



PACE-2021

International Congress on the Phenomenological Aspects of Civil Engineering

Research Article

20-23 June 2021

Utilization of Natural Fibers in Construction Industry: A Review

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Keywords

Production, Properties, Utilization, Significance, economic, Ecological and sustainable, Composites, Matrices, Sustainability.

Abstract

This paper reviews the utilization of the natural fibers and the benefits acquired, following their use as construction materials, to achieve sustainable infrastructure. The concrete being most widely used construction material in the infrastructure industry is brittle in nature causing fatigue and failure cracks without showing the plastic deformation. The addition of fibers however, increases the ductility of the concrete and hence, reduce the failures and cracks. The addition of artificial fibers such as steel and glass fibers to the construction materials have produced successive outcome to transition the nature of concrete to ductility, but they compromise the economy significantly. Consequently, the addition of the natural fibers concludes their use as construction materials for an economic, ecological and sustainable infrastructure. The research on the use of natural fibers as construction materials is necessary to investigate their significance in the construction industry to enhance the sustainability.

1. Introduction

The fibers are hairlike raw materials which are acquired from either a natural or artificial source which include the artificial fibers such as glass, steel and nylon, and the natural fibers such as Researchers have used plant fibres as an alternative source of the artificial fibres to be used in composites in the building materials, primarily concrete [1], for increasing its strength, while not losing the economy. These plant fibres, herein referred as natural fibres, include coir, sisal, jute, ramie bast, pineapple leaf, kenaf bast, date, bamboo, palm, banana, hemp, flax, cotton and sugarcane [3,5]. The significance of these natural fibers is an important factor which must be put under consideration, during the construction practices for the sustainable infrastructure. The construction materials primarily the concrete is brittle in nature, failing without showing the plastic deformation, the need of fibers to add ductility to concrete becomes a necessity [2,6]. Adding the steel fibers to the materials produce the successive outcome to transition their nature to ductility, and prevent the failures such as fatigue failures and cracks [4]. However, the use of the artificial fibers, mainly the glass nylon and/or steel fibers, compromise the economy substantially. Therefore, the use of natural fibers as construction materials provide the economic, ecological and sustainable alternative for sustainable infrastructure.

Construction is a vast field including the categories like structure, design, transportation, Geotech and many other fields. The basic purpose in the construction industry includes that the construction must be environmentally friendly and economical. The determination of the properties of natural fibers is to investigate that it can be used in the construction industry or not. This research is to use of the natural raw fibers rather than the materials are using now a days. This is determined by different tests and experiments such as tensile strength, young's modulus, water absorption, chemical composition, etc. The determination is done carefully under the considerations that it gives a better result and it must be economical and environmentally friendly. The researchers study comparatively about the natural fibers properties and characteristics as reinforced concrete

composites [2]. Coconut fiber can be used as reinforced in corrugated slabs that their properties related according to strength and stability [3]. Natural fibers properties relate with the compressive and tensile strength to achieve for sustainability [4]. The reviewers review about the natural fibers used as composite polymer materials [5]. Researcher Used the coir fiber to improve the properties of expansive soil. They determine the characteristics of the soil and to improve them they use coir natural fiber [2]. The research included the mechanical properties of natural fibers as a reinforced thermoplastic to enhance a sustainable construction [6]. Many researchers work on the

determination of mechanical properties of natural fibers to be used these raw materials as construction materials for sustainable infrastructure.

2. Natural fibers as construction materials

The addition of the fibers has brought the remedies to the failures and the problems prevalent in the infrastructure industry. Due to the considerable brittle nature of the concrete, the problems such as the fatigue and failure cracks arise. Therefore, the addition of the fibers to the materials transitions the nature of the concrete to ductile in nature by showing plastic deformation preceding the failure, and hence bring about the solutions to these problems. For instance, the addition of the artificial fibers such as steel and glass to the concrete does alter the properties and bring about the increase in their strengths. However, the economy of the construction gets compromised substantially. Therefore, the natural fibers as construction materials are preferred for sustainable infrastructure, as these fibers can be renewed and they are non-abrasive, inexpensive, abundant availability, and they exhibit high flexibility and are budget effective as they can be re used over and over again with the abundant availability in the world for their use. Therefore, using the natural fibers as reinforcements in polymer composites is increasing substantially, for inexpensive construction materials these days and in the upcoming years. [14]. An experimental investigation to study the influence of the addition of steel fiber reinforcement on the stress-strain behavior of concrete made with aggregates. Moreover,

the flexural strength and splitting tensile strength was also put under examination. As a consequence, it showed an increase in the toughness and the compressive strength was enhanced.

Furthermore, the natural fiber-reinforced composites are more and more frequently applied to the construction practices. It was determined that the fiber-reinforced composites alter and enhances the mechanical properties of the product obtained [22].

2.1. Production of natural fibers

The natural fibers are the natural raw materials which are acquired from the natural sources such as plants and animals, for instance, the sugarcane, cotton, sisal and hosts of other natural fibers which are easy to acquire due to their abundant availability in the world. The grown crops and the extraction from the animals are primarily the sources of the natural fibers. The statistics show the abundance of the we have to determine the mechanical properties of natural fibers available in the region. As for the determination of mechanical properties of natural fibers, different lab tests and experiments are to be performed. The tests include water absorption, tensile strength, tensile modulus, young's modulus, chemical composition, etc. Many researchers used the natural raw fibers in the specimens to determine the properties that rather it can be used in construction or not. But according to this paper, different tests performed only on the natural fibers sample and determine on the basis of that tests that can it be used in the construction industry or not. We need some specific tests to determine that can it be economical and sustainable for infrastructures. To determine the strength and sustainability of the natural raw fibers.

The researchers perform tests on natural fibers as compressive strength and the tensile strength tests to determine their strength and stability as a sustainable construction material [4]. The natural fiber is a microstructure material and their mechanical properties checking by different tests on breakage of these sample of the fibers [7]. Properties checking on the performance of various natural fibers composites using for different scenarios [16]. The abundant production of the natural fibers in the world is shown in the figure 1 attached below.

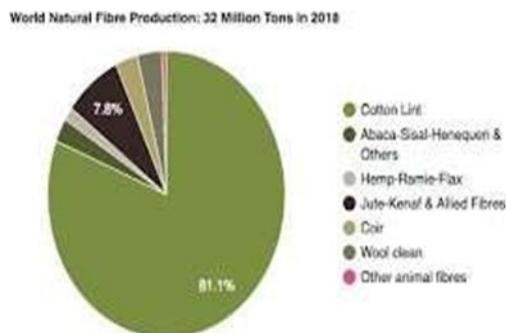


Figure 1. Natural fiber production in million tons in the world (Townsend, T. 2016)

2.2. Properties of natural fibers

The addition of the artificial fibers such as steel and glass to the construction materials do alter the properties and bring about the increase in their strengths. However, the economy of the construction gets compromised substantially. Therefore, the natural fibers as construction materials are preferred for sustainable infrastructure, as these fibers can be renewed, they are non-abrasive, inexpensive, possess abundant availability, exhibit high flexibility, are budget effective, and show less concern with health and safety during handling and processing [10,16,19]. Therefore, there has been a growing interest in utilizing natural

fibers as reinforcement in polymer composite for low-cost construction materials in the recent years [14].

Furthermore, the natural fiber-reinforced composites are more and more frequently applied to the construction practices. It was determined that the fiber-reinforced composites alter and enhances the mechanical properties of the product obtained [22]. However, the determination of their properties is essential to be carried out to check whether they are worthy of being used in the construction industry. For the development of an economic and sustainable infrastructure, the natural raw fibers could be used without exhaustion of resources for future.

The researchers reviewed about the natural fibers (banana, coir, sisal) used as the alternative materials in construction industry. These materials are to be economical and environmentally friendly [19]. To review the fiber properties for use as alternative materials instead of the materials using now in construction [15]. To review the natural raw fibers as used in the construction and as building materials [9]. Fibers are determined according to their mechanical properties for use in design and as materials [8].

2.3. Utilization of natural fibers in construction industry

The addition of the artificial fibers such as steel and glass to the construction materials do alter the properties and bring about the increase in their strengths. However, the economy of the construction gets compromised substantially. Therefore, the natural fibers as construction materials are preferred for sustainable infrastructure, as these fibers are renewable, non-abrasive, cheaper, abundance, show high flexibility and show less concern with health and safety during handling and processing [10,16,19]. Therefore, there has been growing interest in utilizing natural fibers as reinforcement in polymer composite for low cost construction materials in the recent years [14].

Furthermore, the natural fiber-reinforced composites are more and more frequently applied to the construction practices. It was determined that the fiber-reinforced composites alter and enhances the mechanical properties of the product obtained [22].

The physical and mechanical properties of the natural fibers in correlation to the materials and specimens they are used in alter their properties as well. The residual tensile strength (or toughness) of concrete is experimentally determined to be considerably enhanced with the addition of fibers, after the matrix has cracked, and quantifying this defines the material for design. The use of natural fibers enhances all the strength and flexural performance of concrete, and the ductility of brittle construction materials [7,8,11,20]. The results of the investigation showed that natural fibers can be used as reinforcement in the cement-based composites to elevate the economical construction practices, while enhancing the strength, ductility and toughness of the materials. Furthermore, the addition of the natural fibers to the composites modifies beneficially the cracking behavior of concrete and cement matrices. Also, the crack width is reduced [7]. The improvement becomes significant in the fracture toughness of these natural fiber composites. In addition to this, with a slight adverse effect on the compressive strength of the natural fiber composites, their tensile strength gets improved significantly [17,18]. This results in the economic, ecological and sustainable construction practices, with the enhanced strength of the materials they are used in the researchers study comparatively about the natural fibers' properties and characteristics as reinforced concrete composites [2]. Coconut fiber can be used as reinforced in corrugated slabs that their properties related according to strength and stability [3]. Natural fibers properties relate with the compressive and tensile strength to achieve for sustainability [4]. The reviewers reviewed about the natural fibers used as composite polymer materials [5].

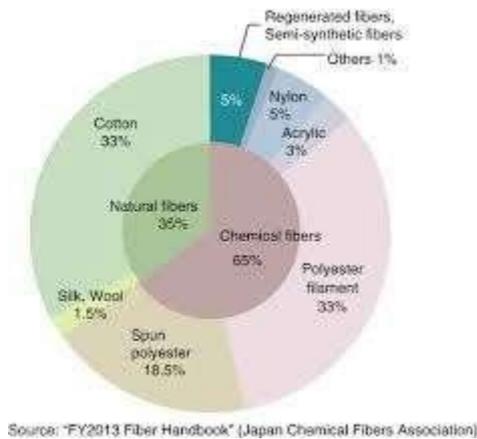


Figure 2. Construction materials conjoining the natural fibers (Fujita, H. 2011)

3. Conclusion

To conclude with, the availability in the abundance of the natural fibers on the planet Earth, summon their use in the construction industry after their properties fulfilling the desired requirements to be used in construction industry. The natural fibers proceeding the determination of their mechanical properties correlating to the properties required, can be utilized as the construction materials, as reinforcement of composites for the sustainable infrastructure signifies the increase in the economic, ecologic and sustainable construction practices, with the considerable increase in all the strengths and the ductility of the materials by altering and enhancing their properties to minimize the failures in the infrastructure industry for sustainability.

Declaration of Conflict of Interests

The author(s) declare(s) that there is no conflict of interest. They have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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