ISSN (Online) 2456-1290
International Journal of Engineering Research in Mechanical and Civil Engineering (IJERMCE)
Vol 2, Issue 3, March 2017

An Experimental Study on Compressive Strength Behaviour of Polypropylene Fiber Reinforced Concrete

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***Abstract:*— The role of construction materials is dominant in construction industry to obtained satisfactory results. The conventional concrete with traditional materials is unable to achieve desired strength at optimum proportioning of materials. Incorporation of additional materials such as fibers in conventional concrete improves its properties. In this present work a Polypropylene Fiber is used in cement concrete at different fiber content to study compressive behaviour of concrete after 7 and 28 days of curing. Results showed, Incorporating polypropylene fiber in cement concrete increases compressive strength. However excess dose of fiber affects workability of concrete.**

***Index Terms*— Polypropylene Fiber, FRC, Compressive Strength.**

I. INTRODUCTION

The traditional concrete with conventional ingredient has unsound results. To overcome this problems certain evolution takes place in concrete mix such as addition of different waste products and various types of metallic, non-metallic and natural fibers to improve quality of concrete. In concrete some physical phenomenon like shrinkage, creep, etc. take place during its life span, Due to this concrete member may get cracks and become week in its design strength. A Fiber Reinforced Concrete (FRC) has been found to improve strength, ductility, toughness and durability of concrete structure[1]. A polypropylene fiber is a non-metallic fiber produced from propylene gas generally in Fibrillated and Monofilament form has significant results in improving compressive and flexural strength when incorporated in conventional concrete mix at varying percentage. Polypropylene fiber can enhance residual strength and fracture energy of concrete[2] However, Increasing fiber dose may affects compressive behaviour of concrete. A maximum of 10% reduction in compressive strength with respect to control concrete was noted with addition of 0.3% volume of polypropylene fiber in the concrete[3].

II. MATERIALS AND METHODS

2.1 Materials

Ordinary Portland Cement (OPC 43) was used as a binder along with Angular crushed stone with 20 mm nominal size as course aggregate. The fine aggregate in the form of natural river sand (zone I) confirming IS 383:1970[11] and potable water were used in the concrete mix. The physical properties of materials are shown in Table 1. A fibrillated form polypropylene fiber with 20 mm cut length were used as a reinforcement material in five fiber content. The technical specification of polypropylene fiber are shown in Table 2.

Table 1. Physical properties of materials

Material	Fineness Modulus	Specific Gravity	Water Absorption (%)
Course Aggregate	6.24	2.68	0.98
Fine Aggregate	3.1	2.5	1.00

Table 2. Technical specification of polypropylene fiber

Particulars	Values
Specific Gravity	0.91
Tensile Strength	0.67 kN/Sq.mm
Young's Modulus	4 kN/ Sq.mm
Melt Point	> 1650 Celsius
Absorption	Nil
Density (Bulk)	910 kg/ cu. m (approx)
Fiber cut length	20 mm
Form	Fibrillated (Mesh)
Colour	Natural

2.2 Mix Proportion

The concrete mix is proportioned to achieve 25 MPa compressive strength in 28 days curing period according to IS 10262:2009[12]. The mix proportion is shown in Table 3.

2.3 Specimen Preparation

To prepare a cube specimen course aggregate, fine aggregate and cement (OPC 43) were mixed dry for 60 sec in concrete mixer. Subsequently polypropylene fiber were added and allowed to mix for additional 30 sec. The water was

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added to dry mix and mixed thoroughly for 120 sec. The uniform mixture was then transferred to standard cube mould of size 150 mm each side and was compacted in three layers with 25 blows in each layer by 16 mm diameter steel rod.

Five fiber contents 0.25, 0.50, 0.75, 1.00 and 1.25 % by weight of cement were used for five mixes and one mix without fiber were prepared for comparison with FRC. Three specimens were prepared for each mix to check repeatability. All the specimens were cured in water for 7 and 28 days.

Table 3. Mix Proportion

Material	Quantity (kg/m^3)
Cement (OPC 43)	438
Fine Aggregate	647
Course Aggregate	1086
Water	197
W/C Ratio	0.45

2.4 Test Method

All the concrete mixes with and without fiber in a fresh state was tested for workability by means of Slump Cone Test. The cone having 100 mm top and 200 mm bottom diameter with 300 mm height was used as per standard test procedure. The slump cone test results are shown in Fig. 2. A cubical specimens cured for 7 and 28 days are tested for compressive strength according to IS 516:1959[13] on Compression Testing Machine (CTM). The results of compressive strength test are shown in Fig. 3 and Table 4.

a. Slump Cone Test b. Compression Test

Fig.1. Slump Cone Test and Compression Test

III. DISCUSSION

Results of concrete incorporating polypropylene fiber in different content are compared with conventional concrete. It is observed that, Workability of FRC decreases with increasing fiber content. At 1.25 % fiber, the workability is decreased up to 73 % when compared to conventional concrete (Fig.2). The compressive strength is observed to be 41 % more after 7 days and 27 % more after 28 days curing period at 0.5 % fiber content than conventional concrete as .

It is seen that, No Polypropylene FRC cube specimen was failed in ideal dumbbell shape as conventional concrete specimen as shown in Fig. 4. Addition of polypropylene fiber in concrete acts as a energy dissipater and prevent concrete from brittle failure.

Table 4. Compressive Strength at 7 days and 28 Days.

Fibre Content (%)	Compressive Strength (MPa)	
	7Days	28 Days
0.00	18.00	32.30
0.25	22.29	37.33
0.50	30.51	44.21
0.75	25.62	31.84
1.00	28.63	39.96
1.25	22.96	31.25

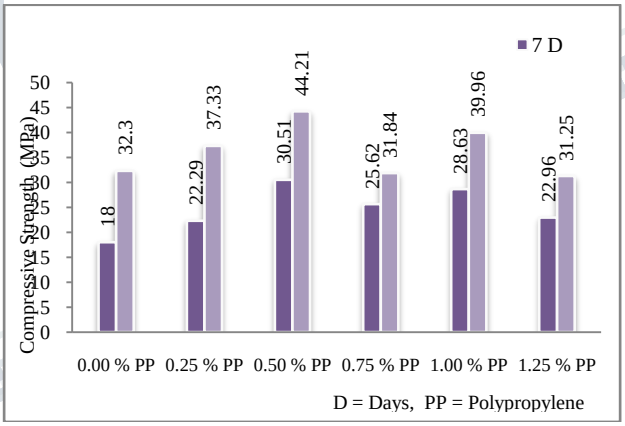

Fig. 3. Compressive Strength at 7 Days and 28 Days.

a. Conventional Concrete b. Fiber Reinforced Concrete
Fig. 4. Failure Pattern of Cube Compressive Strength

IV. CONCLUSION

Incorporating polypropylene fiber in concrete decreases workability with increasing fiber content. A good workability was noted at 0.25% and 0.5% Polypropylene fiber content. 0.5 % polypropylene fiber was found to be

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International Journal of Engineering Research in Mechanical and Civil Engineering (IJERMCE)
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optimum fiber content to achieve around 41% and 27 % more compressive strength after 7 and 28 days age respectively. Use of polypropylene fiber increases bonding in a concrete and prevent from brittle failure.

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