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Coir Fiber Reinforced Concrete-Review

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***Abstract:** As a practical means of enhancing concrete's performance, fiber reinforced concrete (FRC) is gaining popularity. It is crucial to find acceptable, low-cost building and reinforcing methods that work for emerging nations. Utilizing natural fibers may drastically reduce the cost of construction. Prior research in the literature indicates that using coir fibers in concrete improves concrete strength. However, information about the use of coir fiber in concrete is scattered. This report presents a detailed analysis to highlight the usage of coconut fibers as reinforcing material in recent years.*
***Keywords:** Coir fiber, fiber reinforced concrete*

I. INTRODUCTION

A. General

The construction industry is undergoing two major transformations. One approach is the evolution of building techniques, suchas employing automated tools in construction. The other is the approach in high-performance construction materials, such as the advent of high strength concrete. In terms of these high-performance materials, fiber reinforced concrete (FRC) is progressively gaining favour with civil engineers. It is advisable to utilize fibers that are longer than the aggregate's maximum size toguarantee that each fiber strand is effective.

Normal concrete comprises 19 mm equivalent diameter aggregate, which accountsfor 35-45% of the total volume of concrete; fibers longer than 20mm are more effective. Fibers are added to concrete to increase its long-term durability. Fiber Reinforced Concrete is gaining popularity in the concrete industry because of its reducedconstruction time and labour costs.

As the most ductile natural fiber, coconut fiber has the potential to be employed as a reinforcing material in concrete. Since itis biodegradable, the environmental impact will be limited. Most often, these coconut fibers are discarded as agricultural waste,making them readily accessible in vast quantities and at little cost. There are two types of coconut fibers: brown fibers and whitefibers:

B. Brown fibers

Brown fibers are strong, thick, and very abrasion resistant. The following is the procedure for making brown fibers. Toexpand and soften the fibers, the fibrous husks are submerged in pits or nets of slowly moving water. Under the nut's skin, a procedure known as wet-milling separates the longer bristle fibers from the shorter mattress fibers.

The mattress fiber are movedto eliminate debris and other impurities before being sun-dried and packaged. For the purpose of producing twisted fiber,certain mattress fiber is permitted to hold onto moisture longer. The coir fiber has enough flexibility to twist without breaking, and it maintains a curl as though it were continually waved. Making a rope out of a hank of fiber and twisting it by hand or with a machine is how twisting is done. The fiber with the longer bristles is cleaned in clean water, dried, and then knotted intohanks or bundles. The fibers can then be straightened and any shorter fiber fragments removed using steel combs and cleaning solutions.

C. White fibers

White fibers are softer, finer, but also less durable. Following are the preparatory steps. Up to 10 months are spent suspending the young husks in a river or water-filled trench. In order to release the fibers during this period, microorganisms degrade the plant tissues surrounding them.

Retting is the term for this action. The long fibers in the husk segments are then separated out by beating them with iron rods; these fibers are then dried and cleaned. Using a basic one-handed technique or a spinning wheel, cleaned fiber is ready to be spun into yarn.

Three types of coconut fibers are commercially available: bristle (long fibers), mattress (relatively short fibers), and decorticated (mixed fibers). Depending on the need, these various fiber kinds have a variety of purposes. Brown fibers are typically utilised for engineering practise.

Fig. 1: Coconut fibers

D. Applications

Because the fibers are evenly distributed throughout the concrete mixture, it has isotropic qualities that are not present intraditionally reinforced concrete. The primary areas of use for FRC are;

1) Pavements
2) Tunnel lining
3) Aircraft parking
4) Runway
5) Dams
6) Manholes
7) Walls
8) Concrete pipes
9) Slope stabilization
10) Bridges
11) Warehouse floor

II. LITERATURE REVIEW

Jiaxin Chen and Nawawi Chouw (2015) investigated the flexural performance of coconut FRC composites confined with flax fiber reinforced polymer tubes. Six 520 mm long cylindrical specimens underwent a four-point bending test. Single tube and double tube specimens were the two types that were taken into consideration. The first form of coconut FRC was contained with a single flax fibre reinforced polymer on the outside, while the second version had both the exterior polymer tube and a polymer tube running along the middle of the concrete cylinder. The outcome demonstrates that the additional longitudinal reinforcement offered by the inner flax fibre polymer tube improves the flexural behaviour of double flax fiber reinforced polymer in terms offlexural stiffness and ultimate load bearing capacity. The inner flax fiber reinforced polymer tube prevents slippage between theflax fiber polymer tubes and the coconut fiber reinforced composite core, which delays the abrupt loss of flexural strength.

Libo Yan et.al.(2016) studied the use of coir fibers as reinforcement materials for cementitious composites and studied the behavior of untreated and treated alkali coir fibers in concrete. Studies were done using a scanning electronic microscope (SEM)to look at the microstructures of untreated and treated coir fibers. Following the test, the failure patterns for the PC and CFRC were as follows: the PC completely cracked, but the CFRC only had visible cracks that were kept together by coir fibers. As a result, the fibers acted as an efficient secondary reinforcement to prevent the occurrence of cracks and to stop their spread by bridging the neighbouring surfaces of the gaps in the concrete.

When compared to untreated coir fibers, the alkali-treated 5% NaOH solution-treated coir fibers employed in this study had a clearer and rougher surface. Coir fiber incorporation enhances compressive strength as compared to ordinary concrete. The alkali treatment can significantly enhance the compressive stress and strain compared to the untreated CFRC. According to SEM analyses, the failure mechanisms of CFRC are fiber breakage, fiber pull-out, and fiber debonding from the matrix. Along addition to the typical fiber breaking in the direction of the load, bending and splitting patterns of fiber breakage are also seen.
Adewale George Adeniyi et.al.(2019) present an overview of coir fiber and coir fiber reinforced polymer composites. The properties of the coir fibers and that of composites were studied. Fiber treatment improves the matrix interfacial adhesion therebyenhancing the properties. The most popular chemical treatment is alkalization by NaOH. The mechanical properties of the composite depend on the matrix as well as the fiber content of the composite. The Scanning Electronic Microscope analysis shows that the chemically treated fiber reduces the number of voids resulting from the fiber pull-out in coir composites. Untreated fibersare more susceptible to high water absorption than treated fibers.
K. Kochova et.al. (2019) determined the mechanical and physical properties of coir fibre cement boards and compared them to the conventional wood-wood cement boards used for ceiling tiles. The board was created by first combining the fibers with cement paste, placing it in a 150 x 300 mm mould, then pressing it for 24 hours. The composite is then dried for 3 days at room temperature after being cured for 7 days under plastic sheets. The same steps are taken when using pre-treated coir fiber. The outcome demonstrates that a composite made of coir fibers has appropriate mechanical and thermal characteristics. Additionally, a pull- out test was carried out to describe the cement-fiber interaction. Pre-treated fibers provide a better cement contact and less slide behaviour than untreated coir fiber. Additionally, because undesirable components have been removed, the contact between thewashed and unwashed fibers is improved.
Tidarut Jirawattanasomkul (2019) presents an in-depth understanding of the compressive behavior of concrete confined with low-cost natural fiber-reinforced polymer. Uniaxial compression tests are used to create and evaluate concrete cylinders that are contained by cotton, jute, and hemp fibers. For strengthening concrete's ductility and compressive strength, the natural fiber polymer has a strong confinement effect. For jute, hemp, and cotton polymers, respectively, the compressive strength of restricted concrete improves dramatically up to 42%, 25%, and 28%. The findings demonstrated the effectiveness and suitability of naturalpolymers, particularly jute polymer, to improve the confinement effect of concrete.
Chinyere Olufemi Nwankwo and Anthony Nkem Ede (2020) used Kenaf fibre reinforced polymer to strengthen an RC beam in flexure. The dimensions of two RC beams were 1860 mm x 240 mm x 125 mm, with one serving as the control beam and the other being laminated with kenaf fibre reinforced polymer. The outcome demonstrates that the RC beams may be strengthened using natural polymer composites in an efficient manner. The laminate made of kenaf fibre reinforced polymer decreased beamdeflections under equivalent loads. The kenaf fibre reinforced polymer strengthened beam deflected 43% less than the control beam at the control beam's yield load.
B. Nambiyanna et.al.(2021) present the experimental investigation of five slabs tested using two different natural fibers *i.e.,* jute and coir with two configurations strip and square under uniformly distributed load facilitated by a load spreader to find out the suitability of the above fibers as economical strengthening materials. Functional tests such as fibre moisture absorption and fire flow tests were conducted to determine the resistance offered by the fibres to moisture and burning. The test results showed that the coir fiber-reinforced polymer concrete (CFRPC) has an advantage over the jute fiber-reinforced polymer concrete (JFRPC),and this is because jute has a finer fibre structure. The water absorption of JFRPC was somewhat greater than that of CFRPC, andJFRPC burned more quickly. In order to examine the flexural characteristics with and without strengthening utilising natural fibre composites, a flexural test was carried out using a simply supported square slab subjected to a uniformly distributed load, replicating the real-world circumstances. The ultimate load-carrying capacity and cracking load-carrying capacity of reinforced slabs both increased relative to the control specimen, with the corresponding percentage increases falling between 15.03 and 37.25% and 6.67 and 33.33%, respectively. Slabs only developed cracks before they collapsed in flexure. Overall performance demonstrates that natural fibre slabs perform better under flexural loading than the control slabs.
Subramanian Shanmugapuram Vivek, and Chandrasekaran Prabalini (2021) presents the effect of untreated and treated coconut fibers in self-compacting concrete (SCC). The tests were carried out to ascertain the mechanical, chemical, and physicalqualities. In the study, three distinct treatments—soaking, boiling, and chemical treatment—were applied to the fibre. To comprehend the microstructure of the mixtures created with and without treatments, SEM examination was done. In comparison to control mixtures, soaked fibres had slightly lower compressive strength (around 2.71%), improved tensile strength (20.37%),and increased flexure strength (12.5%).

Because of their stronger connection, boiled fibres have demonstrated superior mechanical characteristics. In comparison to control mixes, it demonstrated increases in compressive strength of 23.48 percent, tensile strength of 36.86 percent, and flexural strength of 12.50 percent. Comparing chemically treated fibre to control mixtures, the compressive strength increased by 51.8%, the tensile strength increased by 44.13%, and the flexure strength increased by 37.5%. When compared to the other, chemically treated exhibits enhanced performance based on the strength metrics. The best amount of chemically treated coir fibre to employ for increasing the specimen's mechanical properties is 1%.

We may infer from the literature study that the compressive strength of coir fiber reinforced polymer composites is higher than that of traditional concrete. The ideal fiber dose for the test subject should be less than 1%. The use of natural fiber polymer enhances the specimen's fracture resistance.

III. CONCLUSIONS

As a construction material, concrete is very fragile on its own; its tensile strength is just a tenth of its compressive strength. Since natural fibers have become more prevalent, reinforcing bars are no longer necessary to make up for the stiffness and structural weakness of concrete. Finding solutions to improve the stability and strength of concrete would undoubtedly be advantageous because it is the most widely used construction material worldwide. Concrete may be reinforced with coir fiber, which has been proven to be a successful material. The usage of coir (or coconut fiber) to reinforce concrete has increased due to the amount and accessibility of the material. This has been found to slow the growth of cracks in concrete constructions. Tests were carried out in labs all around the world to see how the performance of concrete would be impacted by coconut fibers.

Coconut fiber is the perfect material for creating a lightweight version of concrete since it is less dense than concrete and so decreases the total weight of construction. Additionally, because of its low heat conductivity, coir promotes natural cooling. Tests have revealed that coconut fiber has a significant deal of potential as a steel-alternative material for concrete reinforcement. Additionally advantageous are its durability, affordability, and natural cooling. These fibers increase concrete specifications and aid in lowering environmental pollution issues. The study's findings support the idea that no more than 1% of the fiber fraction should be used. However, if too many fibers are added, there won't be enough space for the matrix to completely encircle and link with the fibers, which would reduce the strength of the composite. Keeping these factors in mind, conducting tests like the flexural strength test and toughness test will aid in establishing the concrete's capacity to resist deformation.

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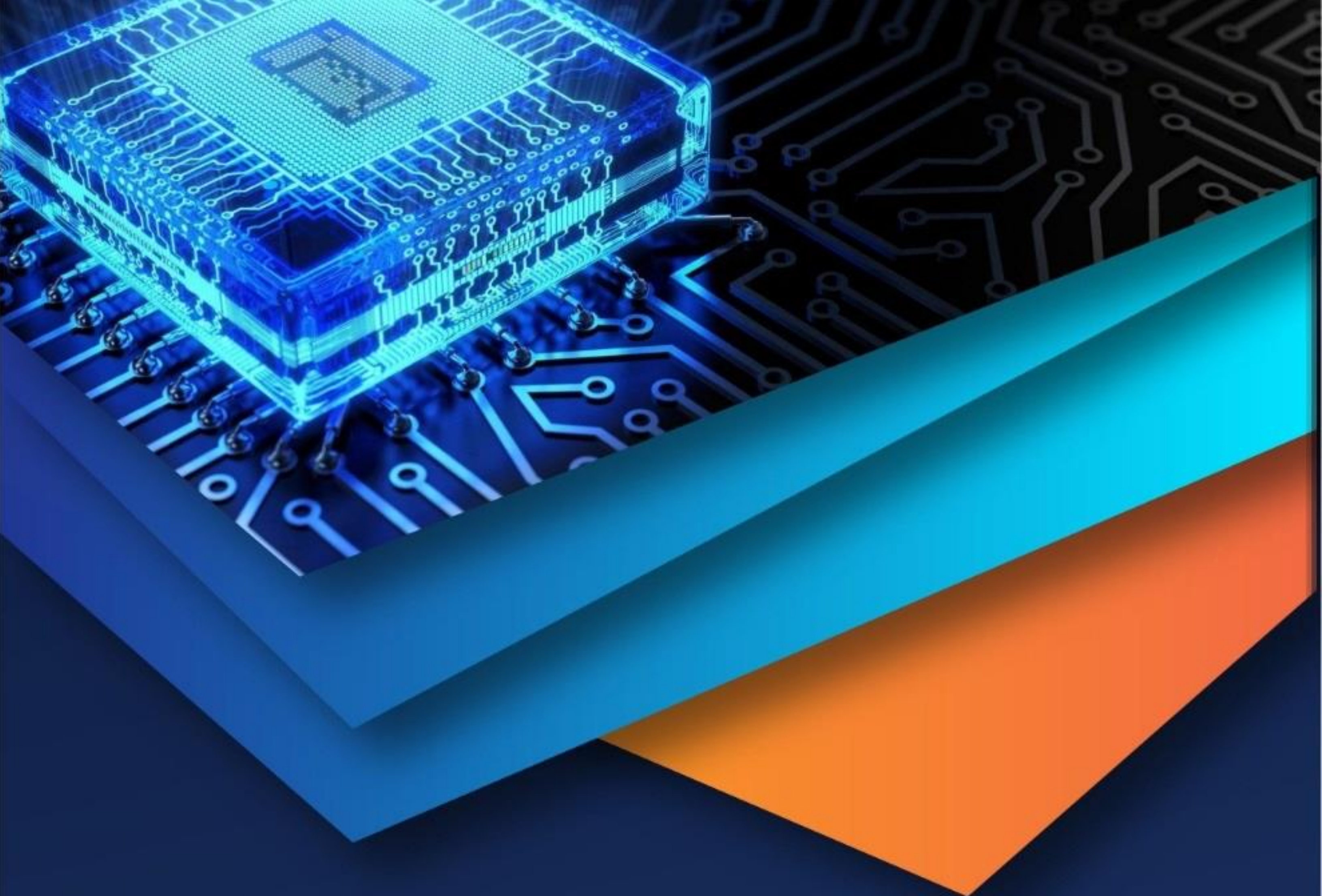

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