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Experimental Investigation on Polypropylene Fiber Reinforced Concrete With Artificial

A. P. Sathe[1], A. V. Patil[2]

[1]ME Civil Engineering Department, NBNSCE, Solapur, Maharashtra, India

[2]Assistant Professor, ME Civil Engineering Department, NBNSCE, Solapur, Maharashtra, India

Abstract: ***The paper presents research work of experimental investigation on polypropylene fiber reinforced concrete by replacing river sand to artificial sand with and without admixture. Use of fiber reinforce polymer in civil engineering increase rapidly. Various type of fiber is used such as glass, carbon, steel, asbestos, polyester and polypropylene. The various experimental investigations for determination of properties of polypropylene fiber are discussed in paper work. This paper presents the effect of polypropylene (PP) fibers on various properties of concrete such as compressive strength, tensile strength, workability, and fracture properties with various content of fiber(0% ,0.5%,1.0%,1.5%). The result of this present investigation indicates that by adding of 0.5% of polypropylene fiber shows maximum compressive and tensile strength.***

Keywords: Polypropylene fibre, Artificial sand, Compressive, tensile strength

1. Introduction

Concrete can be formulated with high compressive strength, but always has lower tensile strength. For this reason it is usually reinforced with materials that are strong in tension .The advantages of using concrete include high compressive strength, good fire resistance, High water resistance, low maintenance, and long service life. The Disadvantages of using concrete include these points:- 1. Week in tension Concrete is week in tension so large amount of steel is required.2. Increased Self Weight Concrete structures have more self weight compared with steel structures so large cross-section is required only to resist self weight, making structure costly.3. Cracking Unlike steel structures concrete structures can have cracks. More cracks with smaller width are better than one crack of larger width 4. Unpredictable Behavior If same conditions are provided for mixing, placing and curing even then properties can differ for the concrete prepared at two different times. 5. Inelastic Behavior concrete is an inelastic material; its stress-strains curve is not straight so its behavior is more difficult to understand. 6. Shrinkage and Creep.

Fibre Reinforced Concrete (FRC) may be defined as composite materials made with Portland cement, aggregate, and incorporating discrete discontinuous fibres. The use of polypropylene fibers has increased tremendously in construction of structures because addition of fibers in concrete improves the toughness, flexural strength, tensile strength and impact strength as well as failure mode of concrete. Polypropylene twine is cheap, easily available, and like all manmade fibers of a consistent quality.Concrete is a mixture of cementious material, aggregate, and water. Aggregate is commonly considered inert filler, which accounts for 60 to 80 percent of the volume and 70 to 85 percent of the weight of concrete. Aggregate is classified as two different types, coarse and fine. Coarse aggregate is usually greater than 4.75 mm, while fine aggregate is less than 4.75 mm. but for fine aggregate, there is alternative material is available, which is artificial crush sand. Demand for manufactured fine aggregates for making concrete is increasing day by day as river sand cannot meet the rising demand of construction sector. Natural river sand takes millions of years to form and is not repleneshible. Because of its limited supply, the cost of Natural River sand has sky rocketed and its consistent supply cannot be guaranteed. Under this circumstances use of manufactured sand becomes inevitable. River sand in many parts of the country is not graded properly and has excessive silt and organic impurities and these can be detrimental to durability of steel in concrete whereas manufactured sand has no silt or organic impurities. Crushed stone produces much more angular and elongated aggregates, which have a higher surface-to-volume ratio, better bond characteristics.

The design of concrete (M30) was done with locally available materials. Concrete added fiber by weight of cement (0% ,0.5%,1.0%,1.5%). three numbers of cubes of 150 X 150 X 150 and cylinder 150 mm dia and 300 mm length were casted for each %age. Hence 24 numbers of cubes and cylinders were casted for each compressive and split tensile strength. The compressive strength and split tensile strength of concrete of all mixes was determined at the ages of 28 days of curing for addition of polypropylene fiber (0% ,0.5%,1.0%,1.5%)

2. Literature Review

B. Vijaya and Dr.S.Elavenil et al.[1] state that The mix with manufacturing sand as 100% fine aggregate gives initial workability of 170mm, which is much higher than that of the mixes with 100% river sand(RS) and crusher dust. The standard mix with 100% manufactured sand has exhibited much higher compressive strength 53 MPa. The standard mix with 100% of river sand has exhibited compressive strength of 49MPa, 7.5% lower than that of manufactured sand. Research findings concluded that, compared to concrete made from river sand, high fines concrete generally had higher flexural strength, improved abrasion resistance, and higher unit weight & lower permeability due to fillings the pores with micro fines.

Rajendra P. Mogre , Dr. Dhananjay K. Parbat et al.[2] :- We concludes that, the replacement of natural sand with artificial sand is fissile and behavior and strength of reinforced concrete will improved. Also the use of polypropylene fibre will enhance strength and behavior of reinforced concrete also improves resistance against impact loading and fire. Polypropylene fibers have a positive impact on ultimate strength of heated beams. For a heating duration of 4.5 hours, the residual ultimate strength is larger than the corresponding strength of beams without polypropylene fibers by more than 60 %. No sudden failures are observed in all beams containing polypropylene fibers.

James E. Shoenberger, Joe G. Tom et al.[3] investigated that PFRC does provide improved impact resistance with increasing volumes of fibers. A PFRC mixture does provide reductions in permeability provided that the water-cement ratio remains below 0.5. Increased percentages of fibers further decreased the permeability provided the mixture remained workable. The study indicates a reduction in plastic shrinkage with increasing amounts of fibers. The polypropylene fibers decrease plastic shrinkage provided the water-cement ratio remains below 0.5. 4. Wear resistance of PFRC has not been widely studied, but one study found an increase in the wear resistance with increasing fiber contents.

Roohollah Bagherzadeh, , Hamid Reza Pakravan, Abdol-Hossein Sadeghi, Masoud Latifi, Ali Akbar Merati et al.[4] :- The influence of polypropylene fibers has been studied in different proportioning and fiber length to improve the performance characteristics of the lightweight cement composites. Fibers used in two different lengths (6mm and 12mm) and fiber proportions (0.15% and 0.35%) by cement weight in the mixture design. Compared to unreinforced LWC, polypropylene (PP) reinforced Lightweight Cement Composites (LWC) with fiber proportioning 0.35% and 12 mm fiber length, caused 30.1% increase in the flexural strength and 27% increase in the splitting tensile strength. Increased fiber availability in the LWC matrix, in addition to the ability of longer PP fibers to bridge on the micro cracks, is suggested as the reasons for the enhancement in mechanical properties. All reinforced lightweight concrete specimens display improvement in their mechanical strength as a result of fibers performance in cement matrix. Among all fiber proportions and lengths, only the PP fiber with 12 mm length and proportion 0.35 % performed better in all respects compared to the physical and mechanical properties of reinforced lightweight concrete.

Priti A. Patel, Dr. Atul K. Desai and Dr. Jatin A. Desai et al.[5] state that, research program on evaluating the performance of polypropylene fibre reinforced concrete. The presence of fibres in concrete alerts the failure mode of material. It is found that the failure mode of plain concrete is mainly due to spalling, while the failure mode of fibre concrete is bulging in transverse directions. Compressive strength enhancement ranges from 8% to 16% for PFRC. Strength enhancement in splitting tensile strength due to polypropylene fibre addition varies from 5% to 23%. The maximum increase in flexural strength of PFRC is 36%.

Slamet Widodo et al.[7]state that ,This research conducted to evaluate the effects of polypropylene fiber addition on fresh state characteristics of Self-Consolidating Concrete (SCC) mixes, and investigate the effects of polypropylene fiber on some hardened properties of SCC. In this research, concrete mixes were added with polypropylene fiber of 0%, 0.05%, 0.10%, and 0.15% volume fraction. Tests results indicate that polypropylene fibers tend to reduce the flow ability and passing ability but will increase viscosity and segregation resistance of SCC. Furthermore, it can be concluded that polypropylene fiber reduce deformability of SCC in the fresh state. After 28 days of curing, concrete specimens' tests indicate that polypropylene fiber addition up to 0.10% of volume fraction tend to improve the compressive strength, tensile strength, and impact resistance of hardened SCC. It also can be suggested that polypropylene fibers allowed to be added into SCC mixes up to 0.10% by volume of concrete

3. Experimental Programme

A. Concrete Mix Design (M30)

Design Stipulations
(1) Characteristic comp. strength required in the field at 28 days 30Mpa Level of quality control Good

Test Data for Materials
(1)Specific Gravity of Cement 3.15
(2)Comp. Strength of Cement at 7 days satisfies the requirement.

12Standard cubic specimens of size 150 mm and 12 standard cylindrical moulds for size 150 x 300mm (three for each percentage of marble powder) were cast. Concrete cube were cast for compressive and split tensile strength of concrete was undertaken at 28 days of age. All specimens were removed 24 hrs before testing.

Table 1: Proportion Of Concrete

	water	cement	Fine aggregate	Coarse aggregate
Ratio	0.42	1	1.72	2.89
Specific gravity	1	3.15	2.6	2.7

Table 2: Comparision of natural and artificial sand

Technical specification – comparison between Manufactured and River sand				
	Property	River sand	Manufactured sand	Remarks
1	Shape	Spherical particle	Cubical particle	Good
2	Particle passing 75micron	Presence of silt shall be less than 3%(IS: 2007)	Presence of dust particle shall be less than 15%	Limit 3% for uncrushed & limit 15% for crushed sand
3	Silt and Organic impurities	Present (Retard the setting & Compressive Strength)	Absent	Limit of 5% for Uncrushed & 2% for Crushed sand
4	Specific gravity	2.4 – 2.7	2.5 – 2.9	May vary
5	Water absorption	1.4 – 2.9%	1.8 – 3.8%	Limit 2%
6	Grading zone(FM)	Zone II and III FM 2.3 -2.9	Zone II FM 2.5 – 3.0	Recommends Zone II for Mass Concrete

Table 3 Proportion of concrete for M30(with & without admixture)

% Fiber	(For1 M^3) 0.0% , 0.5%, 1.0%, 1.5%	(For1 M^3) 0.0% , 0.5%, 1.0%, 1.5%
Cement	370	490
water	148	197
Coarse aggregate	997	997
Fine aggregate	725	725
Super plasticizer	7	-
w/c ratio	0.40	0.40

4. Result

A] Mix Proportions

A mix M30 grade was designed as per Indian Standard method and the same was used to prepare the test samples.

B]Compressive Strength

Compressive strength of concrete is tested on cube at different percentage of polypropylene fiber content in concrete. The strength of concrete has been tested on cube at 28 days. 28 days test gives the data of final strength of Concrete at 28 days curing. Compression testing machine is used for testing the compressive strength test on concrete. At the time of testing the cube is taken out of water and dried and then tested keeping the smooth faces in upper and lower part. The strength of concrete is very much dependant up on the hydration reaction. In this experiment, in all cases, i.e. for 0.5 % adding of cement by polypropylene fiber the test results, as shown in Table and show that twenty eighth days compressive. The reduction of the strength increased with increasing percentage of polypropylene fiber after some specific limit(after 0.5%)

Figure 1: Testing the Cube Specimen

Table 4: Compressive Strength of concrete with admixture

Fiber Content %	Compressive Strength (28 Days Mean)
0.00	39.91
0.50	**49.56**
1.00	43.36
1.50	37.44

Table 5: Compressive Strength of concrete without admixture

Fiber Content %	Compressive Strength (28 Days Mean)
0.00	37.63
0.50	41.48
1.00	38.51
1.50	33.63

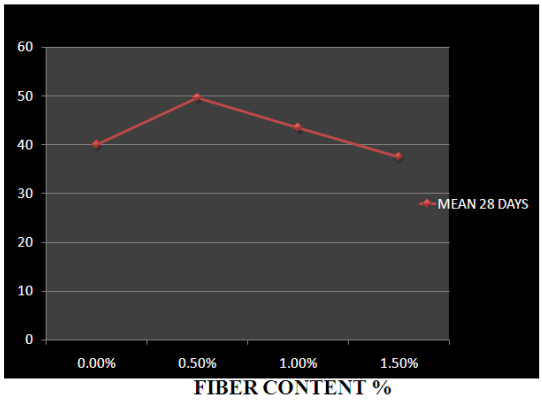

Figure 2: Test result of Compressive strength of 28 days

C] Split tensile strength

Split Tensile strength of concrete is tested on cylinders at different percentage of polypropylene fiber Content in concrete. The strength of concrete has been tested on cylinder at 28 days. 28 days test gives the data of final strength of concrete at 28 days curing. Compression testing machine is used for testing the Split Tensile strength test on concrete along with two wooden boards. At the time of testing the cylinder taken out of water and dried and then tested.

Figure 3: Testing the Cylinder Specimen

Table 6: tensile Strength of concrete with admixture

Fiber Content %	Tensile Strength (28 Days Mean)
0.00	4.12
0.50	**5.09**
1.00	4.79
1.50	4.46

Table 7: Tensile Strength of concrete without admixture

Fiber Content %	Tensile Strength (28 Days Mean)
0.00	3.76
0.50	4.38
1.00	3.82
1.50	3.39

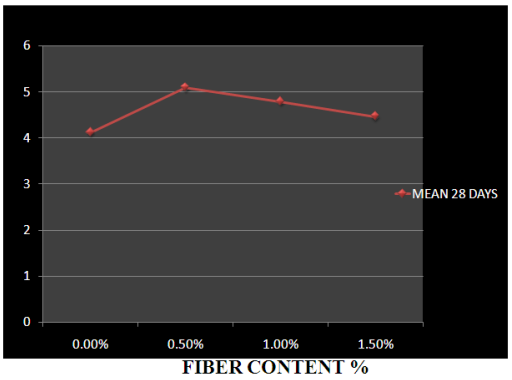

Figure 4: Test result of Tensile strength of 28 days

From the figures, it can be seen that polypropylene fiber improves the compressive and split tensile strengths of concrete. As the percentage adding of concrete with polypropylene fiber increases, the compressive and split tensile strengths increase, reach a maximum value and then decrease.

5. Discussion

1) With the inclusion, by adding polypropylene fiber the strength of concrete gradually increases up to a certain limit(up to 0.5%) but the gradually decreases.
2) The replacement of natural sand with artificial sand is fissile and behavior and strength of reinforced concrete will improved.
3) Concrete mixes were added with polypropylene fiber in range of 0.1% to 1.5%.it improves compressive andttnsile strength of concrete and also show better result on mechanical properties like, improves arrest drying shrinkage cracks ,reduces permeability hence ensures water tightness ,reduces density ensures more yield of mix, minimizes steel reinforcement in industrial floors, improves durability, free from corrosive substances, improves impact strength, increase fatigue resistance & concrete toughness, non-magnetic, chemically inert and 100% alkali proof.

6. Conclusions

1) Up to 0.5% adding of concrete with polypropylene fiber there is optimum percentage to increase in all mechanical properties.
2) Compressive strength of material increases with increasing fibre content. Strength enhancement up to 24% for PFRC.
3) Strength enhancement in splitting tensile strength due to polypropylene fibre addition up to 22%.
4) The durability of concrete improves and addition of polypropylene fibers greatly improves the fracture parameters of concrete. Polypropylene fibre is Reduce number of joints And Reduce repair due to subsequent damage.
5) The compressive strength, split tensile strength increase with the addition of fiber content as compared with conventional concrete.
6) The workability of Polypropylene fibre concrete has been found to decrease with increase in Polypropylene fibre content replacement.
7) To minimize the costs for construction with usage of artificial sand which is cheaply available than natural sand.

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Author Profile

Sathe Abhijeet P. received B.E. in civil engineering from BIGCE, solapur(2013) and percuing M.E. degree in civil engineering from NBNSCE ,soalpur.(2015).

Patil Ashutosh V. B.E. (Civil) M.E. completed from College Of Engineering, Pune. He is working as professor at N.B.Navale Sinhgad College of Engineering, solapur. He has got 9 year of teaching experience.