**International Journal of Advanced Engineering and Technology**
**ISSN: 2456-7655**
**www.newengineeringjournal.com**
**Volume 1; Issue 1; March 2017; Page No. 01-04**

# A review on natural fibres in the concrete

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**Abstract**
Considering global warming issues in the environment, recently there has been a rapid growth in research and innovation in the natural fiber composite (NFC) area. Interest is warranted due to the advantages of these materials compared to others, such as synthetic fiber composites, including low environmental impact and low cost and support their potential across a wide range of applications. Much effort has gone into increasing their mechanical performance to extend the capabilities and applications of this group of materials. This review aims to provide an overview of the factors that affect the mechanical performance and durability performance of NFCs and details achievements made with them.

**Keywords:** composites, cement paste, mortar, fiber reinforced concrete; natural fibers

## 1. Introduction

Fibres are thread like materials which can be used for different purposes. Fibres produced by plants (vegetable, leaves and wood), animals and geological processes are known as natural fibres. Researchers have used plant fibres as an alternative source of steel and/or artificial fibres to be used in composites (such as cement paste mortar and/or concrete) for increasing its strength properties. These plant fibres, herein referred as natural fibres, include coir, sisal, jute, Hibiscus cannabinus, eucalyptus grandis pulp, malva, ramie bast, pineapple leaf, kenaf bast, sansevieria leaf, abaca leaf, vakka, date, bamboo, palm, banana, hemp, flax, cotton and sugarcane.

Natural fibres are cheap and locally available in many countries. So their use as a construction material for increasing properties of composites costs a very little (almost nothing when compared to the total cost of the composites). Their use can lead to have sustainable development. Another benefit may also include the easy usage/handling of fibres due to their flexibility, because the problem arises when a high percentage of fibres is to be used as in case of steel fibres. But for use of very high percentage of fibres, there is a need to invent a methodology for casting. Volume fraction and fibre content are two terminologies used for expressing the quantities of fibres in a given composites reinforced composites can be used for many civil engineering applications including roofing tiles, corrugated slabs, simple slab panels, boards and mortar etc.

## 2. Literature review

Has done the review on mechanical performance of different natural fiber composites and detail achievements made with them are stated that improvement has occurred due to improved fiber selection, extraction, treatment and interfacial engineering as well as composite processing. Also focused on improving strength, stiffness and impact strength, including the effect of moisture and weathering, long and short term performance. NFCs compared favorably with GFRPs in terms of stiffness and cost; values of tensile and impact strength are approaching those for GFRFs. The lower densities for NFCs lead to better comparison for specific properties. Applications of NFCs have extended dramatically, including load bearing and outdoor applications such as automotive exterior under floor panelling, sports equipment and marine structures.

Conducted several investigations on the strength and behavior of concrete reinforced with natural fibers. Since natural fibers are available in abundant quantities in many developing countries, more elaborate research should be directed toward the various problems associated with the use of these fibers. This paper presents a critical review of the factors that affect the properties and behavior of natural fiber reinforced concrete (NFRC).Test results for concretes obtained by using water blended with yeast granules are also reported in this paper. Most of the vegetable fibers, when dried, lose their mois-ture. To achieve better results, the presence of certain amounts of moisture is necessary, and this aspect needs further study. The effect of creep and cyclic reversal of stresses on NFRC should be investigated. Hence, proper treatment of the fibers before mixing may be necessary. To increase durability, partial replacement of ordinary Portland cement by rice husk ash or silica fume is recommended. Other types of admixtures, such as resins and gums, can be tested to prevent decay of natural fibers that have been embedded in concrete.

Reported, results in the investigation indicate that, there is a possibility to enhance the properties of jute fiber reinforced polyester composites. But very few investigations Carried on jute/glass fiber reinforced epoxy composites and properties. Literature showed that there was no much Information available on modal test method to find the dynamic properties

of the composites. Development of a suitable hybrid with a known stacking The sequence will have applications in the automotive industry for weight and cost reduction; this leads the way for the investigation of mechanical and dynamic properties of jute/glass fiber reinforced epoxy hybrid composites by using both static test methods and dynamic test methods and validating the results through FE simulation.

Irene S. Fahim, Salah M. Elhaggar, Hatem Elayat conducted the research on potential usage of virgin Low density polyethelyne (LDPE) reinforced with different concentrations (2%, 5% and 6% by weight) of treated rice straw with different lengths (2 mm, 4 mm and 6 mm) is investigated to produce high value products that have technical and environmental demand. The result of investigating these two mechanical properties, using statistical analysis & design of experiments, showed an enhancement in the mechanical properties of the virgin polymer composite compared to the virgin polymer. The flexural stress of the composite increased three times the virgin flexural stress, while the tensile stress increased eight times the original tensile stress. The most suitable chemical was the phosphoric acid with 1% chemical concentration due to obtaining the highest values of tensile and flexural stress compared to the other treatments. Moreover, the waste generated from the chemical treatment of rice straw using phosphoric acid can be utilized as a fertilizer component for land reclamation. The fiber concentration of rice straw used was 5% as it showed improvement in flexural and tensile stress. This percentage was recommended through literature review. Increasing the fiber concentration to 6% in the experimentation stage lowered the flexural stress 2 times and the tensile stress 4 times.

B H V Pal, Sujith Kumar C.P conducted an experimental investigation on high performance steel fiber reinforced self-compacting concrete (SFRSCC) with silica fume as the filler material. Fiber content was varied from 0 to 5% at intervals of 1 % by weight of cements. Effect of the addition of these fibers on the various strength of concrete was studied. From the experimental study it was found that the compressive strength of concrete at 28 days shows a peak value of 80.44 MPa at w/c ratio of 0.34, with 7.5% silica fume dosage, 0.6% super plasticizer and 4% steel fibers, all by weight of cement.

Conducted experiments using different natural fibers to concrete in order to study the strength properties and also to observe if there is reduction in propagation of shrinkage crack problems. Basically natural fibers are of two types. Natural inorganic fibers such as Basalt, Asbestos…etc and the other are the natural organic fibers such as coconut, palm, kenaf, jute, sisal, banana, pine, sugarcane, bamboo…etc.he concluded that Slump is decreasing with the addition of fibers. More the fiber-cement ratio, more is the decrease in slump due to absorbency of water by fibers. The addition of fibers increased compressive strength with 0.5% fiber-cement ratio and little increase for 1% of fiber-cement ratio compared to plain concrete. But at 1.5% of fiber-cement ratio, though plasticizer is added, the compressive strength is decreasing compared to plain concrete

Has done the review on different natural fibers evaluated in the last few decades, and thus, it can be used as a reference/guideline for the upcoming research of a particular fiber. The use of natural fibers, as reinforcement of composites (such as cement paste, mortar and/or concrete), is economical for increasing their certain properties like tensile strength, shear strength, toughness and/or combinations of these. Since, variations exist in properties of natural fibers; therefore, such deviations should be properly addressed as we have categorized the gradation of aggregates.

Has conducted research to produce a sustainable “green” concrete material using natural fibers such as industrial hemp, palm, and banana leaves fibers. Which would increase the service life and reduce the life cost of the structure, and would have a positive effect on social life and social economy. Test results indicated that the use of natural fibers resulted in reducing the coarse aggregate quantity without affecting the flexural performance of concrete. Based on the preliminary test results, the use of industrial or local hemp fibers in concrete mixes would result in promising compression and flexural strength values a behavior and reduction in the consumption of coarse aggregates, as compared to the control samples in addition to the palm and banana samples. The preliminary test results for palm and banana fibers were acceptable but not as with the industrial hemp fibers; moreover, the preparation process of the fibers is not simple and needs to be updated to include mechanical processing for large quantities production.

Presented the studies on durability of natural fibres such as coconut coir and sugarcane bagasse has been reported by conducting an experimental investigation. This investigation includes two parts. The first part focuses on the determination of mechanical strength properties such as compressive, tensile, modulus of rupture and flexural properties of natural fibre reinforced concrete specimens once every 3 months for a period for 2 years under alternate wetting and drying conditions. Gain or loss in strength of composite concrete at 9 intervals were computed and are reported here. The second part covers the microstructural properties of fresh natural fibres in as received condition and natural fibres reacted with concrete under accelerated curing conditions for two years. SEM and EDAC test results are discussed.

Sravastano *et al.* (2009) [12] reported that the evidence of crack - bridging and fibre pullout was observed on the fractured surface of the R~ curve (Resistance to fracture curve) specimen. It is also reported that the stable fatigue crack growth of the natural fibre cementious composite may be attributed to degradation of bridging zones. Also reported that toughening in the natural fibre reinforced composites occurs largely as a result of crack bridging. It is also reported that the intrinsic toughness of the natural fibre cement composites

reinforced with sisal, banana and eucalyptus fibres was between 1.2 and 1.4 MPa Vm.

Boghossion and Wegner (2008) [2] reported that the addition of low volume fraction of short flax fibers to Portland cement mortar is effective in reducing the cracks resulting from the restrained plastic shrinkage under condition that produce high evaporation rates. It is also reported that the improvement increased with increasing volume fraction but the variation in fibre lengths (10 mm and 38 mm) did not significantly influence the cracking behavior.

Ismail (2007) [4] reported that compressive strength and bulk density are slightly increased at low fibre content (0.3 to 1.5% by volume). However beyond a fiber content of 1.5%, a reduction in compressive strength of about 8.2% for every 0.5% fiber volume increase was observed.

Reis (2003) [9]; Ferreira (2004) [8] reported that coconut fiber reinforcement improved the flexural properties of epoxy polymer concrete and this improvement is more than the glass and carbon fiber reinforced concrete. The Coconut fiber increased the flexural strength by about 25% as compared to referral unreinforced concrete. It is also reported that sugarcane bagasse improved slightly (3.5%) the flexural strength.

Kriker *et al.* (2005) [6] have reported that in water curing, the vegetable fibre reinforced concrete is marginally better in respect of compressive strength.

Reported that the maximum crack width and length are not sensitive to the type and contact of the fibres. However, the ultimate crack resistance is affected significantly by use of coir fibres. The ultimate crack resistance was found to increase with the fibre content. It is also reported that the average increase in the crack resistance ratio (Crs), considering the lower and upper bounds of fiber contact used, is highest for coir fibre reinforced slab.

Savastano *et al.* (2005) [11] reported that the matrix cracking occurred close to the fibers as a result of internal tensile stresses generated by volume changes in the fibers.

Siddiqui (2004) [15] included san fibers (0.30 - 0.90%) in fly ash concrete (fly ash content 30 - 50%) and reported that the fracture toughness of concrete matrix increased with fiber content. The maximum increase in fracture toughness was found at fiber content of 0.9%. The increase was about 7.2, 4.9 and 3.7 times for concrete matrix with fly ash content 30, 40 and 50% respectively at 28 days. At 91 days, the respective changes were 4.9, 3.8 and 2.6times.also reported that addition of san fiber increased the flexural strength of fly ash concrete. This increase is about 5% at 0.25% fiber content while at 0.75% fiber content the increase is about 10%. The addition of twines of natural san fiber enhanced the load carrying capacity and ductility

Filho and Sanjuan (1999) [3] have reported that the addition of 25 mm long sisal fibers (0.2% volume fraction) reduced free plastic shrinkage strains and also reduced cracks widths in restrained ring type specimen of cement mortars.

Savastano *et al.* (1999) [10] reported that the modulus of rupture (MOR) of coir fibre reinforced composite was 18% more than that of referral at same w/c ratio. It is also reported that composite made with Eucalyptus pulp has 16.5% higher MOR as compared to referral.

Soroushian and Ravanbakhsh (1998) [16] have also reported that cellulose fibres (0.06% volume fraction) reduced plastic shrinkage crack area by 78% relative to plain concrete.

## 3. Conclusions

From the above study it may be concluded that the use of fibers in the concrete which is generated from agricultural activities in rural and urban areas construction material.it modifies beneficially the cracking behavior of concrete and cement matrices. This results in stronger, safe and economical structures in rural areas where these are freely and easily available. The workability is adversely affected by fibre addition. The fibre addition improves significantly the crack resistance. Also, the crack width is reduced. The fracture toughness of natural fibre composites is greatly improved. The compressive strength of natural fibre composites is not affected much upto certain fibre content. In general, the tensile strength of natural fibre composites is improved significantly. The fibre inclusion, in general, significantly improves the flexural strength and ductility of matrices. The bond of natural fibres in composites is satisfactory. The fibre inclusion greatly enhances the impact strength of composites.

## 4. Acknowledgments

The Authors are thankful to professor and head, dean, president, Dept. of civil engineering, Dr. M.G.R Educational and research institute university, Chennai.

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