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EVALUATING THE EFFECT OF SUSTAINABLE CONCRETE BY USE OF HAIR FIBRE AND COCONUT SHELL FIBRE

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Hair fibre and coconut shell fibre reinforced concrete (HCFRC) is an innovative composite material that utilizes natural fibres to enhance the mechanical properties of concrete. This project aims to investigate the feasibility and effectiveness of incorporating hair fibers and coconut shell fibres into concrete mixes. The study involves experimental analysis of various mix proportions to determine the optimal combination of ingredients for achieving improved performance characteristics such as flexural strength, durability, and impact resistance.

Experiments were conducted on Concrete cubes of standard size with addition of various percentages of

Human Hair fibre, Coconut Shell Fibre and Mixed Fibres i.e., 1%, 3%, 5% and 7% by weight of cement and results were compared with those of plain cement concrete of M-20 grade.

Also Experiments were conducted on Concrete beams of standard size with addition of various percentages of

Human Hair fibre, Coconut Shell Fibre and Mixed Fibres i.e., 1%, 3% and 5% by weight of cement and results were compared with comparative study of coconut fibre, hair fibre, and plain cement concrete of M-20 grade.

For each percentage of human hair, coconut shell fibre and mixed fibresadded in concrete, three cubes and three beams were tested for their respective mechanical properties at curing periods of 7 days

Keywords:
Hair fibre, Coconut shell, fibre Reinforced concrete, Natural fibres, Flexural strength, Durability,Impact resistance, Sustainability, Eco-friendly, Experimental analysis, etc

INTRODUCTION

❖ Fibre Reinforced Concrete (FRC)

Discrete fibres are incorporated into concrete to improve its performance and structural integrity, a process known as fibre reinforced concrete, or FRC.These fibres are evenly distributed throughout the concrete mixture and are usually made of steel, glass, synthetic polymers, or natural materials like hair or coconut shells. Fibre Reinforced Concrete (FRC) enhances a variety of construction applications, such as pavements, bridges, tunnels, and buildings, by improving qualities like tensile strength, ductility, fracture resistance, and durability.

❖ What is Fibre?

A tiny, elongated substance added to concrete or other building materials to enhance their qualities is referred as a fibre in civil engineering. Many materials, including steel, glass, synthetic polymers, and natural resources like hair or coconut shells, can be used as fibres.Fibers improve properties including tensile strength, crack resistance, ductility, and durability in concrete, which results in stronger and more resilient constructions. To increase elongevity and performance, they are frequently employed in applications like tunnels, buildings, bridges, and pavements.

❖ Why Fibre is used in concrete?

- Improved Strength: Fibres enhance tensile strength and crack resistance property of concrete.
- Crack Control: Fibres acting as micro-reinforcements reduces crack propagation thereby increasingstructural integrity of concrete.
- Increased Durability: Due to the resistance shown by fibres against several environmental chemicalsthey sustain longer.
- Enhanced Ductility: Fibres improve ductility of concrete preventing it from unexpected collapsesunder dynamic loading.

❖ Effects on mechanical properties of FRC

- Compressive Strength: The improvement in compressive strength values (0 to 15 percent) will not besignificantly impacted by the fiber.
- Modulus of Elasticity: The modulus of elasticity increases by 3% for every 1% increase in fibercontent by volume.

- Flexural strength: The flexural strength was reported to be increased by 2.5 times using 4 percentfibres.
- Toughness: For FRC, toughness is about 10 to 40 times that of plain concrete.
- Splitting Tensile Strength: The presence of 3 percent fibre by volume was reported to increase thesplitting tensile strength of mortar about 2.5 times that of the unreinforced one.
- Impact Resistance: The impact strength for fibrous concrete is generally 5 to 10 times that of plainconcrete depending on the volume of fibres.

❖ **Human Hair**

Human hair can be utilized as reinforcing fibers in concrete. This practice is considered sustainable and eco-friendly, as it repurposes waste material. Adding human hair fibers to concrete mixes enhances mechanical properties. It improves tensile strength, crack resistance, and ductility of co crete Human hair fibers contribute to more durable and resilient structures. They are lightweight, readily available, and cost-effective compared to traditional reinforcement materials.

❖ **Why Human Hair as a Fibre?**

Hair possesses high tensile strength comparable to copper wire of similar diameter. Its use as a reinforcing material in concrete helps address environmental concerns by repurposing non-degradable waste. Abundant availability and low cost make it an economically viable option. Hair reinforcement enhances mortar strength and prevents spalling, improving the durability of concrete structures.

❖ **Coconut Fibre: Coconut** fiber, or coir fiber, is extracted from coconut husks and used as reinforcement in concrete. It improves concrete's mechanical properties, including tensile strength, ductility, and crack resistance. Lightweight, readily available, and eco-friendly, coconut fiber is a sustainable alternative to traditional reinforcement materials. It finds applications in various construction projects requiring enhanced durability and resilience, such as pavements, bridges, and building components

❖ **Why coconut fibres are used in concrete?**

- Reinforcement: Coconut fibers enhance concrete's tensile strength and crack resistance as areinforcement material.

- Cost-effectiveness: They offer a cost-effective alternative to traditional materials like steel, beingreadily available in coconut-growing regions.
- Lightweight: Coconut fibers are lighter than steel, facilitating easier handling and transportation,leading to potential cost savings and logistical advantages.
- Improved Workability: Inclusion of coconut fibers improves concrete mix workability, aiding ineasier placement and finishing, ultimately enhancing construction efficiency and product quality.

Materials Used

Material specification for concrete preparation has been discussed below

Cement:

Cement is produced by burning together, in a definite proportion, a mixture of siliceous (containing silica), argillaceous (containing alumina) and calcareous (containing lime) material in a partial fusion, at a temperature of 1400 to 1450°C. By doing so, a material called clinker is obtained. It is cooled and then grounded to the required fineness to get cement. Different types of cement are obtained by varying the proportions of the raw materials and also adding small percentage of other chemicals.

Three types of cement are available in Indian Market. They are:

1. Ordinary Portland Cement (OPC) may be used in normal conditions
2. Portland Pozzolona Cement (PPC) may be used in normal condition but after checking themortar setting
3. High-early-strength Cement (quick setting cement) may be used in cold climate zones and alsoin places where early setting and strength gaining is desirable.

In the project we have used Ordinary Portland Cement.

Aggregate: A mixture of only cement and water is costly and possesses low strength and shrinks unacceptably on drying shrinkage. In order to reduce the cost and modify such properties as the strength and drying shrinkage of the hardened mass, it is usual to introduce insoluble non cementitious particles described as aggregates. Such aggregates usually constitute between 50 to 80% of the volume of conventional concrete and may thus greatly influence its properties. Aggregate should not contain any constituent which affects the hardening of the cement and durability of the hardened concrete adversely. It should be free from organic matter which reduces the hydraulic activity of cement and affects its normal setting and hardening. It should also be free from occupies which decompose or change significantly in volume on exposure to atmosphere, or react adversely with the hardened cement paste.

Classification of aggregate: Aggregates are classified based upon their size as

a) Coarse aggregate and
b) Fine aggregate

a) Coarse aggregate: Coarse aggregate is material which passes through 80 mm sieve and retained on a 4.75 mm sieve. It may be uncrushed gravel if it results from the natural disintegration of rock or crushed stone or crushed gravel if it is produced by crushing hard stone, gravel. In the project we have used crushed stone as coarse aggregate.

b) Fine aggregate: Fine aggregate is material which passes through 4.75 mm sieve and retained on 75 micron sieve. It may be natural sand if it results from the natural disintegration of rock

or crushed stone sand or crushed gravel sand if it is produced by crushing hard stone orgravel, respectively.

In the project we have used river sand and crushed C&D wastes [4,5] as fine aggregate.

Water: Water used for making and curing concrete should be free from injurious substances such as oil, acid, alkali, sugar, salt, organic materials or other elements deleterious to concrete or steel. Portable water is suitable for making concrete. Sea water containing up to 35000 ppm of sodium chloride and other salts is generally suitable as mixing water for plain concrete work. It is not fit for making reinforced concrete as the chlorides present in it may corrode reinforcement and produce efflorescence.

Tests Conducted

In this project we are going to compare the results of concrete with crushed C&D wasted, withnormal concrete by conducting following tests.

Test for cement

1. **Consistency Test:-**
2. Specific Gravity

Test carried out for fine and coarse aggregate

1. Sieve analysis
2. Specific gravity test
3. Fineness modulus
4. Specific Gravity
5. Impact value

Test for workability of concrete

1. Slump cone test

Concrete load bearing capacity test

1. Compressive strength test

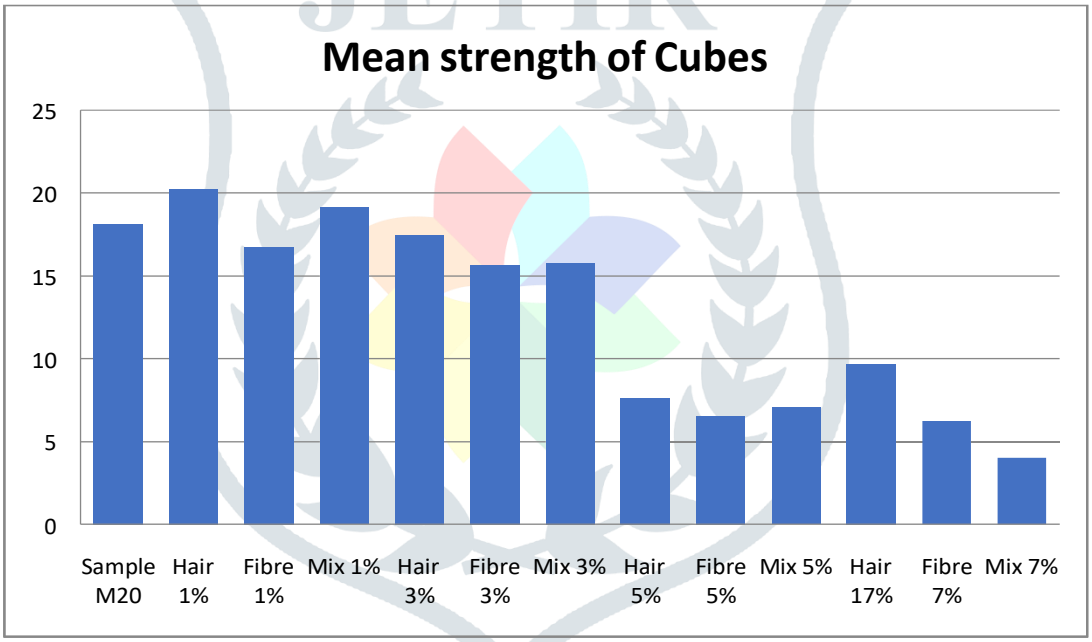
Conclusion:-

From this experimental study, it is found that the optimum content of fibre to be added to M- 20 grade of concrete is 1.5 – 2%. It is observed that there has been improvement in the properties of M- 20 grade of concrete in terms of its compressive strength and flexural strength corresponding to the percentage ofhair and coconut fiber by weight of cement.

The experimental results indicated the following features of M-20 Grade concrete with the addition ofHair and Coconut fibre:-

1. It was found that addition of 1% hair fiber in M-20 grade concrete shown a significant increase in compressive strength as compared to conventional M-20 concrete after 7 days of curing. Achievedstrength was more than 20N/mm^2.

2. Average compressive strength of M-20 grade concrete was achieved after 7 days of curing when 1%mixed fibers and 3% hair fibers were added to concrete.
3. The addition of 1% and 3% coconut fiber and 3% mixed fibers show soe decrease in the compressive strength of fiber reinforced concrete when compared to conventional M-20 concrete.
4. Significant decrease in compressive strength was observed when fibers were increased above 5%. Itis due to the formation of weak zones around fibers which makes the sample overall weak.
5. Maximum Flexural Strength was observed when beams of M-20 grade concrete with addition of1% and 5% hair fiber and coconut fibers were tested for flexure.
6. Significant decrease in flexural strength was observed when hair and coconut fiber were mixed from1% to 5%.
7. It has been observed that fibers imparts some ductile nature in concrete while the testing of beams.
8. The addition of hair fiber up to optimum content enhances binding properties, reduce crack widthand control micro cracking.
9. The ideal water cement ratio for optimum fiber content was observed to be 0.40 when fibers are1.5% - 2%.
10. The concrete shown some signs of bulking and segregation at higher concentrations of fibers, the phenomenon of balling and lumping of concrete was also observed.



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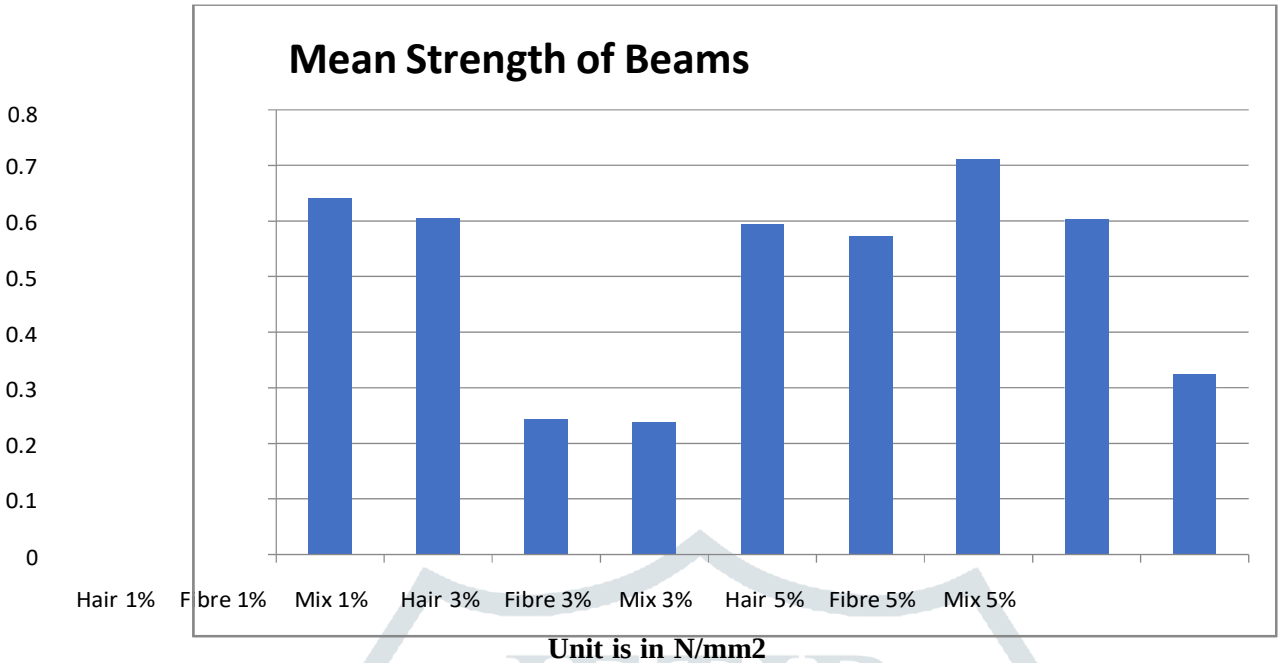

Unit is in N/mm2

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