Experimental Investigation on Steel and Polypropylene Fiber Concrete

Mr. R. Dhilipkumar[1], G.Gayathri[2], T.Karthikeyan[3], R.Thenmozhi[4], R.Prasanth[5]
[1]Asst. Prof The Kavery Engineering College, Salem Tamilnadu
[2,3,4,5] The Kavery Engineering College, Salem, Tamilnadu

***Abstract*— This project presents the Result of an Experimental Investigation on the mechanical behavior of a concrete with steel and polypropylene fibers. The steel fiber of 0.7%, 0.8%, 0.9% and Polypropylene fiber of 0.1%, 0.175%, 0.25% were added together to form hybrid fiber concrete. Mechanical properties such as Compressive strength, Tensile strength and Flexural strength. The purpose of combining the fiber is to improve the multiple properties of concrete mixture. The addition of fiber to concrete is helpful to improve the fracture properties of concrete. The hybrid fiber are comprehensively being used to Rigid pavement, Airfield pavements, Flexible pavements, Earthquake –Resistant and Explosive Resistant structures, mine and tunnel lining, Brick deck overlays, Hydraulic structures, Rock-Slope stabilization etc. The standard cube test specimen of size 15x15x15cm, cylinder test specimen of size 15x30cm were casted, cured and tested for 7,14,28 days as per Indian standard guideline using M30 grade concrete.**

***Index Terms*— Steel Fibers, Polypropylene fibers, Strength, Maintenance**

1. INTRODUCTION

Concrete is the most popular material in the construction. Conventional concrete have good compression strength and it is very less or poor strength in tension as well as flexure strength. Fiber concrete is concrete were the addition of fibers to concrete contains short discrete fibers that are uniformly distributed in concrete. In order to improve the mechanical properties of concrete it is good to mix cement with fiber which have good tensile strength. Adding fibers to concrete greatly increases the toughness of the material .The use of fibers also alters the behavior of the fiber matrix composite after it has cracked, thereby improving its toughness. When to different fibers added to concrete to make the composite structure give maximum strength to concrete.

The basic purpose in using hybrid fiber is to control cracks at different size levels, in different zones of concrete (cement paste or interface zone between paste and aggregate), at different curing ages and at different loading stages. The large and the strong fibers control large cracks. The small and soft fibers control cracks initiation and propagation of small cracks. The combination of steel and polypropylene fiber improve the mechanical properties of concrete because latter can enhance performance by crack bridging and forming fiber cement matrix interfacial bonds .A conplast based super plasticizers was applied to enhance the required slump flow of the mixes with fibers added by 1% of cement weight.

Objective of Study:

The objectives of the current research is to study the durability properties of M30 grade of concrete reinforcement at to develop a strong and ductile connection for precast concrete members in seismic zone and to increase the strength of joints used in the precast beam structure.

2. LITERATURE SURVEY

Conventional concrete have good compressive strength and it is very less or poor strength in tension as well as Flexural strength. When two different fibre added to concrete to make the composite structures gives maximum strength to concrete. The material used for this concrete are steel fiber, polypropylene fiber, hybridization mono fiber. Concrete mixes were prepared using water cement ratio of 0.5. Plain cement and concrete reinforced with combination of 0.035% polypropylene +1% of steel fiber. In this hybrid fiber reinforced concrete the strength of

concrete gets increase without adding any admixtures. The average increase of compressive strength, tensile and flexural strength are increased greatly to conventional concrete

To improve tensile property of conventional concrete, different fibers like steel fibers, polypropylene fiber, glass fiber and many natural fibers are added to it. Materials used for this concrete are cement, fine aggregate, coarse aggregate, micro silica, water, chemical admixtures, fibers. Four sets of test specimen with different dosage say as 0.025%, 0.05%, 0.075% and 0.1% by volume of polypropylene fiber reinforced concrete(PFRC) specimen and 0.25%,0.5%, 0.75% and 1% by volume of steel fiber reinforced concrete(SFRC) specimen. The workability reduced with addition of fiber. The surface area of polypropylene fiber is more. The specimen of PFRC and SFRC did not yield to sudden breakage as observed in case of conventional concrete.

Present construction requirements are recommended for further improvements in Concrete properties in terms of durability, flexibility, impact resistance and energy absorption. The addition of Rubber aggregate from waste tyres to concrete enhance the toughness and Ductility of plain concrete similar to fiber–Reinforced concrete. Materials used of concrete are ordinary portal and cement, coarse aggregate, fine aggregate waste, CR,MS fibers, PP fibers and superplasticizer. Water cement ratio is 0.42.Three fibers combinations were MS fibre alone, PP Fiber alone and MS-PP fiber. The volume of fraction of 1% used. The result of test carried out on fresh concrete show that RUC mixes with CR produce lower slump value than PC mixes due to the high mortar used. The replacement of fine aggregate with CR in all mixes negatively affect overall performance, particularly the mechanical properties.

3. METHODOLOGY

- Collection of Literature Review
- Collection of Materials
- Testing of Materials
- Mix Design Calculations
- Casting and Curing of Concrete Specimens
- Testing of Specimens
- Interpretations of Results and Conclusions

4. MATERIAL CHARACTERIZATION

Cement: Portland pozzolona cement of 43 grade available in local market is used in this investigation. The cement used has been tested for various properties as per IS: 4031 and found to be conforming to various specifications of IS :12269. The specific gravity of cement was 2.88.

Fine aggregate: Locally available manufactured sand confirming to Zone II of IS 2386-1963 is used in the present study. The specific gravity of fine aggregate was 2.59.

Coarse aggregate: Crushed angular granite metal of 20 mm & 12.5mm single size confirming to IS: 2386-1963, from a local source was used as coarse aggregate. The specific gravity of 2.68.

Water: Edible water confirming the requirement of IS 456-2019 used in concrete mix preparation.

Chemical admixtures: ConplastWL4 conforming to IS: 9103:1999 is used as superplasticizer.

Fibers: Polypropylene fibers having diameter 0.036mm, cut length 12mm and aspect ratio 334 and crimped shape steel fibers having 0.6 mm diameter, 30mm length and aspect ratio 20.4-152 is used.

Fig -1: Polypropylene Fiber

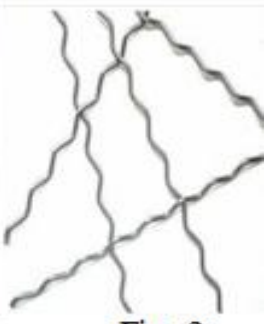


Fig -2: Steel Fiber

5. EXPERIMENTAL PROGRAMME

The experimental programme consists of preparation of fiber reinforced concrete with different percentage (by volume of concrete) of fibers. The details of the mix proportioning of materials as per packing density method are shown in the Table 1.

Table -1: Mix design of HPC as per PD method

Materials	Mix weights	Mix proportions
Cement	329	1
Fine aggregate	694.95	2.2
Coarse aggregate	1224.42	3.5
Water	148	0.45
Superplastizer	3.39	1% of cement weight

Three sets of test specimen with different dosage say as 0.1%, 0.175% & 0.25% by volume of concrete is considered for PFC sets of specimen and 0.7%, 0.8% &0.9% by volume of concrete is considered for SFC sets of specimen. Fresh state tests like slump test & Vee-bee consistency test were carried out and that of in hardened state Compressive, split tensile and Flexural strength of concrete are studied to find optimum dosage of fiber to be added to concrete. The details of different proportions of fiber reinforced concrete test specimens are as shown in table-2

Types of specimen	Sets of test specimen	Percentage of fiber (%)
Polypropylene fiber concrete	PFC 1	0.1
	PFC 2	0.175
	PFC 3	0.25
Steel fiber concrete	SFC 1	0.7
	SFC 2	0.8
	SFC 3	0.9

The number of test specimen with different percentage of fibres casted for the conduction of test as prescribed in the experimental programme are shown in table-3

Table -3: Number of FRC Test Specimen

Type of specimens	Sets of test specimens	% of fibers	Test specimens	
			Cube	Cylinder
Polypropylene fiber concrete	PFC1	0.1	9	9
	PFC2	0.175	9	9
	PFC3	0.25	9	9
Steel fiber concrete	SFC1	0.7	9	9
	SFC2	0.8	9	9
	SFC3	0.9	9	9

6. RESULT AND DISCUSSION

6.1 FRESH STATE TESTS

(i) Slump Test:

The slump test is the most commonly used method because of its easy adoptability. This test can be used for HFC only when slump values exceed 40 to 50mm.The slump test was conducted as per IS 1199-1959 guidelines. The test results are as shown in chart-1.

(ii) Compaction factor:

The measure of workablity by compaction factor is prime important since the concrete is fibrous. In this test the compaction factor is determined by the ratio of weights of partially compacted to fully compacted concrete. The compaction factor test was conducted as per IS 1199-1959 guidelines. The test result are as shown in chart-2.

6.2 HARDENED STATE TEST

(i) Compression Test :

The cube specimens are tested for compressive strength at the end of 28 days.

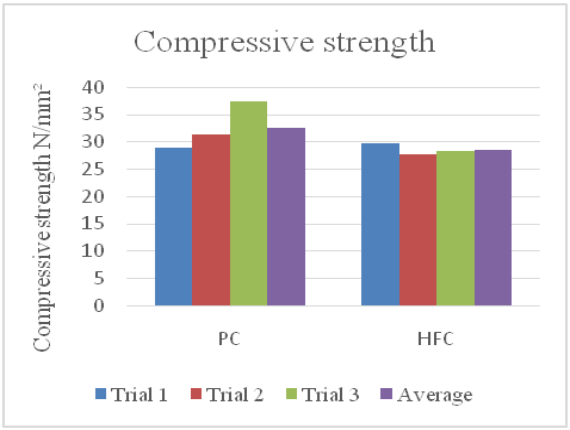
$F=P/A$ N/mm²

The result of the compressive strength test on concrete cubes are shown in table 4.

Table 4: Compressive strength of cubes at the end of 28 days.

Index	Compressive strength MPa			Average stress N/mm²
	Trial 1	Trial 2	Trial 3	
PC	28.8	31.4	37.28	32.49
HFC	29.75	27.65	28.32	28.57

From the above table it is clear that compressive strength of plain concrete is lesser than compressive strength of HFC



Given above is the graphical representation of the compressive strength test.

(ii) Split Tensile Test:

The cylinder specimen were tested for Split Tensile strength at the end of 28 days. The tensile strength of the specimen was calculated by using the formula

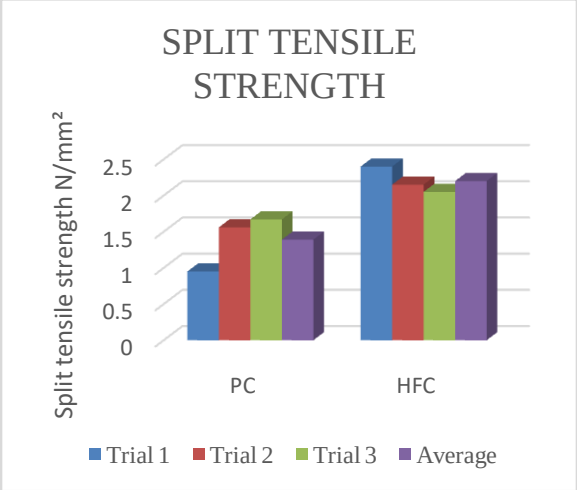
Split Tensile =2P/πDL

The result of the split tensile strength tests on concrete cylinders are shown in table 5.

Table5: Split tensile strength of cylinder at the end of 28 days.

Index	Split tensile N/mm²			Average stress N/mm²
	Trial 1	Trial 2	Trial 3	
PC	0.95	1.56	1.67	1.39
HFC	2.40	2.15	2.05	2.20

From the above table it is clear that split tensile strength of plain concrete greater than split tensile strength of HFC, it's 39% by increase.



The given above is the graphical representation of the split tensile strength test.

7. CONCLUSION

Following conclusion based on the experimental investigations concerning on the cube, cylinder of its compressive strength and split tensile strength of concrete by plain concrete and hybrid fibre concrete observations from the present study.

- Compressive strength of concrete of cube at the end of 28 days for plain concrete and HFC are 32.49 N/mm² and 28.57N/mm² respectively.
- The average decrease in the compressive strength is 12%
- Split tensile strength of concrete of cylinder at the end of 28 days for plain concrete and HFC are 1.39N/mm² and 2.30N/mm² respectively.
- The average increase in the split tensile strength of concrete cylinder is 39%.

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