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Enhancement of Physio-Mechanical Properties of Concrete Using Steel, PPF, SYF Fibers and their Feasibility for Road Construction

Mrudula M. Darade,
Post Graduation Student,
Civil Engineering Department,
Savitribai Phule Pune University,
Dr. D Y Patil School of Engineering, Lohegaon
Pune, Maharashtra412105, India

Ashish P. Waghmare
Assistant Professor,
Civil Engineering Department,
Savitribai Phule Pune University,
Dr. D Y Patil School of Engineering, Lohegaon
Pune, Maharashtra412105, India

Abstract— Plain concrete has two major deficiencies, Aghuy y low tensile strength and a low strain at fracture. The tensile strength of concrete is very low because plain concrete normally contains numerous micro cracks. It is the rapid propagation of these micro cracks under applied stress that is responsible for the low tensile strength of the material, eventually leading to brittle fracture of concrete. In past attempts have been made to impart improvements in tensile properties of concrete members by way of using conventional reinforced steel bars and also by applying restraining techniques. Although both methods provide tensile strength to concrete members, they how ever do not increase inherent tensile strength to concrete itself. It has been found that the addition of small closely spaced and uniformly dispersed fibers to concrete would act as crack arresters and would substantially improve its static and dynamic properties. This type of concrete is known as "Fiber Reinforced Concrete" (F.R.C.)

This paper gives experimental investigation of steel, polypropylene and synthetic fiber in a glance. 24 cubes and 16 beams of M-40 grade concrete have been casted for different volumes of fiber based on literature survey. These specimens have been tested for compressive and flexural strength in laboratory based on the procedure given in codes. The results are analyzed and final conclusion is drawn. Based on conclusion, the fiber percentage is selected with considering technical and economical aspects which is 0.3% polypropylene fibers. Two slabs having dimensions 1m X 1mX 0.25m, one with 0.3% polypropylene fiber and another with normal concrete of M-40 grade have been cast. These slabs have been observed for the crack behavior after 28 days curing to come to final conclusion of the work done.

Keywords— *Aspect ratio, Admixture, Flexural Strength.*

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I. Introduction

Ordinary concrete is very strong in compression whereas weak in tension and flexural properties. Popular to reinforce concrete with small, randomly distributed fibers. And we know that corrosion is failure factor of structure because salt present in it.

There are different ways to minimize the failure of R.C.C. structures one of them is to use the fiber in concrete called as fiber in concrete called as fiber reinforced concrete which will increase the toughness and to reduce crack. In construction industry for many applications it is becoming popular to reinforce concrete with small, randomly distributed fibers.

II. Objectives Of Study

1. To know and to improve the physical and mechanical properties of the fiber.
2. To study the exact type and exact percentage of the fiber.
3. To study exact fiber for road constructions or road pavement.
4. To study and compare the behavior of normal concrete and Fiber Reinforced Concrete.

III. Methodology

1. An experimental investigation is to be carried out to know the optimum percentage and type of fiber for concrete pavements.
2. For the Reinforced concrete cube, beam and cylinder be casted with different volume percentage of steel 1,2,3% polypropylene0.2%,0.3%,0.4% and synthetic 0.2%,0.3%,0.4% fibers in concrete grade of M-40.
3. Total hundred no. of specimens were casted and tested according to the IS codes. Two slabs having dimensions 1m x1m x0.3m have been casted out of which one for normal concrete and the other for 0.3% polypropylene fiber reinforced concrete are casted at the J Kumar RMC plant Hadapsar, Pune under the guidance of RMC head Mr. Yusuf Inamdar.
4.

TABLE NO.-1

		TEST		
		%Fiber	Comp.Test	Flex.Test
No.Of Sample with Fiber Content	P.C.C	0%	6	4
	S.F	1%	6	4
		2%	6	4
		3%	6	4
	P.P.F	0.2%	6	4
		0.3%	6	4
		0.4%	6	4
	Synthetic	0.2%	6	4
		0.3%	6	4
		0.4%	6	4
	Total	-	60	40

IV. EXPERIMENTAL WORK

a) Mix design

As per IS10262:2000 the mix design for M40 grade concrete is prepared with varying the percentage of fiber. As use of fibers affects the workability of concrete, the super plasticizer (H.R.Johnson) is used.

TABLE NO.-2

Sr No	Ingredient	Quantity For 1m3
1	W/C	0.37
2	Cement	365 kg/m3
3	Fly ash	85 kg/m3
4	Crushed sand	826 kg/m3
5	10 mm aggregate	425 kg/m3
6	20 mm aggregate	643 kg/m3
7	Water	165 litre
8	Admixture	4.32 litre

Sources:

Cement- OPC 53grade
Coarse aggregate- VMR, Robo /silicon
Admixture- H.R Johnson (endure-28)
Water- Potable
Fly ash- Nashik

b) Tests on cement

OPC cement of 53 grade is used. The standard consistency of cement is 27%, fineness is 3% and density is 3.12.

c) Tests on aggregates

TABLE NO -3

Sr. No.	Content	10mm	20mm
1	Specific gravity	2.95	2.96
2	Fineness modulus	6.27	7.08
3	Water absorption	0.78%	1.03%
4	Flakiness index	14%	13%
5	Elongation index	18%	18%

d) Tests on water

TABLE NO- 4

Sr. No.	Test	Permissible limit
1	Chloride test	10 ppm
2	Sulphite test	5 ppm
3	Hardness	200 ppm

e) Tests conducted on concrete

Specimens of cubes, beams and cylinders are tested after seven and twenty eight days to check compressive, flexural and tensile properties of fiber reinforced concrete for different percentage of steel and polypropylene fibers. Percentage of fibers used:

Steel fiber: 1%, 2%, 3% of volume of cement and fly ash.
Polypropylene fiber: 0.2%, 0.3%, 0.4% of cement and fly ash.
Syntheticfiber: 0.2%, 0.3%, 0.4% of cement and fly ash.

Fig.1 Flexural Test

Fig.2 Compression Test

Fig.3 casting of beams

e) Results of compressive and flexural Test:

Table No.5

Sr. No.	% of fiber	Polypropylene fiber		Synthetic fiber		% of fiber	Steel fiber	
		Compressive strength	Flexural strength	Compressive strength	Flexural strength		Compressive strength	Flexural strength
1	0	49.42	5.64	49.42	5.64	0	49.92	5.64
2	0.2	50.51	5.56	49.5	3.02	1	67.99	5.91
3	0.3	56.74	7.11	53	3.74	2	66.22	6.45
4	0.4	51.4	6.41	52.5	2.67	3	44.74	6.12

V. COST COMPARISON:

Table No.6

Material	Rate (Rs.)	Cost of concrete (Rs.)			
			Synthetic	Steel	Polypropylene
Cement	320/Bag	2336	2336	2336	2336
Steel Fiber	65/Kg	-	-	585	-
PPF	74/Kg	-	-	-	100
Synthetic	56/Kg	-	76		-
Fly ash	2.20/Kg	187	187	187	187
Crushed Sand	32/C.Ft	578.84	578.84	578.84	578.84
10mm Aggregate	28/C.Ft	281.33	281.33	281.33	281.33
20mm Aggregate	28/C.Ft	426	426	426	426
Admixture	50/Kg	180	180	180	180
	Total (Rs.)	**3998/-**	**4074/-**	**4583/-**	**4098/-**

VI. SLAB CASTING

On the basis of results obtained after testing the samples 0.3% of polypropylene fiber is selected to cast the slab as it gives very good test results for compressive and flexural strength. Basically two slabs normal and fiber reinforced having dimensions 1m x 1m x 0.3m are casted. After curing for 28 days both the slabs are observed.

Fig.4 Normal slab

Fig.4 (i) FRC slab

Fig.4 (ii) FRC slab

From the above two slab samples it is clear that the crack arresting properties of concrete have significantly increased with the use optimum percentage of fibers to the normal concrete, which indicates the suitability of polypropylene fibers in the concrete pavements.

VII. CONCLUSION

- With very less increase in cost, Maximum flexural and compressive strength can be achieved by using 0.3% of **polypropylene** fibers, 2% of **steel** fibers, and 0.3% of **synthetic** fibers.
- When slabs are casted and cured for 28 days the distinguish between the normal concrete and fiber reinforced concrete can be easily studied.
- When 0.3% of polypropylene fibers are added in normal concrete the crack arresting phenomenon observed is significantly increased.(as shown in fig.3&4)

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