elephant grass (Pennisetum purpureum), switch grass (Panicum virgatum) and bamboo (Bambusavulgaris) are important sources of fibres. Fibrous crop residues such as pulse seed coat, peanut shell, hazelnut husk, corn husk, millet Stover, and etc. can potentially be used as fibre reinforcements in cement-based composites [9].
6) *Wood and specialty fibres:* Wood fibres are sourced from a wide variety of trees. Hence, they are in abundant supply across the world. Wood fibres are broadly divided into two groups, softwood and hardwood. The major difference between these two groups is that while softwood fibres are generally longer than hardwood fibres [10].

C. Characteristics Of A Fibre

1) *Length to Diameter Ratio:* For a fibre to be suitable for textile purpose, its length to diameter ratio must be at least in the range of hundreds. This physical structure enables fibres to be bundled and twisted together to form yarns and threads. Larger items having bigger diameters such as cords and robes are made by first assembling fibres into yarns and in turn assembling them into cords and further into robes through twist and turn.
2) *Strength and Flexibility:* A fibre for textiles must be strong and essentially flexible too. Its inherent high strength enables it to withstand the rigours of the spinning and weaving process and to provide the desired strength in the woven cloth. Flexibility permits the fibres to be duly spun and woven and gives to the textile cloth its unique folding and draping characteristics.
3) *Fibre length:* Fibre length is an important physical parameter. Fibres can be infinitely long, but they must not be shorter than 6-12mm in length, so as to ensure that they are held together by the imparted twists during spinning.
4) *Elasticity and Resilience:* Besides having good strength and flexibility, a textile fibre should also have a good degree of elasticity and resilience without detrimental brittleness. For fibres for clothing, garment and bedding sectors, a good degree of moisture absorption is desirable for good feel and comfort.
5) *Density:* Further, the density of the fibre largely influences its draping qualities when it is made into cloth. Smaller density and lower diameter make finer fibre. Fabrics made from very light fibres may not drape well; if the fibre is too dense, it feels harsh and is heavy and uncomfortable too, with poor drapability [11].

II. PROPERTIES OF NATURAL FIBRE OVER SYNTHETIC FIBRES

Natural fibre is becoming an important alternative to manmade fibres due to their abundant availability, being economical, recyclable and bio degradable as well as high mechanical strength. A lot of environmental problems will be solved by the use of natural fibres. Natural fibres containing unsaturated polyester matrix is greatly advantageous than those of the unreinforced plastics due of the resulting strength and toughness of the composites. Besides, cellulosic natural fibres are strong enough, light in weight, inexpensive, abundant and renewable [12]. In view of development of economical and environment friendly materials for sustainable products, researchers are trying their best to minimise the use of man-made fibres as much as possible by using natural fibres on account of its benefits like low density, eco-friendliness, biodegradability, and high specific strength and modulus [13]. In addition to this, they have other benefits too such as huge availability at low cost, non-toxic in nature, non-carcinogenic, recyclability and so forth.

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Strength and water absorption capacity of these fibres mainly depends upon their constituents such as cellulose, hemicelluloses, lignin, pectin and wax. Cellulose provides the strength to fibres whereas hemicellulose increases the water absorption capacity [14].

Fibre reinforced composites have received much attention based on different applications because of the good properties and the advantages found over synthetic fibres. Here natural fibres contain low cost, density and weight, less pollution during production resulting in minimal health hazards and eco-friendly nature. Composites reinforced with natural fibres also have a short lifetime when it comes to degradation with limited environmental damage whereas synthetic fibres have a negative impact due to degradation pollution [15].

Natural fibres have good absorbency properties while synthetic fibres does not absorbs moistures and these fibres were failed to absorb perspiration. A lot of natural fabrics are extremely breathable and excellent at absorbing excess moisture. This is due to the fibre structure of these fabrics. In most natural fabrics, the fibres are fairly hollow. This allows them to be highly permeable, meaning that any excess heat or odour is passed through the fabric instead of being held in against the body. In contrast, synthetic materials tend to lock in extra heat thus do a very poor job at helping to keep the body at a comfortable temperature. Some synthetic fibres are often prone to skin allergy, because of the dermatological action but the natural fibres gives smooth and soft textures. Natural fabrics, such as wool, silk and cotton, are wonderful because they are naturally hypoallergenic and possess anti-bacterial characteristics. Which makes them perfect for people that may have sensitive skin or allergies. Unlike synthetic materials which have the potential to irritate the skin and lock in unwanted odour [16].

The fibre reinforced polymer composites are developed primarily using synthetic fibres such as glass, carbon, Kevlar. Etc. But the growth in environmental consciousness, community interest the new environmental regulations and unsustainable consumption of manmade materials, led to thinking of the use of environmentally friendly materials. Owing that view natural fibre is considered as one of the best environmentally friendly materials which have good properties compared to synthetic [17].

III. APPLICATION OF NATURAL FIBRES IN VARIOUS FIELDS

The applications of natural fibres are growing in many sectors such as automobiles, furniture, packing and construction. This is mainly due to their advantages compared to synthetic fibres, i.e., low cost, low weight, less damage to processing equipment, improved surface finish of moulded parts composite, good relative mechanical properties, abundant and renewable resources [18]. Natural fibres are used in various applications such as building materials, particle boards, insulation boards, human food and animal feed, cosmetics, medicine and for other biopolymers and fine chemicals [19].

Automotive and aircrafts industries have been actively developing different kinds of natural fibres, mainly on hemp, flax and sisal and bio resins systems for their interior components. High specific properties with lower prices of natural fibre composites are making it attractive for various applications [20].

Natural fibres reinforced composites are emerging very rapidly as the potential substitute to the metal or ceramic based materials in applications that also include automotive, aerospace, marine, sporting goods and electronic industries [21]. Natural fibre composites exhibit good specific properties, but there is high variability in their properties. Their weakness can and will be overcome with the development of more advanced processing of natural fibre and their composites. Their individual properties should be a solid base to generate new applications and opportunities for bio composites or natural fibre composites in the 21st century “green” materials environment. The exploitation of natural fibre composites in various applications has opened up new avenues for both academicians as well as industries to manufacture a sustainable module for future application of natural fibre composites [22].

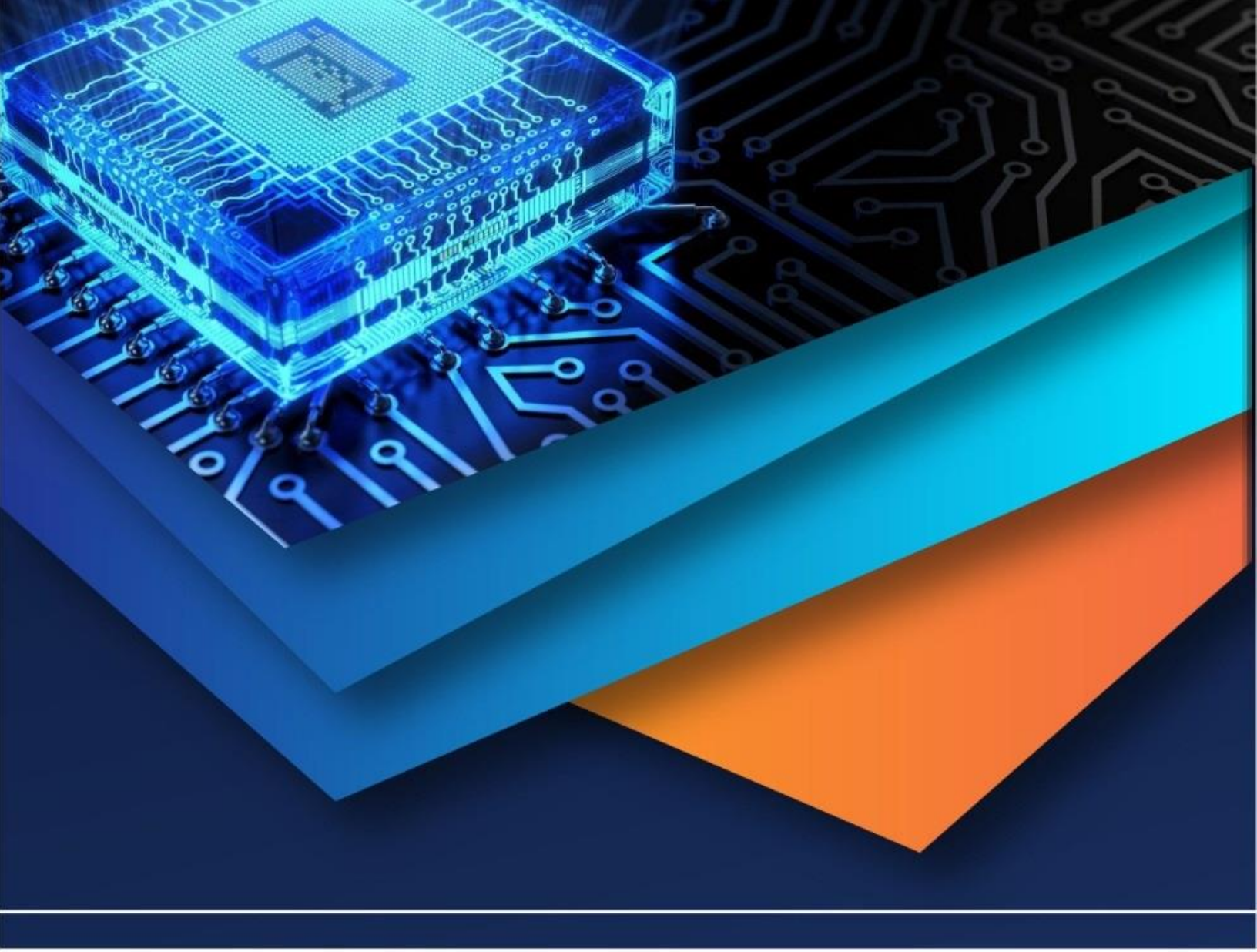
There are several industries such as automotive, construction, energy and aerospace, among others which are being challenged by the society and governments to make products which are more environmentally sound and reduce their dependence on fossil fuels [23]. This type of legislation is a significant driving factor towards the adoption of natural fibre composites. In this scenario, natural fibres are an attractive option for industries to meet socio-economic and environmental challenges. Furthermore, the use of natural fibres would create employment opportunity in rural and less developed regions thus helping in achieving the sustainable development goals [24].

IV. CONCLUSION

Natural fibers that are renewable and environmentally friendly source of raw materials to create environmentally friendly products have played an important role in human civilization. Natural fibre is considered as one of the best environmentally friendly materials which have good properties compared to synthetic. Now a days natural fibers are used in all sectors like agriculture, automobile, building construction, insulation boards, medicine, composite materials etc…

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