EFFECT OF POLYPROPYLENE FIBER ON CEMENT CONCRETE PAVEMENT

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ABSTRACT

This investigation was directed towards the laboratory Evaluation of the Compressive and Flexural Strength of Concrete prepared with Polypropylene Fiber of different Aspect Ratio. Number of researches in the past has investigated the effect of PP Fiber on the strength of the Concrete. The result of these studies indicates that addition of PP Fiber. To Concrete has resulted in an increase in Compressive and Flexural strength of Concrete [1]. However, from the literature study it was observed that the effect of Aspect Ratio of Fiber on the strength of concrete has been not evaluated [5]. In this study, the Polypropylene Fiber of 6 mm and 12mm length were added at a rate of 0.5%,1%,1.5%,2% by weight of cement.

Keyword: Polypropylene Fiber

1. INTRODUCTION

Waste polymer textile bags are harmful to the environment and sustainable means to reuse them are urgently being sought. Number of researchers in the past has investigated the effect of polypropylene Fiber on the strength of the concrete. The results of these studies indicate that addition of polypropylene fibers to concrete has resulted in an increase in compressive and flexural strength of concrete. The displacement ductility was significantly improved with the use of fibers [7]. The increase in flexural strength of concrete will result in reduction in thickness of PQC layer of concrete pavement. However, from the literature study it was observed that the effect of length of Fiber on the strength of concrete pavement has been not evaluated [8]. So, in a present study the effect of different length of Fiber on the compressive and flexural strength of the concrete will be evaluated.

1.1 Objectives -

- To compute the effect of compressive strength of M40 mix concrete polypropylene fiber with ordinary concrete.
- To carryout cost analysis for pavement constructed with polypropylene fiber & without polypropylene fiber reinforced concrete
- Increase the compressive and flexural strength of pavement.

1.2 Scope of Study – To Investigate the effect of different length of Fibers on the strength of concrete.

2. MATERIALS

2.1 Polypropylene Fiber

Polypropylene (PP) is a thermoplastic. It is a linear structure based on the monomer CnH2n. It is manufactured from propylene gas in presence of a catalyst such as titanium chloride. Beside PP is a by-product of oil refining processes [3]. Most polypropylene used is highly crystalline and geometrically regular (i.e., isotactic) opposite to amorphous thermoplastics, such as polystyrene, PVC, polyamide, etc., which radicals are placed randomly (i.e., atactic). The first polypropylene resin was produced by Giulio Natta in Spain, although commercial production began in 1957 [8]. The diameter of PP is 18 micrometer and cost are ₹100/kg. Polypropylene Fibers tend to hold the concrete mix together. This slows the settlement of coarse aggregate and thus reduces the rate of bleeding. A slower rate of bleeding means a slower rate of drying and thus less plastic shrinkage cracking. In hardened concrete, polypropylene Fiber's act as crack arresters [5].

Fig -1: Structure of Polypropylene

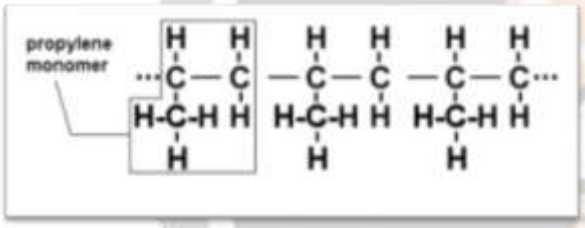

Fig -1(a): Polypropylene fiber

2.2 Cement

Cement is a binder, a substance used for construction that sets, hardens, and adheres to other materials to bind them together. Cement is seldom used on its own, but rather to bind sand and gravel (aggregate) together. Cement mixed with fine aggregate produces mortar for masonry, or with sand and gravel, produces concrete [8]. Portland cement is the basic ingredient of concrete. Concrete is formed when Portland cement creates a paste with water that binds with sand and rock to harden. Cement is manufactured through a closely controlled chemical combination of calcium, silicon, aluminum, iron and other ingredients. Common materials used to manufacture cement include limestone, shells, and chalk or marl combined with shale, clay, slate, blast furnace slag, silica sand, and iron ore [6].

Fig -3: Cement

Fig -3: Aggregates

2.3 Aggregates

Construction aggregate, or simply “aggregate", is a broad category of coarse to medium grained particulate material used in construction, including sand, gravel, crushed stone, slag, recycled concrete and geosynthetic aggregates. Aggregates are the most mined materials in the world. The aggregate gives volume, stability, resistance to wear or erosion, and other desired physical properties to the finished product [3]. Fine aggregate usually consists of sand, crushed stone, or crushed slag screenings; coarse aggregate consists of gravel (pebbles), fragments of broken stone, slag, and other coarse substances. Fine aggregate is used in making thin concrete slabs or other structural members and where a smooth surface is desired; coarse aggregate is used for more massive members [7]. The aggregates used in the present study are brought from the crusher located at Jambul wadi, Pune

2.4 Methods

During our project timespan following tests were done [4]:

a. Sieve Analysis
b. Gradation of Aggregate
c. Zone of Fine Aggregate
d. Moisture content
e. Water Absorption
f. Specific Gravity
g. Mix Design
h. Slump Cone
i. Flexure Strength of Concrete Beam
j. Compression Test of Concrete Cube

IS Codes used in the testing [8]:

1. IS: 516-1959, Methods of tests for strength of concrete
2. IS 2386-1 (1963), Methods of test for Aggregates for concrete
3. IS 383-2016, Zoning of fine aggregates
4. IS: 2386 (Part III) - 1963, Determination of water absorption

Testing was done mainly using 6mm & 12mm length polypropylene fibers. Addition of fibers in the concrete are in 0.5%, 1.0%, 1.5%, 2.0% respectively. Result includes of flexural & compressive strength tests to prove the difference between conventional concrete & fiber added concrete [3].

3. RESULT & DISCUSSION

3.1 Compressive Strength Using 6 mm Length of Polypropylene Fiber

Combination	Specimen	Compressive Strength (Mpa)	Average (Mpa)	%Increase in Strength
Concrete	1	49.715	49.88	0
	2	50.044		
	3	49.875		
Concrete + 0.5% PP	1	50.97	50.80	1.84
	2	50.64		
	3	50.79		
Concrete +1.0%PP	1	51.78	51.80	3.85
	2	52.08		
	3	51.54		
Concrete +1.5%PP	1	51.04	51.30	2.85
	2	51.33		
	3	51.52		
Concrete +2.0%PP	1	50.08	50.20	0.64
	2	50.20		
	3	50.32		

3.2 Compressive Strength Using 12 mm Length of Polypropylene Fiber

Combination	Specimen	Compressive Strength (Mpa)	Average (Mpa)	%Increase in Strength
Concrete	1	49.715	49.88	0
	2	50.044		
	3	49.875		
Concrete + 0.5% PP	1	52.826	52.728	5.71

	2	52.631		
	3	52.729		
Concrete +1.0%PP	1	53.138	53.400	7.06
	2	53.640		
	3	53.395		
Concrete +1.5%PP	1	52.746	52.560	5.37
	2	52.364		
	3	52.554		
Concrete +2.0%PP	1	51.760	51.700	3.65
	2	51.640		
	3	51.695		

3.3 Flexural Strength Using 6 mm Length of Polypropylene Fiber

Combination	**Specimen**	**Strength 28 Days (Mpa)**	**Flexural Strength (Mpa)**	**Average (Mpa)**	**%Increase in Strength**
Concrete	1	29.22	6.06	6.20	0
	2	31.58	6.55		
	3	28.88	5.99		
Concrete + 0.5% PP	1	31.58	6.55	6.30	1.61
	2	29.65	6.15		
	3	29.89	6.20		
Concrete +1.0%PP	1	34.62	7.18	7.20	16.13
	2	36.78	7.63		
	3	32.74	6.79		
Concrete +1.5%PP	1	31.48	6.53	6.50	4.84
	2	33.36	6.92		
	3	29.17	6.05		
Concrete +2.0%PP	1	31.34	6.50	6.2	0
	2	29.55	6.13		
	3	28.78	5.97		

3.4 Flexural Strength Using 12 mm Length of Polypropylene Fiber

Combination	Specimen	Strength 28 Days (Mpa)	Flexural Strength (Mpa)	Average (Mpa)	%Increase in Strength
Concrete	1	30.5	6.32	6.20	0
	2	29.5	6.11		
	3	30.0	6.17		
Concrete + 0.5% PP	1	33.5	6.88	6.49	4.68
	2	29.0	6.01		
	3	31.7	6.57		
Concrete +1.0%PP	1	36.5	7.57	7.53	21.45
	2	35.5	7.36		
	3	37.0	7.67		
Concrete +1.5%PP	1	31.0	6.43	6.43	3.71
	2	30.0	6.22		
	3	32.0	6.63		
Concrete +2.0%PP	1	25.0	5.18	5.56	-10.32
	2	27.0	5.60		
	3	28.5	5.91		

3.5 Comparison of 6 mm & 12 mm PP added Concrete

Points	6 mm length PP	12 mm length PP
Compression Strength	51.80 Mpa	54.569 Mpa
Flexural Strength	7.20 Mpa	7.53 Mpa
Cost of Pavement (6 Lane 2-way Road – 1Km)	2.13 crore	2.07 crore

4. CONCLUSIONS

- Compressive strength of concrete with 6 mm length PP increases till Concrete + 1%

PP then further increase in % of PP reduces the compressive strength.

- Compressive strength of concrete with 12 mm length PP increases till Concrete + 0.5% PP then further increase in % of PP reduces the compressive strength.
- Using 6 mm length PP we get maximum compressive strength at Concrete + 1% PP which is 51.80 Mpa.
- Using 12 mm length PP we get maximum compressive strength at Concrete + 0.5% PP which is 54.569 Mpa.
- Flexural strength of concrete with 6 mm and 12 mm length PP increases till Concrete + 1% PP then further increase in % of PP reduces the compressive strength.
- Using 6 mm length PP we get maximum flexural strength at Concrete + 1% PP which is 7.20 Mpa.
- Using 12 mm length PP we get maximum flexural strength at Concrete + 1% PP which is 7.53 Mpa.
- In case of PP length 6mm for 1% PP and in 12mm length of PP for 0.5% and 1.0% PP thickness of slab is less than 200 mm. In such case as per IRC: 58-2011 there is no need of Dowel bars.
- Cost required for construction of 1km concrete pavement is 2.26 Crores, where cost required for construction of 1km concrete with 1% of 6 mm length PP is 2.13 Crores, total reduction in cost is 5.75%. Cost required for construction of 1km concrete with 1% of 12 mm length PP is 2.07 Crores. Total reduction in cost is 8.41%
- The length of Pune ring road is 128 km. Total cost required to construct concrete pavement will be ₹289.28 Crores. And to construct Concrete + 1% PP of 6 mm length pavement road will be ₹272.64 Crores, total reduction in cost is **₹16.64 Crores**. Also, to construct Concrete + 1% PP of 12 mm length pavement road will be ₹264.96 Crores, total reduction in cost is **₹24.32 Crores**.
- The optimum dose is found to be 1% by weight of concrete of 12 mm length PP

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