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RESEARCH ARTICLE

MECHANICAL & STRUCTURAL CHARACTERISTIC OF HYBRID FRC.

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Abstract

Background/Objectives: To evaluate the suitability of short rubber fiber, coir fiber & PP as a reinforcing agent in cement concrete/ mortar. Methods/Statistical analysis: Based on basic properties data of material a mix design for M_{20} grade concrete taking a weight fraction of cement is 1%.For this work 12nos of cube (150 mm * 150 mm * 150 mm) and 12nos of beam (700mm *150 mm*150 mm) were casted by using different fiber proportion of polypropylene fiber, coir fiber & rubber fiber in the laboratory; and for the compared study with the HFRC one set of control specimen were cast. Findings: All the cube specimens were tested by UTM and beam specimens were also tested in UTM by using two points loading as per IS 516-1959. The test result shows that the hybrid of 1% with PP, CC & RF combination specimens improves compressive strength & flexural strength as compared with control specimen. Applications/Improvements: The hybrid fiber reinforced concrete can be used in non-structural components like Walls & Surfaces of Septic Tank, Water Storage Tanks and Dams, Sports Grounds, Industrial, Residential Floors, Warehouses & also used in severe earthquake area etc. The major contribution of fibers in crack resistance and crack control, improve the ductility of concrete.

Introduction:-

The design of a durable and economical fiber reinforced concrete for construction purpose is a technically challenged in developing countries like India. It has a potential to be used as a secondary reinforcing agent to overcome the inherent deficiencies in cementitious materials. Currently, different types of fibers are used included steel, glass, polymers, carbon & natural fibers. From the economical consideration have restricted to use of carbon fiber in cementitious composite due to corrosion & non-economic performance.Since the unreinforced concrete has adequate strength for much structural application but is relatively brittle materials. The addition of fibers in concrete has been used to overcome that problem. Factors affecting properties of FRC are fiber types, geometric forms, surface condition, mix proportion and age of curing period.

For a hybrid, more than two different fibers are mixed with a concrete matrix to produce a composite material. Use of both synthetic and natural fiber can give potential advantages in improving the performance of concrete matrix. HFRC can be useful in a variety of activity in the field of civil engineering. Hence, this experiment proves the feasibility of HFRC with required grade of the concrete matrix with a weight of cement fraction of 1% in various construction fields in future.

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Previously straw, horse hair was used as reinforced brick & reinforced plaster respectively. Now- a-days asbestos fiber are being used with OPC to produced water resisting sheet.

From the study of HFRC of S.Sarangi& A.K. Sinha can be found out that combination of both coir fiber and PP fiber with mix proportion of CC 0.25 PP 0.75 gives a compressive strength & flexural strength of 40.98 Mpa & 14.339 Mpa respectively at the age of 28 days.

F.PachecoTorgal& S. Jalali proposed a review on tire rubber wastage based concrete matrix & recommended for a concrete structure located in areas of several earthquake risks and also used for a dynamic load like structure (railways sleeper).

Dr. T. Ch. Madhavi found from her review study that, Polypropylene fibers reduce the water permeability, plastic, shrinkage, and settlement and carbonation depth. Using excess amount of PP fiber in concrete gave poor workability, which can be counteracted by adding HRWR admixture even if at w/c ratio of 0.3.

Materials Used:-

In this experimental study cement, fine aggregate, coarse aggregate, coconut coir fiber, polypropylene fibers were used.

Cement:-
Portland Slag based Cement (Brand-UltraTech) conforming to IS 455:1989. Test results are shown in Table 1

Fine Aggregate:-
Clean and air dry river silica grained sand locally available was used. Sand passing through IS 4.75mm sieve [IS: 383:1970] was used as sample specimens. The test result of FA is presented in Table 2

Coarse Aggregate:-
Locally available crushed granite stone of 20mm is used for this experiment. Test results on coarse aggregate are given in Table 3

Polypropylene Fiber:-
Fine fibrillated polypropylene monofilaments named as “Fiber Guard”; supplied by M/S Bajaj Reinforcement LLP Nagpur, Maharashtra, India was used. The various properties of Polypropylene fiber are given in Table 4

Coconut Coir Fiber:-
Brown clean coconut coir fiber was collected from a local market. Properties of coconut coir fiber are presented in Table 5

Rubber (Tyre) Fiber:-
Scrap rubber is collected from near tyre resoling center. Cleaned and air dry tyre particles are used in this experiment. Properties of rubber fiber are shown in Table 6

Water:-
Portable drinking water for mixing & curing,

Mix Design:-
A design mix has been adopted as per IS10262:2009 for M_{20} grade concrete. Mix proportion details are shown in Table-7

Experimental Methodology:-

Compressive Strength Test:-
It is determined by using the compressive testing machine as specified IS 516-1959. Cubes of 150 mm size were subjected to a uniformly rated compressive load of 140 Kg/cm^2 per minute until failure at ageof 28 days. Average of three is taken. Test results are shown in graph-1

Flexural Strength Test:-

Plain concrete also having a negligible tensile property as compared to compressive strength.Flexural strength value is very much similar to the tensile strength of the material. Here flexural strength test is done by using two points loading frame method in UTM is considered. According to Indian standard, a beam of 700 mm *150 mm * 150 mm was cast in cast iron form work. After de-moulds allowed the beam for normal (submersed in a water bath) curing at room temperature for an age period of 28 days. By using two points loading method, applied a uniform load rate of 400 Kg / Min. & noted down the ultimate fracture load and by computing can find out the flexure strength of the concrete. Averages of three sample test results are. The beam set up in machine and cross-section of hybrid fiber reinforced beam is shown in Figure 2 and 3 respectively.

Flexural strength = 3/2 ($pl/(bd^2)$)
b: Breadth of the tested beam (mm)
p: Ultimate cracking load (N)
l: Length of the support span(mm)
d: Depth of the tested beam(mm)
Test results are shown in graph-1

Table 1:-Properties of Cement

Properties	Value
Fineness (%)	3.5
Sp. gravity	3.10
Soundness (mm)	2
Consistency (%)	32
Initial setting time (Minute)	50
Final setting time(minute)	320

Table 2:-Properties of FA .

Properties	Value
Sp. gravity	2.67
FM	5.17
Zone	II
Moisture Content	8%
Bulk Density $^{grm}/_{cm^3}$	1.890

Table 3:-Properties of CA.

Properties	Value
Sp. gravity	2.95
FM	6.97
Bulk density($^{grm}/_{cm^3}$)	1.635
Impact strength (%)	25.37

Table 4:-Properties of PP Fiber

Properties	Value
Length (mm)	20
Diameter (mm)	0.1
Sp. gravity	0.91
Water absorption	Nil
Tensile strength (KN/Sq mm)	0.67

Table 5:-Properties of Coir Fiber

Properties	Value
Length (mm)	6-24
Diameter (mm)	0.29-0.83
Water absorption	10%

Table6:- Properties of Rubber Fiber.

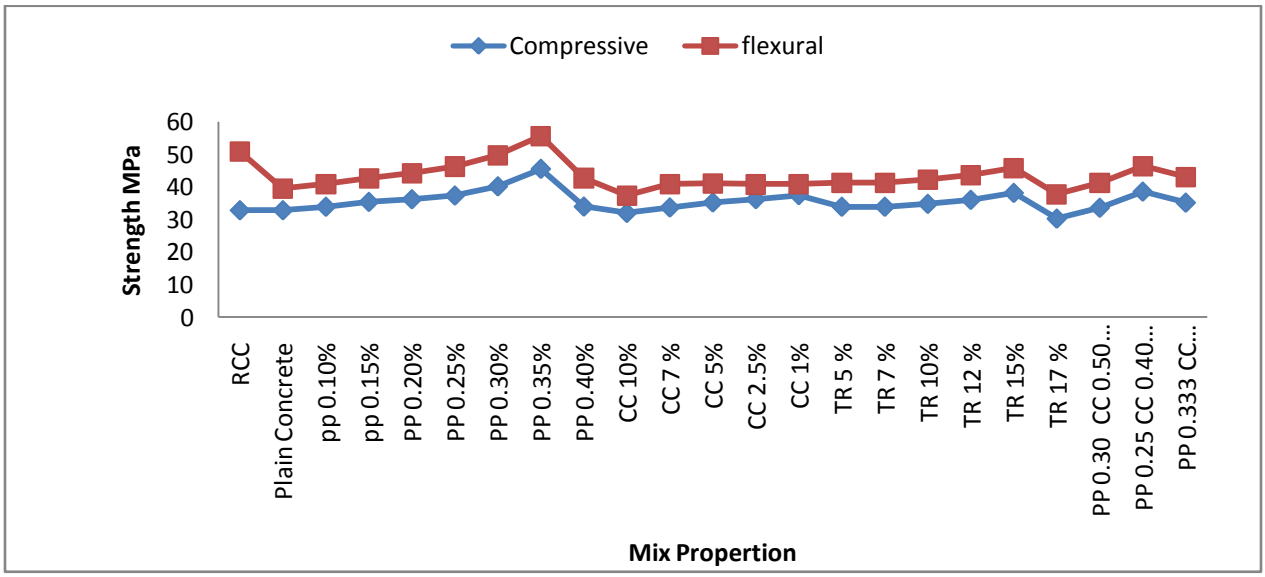
Properties	Value
Length (mm)	20
Diameter (mm)	0.2
Water absorption	Nil

Table 7:-Mix Proportion

Particulars	Value
Cement (Kg) per Cum	372
FA (Kg) per Cum	833
CA (Kg) per Cum	1125
Water (Lit) per Cum	186
w/c	0.50 %
Ratio (C:FA:CA)	1:2.23:3.13

Results and Discussion:-

Results of compressive strength and flexural strength test for M_{20} grade concrete mix with 0%(PCC), RCC, PP (0.10% to 0.40%), CC (1%to 10%), TR(5% to 17%) with hybrid mix of{ (PP 0.30% CC 0.50% TR 0.20%),(PP 0.25% CC 0.40% TR 0.25%) & (PP 0.33% CC 0.33% TR 0.33%)} are shown in the Grahp-1.



Graph1:- Compressive & Flexural Strength

Fig 1:- Cubes in CTM.

Fig 2:- Beam is set for testing.

Fig 3:- C/S of beam after failure

Conclusion:-

From the all types of mix proportion PP0.25 CC0.40 TR0.35 gives a satisfactory strength with increased 17.38% as compared to plain concrete. But, from the analysis study of the flexural strength at 28 days of the entire specimen found that uses of RCC give more strength as compared to others. As reinforcement is a corrosion material. So, PP 0.35% achieved 52.12% of the strength i.e. (PFRC). However, a hybrid of all the three fiber gives 19.43% more strength as compared to normal (Ref) concrete specimen. Therefore, concluded that use of a hybrid form of the entire material can increase the structural & mechanical quality of the concrete which is economical & eco-friendly. Henceforth it can be used as construction materials.

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