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A Review of Testing of Natural Fibers: Form Theory to Practice

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ABSTRACT:

This study examines both traditional and cutting-edge testing on natural fibers. The testing of natural fibers is the subject of numerous research articles. Prior to being tested in a lab to determine their basic and cutting-edge properties, natural fibers are sampled and ready for analysis. Various lab tests on natural fibers are conducted to determine the properties that can it be used in the construction industry or not. Determination of natural fibers including their characteristics, mechanical properties, and their chemical composition. Various natural fibers such as sisal, kenaf, jute, kapok, sugarcane, coconut, cotton, wheat straw, rice straw, etc. can be used as sustainable construction materials after their basic and state of art testing determined on the prepared samples. These natural fibers are cut and are organized according to the prescribed standards and requirements, so the determination of their properties through the lab tests can be preceded. The problems included that the materials that are used in construction industry are harming our environment and they are not economical as much. The research on the determination of properties of the natural fibers is necessary to investigate the needs for construction industry to be economical and environmentally friendly by various basic and state of art testing.

KEYWORDS: Sampling of natural fibers, basic testing, state of the art testing.

1. INTRODUCTION:

Natural fibers obtained from plants and animals that are thread or rope like microstructure which are used in different purposes as according to their different use and their significances. Natural fibers can be stretched more than 500% of their original size and can also return to its original shape when load is removed. They are more durable, and they are of low cost, cheap, easily available, light weight, etc. Construction is a vast field including 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 properties'



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determination of natural fibers is to investigate whether can it be used in the construction industry or not. For the determination of properties, various lab tests and experiments are conducted. Various tests and experiments such as tensile strength, young's modulus, water absorption, chemical composition, XRD, SEM Analysis, XEN, etc. The determination is made carefully under the considerations that it gives a better result, and it must be economical and environmentally friendly. The researchers study comparatively about the basic and state of the art testing on natural 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. These basic tests are for the determination of their mechanical properties [4]. Natural fiber is a microstructure material and their mechanical properties are checked by different tests on breakage of these samples of the fibers. The samples prepared were tested and the researcher determines the properties of these natural fibers for construction use [7]. Composite materials combine two dissimilar materials to attain better properties. A specimen product of such a composite material is sampled to check the properties at a certain temperature. The composite material is tested for its mechanical properties using various testing machines in labs and the results from them will be recorded. The composite material specimen is analyzed with ANSYS software for its mechanical properties.

The results from this show the variation according to different areas. Natural Fibers take out from the middle have more tensile strength and greater elongation than top and bottom fibers. The dependence on the diameter of mechanical properties of fibers is observed [5]. In this paper, mechanical response was measured by the tension test and bending test while the crack formation was determined by using a high-resolution image capturing procedure. Crack spacing was measured by the analysis of image and correlated with the applied load under both the tensile tests and bending tests. The effect of flexural cracking was measured by strain gauges during the bending tests [7].

As to use natural fibers, the properties and characteristics of natural fibers are to determine. For these properties' determination, the basic lab tests and experimental procedure are required. By knowing about the properties of natural fibers, we can conclude that either the raw fibers can be used in the construction field or not. So, for this, different basic tests are required for properties' determination of natural fibers to be used in construction industry. These tests include physical properties (diameter, length, flexural strength) of natural fibers, SEM Analysis, EDX, XEN, tensile strength test, young's modulus, tensile modulus, etc. The basic and state of the art testing on fibers including the sampling of natural fibers, basic testing and state of the art testing.



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1.1 Sampling of natural fibers

Natural fibers are the raw materials which are extracted from the animal or the plant sources, such as wheat straw, sugarcane, hemp, cotton, and multiple other natural fibers which are abundantly available from nature. These fibers, before the lab testing for the determination of the basic and the state-of-the-art properties, are sampled and prepared for the testing. These natural fibers, after being acquired from the different sources are sampled and are gathered for further testing of the properties.

Furthermore, these natural fibers are cut and are organized according to the prescribed standards and requirements, so the determination of their properties through the lab tests can be preceded. The state-of-the-art testing comprises of testing and analyzing the chemical composition and the chemical determination of the natural fibers. The sampling is that the various tests are performed on the natural fibers for their mechanical properties as to be used in the construction field. For the tests their samples are to be prepared by different processes of preparation for testing.

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. This could be done by preparing different samples of the natural fibers on the basis of their needs and use in the micro testing machines [4]. Natural fiber is a microstructure material and their mechanical properties are checked by different tests on breakage of these samples of the fibers. The breakage is determined that it has maximum or minimum strength and stability to be used in construction field [7].

Fibers	Tensile Strength	Young's	Elongation at break	Density (g/cm3)
	(MPa)	modulus (GPa)	(%)	
Coir	220	6	15-25	1.25
Cotton	400	12	3-10	1.51
Flax	800-1500	11.8	3.7-4.3	1.4
Hemp	550-900	60-80	1.2-1.6	1.4
Jute	410-780	70	1.6	1.48
Kenaf	930	53	1.6	-
Ramie	500	44	2	1.5
Sisal	610-720	9-24	2-3	1.34

Table 1: Mechanical properties of natural fibers (Sanjay, M. R. 2015)

Properties checking on the performance of various natural fibers composites using for different scenarios. The samples of the fibers are ready to investigate the properties by various testing machines by placing the specimens [8]. In this paper, the SEM test is processed to analyze the



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multi-level cracking mechanism and fiber-matrix bond. The results obtained from different mathematical models of uniaxial compressive stress-strain curve are in good agreement with experimental data [10]. Different studies were done on natural fiber reinforced specimens to determine the properties of fibers to be use in the construction industry. The overall aim of the research program is to improve construction techniques for the rigid pavement by use of easily available natural fibers. This will be done by preparing the samples of fibers and used as specimens in micro-structural machines [5].

1.2 Basic testing

To determine the properties of natural fibers, various lab tests and experiments are carried out. As the use of natural fiber is determined by the properties and characteristics of natural fibers. For these properties' determination, the basic lab tests, and experimental procedure are required. By knowing about the properties of natural fibers, we can conclude that either the raw fibers can be used in the construction field or not. So, for this, different basic tests are required for the properties' determination of fibers to be used in construction industry. These tests include physical properties (diameter, length, flexural strength) of natural fibers, SEM Analysis, EDX, XEN, tensile strength test, water absorption, young's modulus, tensile modulus, etc. These are some basic tests on natural fibers through which their use in construction industry could be determined. The tests performed on natural fibers as compressive strength and the tensile strength tests to determine their strengthand stability as a sustainable construction material. The natural fibers are microstructure material and their mechanical properties checking by different tests on breakage of these samples of the fibers.

Fiber and concrete properties are determined by various experimental tests. The equations are proposed for determining the natural fibers by different tests such as tensile stress tests, elastic modulus toughness tests, etc. Empirical equations are also developed to determine the bonding strength and the energy which is required for fiber carried out [3]. The toughness of coconut fiber is higher than the natural fibers. As the availability of this fiber is easy and it has low cost, it is more convenient for its use in concrete composites. The concrete road thickness can be reduced using natural fibers. Thus, the improvement in mechanical properties, their utilization to be used in concrete roads for reduction of thickness [4]. The natural fibers such as cotton, kenaf, kapok or sisal has the key advantage that they are environmentally friendly if being used in the construction industry and also, they are of low cost and low weight, easily available and they are cheap. In this paper, the experimental work on the fibers to determine their properties for use. The results showed from the study point of view that the cotton fiber is to be satisfied as in the structural performance [11]. In this paper, the characteristic's determination of the following natural fibers including kenaf, kapok, sisal, cotton, coconut, etc. involved. The coefficient of absorption and resistance of flow for the prepared samples of dissimilar thickness have been measured. The study also



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differentiates the measured behavior with the theoretically (actual) predicted behavior [12]. This paper produces the results of overall experimental investigations by different tests that include triaxial shear tests, swelling, and consolidation tests. The paper includes the discussion about the mechanisms of improvement in strength, shrinkage, swelling and compressibility behavior of black cotton soils by the addition of coir fibers [1]. Figure 1 shows relationship between tensile strength and fiber weight fraction.



Figure 1: Relationship between tensile strength and fiber weight fraction (Hanna, W. A. 2011)

1.3 Result and Testing Analysis

The state-of-the-art testing comprises of chemical composition and the chemical analysis of the natural fibers. The chemical composition of natural fibers is analyzed, and the tests performed mainly are SEM analysis, XRD, ADX and a few other tests to analyze the natural fibers chemically. Furthermore, the analysis of the chemical composition provides adequate statistical data regarding the bonding, micro-level particle shape and the cohesion between the particles. The use of biobased material in construction can improve the environment condition as sustainability. There is a use of natural materials to develop more adaptable products. The chemical composition of natural fibers is determined by various testing with different materials and by knowing their properties.

The success of natural fibers under the loading by using in concrete is to be investigated. The impact resistance and flexural strength are determined by various tests conducted. The surface which is fractured is analyzed at micro level by Scanning Electron Microscope (SEM) test under impact and flexure loads [9]. There is a need to explore fiber for use of material. For this purpose, we need to explore wheat straw reinforced concrete (WSRC) in depth. Micro-structural analysis of wheat straw is evaluated and determines its bonding strength with concrete [2].



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This paper investigates the effects of cellulose and combustion of natural fibers (cotton, coconut, kenaf, kapok, sisal). Different aspects have been studied to evaluate the relation between chemical composition, combustion, and effective heat of combustion. A correlation was found between these aspects [6]. This paper shows the development of eco-composites by use of natural raw fibers. So, for this, their basic mechanical properties are to be determined. The tensile strength of the natural fiber reinforced composites was measured by the tensile test. The experimental results showed that the specific modulus of the fibers was as high as that of the conventional glass fibers. The results from the test show that the fibers have a potential to be used as reinforced composites [8]. Figure 2, illustrate the chemical composition of natural fibers through SEM analysis Test.



Figure 2: Chemical composition of natural fiber through SEM Analysis (Fiore, V. 2014)

2. CONCLUSION

The findings of the research stated that the lab tests and studies carried out to determine the mechanical properties of natural fibers rely heavily on both basic and state-of-the-art testing on natural fibers. The tests are conducted not only to verify their characteristics but also to assess their suitability as building materials. There will be laboratory tests. These natural fibers are arranged and cut in accordance with the guidelines and criteria specified so that their qualities can be ascertained in advance through laboratory testing. Modern testing includes examining and evaluating the natural fibers' chemical makeup as well as their chemical composition. The sampling includes the preparation of the samples of natural fibers for different basic testing to magnify the natural fiber's properties as construction materials. Also, the chemical composition of natural raw fibers is determined for their use in the construction industry.



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