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The Use of Natural Organic Fibres in Cement Concrete: A Review

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Abstract *In this study, literature review has been conducted to investigate the effect of natura fibre such as coir, banana, bamboo, pineapple, sisal, sugarcane baggash, cotton, hibiscus, kenaf, flax and jute fibres on characteristics strength properties of natural fibre reinforced concrete. Review of work done by various researchers are studied and compiled here.* Incorporation of natural fibres to the concrete enhances all strength and durability properties significantly. Workability of natural fibre reinforced concrete can be improved by use of suitable super-plasticizer and mineral admixture.

Key Words: Natural fibres, reinforcement, concrete, compressive strength, split tensile strength, flexural strength.

1. INTRODUCTION

Natural fibres are prospective reinforcing materials and their use until now has been more traditional than technical. They have long served many useful purposes but the application of materials technology for the utilization of natural fibres as the reinforcement in concrete has only taken place in comparatively recent years. The distinct properties of natural fibres reinforced concrete are improved tensile and bending strength, greater ductility, and greater resistance to cracking and hence improved impact strength and toughness. Besides its ability to sustain load, natural fibre reinforced concrete is also required to be durable. Durability relates to its resistance to deterioration resulting from external causes as well as internal causes [1].

Natural reinforcing materials can be obtained at low cost and low levels of energy using local manpower and technology. Utilization of natural fibres as a form of concrete enhancement is of particular interest to less developed regions where conventional construction materials are not readily available or too expensive. Coconut and sisal fibre reinforced concrete have been used for making roof tiles, corrugated sheets, pipes, silos and tanks [2].

2. NOTEWORTHY CONTRIBUTIONS IN THE FIELD OF CONCRETE INCORPORATING NATURAL FIBRES

Application of natural fibre to mortar and concrete is recent trend and many studies have been conducted to evaluate the performance characteristic of the natural fibre reinforced concrete and mortar [3 to 14]. The brief literature reviews of the latest studies are as follows.

Ramakrishna and Sundararajan [3] used four types of natural fibre coir sisal, jute and hibiscus cannebinus with 0.5 %, 1.0 %, 1.5 % and 2.0 %by weight of cement. Sample were tested for impact resistance, residual impact ratio, crack resistance ratio and condition of fibre at ultimate strength. It was concluded that coir fibres absorb more energy 253.5 J at 2 % fibre content and length of 40 mm.

Sivaraja et. al. [4] conducted experimental study to find mechanical and durability properties of natural fibre concrete composites using coconut coir fibre and sugarcane bagasse fibre. Author concluded that both fibres enhances compressive strength, split tensile strength, modulus of rupture and flexural strength. It was found that both fibres were less susceptible against sulphate attack in terms of mass loss and compressive strength deterioration. Although effect of freezing and thawing on natural fibre reinforced concrete was higher than conventional concrete.

Ali and Chouw [5] investigated mechanical and dynamic properties of coconut fibre reinforced concrete. Effect of fibre content 1%, 2%, 3%, 5% and fibre length on 2.5cm, 5cm, and 7.5cm on concrete properties were determined and compared with plain cement concrete. It was found that CFRC beam with fibre length of 5 cm and a fibre content of 5% shows best results.

Hisana et. al. [6] conducted experimental study to examine the effect of pineapple leaf fibre reinforced concrete for M20 grade. Percentage of pineapple leaf fibre content were 0.05, 0.1, 0.15 and 0.2 weight of cement. Investigation shows 0.1 % fibre

content as optimum percentage that shows increase in compressive strength, split tensile strength, and flexural strength 82.3 %, 43.24 % and 35.24 % respectively with respect to plain cement concrete.

Mouli et. al. [7] investigated the strength properties of concrete reinforced with banana fibres for M 30 grade. Author used banana fibre content 1 %, 2 %, 3 %, 4 %, 5 % and 6 % with 40 mm length. Maximum compressive strength were found 55.10 MPa at 3 % fibre content and maximum split tensile strength were found 5.94 MPa at 4 % fibre content at 28 days of curing.

Ede and Olofinnade [8] conducted experimental study to examine the effect of bamboo fibres and limestone powder as filler material on self-compacting concrete. Percentage of fibre content and length used in the study were 0.25 %, 0.50 %, 0.75%, 1.0 % and 50 mm respectively. Maximum compressive strength were found 28.04 MPa at 0.75 % fibre content and maximum split tensile strength were found 3.26 MPa at 40.5 % fibre content alongwith 10 % limestone powder.

Azzmi and Yatim [9] conducted experimental study to examine the effect of kanaf fibres on strength properties of M30 grade of concrete. Kanaf fibres were used 0 %, 0.5 %, 0.75 % and 1.0 % by volume fraction whereas the length of fibre was 25 mm and 50 mm. It was found that incorporation of kenaf fibres results in reduced slump, density, compressive strength but increased splitting tensile strength, flexural strength. Kenaf fibre of 25 mm length at 0.75% by volume shows optimum results.

Assaedi et. al. [10] prepared geoplymer composites reinforced with 2.4%, 3.0% and 4.1 % woven flax fibres. It was found that incorporation of flax fibre remarkably increases compressive strength, flexural strength, hardness and fracture toughness compared to neat geopolymer. SEM analysis shows a number of toughening mechanisms that include crack bridging, fibre pull out and fibre fracture. Thermogravimetric analysis of samples indicated that FF reinforced geopolymer exhibits higher net weight loss than pure geopolymer due to the degradation of flax fibres.

Pichardo et. al. [11] elaborated polyester concrete with waste cotton fibers from blue-jeans and carried out treatment by gamma irradiation. Author investigated that effect of gamma radiation results in improved compressive strength by 40% and flexural strength by 7%. Maximum compressive strength and flexural strength found at 1 % cotton fibre content.

Balaguru and shah [12] examined the effect of jute fibres on quality and strength of concrete. Author observed the aspect ratio, volume fraction and shape of jute fiber affects the strength of concrete. Author found that there is no significant change in workability and durability property of concrete but strength increases in significant manner.

Kim et al. [13] described the effect of volume fraction on the compressive strength of jute fiber concrete. Author concluded Jute fibers affect the workability and the compressive strength of the concrete. It was found that compressive strength of jute fiber concrete improved by 40% when compared to the concrete without fiber.

Amarnath and Ramachandrudu [14] investigated properties of foamed concrete using sisal fibre. Length of sisal fibre was 30 cm and replacement percentage were 0.67- 2% by weight of cement. Slump, stability, density, compressive strength, split tensile strength, water absorbtion and moisture migration tests were conducted to determine the properties of concrete containing sisal fibre. The test result shows that use of sisal fibre into foamed concrete can improve performance of foamed concrete

3. CONCLUSIONS

On the basis of current study reviewed by various researchers it can be easily said that incorporation of natural fibres for concrete production enhances strength of concrete whether it is physical or mechanical properties. Incorporation of natural fibres to the concrete enhances all strength and durability properties significantly. Workability of natural fibre reinforced concrete can be improved by use of suitable super-plasticizer and mineral admixture.

4. FUTURE SCOPE

After reviewing the various works done by different researchers, it can be inferred that there is a vast scope in improving the characteristics of concrete using natural fibres. It is clear that all the natural fibres presented in this paper affect the properties of concrete in a unique way. Thus, future work lies in utilization of natural fibre in correct proportion and manner to increase

workability, strength and durability. Also, new alternative fibres should be found which can overcome the drawbacks of the fibres used in the present study

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