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EXPERIMENTAL STUDY ON POLYPROPYLENE REINFORCED CONCRETE PAVEMENT

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Abstract: The capability of durable structure to resist weathering action, chemical attack, abrasion and other degradation processes during its service life with the minimal maintenance is equally important as the capacity of a structure to resist the loads applied on it. Although concrete offers many advantages regarding mechanical characteristics and economic aspects of the construction, the brittle behavior of the material remains a larger handicap for the seismic and other applications where flexible behaviour is essentially required. The interest in the use of fibers for the reinforcement of composites has increased during the last several years. Recently, however the development of polypropylene fiber-reinforced concrete (PFRC) has provided a technical basis for improving these deficiencies. A combination of high strength, stiffness and thermal resistance favorably characterizes the fibers. In this study, the results of the Strength properties of Polypropylene fiber reinforced concrete have been presented. This study shows the effect of mechanical properties of concrete in which the compressive strength, split tensile strength, flexural strength and sulphate attack of concrete samples made with different fibers amounts varies from 0%,0.5%,1% 1.5% and 2.0% were studied.

1. INTRODUCTION

Polypropylene is a 100% synthetic fiber which is transformed from 85% propylene. The monomer of polypropylene is propylene. Polypropylene is a byproduct of petroleum.

It is added in mortar or concrete in order to inhibit the plastic shrinkage crack of cement mortar and concrete before curing, and improving the quality of cement mortar and concrete in strength basis and durability, and thus reducing maintenance costs, and extend the service life of the pavement.

In recent years, many studies have been conducted in the mechanical characteristics of reinforced fiber concrete. Polypropylene fibers (at relatively low volume fractions <0.3%) are used for: secondary temperature shrinkage reinforcement, overlays and pavements, slabs, flooring systems, crash barriers, precast pile shells and shotcrete for tunnel linings, canals and reservoirs. Two kinds of fiber that very often used in the concrete are: steel fiber and polypropylene fiber. Polypropylene fibers have hydrophobic levels, which protect them against wetting with cement paste. The hydrophobic nature of polypropylene has no effect on the amount of water needed for concrete. The characteristics offiber is listed in given Table I. In this study the influence of different amount of polypropylene fibers content on concrete properties were investigated by measuring compressive strength, splitting Tensile strength, flexural strength, sulphate attack and thermal effects on the concrete.

Table I. Material properties

Properties	**Fine aggregates (river sand)**	**Polypropylene**	**Coarse aggregates**
Fineness Modulus	2.51	-	2.58
Specific Gravity	2.528	0.90	2.568
Bulk Density	1.55 kg/lit		1.43 kg/lit
Water Absorption	0.944 %	0%	0.5%
Crushing strength	-	-	13.80 %
Impact Strength	-	-	15.55%
Young's modulus		3.45x103 Mpa	

Tensile strength		551 Mpa	
Ultimate elongation		25%	
Thermal conductivity		6.0	

Properties of polypropylene concrete

Table 2 Properties of Polypropylene

Specific gravity	0.91gm/cm3
Cut length	12mm
Width crossing	circular
Melting point	250oc
Water absorption	0

2. EXPERIMENTAL INVESTIGATIONS

The test consists of two parts, namely analyzing the properties of constituent materials such as cement, coarse and fine aggregates,and polypropylene as per the relevant Indian Standard Code Specifications. Cylinders of diameter of 150mm and height of 300mm.Beams of size 100 x 100 x 500 mm and cubes of size 150mm x150mm x 150mm are casted.

Fig. 1, Compressive strength test

Fig. 2. Flexural strength test

Fig 3. Split tensile strength

Fig. 4. Split tensile test crack in cylinder

3. Results and Discussion

3.1 Compressive strength

The compressive strength of concrete at 7, 14 and 28 days are presented. The cube compressive strength observed as 40.9 N/mm2 for 0.5% of fibers, 44.12 N/mm2 for 1% of fibers and 45.25 MPa for 1.5% fiber content in the concrete at 28 days. The compressive strength was decreased to 40.50 N/mm2 for 2% fiber content . There is a reduction in slump with increase in fiber content, especially beyond 1.5% dosage. However, The compressive strength for controlled mix at 28 days was observed as 33.70 N/mm2. It is observed that the cube compressive strength increased upto 1.5 % fiber content there after strength is decreased at 2.0% of fiber content.

Fig.5 Compressive Strength for 7 & 28 days

3.2. Split Tensile Strength

Split tensile The strength of concrete at 7, 14 and 28 days are presented. The split tensile strength at 28 days observed as 3.22 N/mm2 for 0.5% of fibers , 3.4 N/mm2 for 1% of fibers and 3.52 N/mm2 for 1.5% fiber content in the concrete. However, the split strength for controlled mix at 28 days was observed as 2.52 N/mm2. From the Experimental investigation carried out, it was observed that when fibers are used in concrete it enhances both the compressive and split tensile strength of concrete. This trend is observed with all percentages of fiber content 0.5-1.5% at all ages. The reduction of slump with increase in fiber observed and the mix becomes fibrous so a dosage rate of 1.5% would yield economical result. It is observed that the Split tensile strength was increased upto 1.5 % fiber content there after strength is decreased at 2.0% of fiber content.

Fig.6 Split tensile Strength for 7 & 28 days

3.3. Flexural Strength

The flexural strength of concrete at 7, 14 and 28 days are presented. The Flexural strength at 28 days

S.NO	Addition of Fibers	Load (N)	Tensile Strength (N/mm2)
		M30	M30
1	0.5%	8600	4.3
2	1.0%	9600	4.8
3	1.5%	8500	4.25
4	2.0%	8300	4.15

Table 3. Flexural Strength

Fig. 7 Flexural Strength for 28 days concrete

3.4 Suphate attack

Sulphate attack was caused by the chemical reaction between sulphate and calcium hydroxide (Ca(OH)2), forming gypsum.The gypsum reacted with tricalcium aluminate (C3A) in the concrete to form Ettringite and monosulphoaluminate .Ettringiteis a hydrous calcium aluminium sulphate mineral with formula: Ca6Al2(SO4)3(OH)12. These reactions resulted in a substantial increase in volume with subsequent cracking and peeling. The sources of sulphate ion were seawater, sewage industrial waste, salts in ground water and delayed release of clinker.

The compressive strength of PPFRC was observed to increase between 10 per cent and 18 per cent, respectively, for 7 and 28 days. Corresponding values for Hybrid concrete was increased by 3 per cent to 22 per cent for 7 to 28 days, respectively, when compared to conventional concrete. The effect of polypropylene fiber content on the sulphate resistance of concrete under continuous soaking condition was studied.

In M30 grade concrete the gain of compressive strength after the immersion period of 60 days and 90 days under sulphate solution were

Table 4. Sulphate attack test

Grade of concrete	Type of concrete	Type of chemical	Appearance in 60 days and 90 days	28 days strength in MPa without H_2SO_4
M30	Conventional concrete	H_2SO_4	Slightly white	50.1
	PPFRC	H_2SO_4	Slightly white	45.3

4. Overall Comparison

The overall comparison of compressive strength, tensile strength and flexural strength is done . The specimen with polypropylene reinforced concrete gave the best performance in terms of all the strengths.

5. CONCLUSIONS

From the Exhaustive experimental study presented in the present project, the following conclusions can be made:

This experimental study on polypropylene reinforcedconcrete has proved to be better way in providing strong and durable concrete. From the Experimental study, the following conclusions were drawn.

(1) The compressive strength and splitting tensile strength tests shows that, the strengths were increased proportionately with the increase in volume ratios of polypropylene fibers on addition upto 1.5% when compared to the controlled mix without fibers.

(2) The Reduction of slump is noticed with increase in fiber content, especially beyond 1.5% dosage, the mix becomes fibrous which is difficult to handle.

(3) The maximum increase in compressive strength was 34% and split tensile strength was 40% compared to the mix without fibers.

(4) The samples with fibers content of 1.5% showed optimum results in comparison with other samples in the study.

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