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Experimental Study on Behavior of Concrete by Adding Hybrid Fiber

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Abstract: - The current investigation of the experiment is to obtain the performance and strength of concrete by adding hybrid fibers. The use of more than one fiber is called hybrid fiber. The combination of the fiber is called hybridization investigated in their paper for M20 grade of concrete. In this investigation of the fibers named polypropylene and coconut fibers are used with the different proportions. The performance of concrete is known by conducting the tests of compressive strength and split tensile strength test. The compressive strength test and split tensile test were extensively analyzed to associate with above fiber combination.

I. INTRODUCTION

Hybrid fiber concrete can be defined as a composite material consisting of mixture. Of cement, mortar or concrete and discontinues, discrete, uniformly dispersed suitable fibers. And fiber is a small piece of reinforcing material possessing certain characteristics properties. They can be circular or flat that fiber is often described by the parameter ratio which ratio of fiber length to its diameter. The hybridization of fibers provides improved specific or synergistic characteristics not obtainable any of the original fiber acting alone.

The usefulness of hybrid fiber reinforcement concrete in various Civil engineering applications is thus indisputable. Hence the study explores the feasibility of hybrid fiber reinforcement with a given grade of concrete. Hybrid fiber reinforcement concrete is formed from a combination of different types of fibers, which differ in material properties; remains bonded together when added in concrete and retain their identities and properties. Hybrid fiber reinforcement concrete is use of two or more than two fibers in a single concrete matrix to improve overall properties of concrete. In well-designed hybrid composites, there is positive interaction between the fibers and the resulting hybrid performance exceeds the sum of individual fiber performances.

As a research work on FRC has established that addition of various type of fibers such as metallic and non-metallic fibers (glass, synthetic, natural carbons) in plain concrete improves strength, toughness, ductility, post-cracking resistance, etc. for optimal result therefore different types of fibers may be combined and the resulting composite is known as hybrid-fiber reinforced concrete in this experiment steel fiber (continuously crimped) and natural fiber (coconut) have been tried.

II. OBJECTIVES AND SCOPE

The performance of concrete is known by conducting the tests of compressive strength and split tensile strength test. The compressive strength test and split tensile test were extensively analyzed to associate with above fiber combination.

To determine the optimum percentage combination of hybrid FRC

I. To compare the strength of concrete cube containing hybrid fibers with fixed 1% proportion of volume of the concrete with normal concrete beams.

II. To determine the optimum replacement of cement with slag without affecting the concrete strength.

In this project one method is suggested which will help to address the above problem by adding coconut and polypropylene fibers in conventional concrete.

Scope:

1. Use of Environment free Fibers
2. Use of this Secondary Reinforcement as an important material in Concrete. Fiber reinforced concrete as we all know are used to impart special properties to concrete that cannot be achieved by normal conventional method of mixing, placing and curing practices.

The two fibers are used in such a way that they will act as a unit and impart special properties to a concrete. Their various proportions and relationship with strength will be established. It, thus, establishes a good scope for future as mixing of various fibers in small proportion may lead to a high tensile, elastic concrete.

III. LITERATURE SURVEY

Nikhil T.R. conducted an experimental study on high volume concrete by adding fly ash in concrete. He found that 50% replacement of fly ash with cement gives maximum durability and strength and also make concrete economical. The flexural strength of such concrete also improved by 6.27%.

P.R. Wankhede et al Discussed about the effects of fly ash in concrete they take 10, 20, and 30% replacement of fly ash with cement. They found that 10 and 20% replacement of fly ash shows very good result in case of compressive strength for 28 days but at 30% replacement of fly ash shows ultimate strength of compressive strength.

V.R. Prasath Kumar et al did An experimental study by replacing coarse aggregate with fly ash coarse aggregate and discussed the result at 7 and 28 days. They investigated that both concrete with natural aggregate and with fly ash aggregate shows same result.

Aman Jatale et al conducted an experimental investigation by replacing fly ash with cement in the ratio of 20, 40, and 60 %. They conducted experiment on M15, M20, M25 grades of concrete. They investigated that workability has improved, density and air content of concrete remained unaffected, bleeding and shrinkage of concrete got reduced, durability of concrete improved, modulus of elasticity got reduced, compressive strength of concrete got reduced as increase in fly ash.

IV. EXPERIMENTAL PROGRAMME MATERIAL USED

In this study, cement, sand, coarse aggregate, water, coconut and polypropylene fibers were used.

Cement: The cement used was ordinary Portland cement (53 Grade) with a specific gravity of 3.15. Initial and final setting time of the cement was 22min and 219min respectively. Ordinary Portland cement of 53 grades was used, conforming to IS 12269:1987

Sand: Good quality river sand was used as a fine aggregate. Locally available sand, conforming to Zone II with specific gravity 2.60, water absorption 2% and fineness modulus 3.08, conforming to IS 383-1970

Coarse aggregate: locally available, maximum size 20mm, specific gravity 2.79

Water: portable water are used

Coconut fiber: The coconut is the fruit of the Cocos nucifera, a tropical plant of the Arecaceae (palmae) family. It is locally available material nearby kalaburgi.

Mechanical properties of coconut fiber (As per ACI 544.1R-96)

Properties	Coconut fiber
Fiber length (mm)	50-110
Fiber diameter	0.1-0.406
Specific gravity	1.12-1.15
Elongation (%)E	10-25
Modulus of elasticity (Ksi)	2750-3770
Average tensile strength (N/mm^2)	150

Table 1: Properties of coconut fiber

Polypropylene fiber: Polypropylene fiber is obtained as continuous mono-filaments with circular cross section. It is a synthetic carbon polymer. Polypropylene fibers are tough with low tensile strength and modulus of elasticity. A blend of steel with polypropylene fiber can arrest plastic cracking in fresh concrete and drying shrinkage cracking in hardened concrete. It is also to improve the post-cracking toughness.

Properties	Polypropylene fiber
Fiber Length (mm)	50mm
Fiber diameter (mm)	0.5mm

Table 2: Properties of polypropylene fiber

Concrete for M20 grade were prepared as per IS 10262:2009 with w/c ratio 0.40

Material	Quantity	Proportion
Cement	478.95 Kg/m^3	1
Sand	539.35 Kg/m^3	1.126
Coarse aggregate	1105.84Kg/m^3	3.24
water	191.58Kg/m^3	0.40

Table 3. Mix proportion

V. METHODOLOGY

The test have been performed to determine the mechanical properties such as compressive strength and split tensile strength of hybrid mix 0%, 1%, 2%, 3% volume of concrete.

A. Compressive strength test

The specimens have been subjected to an applied load to obtain a optimum percentage of bacteria induced concrete which is having more compressive strength.

Compressive strength = Ultimate load/Cross sectional area

Compressive strength was expressed in N/mm^2

Figure 1. Compressive strength tests

B. Split tensile strength test

The test was conducted as per IS 5816:1999. It was the standard test, to determine the tensile strength of concrete in an indirect way. This test could be performed in accordance with IS : 5816-1970.A standard test cylinder of concrete specimen (300 mm X 150mm diameter) was placed horizontally between the loading surfaces of Compression Testing Machine The compression load was applied diametrically and uniformly along the length of cylinder until the failure of the cylinder along the vertical diameter. To allow the uniform distribution of this applied load and to reduce the magnitude of the high compressive stresses near the points of application of this load, strips of steel plate were placed between the specimen and loading platens of the testing machine. Concrete cylinders split into two halves along this vertical plane due to indirect tensile stress generated by Poisson's effect.

Figure 2. Split Tensile Strength Test

Split tensile strength = $2P/\pi DL$

Where,

P - Average compressive strength (Mpa)

D - Diameter of cylinder (Cm)

L - Length of cylinder (Cm)

VI. EXPERIMENTAL RESULTS

A. Compressive strength result:

The compressive strength of control and various percentage of hybrid fiber concrete at the age of 28 days were shown in table 4and figure 1.

Specimen	No of days	Compressive strength(N/mm^2)
Cube for conventional concrete	7	20.08
	14	23.20

	28	27.12
Cube for HFSC at the ratio 1%	7	24.45
	14	30.89
	28	39.12
Cube for HFSC at the ratio 2%	7	22.77
	14	28.20
	28	35
Cube for HFSC at the ratio 3%	7	21.32
	14	26.52
	28	31.88

Table 4 Result of compressive strength using cubes specimen

Mix 0% shows increase in compressive strength of 0.34% when compared to control specimen. Mix 1% shows increase in compressive strength of 3.96% when compared to control specimen. Mix 2% shows decrease in compressive strength of 1.64% when compared to control specimen.

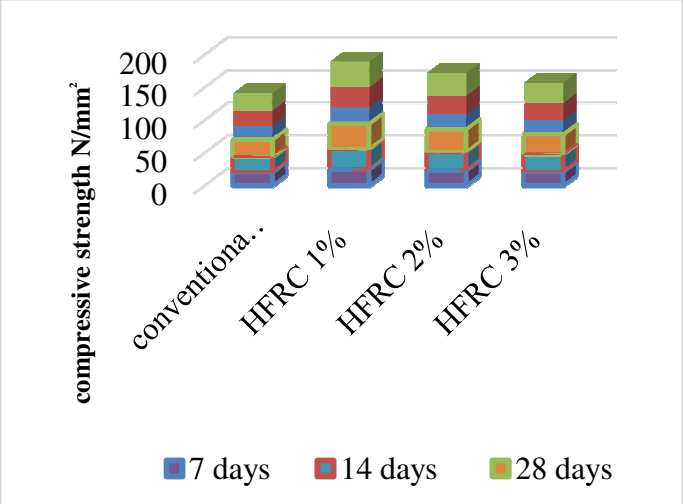

Chart 1. Bar Chart Result of Compression Test

By the compressive strength result, the 1% mix gives is the optimum compressive strength which is used for all other tests conducted.

B. Split tensile strength

The split tensile strength of control and optimum percentage of bacterial concrete at the age of 28 days were shown in table 5 and figure 2.

Specimen	No of days	Compressive strength(N/mm^2)
conventional concrete	7	4.3
	14	4.58
	28	5.11
HFSC at the ratio 1%	7	5.29
	14	7.17
	28	9.68

HFSC at the ratio 2%	7	4.62
	14	5.18
	28	8.12
HFSC at the ratio 3%	7	3.45
	14	4.05
	28	7.15

Table 5 Result for split tensile strength using cylinder

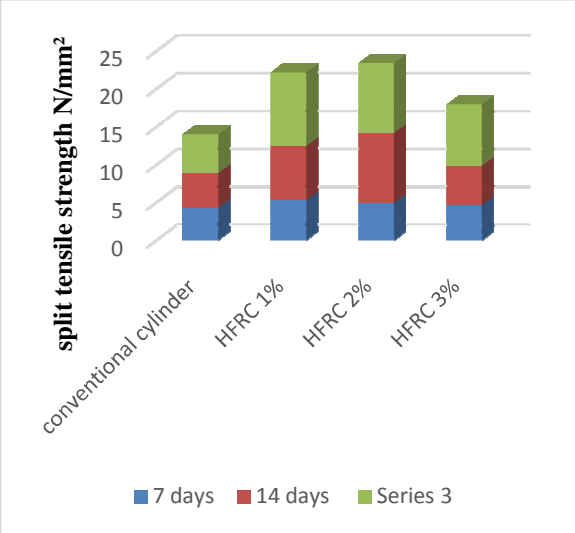

Chart 2. Comparison of split tensile strength

VII. CONCLUSION

The study on the effect of hybrid fibers with different proportions can still be a promising work as there is always a need to overcome the problem of brittleness of concrete.

The following conclusions could be drawn from the present investigation

1. Compressive strength

We conclude that the compressive strength between HFRC 2% and HFRC 3% is increase high as compare to other interval.

HFRC 2% gives high strength as compare to other combination

2. Split tensile strength

HFRC 2% gives high

strength as compare to other combination

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