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Experimental Study on Mechanical Properties of Fiber Reinforced Concrete Using Natural Fibers in Concrete

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ABSTRACT: Concrete, the most widely used substance on the planet is strong in compression and weak in tension and hence split tensile strength and flexural strength is less than compressive strength, so to increase the tensile properties certain materials are used in concrete, fiber is one of them. maximum compressive strength after 0.5 percent jute addition in M30 grade was 45.23 N/mm², which was 14.50 percent greater than the control mix M30. In the instance of M35 grade, the maximum compressive strength after 0.5 percent jute addition was 51.75 N/mm², which was 15% more than the control mix M30.

The maximum flexural strength after 0.5 percent coconut fiber addition in M30 grade was 5.97 N/mm², which was 7.95 percent greater than the control mix M30. In the case of M35 grade, the maximum flexural strength measured after adding 1 percent coconut fiber in M35 was 6.10N/mm², which was 3.38 percent more than the control mix M35.

KEYWORDS: Concrete, Coconut Fiber, Jute Fiber, Compressive strength, Flexural strength, Splitting tensile strength.

I. INTRODUCTION

Plain cement concrete has a very low strength, poor flexibility, and negligible crack resistance. Fiber is a composite material that contains fibers in an organized or randomly distributed pattern in the cement matrix. And the properties of fibers are determined by the effective transmission of stress between the matrix and the fibers, which is mostly determined by the type of fiber, fiber shape, fiber content, aggregate form and size, and fiber aspect ratio. Nowadays, every engineer needs stronger load bearing capacity in concrete. So, in this study, various natural fibers with high tensile strength and that do not alter the compressive strength of the concrete were tested. As a result, we discovered that adding natural fiber at 0.05 percent and 1 percent by mass of cement in M30 and M35 grades had no effect on compressive strength.

Some natural fibers, such as coconut fiber and jute fiber, have higher tensile strength and are readily available in the market at inexpensive prices. As a result, it has no effect on the cost of building with natural fibers. The use of natural fiber reinforced concrete reduces the need for reinforcement since natural fibers provide tensile strength to concrete.

Fiber of Natural Origin:

Vegetable fibers are natural aggregates with a cellular structure made up of varying quantities of cellulose, hemicelluloses, and lignin. Linear polymers composed of glucose units, whereas hemicelluloses are polymers composed of different polysaccharides.

Chemical Properties of Natural Fiber:

Natural fibre reinforcing efficiency is determined by the type of cellulose and its crystalline nature. cellulose, hemicelluloses, lignin, pectin, and waxes are all found in natural fibres. Hemicelluloses are polysaccharides made up of a combination of 5 and 6 carbon ring sugars. Cellulose is a glycosidic linkage, but hemicelluloses are made up of polysaccharides made up of combinations of 5 and 6 carbon ring sugars. The composition of coconut fibres includes cellulose and hemicellulose.



Fiber type	Cellulose (Wt %)	Hemicellulose (Wt %)	Lignin (wt %)	Pectin (Wt %)	Moisture content (Wt %)	Waxes (Wt%)	Micro fibrillar angle
Jute	61.1-71.5	13.6-20.4	12-13	0.2	12.5-13.7	0.5	8
Coir	32-42	0.15-0.25	40-45	3-4	8	0	30-49

Advantages of Natural Fibers:

When natural fibers added to the concrete, we keep our environment clean by uses of fibers which will be in dustbin and pollute the environment. It also helps the project to maintain low cost. Concrete, as we know, is sturdy but weak in tension. It Increases increased capacity of the concrete by incorporating a small amount of natural fibre, which acts as a structural element inthe tension zone.

Sr.No.	Natural Fibers	India (Tons)	World (tons)
1	Jute	1,44,000	2,500,000
2	Coconut	1,60,000	282,000

Table 1.2 Details of Material Production

Sr. No.	Fibers	Density (g/cm ³)	Tensile strength	Elongation %	Young's modulus	Dia in mm	Water absorption
1	Jute	1.45	460-533	1.5-1.8	26.5	0.25	160-200 %
2	Coconut	1.15	250-450	25	4-6	0.50	70-95 %

Table 1.3 Natural Fibre Physical Characteristics

Rigid Pavement Study:

The main purpose of a highway pavement is to disperse the load applied to the sub-grade by layering processed materials on top of the soil sub-grade. Decent riding quality, acceptable skid resistance, good light reflecting properties, and low pollution are all requirements for a pavement's construction.

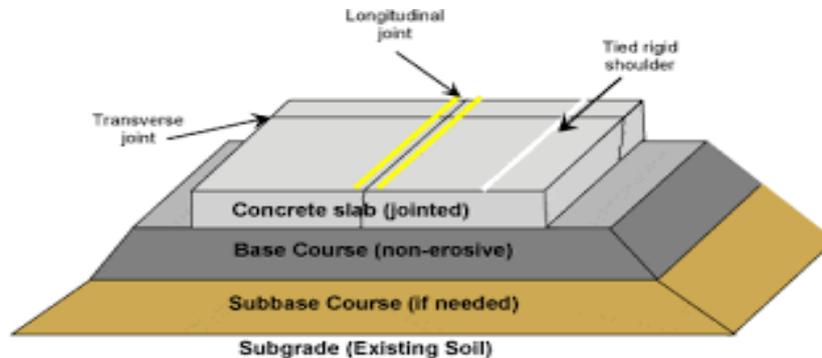


Figure 1.1 Rigid Pavement Cross Section

Objective of Study:

- The study's goal is to examine each fiber's contribution to workability and performance under flexural induced tensile loads to discover the best fibre for crack control.
- The study's goal is to develop an efficient cast-in-place concrete for use in rapid construction projects while limiting shrinkage.

The research illustrates how adding high strength microfibers to concrete might improve certain properties.

II. RELATED WORK

Many studies have focused on employing natural fibres as reinforcing material to achieve flexural and split tensile in order to withstand tensile strength.

Various percentages of Jute (0.1 percent, 0.2 percent, and 0.3 percent) and GI fibres (1 percent, 1.5 percent, and 2%) with varying lengths are added to concrete by Md. Shah Newaz Aftab Chayon et al. [1] Between plane cement and fibre reinforced concretes, a considerable increase in compressive strength and split tensile was seen. The purpose of this article is to compare the ultimate strength of metallic fibre and non-metallic fibre in concrete to those of plain concrete specimens. E. Arunakanthi [2] Studied that FRC has a high tensile strength and fire resistance, which reduces the loss of damage during fires. Strength investigations are carried out in this work to compare glass and steel fibre concrete. For M20 grade concrete, FRC is added in increments of 0.5, 1, 2, and 3%. The % rise in mechanical properties, flexural strength, and fracture toughness over 28 day. Compression and tension experiments were used to characterise the mechanical properties of PFC and FRFC with a concentration of 700 kg/m³ by Joaquin F. Castillo-Lara [3] FRFC was reinforced with henequen (un - treated or alkaline-treated) in volume fractions of 0.5, 1 and 1.5. Referencing polypropylene fibre reinforcing. Uniaxial stress and tension tests were conducted on PFC and FRFC with a target dry unit weight of 700 kg/m³. This was reinforced using henequen natural fibres and PP fibres at 0.5, 1 and 1.5 volume fractions. The increased usage of plastic packaging, plastics shopping bags, PET bottles, and other items in low-income cities today has resulted in an increase in plastic trash. But concrete and also its active metabolites are widely utilised in building, but the longevity of concrete is now a big concern due to the high number of cracks it produces. To address these two issues, we're developing Plastic Fiber Reinforced Concrete, which incorporates discarded plastic pots as a fibre (PFRC) by T. Senthil Vadivel et al. [4] tested the mechanical characteristics of concrete with varying ratios of plastic fibre addition. As a result, we deduced that the percentage of plastic fibres in concrete had increased and shows that as the amount of plastic fibre increases, the mechanical qualities improve but workability remains relatively same.

III. METHODOLOGY

MATERIALS

Cement:

Portland cement is made from calcareous resources such as lime or chalk and argillaceous minerals such as sandstone or clay.

After doing a study on the conventional mix proportion (1:3) with the replacement of sand with Granite slurry and getting good results regarding compressive and flexure strength, it comes into mind to make some new proportions which will be suitable for different works as per the requirement.

We utilised OPC 43 quality cement that was marketed under the brand name "Ultratech cement." OPC is advantageous for gaining strength quickly and is also ideal for mixture design of various grade of concrete

Aggregates:

Concrete is made up of aggregate. Aggregates provide concrete body, decrease shrinkage, and save money. Concrete consumes 70-80% of its aggregate volume. For optimal engineering application, aggregate must be free of absorbing chemicals, clay coatings, and other fine contaminants that might impair the hydration and bonding of the cementitious material. Friable or splittable aggregate particles are undesirable. Avoid aggregate containing significant proportions of sandstone or other shaly stones, soft or porous materials.

Sr. No.	Mechanical Property	Maximum (%)
1	Aggregate Crushing Value	45
2	Aggregates Impact Value	45
3	Aggregate Abrasion Value	50

Table 3.1 Aggregate Mechanical Properties

Sr. No.	Tests	Coarse Aggregate		Fine aggregate
		10 mm	20 mm	
1	Density (OD)	13.52 KN/m ³	14.76 KN/m ³	16.22 KN/m ³
2	Density (SSD)	14.78 KN/m ³	15.60 KN/m ³	16.70 KN/m ³
3	Bulk Density (Dry)	15.25 KN/m ³	14.80 KN/m ³	16.22 KN/m ³
4	Sp. Gravity (OD)	2.72	2.72	2.61
5	Sp. Gravity (SSD)	2.74	2.74	2.62
6	Water absorption	0.68 %	0.68 %	2.57 %

Table 3.2 Physical Properties of Coarse and Fine Aggregate

Admixture:

Admixture is a substance used in concrete other than cement, water, and aggregate. Adding admixtures improves workability, reduces bleeding, increases strength and durability, and reduces water usage.

Natural Fibers:

Fibers derived from coconut Palm fibres are agricultural residues products obtained during the manufacturing of coconut oil and are abundant in the tropical regions of the world. Coconut fibres have been utilised to improve overall toughness of concrete and have been shown to do so.

The jute plant's outer skin yields the fibres used in jute products. Retting is used to remove the fibres first. Jute stems are bunched together and submerged in slow-moving water as part of the retting process



IV. EXPERIMENTAL RESULTS

We replaced the natural fibre with Jute and Coconut fibre in 0.5, 1, 1.5, and 2 percent increments with ratio 100. We measured slump, density, compressive, flexural, and tensile strength. We observed that adding more than 1.5% natural fibres reduces compressive strength but neither flexural or tensile strength.

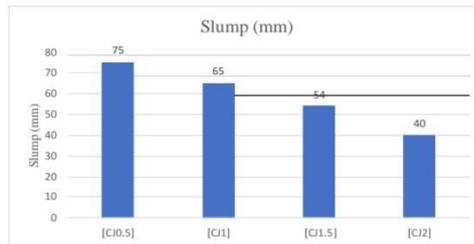


Figure 4.1 Slump value with varying ratios of natural fibres M30 Addition of Natural Fibre reinforced Slump

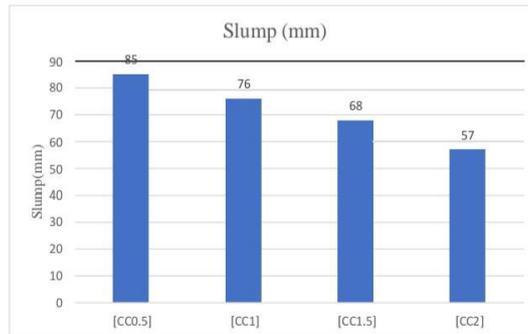


Figure 4.2 Slump value with varying ratios of natural fibres M30 Addition of Coconut Fibre reinforced Slump

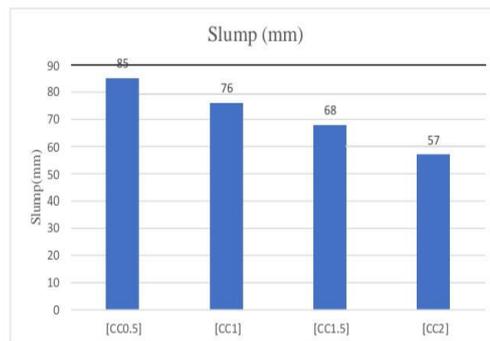


Figure 4.2 Slump value with varying ratios of natural fibres M30 Addition of Coconut Fibre reinforced Slump

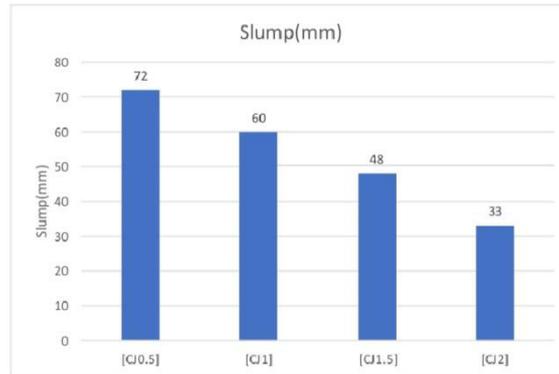


Figure 4.4 Slump value with varied ratios of natural fibres added

Test for compressive strength is generally carried out either on a cube or cylinder. Here in order to determine the compressive of all given mixtures, 150 mm cube specimens of length, breadth, and height were used (h). All specimens were evaluated for concrete strength after seven days of curing and 28 days of curing in a water tank in accordance with IS 516:2018

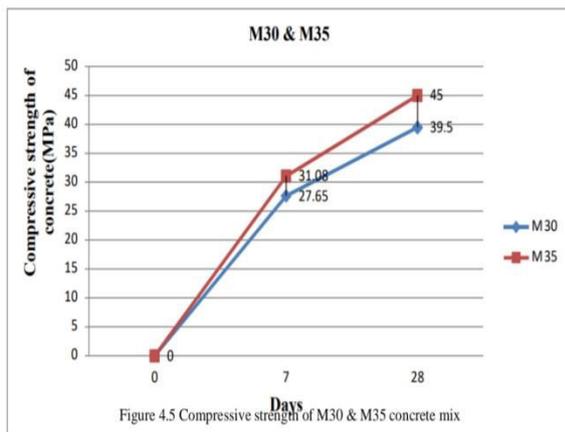


Figure 4.5 Compressive strength of M30 & M35 concrete mix

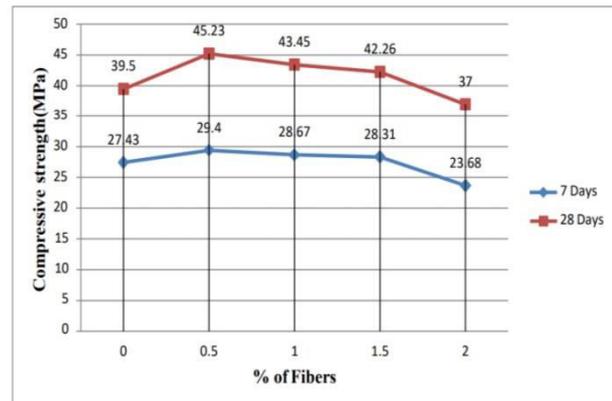


Figure 4.6 Compressive strength of M30 with addition of Jute in different ratio

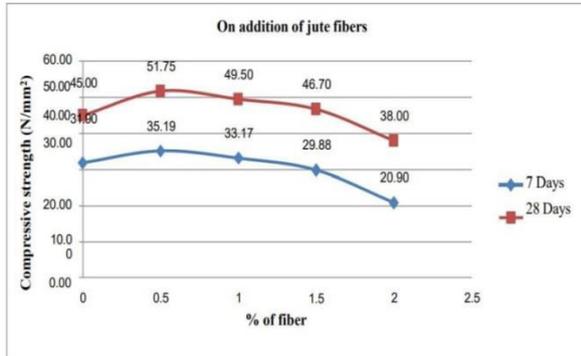


Figure 4.8 Compressive strength of M35 with addition of Jute in different ratio

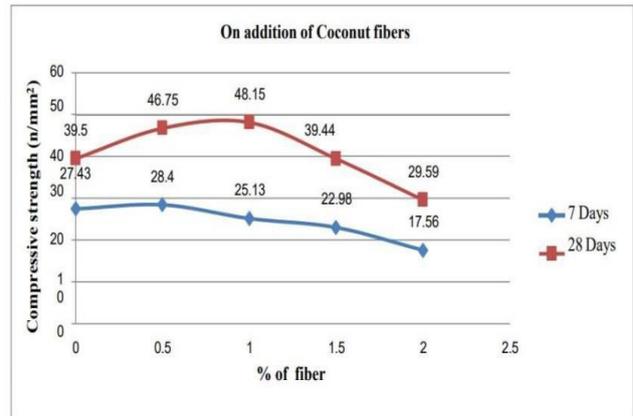


Figure 4.7 Compressive strength of M30 with addition of Coconut Fiber in different ratio

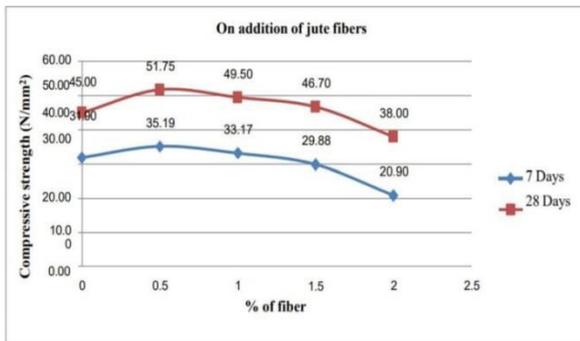


Figure 4.8 Compressive strength of M35 with addition of Jute in different ratio

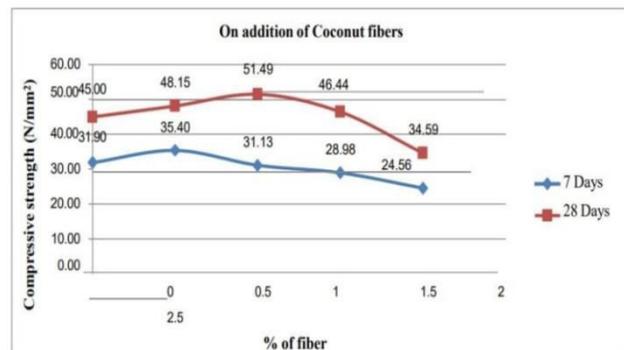


Figure 4.9 Compressive strength of M35 with addition of Coconut Fiber in different ratio

V. CONCLUSION AND FUTURE SCOPE

maximum compressive strength with 0.5 percent jute addition in M30 grade was 45.23 N/mm², 14.50 percent higher. In case of M35 grade, maximum compressive strength after addition of jute on 0.5 % as 51.75 N/mm² which was 15% greater. maximum compressive strength of M30 grade with 0.5 percent Coconut Fiber fibre was 48.15 N/mm², which was 21.89 percent higher than M30 control mix. The highest compressive strength of M35 with 0.5 percent Coconut Fiber addition was 51.49 N/mm², which was 14.42 percent higher. It was 17.72 percent stronger than the control mix M30 after adding 1% jute. The highest flexural strength of M35 with 1% jute addition was 6.91 N/mm², which was 17.11 percent higher than the control mix M35. It was shown that adding 0.5 percent coconut fibre to M30 grade increased maximum flexural strength by 7.95 percent. The highest flexural strength of M35 after adding 1% coconut fibre was 6.10 N/mm², which was 3.38 percent higher than the control mix M35. In M30 grade, the greater slump value was obtained to be 90 mm, whereas in M35 grade, the higher slumping value was found to be 85 mm in the control mix.

Future Scope:

- Certain admixtures and superplasticizers can help concrete flow.
- Adding natural fibre to OPC grade 43 might lead to stronger strength concrete than M30 and M35 grade concrete in the future.
- Using natural fibre M30 & M35, decreasing interval @ 0.25 percent (instead of 0.5 percent) may be examined.
- The durability of M30 and M35 standard ensures with natural fibre addition of 0.5, 1, 1.5, and 2 percent by weight of the cement may be studied.
- A comparison research on chemical treatment of natural fibre for M30 & M35 grading concrete is required.
- To investigate M40 and M45 concrete grades. Economists could research it.



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