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Experimental Study on Performance of Poly Propylene Fiber on Concrete

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Abstract –The concept of using fibers in concrete to improve resistance to cracking and fragmentation is old and intuitive. During the last 30 years different types of fibers and fiber materials were introduced and are being continuously introduced in the market as new applications. These fibers can be made of metals, natural, glass or organic materials. In the past three decades, extensive research on fiber reinforced concrete has shown that some types of fibers can be added to concrete to improve its gradient on the surface of fresh and mature concrete due to the severe environmental conditions of the Chandigarh area of India has been marked as one of the several causal factors of deterioration of reinforced concrete in the country.
Commercially available synthetic fibers namely, polypropylene, is used to study the effects of polypropylene fiber used for reinforcing concrete mixes and to obtain basic strength. The compressive, splitting tensile strength tests were performed by changing fiber weight content from **0% to 1%** of the cement weight content.. The compressive strength has increasing by 10% with (0.25%) of fiber than start decrease with increase the fiber quantities
Key Words: Fiber reinforced concrete; Polypropylene, steel and glass fibers, Concrete, Compressive Strength.

1. INTRODUCTION

The use of fibers in building materials to improve their behavior is an old and intuitive concept. Examples include adding straw fibers to sun-dried mud bricks (adobe) and asbestos fibers to pottery to create a composite with a better performance. Recently, research and design of fiber reinforced concrete began to increase in importance in the 1970s, and since those days various types of fibers have been developed such as steel fiber, Synthetic Fibers (Polypropylene, Nylon and Polyester), glass fiber.
Concrete is strong under compression yet weak under tension and a relatively brittle material. As such, a form of reinforcement is needed. The most common type of concrete reinforcement is via steel bars. The advantages to using concrete include high compressive strength, good fire resistance, high water resistance, low maintenance, and long service life. The disadvantages to using concrete include poor tensile strength, and formwork requirement

1.1 FIBRE REINFORCED CONCRETE

Fiber material can be steel, cellulose, carbon, polypropylene, glass, nylon, and polyester. The amount of fibers added to a concrete mix is measured as a percentage of the total volume of the composite (concrete and fibers)

1.2 Plastic Shrinkage Cracking

This type of cracking is common on exposed surfaces of freshly placed floors, slabs, and other elements with large surface areas when subjected to rapid loss of moisture due to low humidity, high temperature, and high wind velocity.When moisture evaporates from the surface of freshly placed concrete faster than it is replaced by bleeding water, the concrete surface shrinks. Tensile stresses develop in plastic concrete, resulting in shallow cracks that are usually short and run in all directions.

1.2 Drying Shrinakge Cracking

Restrained drying shrinkage is the most common cause of concrete cracking. Drying shrinkage of concrete is due to the loss of free water from the matrix gel. When concrete dries, it shrinks, and when it is wetted again, it expands. These volume changes do not cause any cracks in concrete structures, if they could take place without any restraint. The cause of cracking due to drying shrinkage is the combination of both shrinkage and restraint which develops tensile stresses higher than the tensile strength of concrete.

1.3 OBJECTIVE

The objective of this work is to study of the effect of using polypropylene fiber on concrete compressive and split tensile strength.Assessment of the effect of polypropylene fiber reinforcement in minimizing plastic and drying shrinkage cracks of the concrete.The philosophical objective of the thesis is to contribute to the knowledge of the properties of fiber reinforced concrete (FRC), helping to extend the use of the material to structural design.Developjoints between columns and beams by use steel fiber reinforced concrete specially in joint seismic performance.

2. LITERATURE REVIEW

V.R.Rathi ,A.V.Ghogare et.al represent his study, the result of glass fiber reinforced moderate deep beam with and without stirrups have been presented. Six tee beams of constant overall span and depth 150mm, 200mm, 250mm, 300mm with span to depth (L/D) ratios of 4,3,2.4, &2 and glass fibers of 12mm cut length and diameter 0.0125mm added at volume fraction of 0%, 0.25%, 0.50%, 0.75% & 1 %.The beams wear tested under two point loads at mid span. The results showed that the addition of glass fiber significantly improved the compressive strength, split tensile strength, flexural strength, shear stress and ductility of reinforced moderate deep beam withoutstirrups .

Yasir Khan, M Anwar Ansari, et.alsuggested the study of Experimental investigation on strength and durability properties of steel and glass fibre reinforced concrete composite. In present project work M 35 grade (1: 1.7: 2.4) concrete with constant w/c ratio of 0.45 is designed mixed, cubes and cylinders are casted. The strength and durability properties are carried out for various mix designations and compared with normal conventional concrete. The physical tests on materials are carried out on cement, fine aggregate, coarse aggregate. Specific gravity, water absorption, fineness modulus, normal consistency setting time tests are carried out. Cube compressive strength and split tensile strength for 7 and 28 days are obtained. The various mix designation set for fibre reinforced concrete are tested for 7 and 28 days and compared with normal conventional concrete.

Water absorption, porosity, fire resistance tests are also carried out to check durability properties. Average compressive strength v/s various mix designations for cubes and cylinders are plotted graphically. The optimum dosage of fibre (steel and glass) reinforced concrete for various mix designation is plotted graphically. Water absorption, porosity and fire resistance are also shown graphically.

Olario, Ioani and Poienaret. alpresented results of testing on steel fiber beam column joints built according to the Romanian Building Code. Six joints with steel fibers of varying fiber content from 0.5% to 1.5% and two plain concrete joints were tested. The fibers used were stainless, straight, round, had a length of 1 to 1.18-in (25 to 30-mm) and a diameter of (0.38-mm). The test purpose was to analyze the influence of steel fiber reinforced concrete on stiffness, ultimate joint strength, cracking, final ductility, bond of bars, and energy dissipation. It was found that fibrous joints had a ductility increase up to 30% and an energy dissipation increase up to 46%.s

Narayanan &Darwish et. al (1987) tested 49 simply supported rectangular beams to study the effectiveness of SFRC as shear reinforcement, and to study the replacement of stirrups by steel fibers [18]. Crimped steel fibers with a length of 1.18-in (30-mm) and an aspect ratio of 100 and fibers with a length of 1.57-in (40-mm) and an aspect ratio of 133 were used at volume fractions ranging from 0.25% to 3%. It was found that for a volume fraction of 1% steel fibers, ultimate shear strength increased by up to 170% due to the crack arresting mechanism of fibers.

Gefken and Ramey (1989)published results regarding the application of steel fiber concrete in seismic joints with increased hoop spacing. Straight, 1-in (25-mm) long brass-coated steel fibers with an aspect ratio of 62.5% were used at a volume fraction of 2%.The joints were designed to meet the ACI requirements for seismic joints. The fiber concrete joints were found to have a higher ultimate strength and a higher residual strength than the plain ones. It was also found that the fiber concrete joints had better energy dissipation, ductility, and stiffness, as well as less spalling than the plain concrete joints

Ghalibet. al (1980)proposed a design method based on ultimate strength criteria for small steel fiber reinforced concrete (SFRC) slabs. This method is based on test results of eight steel fiber reinforced two-way slabs. Since then, no new method has been proposed for designing fiber concrete slabs and ACI committee 544 has recommended the same method for design of slabs with small spans. However, the committee has recommended that this method should not be used for slabs with dimensions larger than those tested by Ghalib.

Henageret.al(1974) was the first to publish a paper on testing of steel fiber reinforced concrete beam-column joints. Two full-scale joints were constructed. One joint was built according to ACI 318-71. The other joint reduced steel congestion common in seismic resistant joints by replacing hoops with steel fiber concrete . Brass plated steel fibers with a length of 1.5-in (38-mm) and an aspect ratio of 75 were added to the concrete mix at a volume fraction of 1.67%. An earthquake loading was simulated using a quasi-static loading rate utilizing an applied double acting hydraulic actuator. It was found that the steel fiber reinforced concrete joint had a higher ultimate moment capacity, had better ductility, was stiffer, and was more damage tolerant. Henager concluded that hoops, in the joint, could be replaced with steel fibers. Henager also concluded that SFRC could provide for a more cost effective joint**.**

Viteri, and Kerteszet. al(1984)reported testing of half-scale seismic beam-column joints to show that SFRC can produce a more seismic resistant joint. Two variations of hooked end steel fibers were used at a volume fraction of 1.5%. One of the variations had a length of 1.18-in (30-mm) and an aspect ratio of 60. The other had a length of 1.97-in (50-mm) and an aspect ratio of 100. It was found that a joint with hookedend steel fibers provided better confinement than a plain concrete reinforced joint. It was also found that the SFRC joints had less structural damage, had a greater shear capacity, greater stiffness, and had approximately 15% increase in maximum moment at each ductility factor

3.Experimental Methodology & Investigation

An experimental investigation will be performed to meet the objectives, where 48 specimens of concrete (150mm diameter x 300 mm height) cylinders were constructed to a full-scale. Local ingredients were used in this experiment. One mix was

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used with four percentage fiber by weight of cement content following:-

1- 12 Specimens with 0% fiber weight fraction (control mix).
2- 12 Specimens with 0.25% fiber weight fraction.
3- 12 Specimens with 0.50% fiber weight fraction.
4- 12 Specimens with 1.00% fiber weight fraction.

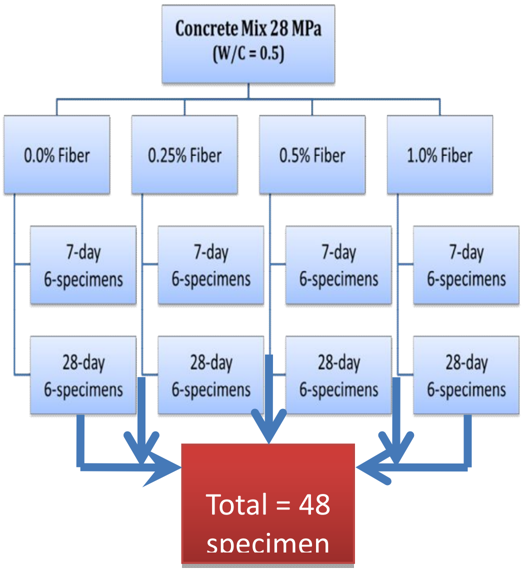

Fig 1:Flow Chart of The Experimental Program

3.1 Materials Used And Their Properties

In this present investigation material used are cement, aggregate steel, water and sand.The cement used in preparing the specimens was Type V (sulfate resisting Portland cement) according to ASTM C150-04.The chemical composition of the cement used shown in Table 4.1. In this study, constant cement content of 330 kg/m3 was used.

3.2 Coarse Aggregate (10mm and 20mm)

The water absorption of the coarse aggregate used in this study was found to be 1.5%. Specific gravity of 2.6 determined in accordance with the ASTM C127-84.The chemical composition of the coarse aggregate

Table-1 Details Of Various Mixes

S. No	Chemical Analysis	Results(%)
1	Silicon Dioxide SiO2	21.34
2	Aluminum Oxide Al2O3	3.4
3	Ferric Oxide Fe2O3	4.52
4	Calcium Oxide CaO	65.35
5	Magnesium oxide MgO	2.03
6	Sulfur Trioxide SO3	1.86
7	Loss on ignition L.O.I.	1.47
8	Insoluble residue I.R.	0.48
9	Alkalies	0.32
10	Lime Saturation Factor	94.04
11	Tricalcium Silicate	63.76
12	Dicalcium Silicate	13.08
13	TricalciumAluminate	1.52
14	TetracalciumAluminoferrite	13.75
15	C4AF+2C3A	16.80
16	Chloride CI	0.004

3.3 Fine Aggregate

The fine aggregate used in this investigation was dune sand from Riyadh road. The specific gravity of 2.60.The water absorption is 0.8%.

3.4 Water

The water used for preparing and curing the specimens was potable water from the laboratory tap. Water content of 165 kg/m^3

3.5 Polypropylene Fibres

Commercially available polypropylene fibers is 12 mm length fibrillated chopped was used as shown in picture below. It is complies with the requirements of ASTM C–1116

Table-2 Properties Of Propylene Fibre

S. No	Chemical Analysis	Results(%)
1	Specific gravity	0.91 g/cm3
2	Alkali content	Nil
3	Sulphate content	Nil
4	Air entrainment	Air content of concrete will not be significantly increased
5	Chloride content	Nil
6	Constituents	Virgin polypropylene C3H5
7	Fiber thickness	6 Denier, where 1denier = 10 micrometers
8	Storage life	Minimum 12 month from date manufacture
9	Young's modulus (MPa)	5500-7000
10	Tensile strength (MPa)	350
11	Melting point (^oC)	160
12	Specific gravity	0.91 g/cm3
13	Alkali content	Nil
14	Sulphate content	Nil

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15	Air entrainment	Air content of concrete will not be significantly increased
16	Chloride content	Nil

4. Experimental Test Results

An experimentation will be performed to meet the objectives, where 48 specimens of concrete (150mm diameter x 300 mm height) cylinders were constructed to a full-scale. Local ingredients were used in this experiment

3.1 Workability

The unit weight of freshly mixed concrete was determined in accordance with ASTM C 138-81, using metal cylinders. This test was carried out for all the mixes. The workability of all the mixes was measured by the slump test

3.2Water Absorption Test Procedure

The cubes specimen, were placed for curing in water for 28 days. After 28 days were completed, the cubes specimens were taken outweighed. The weight of specimen after curing minus the weight of specimen before curing is considered as the water absorbed by specimens.

Water absorbed = weight after curing – weight before curing

3.3 Compressive Strength

It is the most important material parameter used to characterize cement based products. Usually, the term strength implies a crushing strength of cubes cast in a steel moulds. Cube specimens of size 70.6mm × 70.6mm × 70.6mm were cast for compressive strength as per IS Code:4031 (part 6)-1998. After casting, all tests specimens were finished with steel trowel. Specimens were remoulded after 24 hours and then cured in water at approximately room temperature till testing. Compressive strength test for cubes was carried out at 7 and 28 days. All the specimens were tested in UTM. The compressive strength was calculated using the formula:

$$F_C = P/A$$

Where

F_c= compressive strength (N/mm^2)

P= maximum load (KN), A= cross section of the sample (mm^2)

Table 3.Compressive Strength at (7&28days) curing

Fiber Weight Fraction (%)	Compressive Strength 7-day (MPa)	Compressive Strength 28-day (MPa)	Percentage (%)	
			7-Day	28-Day
0.0	28.7	35.25	100	100
0.25	31.8	37.35	111.8	106
0.50	23.08	31.20	80.5	88.6
1.0	21.1	25.68	73.6	73

* Average of 3 Specimens. Note: Compressive Strength test according to ASTM C 39

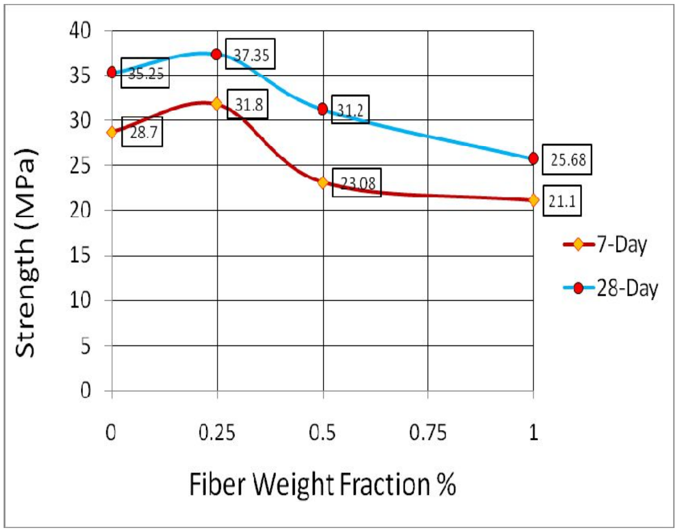

Fig.2. Compressive strengths of polypropylene fiber concrete

3.4Split Tensile Strength

The split tensile strength was conducted on cylinders of standard size 300mm*150mm according to IS code 5816-1970. The specimen were taken out of curing tanks after required time and were dried out before testing. The dried specimens were tested on compression testing machine as per requirement given in IS 516-1959. The cylindrical specimen were placed on CTM at right angle to that of casting position. The load was gradually increased at constant rate of 2.4N/mm^2/minute till the failure of specimen took place and thus the split tensile strength of the specimen can be computed. The split tensile strength is calculated by using formulae given below:Tsp = (2P/ (dL))

Where, P= maximum load ,L = Length of specimen in mm D = diameter of width of specimen in mm

Table 4 Split Tensile Strength at (7&28days) curing

Fiber Weight Fraction (%)	Split Tensile Strength 7-day (MPa)	Split Tensile Strength 28-day (MPa)	Percentage (%)	
			7-Day	28-Day
0.0	2.40	2.6	100	100
0.25	2.80	3.04	116.7	116.9
0.50	2.91	3.10	121.2	119
1.0	3.01	3.20	125.5	123

*Average of 3 Specimens. Note: Split Tensile Strength test according to ASTM C 496

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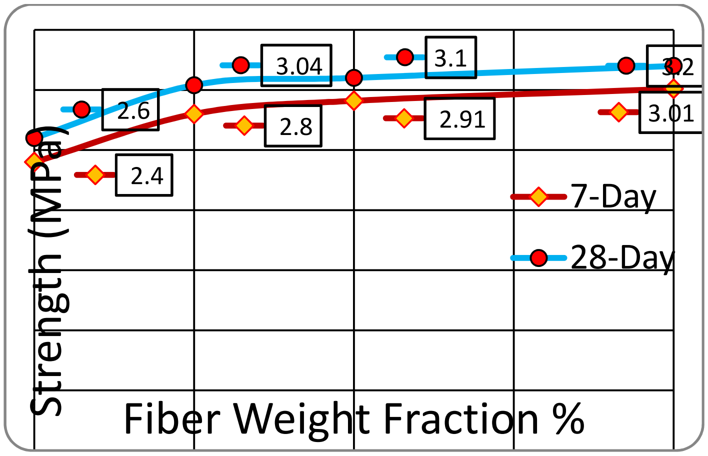

Fig.3. Tensile strengths of polypropylene fiber concrete

5. Discussions

5.1Compressive Strength Results Discussion

- The addition of polypropylene fibers effect on the compressive strength has increasing by 10% with (0.25%) of fiber than start decreases by with increase the fiber quantities.
- High quantities of fiber produced concrete with poor workability and segregation, higher entrapped air and lower unit weight.
- A significant effect on the mode and mechanism of failure of concrete cylinders in a comp. testing with (FRC).The fiber concrete fails in a more ductile mode.
- The (PC) cylinders typically shatter due to an inability to absorb the energy by the test machine at failure.
- Fiber concrete cylinders continue to sustain load and large deformations without shattering into pieces

5.2 Split Tensile Strength Results Discussion

- The addition of polypropylene fibers effect on the split tensile strength has increasing by 17%, 18% and 20% with 0.25%, 0.5% and 1.0% of fiber respectively.
- That improve the tensile and cohesion of concrete.
- The fiber concrete fails in more ductile mode opposite the plain concrete that shattering into pieces.

3. CONCLUSIONS

Experimental Investigation Showed following Conclusions

1. The addition of polypropylene fibers effect on the compressive strength has increasing by 10% with (0.25%) of fiber than start decreases by with increase the fiber quantities.
2. High quantities of fiber produced concrete with poor workability and segregation, higher entrapped air and lower unit weight.
3. A significant effect on the mode and mechanism of failure of concrete cylinders in a comp. testing with (FRC).The fiber concrete fails in a more ductile mode.
4. The (PC) cylinders typically shatter due to an inability to absorb the energy by the test machine at failure.
5. Fiber concrete cylinders continue to sustain load and large deformations without shattering into pieces.
6. The addition of polypropylene fibers effect on the split tensile strength has increasing by 17%, 18% and 20% with 0.25%, 0.5% and 1.0% of fiber respectively.
7. That improve the tensile and cohesion of concrete.
8. The fiber concrete fails in more ductile mode opposite the plain concrete that shuttering into pieces.

References

1) Various Codeswere used: IS: 8112-1989, IS: 383-1970. IS: 2386 (PART-1)-1963, IS: 456-2000, IS: 4031(PART-6)-1988.
2) **V.R.Rathi ,A.V.Ghogare**“EFFECT ON COMPRESSIVE STRENGTH OF HIGH PERFORMANCECONCRETE INCORPORATING FIBRE CONCRETE AND FLY ASH” ISSN: 2320-5083, Volume 2, Issue 2, March 2014.
3) **Yasir Khan, M Anwar Ansari, et.al**Optimization of Blended Cement using FIBRES ”(ISSN 2347 – 6435, Volume 4, Issue 9, September 2015).
4) **Olario, Ioani and Poienaret. al**“Study on Blended Cement Composites with 53Grade OPC Composite for MarineCondition/Environment”(ISSN: 2278-0181, Vol. 4 Issue 03, March-2015).
5) Priyanka A. Jadhav, Dilip K. Kulkarni “Effect of replacement of natural sand by manufactured sand on the properties of cement mortar” (ISSN 0976 – 4399 Volume 3, No 3, 2013)
6) Seyed M. Joorabchian “Durability of concrete exposed to sulfuricacid attack /http://digitalcommons.ryerson.ca/ dissertations (2010).
7) Dr M. VijayaSekhar Reddy, K. Ashalathaand K.Sasi “Strength Properties of Ternary Blended Concrete by Alccofine Bottom Ash Replacement in Cement and Blast Furnace Slag in Fine Aggregate” ISSN 0974-3154 Volume 9, Number 2 (2016), pp. 111-120.