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Literature Study on Characteristics of Concrete Reinforced with Coconut Fibre

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Abstract: *Engineering properties of concrete can be enhanced by reinforcement of various materials. In this study coconut fibers were used as they have many advantages such as easily available and cost effective. An experimental study is held for study on properties of concrete reinforced with coconut fiber. A good bonding in the concrete is observed due to its flexural strength by addition of coconut fibres. The research carried out in the last few years were reviewed in this paper. The major aim of this study is to create awareness among the society about the importance of coconut fiber as construction material. Impact and fracture toughness of coconut fibre concretes are also examined.*

Keywords: Coconut Fiber, Concrete, Properties, Strength

I. Introduction

Fiber reinforced concrete (FRC) is a concrete comprising fibrous material which increases its structural integrity. Uniformly distributed and randomly oriented are present that is short discrete fiber. Fibers comprise glass fibers, steel fibers, natural fibers and synthetic fibers. Coconut fiber is available in abundance, which makes it quite feasible as a strengthening material in concrete. Fibers can control cracking more effectively owing to their tendency to be more closely spaced than conventional reinforcing steel bars. Each fiber has its own characteristics and its limitations. The primary goal of this project is to conduct experimental studies for enhancement of characteristics of concrete by reinforcing it with coconut fibers. Usage of coconut fiber leads to improvement in properties of cement concrete in addition to providing a proper solution for disposal of this natural waste. This study comprises of the characteristic features of coconut fiber concrete with conventional concrete. This study also reviews the effects of addition of CFs in concrete, and examines few properties, applications of coconut fiber reinforced concrete (CFRC). The two major properties needed to undergo include dynamic and mechanical properties of the coconut fibre. Various tests to be performed include strength, durability, workability, compressive strength etc.

Coconut Fiber: It is extracted from the outer shell of a coconut. The common name, scientific name and plant family of coconut fiber is coir, Cocos nucifera and Arecaceae respectively.

II. Literature Survey

[1] Majid Ali et.al (2012)

"Mechanical and dynamic properties of coconut fibre reinforced concrete", Coconut fibres have the highest toughness amongst natural fibres. They have potential to be used as reinforcement in low-cost concrete structures, especially in tropical earthquake regions. The influence of 1%, 2%, 3% and 5% fibre contents by mass of cement and fibre lengths of 2.5, 5 and 7.5 cm is investigated. To evaluate the effect of coconut fibres in improving the properties of concrete, the properties of plain concrete are used as a reference. CFRC with higher fibre content has a higher damping but lower dynamic and static modulus of elasticity. The CFRC with 5 cm long fibres having 5% fibre content has an increased compressive strength, compressive toughness, modulus of rupture and total toughness index up to 4%, 21%, 2% and 910%, respectively, and decreased static modulus of elasticity, splitting tensile strength and density up to 6%, 2% and 3%, respectively, as compared to that of plain concrete. The static and dynamic modulus of elasticity decreases with an increase in fibre content or fibre length. From the considered cases, CFRC with 5 cm long fibres and 5% fibre content has the best overall mechanical and dynamic properties.

[2] B. M. Ahuja et.al (1983)

"Behaviour of concrete reinforced with jute, coir and bamboo fibres", Short discrete vegetable fibres namely jute, coir and bamboo have been examined for their suitability for incorporation in cement concrete. The physical properties of these fibres have shown no deterioration in a concrete medium. It is shown that workable and homogeneous mixes can be obtained using a special method of proportioning. While compressive and tensile strengths of vegetable fibre concretes are no higher than those of control concrete, their deformation behaviour shows improvement in ductility and reduced shrinkage. Impact and fracture toughness of vegetable fibre concretes are also distinctly higher. The various experiments result presented in the paper show that jute, coir and bamboo fibres can be used with advantage in concrete in a manner similar to other fibres. Impact strength improvement of over 25% and increased ductility under static loading and considerably lower shrinkage characteristics of the order of 50% to 70% associated to those of plain concrete, are noted as positive features of vegetable fibre additions. No serious adverse effects of fibre additions have been noted.

[3] A. C. Seibi et.al (1995)

"Mechanical characterization and impact behaviour of concrete reinforced with natural fibres", An experimental study conducted on high strength concrete reinforced with glass fibres and natural fibres (palm tree leaves), both used at a relatively low volume fraction, is presented. Compressive, splitting, three-point bending and impact test methods have been used to characterize reinforced concrete materials, and the results are analysed statistically. It is observed that natural fibres enhanced the mechanical properties and impact resistance of concrete and exhibit comparable response to the glass fibres. A finite element model using ANSYS was employed to study the flexural behaviour of fibre reinforced concrete. It is concluded that both experimental and numerical results are in good agreement. The glass fibres are similar with natural fibres in enhancing toughness and improving impact resistance and all stress components are tensile

[4] P. Paramasivam et.al (1981)

"Prospects for natural fibre reinforced concretes in construction", This paper reports the recent past and current research and developments for the effective utilization of natural fibres from coconut husk, sisal, sugarcane bagasse, bamboo, jute, wood, akwara, plantain and musamba for making concrete*. Factors affecting the properties of natural fibre reinforced concrete both in fresh and hardened states are critically discussed. An outline is also given of the prospects of this new material for potential applications in construction. Efficient and Economical methods of fibre extraction, treatment, conversion into usable forms, dispersion in the concrete mix, casting, placing and curing are highly essential. Strength, deflection, impact and abrasive resistance, water absorption, shrinkage, chemical resistance, acoustic requirements, thermal performance and durability parameters must be properly assessed.

[5] Avinash Singh et.al (2019)

"An experimental study on coconut fiber reinforced concrete", Coconut fiber is obtainable in abundance, which makes it quite viable as a reinforcement material in concrete. This paper presents a experimental discussion on the subject of coconut fiber reinforced concrete, CFRC. It discusses usually used terms and models of behavior that kind a basis for understanding material performance with presenting mathematical details. In this research it is shown that flexural strength of coconut fiber reinforced concrete is directly proportional to the coconut fiber content and inversely proportional to the water-cement ratio. This study aimed toward analyzing the variation in strength of coconut fiber concrete at variable fiber contents and to establish it with that of conventional concrete. The various strength aspects analyzed are the flexural, compressive and lastingness of the coconut fiber concrete at variable percentages (1%, 2%, 3%, 4%, 5%) by the load of cement of fiber. This research is based on the use of coconut fibers in structural concrete to enhance the mechanical properties of concrete. It is observed that CFRC can be used to increase ultimate strength, durability because the satisfactory improvement in strength is observed with the inclusion of coconut fibers but the gain in strength is found to depend upon the amount of fiber content. Owing to its relatively higher strength and ductility, it can be good replacements for asbestos fibers in roofing sheets, which being natural in origin resulting less risk to the environment.

[6] Anila Kumar et.al (2018)

"Comparative study of strength properties of coconut coir fiber reinforced concrete due to partial replacement of cement by pozzolanic materials", The main objective of the modern-day Civil Engineering is to achieve Sustainability and the term is also widely accepted by engineers worldwide. The construction industry is revolutionizing in terms of both equipment, materials. Thus, the basic cost of construction has increased exponentially along with detrimental effects on environment. Thus lot of research work is been carried to reduce the usage of non-renewable resources and to achieve economy. The primary objective of the current project is to investigate the strength properties of coconut coir fiber reinforced concrete due to partial replacement of cement by various pozzolanas. The coir fiber reinforced concrete along with GGBFS, is a good material to attain both compressive and flexural strength. Both fly ash, GGBFS has remarkably increased the strength properties.

[7] M. J. Ienamul Hasan Ali et.al (2018)

"Experimental study on coir fibre mixed concrete", This paper presents the versatility of coconut fibre is one of the natural fibers abundantly available in tropical regions, and is extracted from the husk of coconut fruit the properties of composites of concrete in which coconut fibers are used as reinforcement, are discussed. The research carried out and the conclusions drawn by different researchers in last few decades are also briefly presented. Coconut fibers reinforced composites have been used as cheap and durable non-structural elements. The flexural strength of coir fiber reinforced concrete increases for 1%, 2%, 3% of fiber used for M20 grade when compared with conventional concrete. The coir fiber reinforced concrete is more effective than conventional concrete. The aim of this project is to spread awareness of coconut fibers as a construction material in Civil Engineering.

[8] W H Kwan et.al (2013)

"Strength and durability of coconut-fiber-reinforced concrete in aggressive environments", The aim of this experiment is to mitigate this limitation by incorporating short, discrete coconut fibers into high-strength concrete. This method is based on the idea that the localized reinforcing effect provided by the discrete fiber can restrain the development of cracks caused by aggressive environments. The mineralogy and microstructure were studied by means of X-ray diffraction and scanning electron microscopy examinations. The experimental results prove that the compressive and flexural strengths of the structures improve up to 13% and 9%, respectively, with the incorporation of coconut fibers. This study recommends that the coconut fiber undergo treatment prior to its application in concrete to protect it against degradation or that it be replaced with a non-corrosive fiber. It concludes that the recommended threshold value of the fiber content that will benefit the long-term strength and durability of the concrete in all tested aggressive environments is 1.2%.

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[9] Nawawi Chouw et.al (2016)

"Effect of alkali treatment on microstructure and mechanical properties of coir fibres, coir fibre reinforced-polymer composites and reinforced-cementitious composites", In this study, coir fibres were studied for use as reinforcement materials for polymer and cementitious composites. The effect of fibre treatment (i.e. 5 wt.% NaOH solution at 20 ºC for 30 min) on microstructure and mechanical properties of coir fibre, coir fibre reinforced epoxy (CFRE) and coir fibre reinforced cementitious (CFRC) composites were investigated. The test results show that coir fibre had a much cleaner and rougher fibre surface after the alkali treatment. Compared with the untreated CFRE, treatment improved the tensile and flexural properties of composites, i.e. 17.8% and 16.7% growth in tensile and flexural strength, respectively. However, the treatment also reduced the damping ratio of the CFRE. The increase in tensile and flexural properties and reduction in damping ratio are attributed to the improvement of fibre and epoxy matrix interfacial adhesion due to the treatment, as displayed by SEM micrographs. Compared with the plain concrete, coir fibre improved the compressive strength, flexural strength and toughness effectively. The treatment can further improve these properties of CFRC. SEM studies clearly confirmed that the failure modes of coir fibres in cement matrix are fibre breakage, fibre pull-out and fibre debonding from the cement matrix. The microstructure of coir fibre, CFRE and CFRC were correlated with their mechanical properties. Alkali treatment with 5 wt.% NaOH solution causes a clearer and rougher surface of the coir fibre, compared with the untreated fibre surface. In this study, untreated and alkali-treated (i.e. 5 wt.% NaOH solution at 20 ºC for 30 min) coir fibres were used as reinforcement for epoxy (CFRE) composites and cementitious (CFRC) composites.

[10] M. A. Cincotto et. al. (2005)

"Durability of slag mortar reinforced with coconut fibre", A comparative study of the microstructure of both new and in-use aged blast-furnace slag cement coir reinforced composite was performed. Aged samples came from internal and external walls of a 12-year-old house, built in Sa˜o Paulo. The panels of the house were produced using 1:1.5:0.504 (binder: sand: water, by mass) mortar reinforced with 2% of coir fibre by volume. The binder was blast-furnace slag activated by 2% of lime and 10% of gypsum. Fibres were removed from the composite and subsequently cleaned with acid solution (chloridric acid, 10%) in an ultrasonic bath. Both aged and new fibres were studied under low pressure BSE SEM with EDS analysis. No significant difference was found in the lignin content of fibres removed from external and those removed from internal walls. it is necessary to point out that an eventual leaching of lignin has not proved to have had any effect on the walls in-use performance.

[11] X Wang et. al. (2006)

"Flexural Characteristics of Coir Fiber Reinforced Cementitious Composites", This study has examined the flexural properties of natural and chemically modified coir fiber reinforced cementitious composites (CFRCC). Coir fibers of two different average lengths were used, and the longer coir fibers were also treated with a 1 % NaOH solution for comparison. The fibers were combined with cementitious materials and chemical agents (dispersant, defoamer or wetting agent) to form CFRCC. The flexural properties of the composites, including elastic stress, flexural strength, toughness and toughness index, were measured. The effects of fiber treatments, addition of chemical agents and accelerated ageing of composites on the composites' flexural properties were examined. The results showed that the CFRCC samples were 5–12 % lighter than the conventional mortar, and that the addition of coir fibers improved the flexural strength of the CFRCC materials. Toughness and toughness index, which were associated with the work of fracture, were increased more than ten times. SEM microstructure images revealed improved physicochemical bonding in the treated CFRCC. Within the naturally cured samples, flexural strength increased by up to 12 % for short untreated fiber composites. The toughness (15.5D), toughness index (I30) and ductility of CFRCC were increased by 340-940 %, 615-1680 %, 860-1280 % respectively. Within the accelerated ageing samples, the toughness (15.5D), toughness index (I30) and ductility of CFRCC were increased by as much as 375 %, 400 %, and 1740 % respectively. CFRCC have a good physicochemical bonding which accounts for its superior properties. The untreated fiber composites showed a large difference in their ductility property compared to the naturally cured samples, which meant their properties would probably deteriorate over time.

III. Conclusion

1. Coconut fiber is a good insulator itself and as such it can improve the thermal properties of concrete.
2. As we increase the fiber percentage, the strength of coir fiber reinforced concrete is also increased progressively.
3. The coir fiber reinforced concrete is more effective than conventional concrete.
4. CFRCC have a good flexural strength, ductility and physicochemical properties.
5. The natural fibres are similar with glass fibres to enhance toughness and improving impact resistance

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