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Research on Coconut Shell Fiber Reinforced Concrete

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ABSTRACT

This experimental study investigates the effectiveness of coconut shell fiber as a reinforcement material in concrete, with the objective of improving its mechanical properties while fostering sustainable construction practices. In light of the growing emphasis on environmental sustainability, the use of agricultural by-products such as coconut shells presents an innovative strategy for enhancing concrete reinforcement. The research involved the preparation of concrete specimens incorporating varying proportions of coconut shell fibers (0%, 2%, 4%, 6%, 8%, and 10% by weight of cement) to assess the impact of fiber content on concrete performance. Mechanical properties were evaluated through a series of rigorous testing methods, including compressive strength, flexural strength, and split tensile strength, conducted at curing intervals of 7, 14, and 28 days. The findings revealed a significant enhancement in flexural and tensile strengths with the addition of coconut shell fibers, particularly at lower percentages (up to 6%). Conversely, a reduction in compressive strength was noted at higher fiber contents, likely attributed to insufficient bonding between the fibers and the cement matrix. This research underscores the potential of coconut shell fibers as a sustainable reinforcement alternative, contributing to improved ductility and energy absorption properties in concrete structures. The results indicate that the incorporation of coconut shell fibers not only effectively utilizes agricultural waste but also enhances the overall performance of concrete, aligning with modern sustainable construction objectives. Further research is recommended to investigate optimal fiber content and treatment techniques to fully leverage the advantages of coconut shell fiber reinforcement in concrete applications.

Keywords : Coconut shell fiber, concrete reinforcement, mechanical properties, compressive strength, flexural strength, tensile strength, agricultural waste, sustainability, experimental investigation, ductility, energy absorption

Introduction:

Concrete is recognized as the most extensively utilized construction material across various regions of the world. It ranks as one of the most consumed materials by humanity in contemporary society, surpassed only by fresh water (Aitcin 2000). The production of concrete requires substantial amounts of natural resources. Over the years, this limitation has been addressed through the incorporation of reinforcing bars (rebar) to form reinforced concrete, enabling it to effectively withstand compressive, tensile, and shear stresses. In beams, the longitudinal rebar counteracts flexural (tensile) stress, while stirrups, which encircle the longitudinal bars, mitigate shear stresses. In columns, vertical bars resist buckling and compressive stresses, whereas ties provide shear resistance and confinement for the vertical bars. The application of reinforced concrete results in a robust composite material suitable for a wide array of applications. However, in reinforced concrete, steel bars only locally counteract tension. Cracks in reinforced concrete elements can propagate freely until they encounter a rebar. The necessity for multidirectional and closely spaced steel reinforcement arises, which is often impractical. A viable solution to this issue is the use of steel fiber reinforcement. This approach involves a concrete mix that incorporates short, discrete fibers that are uniformly distributed and randomly oriented. Four categories of fiber reinforcement have emerged from these various formulations: steel fibers, glass fibers, synthetic fibers, and natural fibers. The characteristics of Fiber Reinforced Concrete vary based on the densities, geometries, orientations, distributions, and materials of the fibers used. The proportion of fibers added to a concrete mix is expressed as a percentage of the total volume of the composite concrete, referred to as Volume Fraction, which typically ranges from 0.1% to 3%.. Calculation of Aspect ratio (l/d) is done by dividing fiber length with its diameter. To calculate aspect ratio, an equivalent diameter of Fibers with anon-circular cross section will be used. If the modulus of elasticity of matrix concrete or mortar binder, is lesser than the fiber concrete, they help to carry the load by increasing the material strength characteristics. Flexural strength and toughness of the matrix is segmented with the increase in the aspect ratio of the fiber. Workability problems will be created however in the fibers which are too long tend to "ball" in the mix.

Materials:

Coconut Fiber

This research utilizes both raw and processed coconut fiber. Coconut fiber is derived from unripe coconuts and is a natural fiber extracted from the coconut husk. The extraction process involves soaking the coconut in hot seawater, followed by the removal of fibers from the shell through combing and crushing, similar to the method used for jute fiber. The individual fiber cells are characterized by their narrow, hollow structure with thick cellulose walls, measuring approximately 1 mm in length and 10–20 µm in diameter. The raw coconut fibers exhibit lengths ranging from 15 to 35 cm and diameters between 50 and 300 µm. As the fibers mature, they harden and develop a yellow hue due to the deposition of lignin on their walls. Coconut fiber is known for its considerable stiffness and is utilized in various products, including floor mats, doormats, brushes, mattresses, coarse filling materials, and upholstery.

Raw Fiber

This material is a byproduct of mattress manufacturing and possesses a high tensile strength of 21.5 MPa. Prior to use, the fibers undergo thorough washing to eliminate dust and residual particles, enhancing the contact surface between the fiber and the mix. This process results in improved bonding between the reinforcement and concrete, ultimately leading to increased strength. The fibers are subsequently cut into square meshes measuring 5 cm x 5 cm.

Concrete Mixing

The process of mixing concrete is crucial for achieving a consistent and uniform product. It is imperative that the mixing results in a homogeneous mixture with uniformity and proper consistency. The mixing procedure adheres to the guidelines set forth in I.S: 516-1959. Typically, a pan mixer is utilized for this purpose. The components, including cement, fine aggregates, coarse aggregates, and water, are introduced into the pan mixer. Initially, the dry cement is combined with fine aggregates, followed by the addition of coarse aggregates, ensuring thorough mixing throughout the process.

Slump Cone Test

The slump test is the most widely utilized method for assessing the consistency of concrete, applicable in both laboratory settings and on construction sites. However, it is not suitable for extremely wet or dry concrete mixtures. This method does not account for all factors influencing workability, nor does it always accurately represent the workability of the concrete. Nevertheless, it serves as a convenient control test, providing an indication of the uniformity of concrete across different batches.

Compaction Factor Test

The compaction factor of fresh concrete is assessed to evaluate its workability through the compaction factor test, as outlined in IS: 1199 – 1959. The equipment utilized for this test is the compaction factor apparatus, which is specifically designed for concrete with a nominal aggregate size not exceeding 40 mm. This test is predicated on the understanding that workability refers to the property of concrete that influences the effort required to achieve complete compaction. The procedure involves applying a standardized amount of work to a specified quantity of concrete and measuring the resultant compaction. The compaction factor is defined as the ratio of the weight of the partially compacted concrete to that of the fully compacted concrete, and it is reported to the nearest second decimal place.

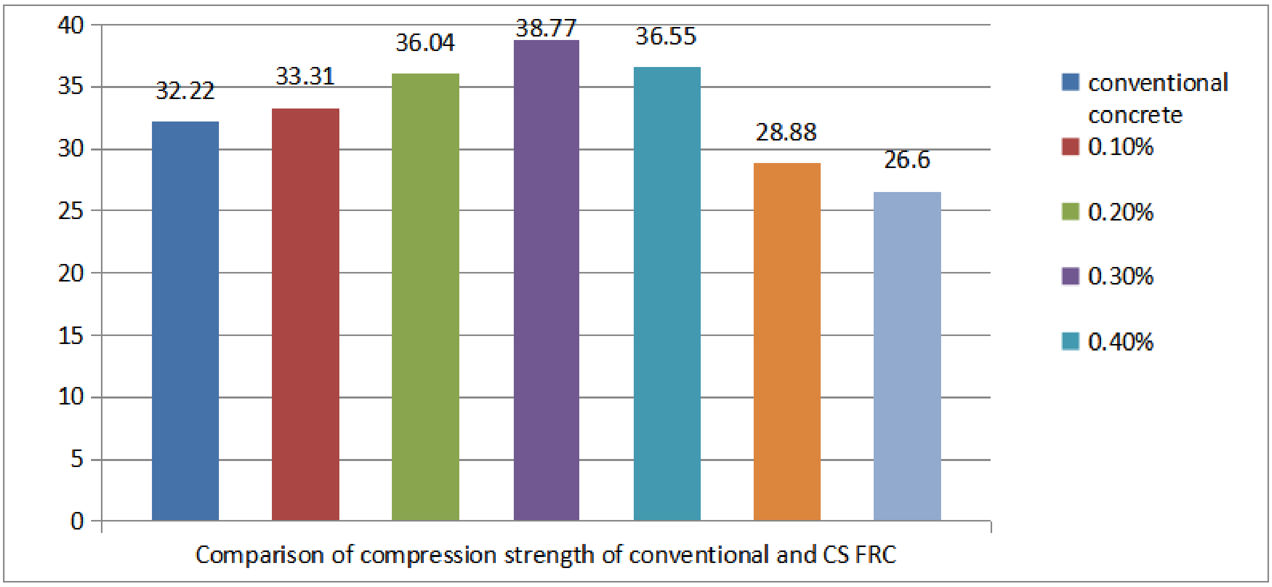
Cube Compressive Strength

The compressive strength test was conducted in accordance with IS: 516-1959. All concrete specimens were evaluated using a Universal Testing Machine (UTM) with a capacity of 200 tons. Concrete cubes measuring 150 mm x 150 mm x 150 mm were subjected to testing. The crushing strength of the concrete was determined by applying a load at a rate of 140 kg/sq. cm/minute until the specimens failed. The maximum load applied to the specimens was recorded, and the ultimate compressive strength was calculated by dividing the failure load by the area of the specimens.

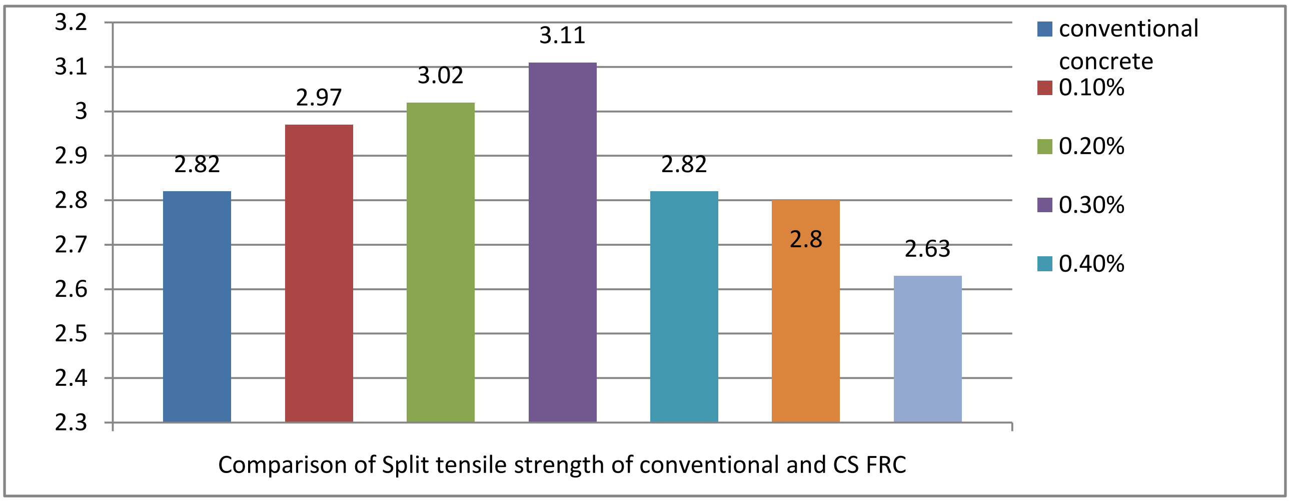
Split Tensile Strength

SplitTensileStrengthtestwasdoneconfirmingtoIS:516-1959.Alltheconcrete specimens were testedin aUniversal TestingMachine(UTM)ofcapacity200 tones. Concrete cubes of size 150 mm x 300 mm ht. were tested for split tensilestrengthofconcretewasdeterminedbyapplyingloadattherateof140kg/sq.cm/minute till thespecimensfailed.The cylinderspecimensof concrete wasplacedhorizontal, so that its axis ishorizontal between the platesofthetestingmachine.Narrowstripsofthepackingmateriali.e.plywoodwasplacedbetweentheplatesandthe cylinder, to receive the compressive stress.

Results and Discussion



Compressivestrengthof CSFRC 28days



Split Tensile strength of CSFRC 28 days

Conclusions

From the results of the experimental investigation, the following conclusions are drawn on concrete without and with CS fibers.

- The compression strength of conventional concrete for 28 days is 32.22Mpa and for CS FRC of 0.1 %, 0.2%, 0.3%, 0.4%, 0.5%, and 0.6% is 33.31, 36.04, 38.77, 36.55, 28.88, and 26.6Mpa respectively.
- Therefore the compressive strength of CS FRC at 0.3% is higher when compared to other percentages.
- When compared to conventional concrete the compression strength of CS FRC is 24% high. Hence 0.3% is adopted.
- The split tensile strength of conventional concrete for 28 days is 2.82Mpa and for CS FRC of 0.1 %, 0.2%, 0.3%, 0.4%, 0.5%, and 0.6% is 2.97, 3.02, 3.11, 2.82, 2.8 and 2.63Mpa respectively.
- Therefore the split tensile strength of CS FRC at 0.3% is higher when compared to other.

When compared to conventional concrete the split tensile strength of CS FRC is 10.28 % high. Hence 0.3% is adopted.

References

- Majid Ali, Nawawi Chouw (2012),"Experimental investigations on coconut-fibreropetensilestrengthandpulloutfromcoconutfibrereinforcedconcrete",*Constructionand Building Materials, 41, 681–690*
- Reis J.M.L (2005),"Fracture and flexural characterization of naturalfiber-reinforcedpolymer concrete", *Constructionand BuildingMaterials 20 (2005)673–678*
- MajidAli,AnthonyLiu,HouSou,NawawiChouw(2011),"Mechanicalanddynamic properties of coconut fibre reinforced concrete" *Construction and BuildingMaterials 30 (2011) 814–825*
- Noor Md. Sadiqul Hassan, Habibur Rahman Sobuz (2012),"Use of coconut fibre inproduction of structural light weight concrete", *Journal of applied sciences 12(9) 831-839, 2012*
- AZuraida,HZahurin,ISopiyan(2011),"Effectoffibrelengthvariationonphysicalandmechanicalpropertiesofcoirfibrereinforcedconcrete",*MaterialsPhysicsand Mechanics 16 (2013) 107-117*
- P Nibasumba, X L Liu (2011),"Recent developments in fibre reinforced concreteand their effect on concrete columns analysis", *Construction and Building Materials2011;18(7):549–58*
- Joanna M Ferraz, Sabrina A Martins, Claudio H.S Del Menezzi (2013), "Effect ofcoir fibre treatment and coir-fibre ratio on properties of cement bonded composites",*BioResources 6(3), 3481-3492*
- Dr.M.Sivaraja (2009), "Application of Coir Fibres as Concrete Composites forDisasterproneStructures"*InternationalJournalofCivilandEnvironmentalEngineering Sci., Vol. 33, No. 6, December 2009,pp. 719–729.*
- IzadAmirBinAbdulKarim(2012),"Effectofcoconutwasteonconcretestructure component"*ARPN Journal of Engineering and Applied Sciences, 30(2012).2538 – 2547.*
- Yalley, P. P. and Kwan, A.S K (2008), "Use of coconut fibre as an enhancementofconcrete",*InternationalJournalofSustainableConstructionEngineering&Technology,27(5), 2008, pp. 575-582.*
- Kamel K.Alzboon and Khalid N.Mahasneh (2009), "Effect of Using MattressWaste on the Compression Strength and Slump Characteristics of Concrete",*Constructionand Building Materials 2009;23(2):865–71.*
- Nanayakkaza N.H, (2011) "Characterisation and determination of properties ofSri Lankacoconut", *Journal of NaturalFibres, 2(1), 2011,pp 69-81.*
- Bhowmick B.B. and Debnath C. R. (2007), "Properties of coir", *Indian coconutjournal,15,*(5), 2007. p.12