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Experimental Studies on Mortar Using Polypropylene Fibers

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Abstract

An experimental program was carried out to evaluate the properties of cement Mortar. Compressive strength test, splitting tensile strength test and the water absorption test were performed and the results were analysed statistically. Polypropylene fibers can greatly increase the properties of cement Mortar. Specimens containing fiber of 0.00%, 0.10%, 0.20% and 0.30% are prepared and tested in this work. It is demonstrated that a certain amount of fibers enhances the compressive, splitting tensile strength and the water absorption capacity of the fiber reinforced cement mortar. The Compressive strength of mortar was increased to 118.15 % at 7 days & 29.14 % at 28days and splitting tensile strength was increased by 130.30 % at 7 days & 56.15 % at 28 days.

Keywords: Polypropylene Fiber, Cement Mortar (1:6), Compressive Strength Test, Splitting Tensile Strength Test, Water Absorption

Introduction

Contemporary Civil engineering is permanently setting new conditions concerning the quality of engineering materials. These conditions have to be completely fulfilled in order to increase the durability, serviceability and cost-effectiveness of modern buildings. The composite materials, which will be the main subject of this paper, are offering great possibilities in the field of research and combination of more advanced solutions in order to keep up with contemporary trends.

In any construction brick masonry is very much of used to make a walling unit and in that cement mortar is one of the important ingredients it makes up as little as 7% of total volume of brick masonry and it also prevent moisture and air penetration so in short cement mortar is very much of use in brick masonry so if we change a certain amount of cement with Polypropylene Fiber materials which is less in cost than cement and it also reduces the danger to the environment so it is essential to check that how much amount of cement is replaced by various materials.

The aim of this research is to Polypropylene fiber materials as an addition in cement mortar accordingly in the range of 0.00%, 0.10%, 0.20% and 0.30% of Cement weight of 1:6 proportion of mortar.

To check mechanical properties of cement mortar by Compression Test (at 7 and 28 days), Splitting test (at 7 and 28 days) and Water absorption test (at 28 days).

Design Mix Materials

A. Cement:

The cement used OPC 53 grade. The Ordinary Portland Cement of 53 grades conforming to IS: 8112-1989 was used. Tests were conducted on the cement like Fineness Specific Surface, Soundness, Setting time, Consistency, Compressive Strength N/mm^2 3, 7, and 28 days. The Physical Properties of O.P.C are given in table 1.

TABLE-1 Physical Properties of O.P.C

Sr. No.	Description	Test Result of O.P.C	Requirements As Per IS: 12269-1987
1	Fineness Specific Surface m^2/kg	299 m^2/Kg	**Min. 225 m^2/Kg**
2	Soundness in mm	1.25 mm	**Max. 10mm**
3	Setting time in min		

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	(a) Initial	33 min	**Min. 30 min**
	(b) Final	174 min	**Max. 600 min**
4	Consistency in %	27%	**30-35**
5	Compressive strength in N/mm^2		
	(a) After 3 days	29.33 Mpa	**Min. 27Mpa**
	(b) After 7 Days	44.49 Mpa	**Min. 43 Mpa**
	(c) After 28 Days	55.94 Mpa	**Min. 53 Mpa**

B. Fine aggregate

Those fractions from 4.75 mm to 150 microns are termed as fine aggregate. The river sand is used as fine aggregate conforming to the requirements of IS: 383. The river sand is washed and screens, to eliminate deleterious materials and oversize particles. The Properties of Fine Aggregate are given in Table 2. The aggregate Shown in fig. 2.

Fig 2 Fine Aggregate (Sand)

TABLE- 2 Properties of Fine Aggregate

Sr. No	Name of Test	IS Code	Result	Permissible Limit of IS Code
1	Sieve analysis	IS: 2368-1963 Part-I, IS: 383-1970	Zone-I	-
2	Fineness Modulus	-	3.01	-
3	Specific Gravity	IS: 2386-1963 Part-III	2.73	2.6-2.8
4	Water absorption	IS: 2386-1963 Par-III	0.96%	Max. 2 %

C. Water

Water is an important ingredient of Mortar as it actually participates in the chemical reaction with cement. Since it helps to from the strength giving cement gel, the quantity and quality of water are required to be looked into very carefully.

D. Polypropylene Fiber

Polypropylene is the first stereo regular polymer to have achieved industrial importance. The Fibers from Polypropylene were introduced to the textile arena in the 1970s and have become an important member of the rapidly growing family of synthetic Fibers. Today Polypropylene enjoys a fourth spot behind the "big three" Fiber classes, i.e. polyester, nylon and acrylic. However, as opposed to other commodity Fibers, its use as apparel and household textiles has been rather limited; the bulk of the Fiber produced is used for industrial applications. The Properties of Polypropylene Fiber are given in Table 3. The Polypropylene Fiber shown in fig. 3.

Fig 3 Polypropylene Fiber

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TABLE- 3 Properties of Polypropylene Fiber

Properties	Polypropylene Fiber
Base Material	100% Virgin Polypropylene
Length (mm)	12mm
Melt-point	165°C
Surface	Coated for dispersion and adhesion
Colour	White/Opaque
Absorption	Nil
Suitable for	All mixers, including high-intensity, Turbo, conventional and low-intensity mixers. Disperses rapidly and we Fibrillated fibers form an interconnected Fibrous network throughout the mix.

Source: FIBREZONE Navrangpura, Ahmadabad, Gujarat

Mortar compositions

A cement mortar mix 1:6 was designed as per IS: 2250 methods and the same were used to prepare the test samples. The design mix proportion is done in Table 4 and 5.

TABLE- 4 Mix Design Proportions

	Water	Cement	Fine aggregate
By Weight, [gms]	45	100	600

TABLE - 5 Design Mix Proportions for Mortar (1:6)

Mortar Mix	Design Mix Proportions For Mortar (1:6)		
	Cement	Fine aggregate	Addition of Polypropylene Fiber by Cement Weight
A0	1	6	-
C1	1	6	0.1
C2	1	6	0.2
C3	1	6	0.3

Experimental Methodology

A. Compressive strength

Compressive strength tests were performed on compression testing machine using cube samples. Three samples per batch were tested with the average strength values reported in this paper. The loading rate on the cube is 35 N/mm^2 per min. The comparative studies were made on their characteristics for cement mortar ratio of 1:6.

Three cube samples were cast in the mould of size 70.6 x 70.6 x 70.6 mm for test. The Compressive strength testing Machine Shown in fig. 4

Fig 4 Setup of Compressive strength test

B. Splitting Tensile Strength

The splitting tensile strength test will be carried out on the specimens at the end of 7 days and 28 days of curing. The procedure to be followed is as given below.

Tensile strength is an important property of a mortar because mortar structures are highly vulnerable to tensile cracking due to various kinds of effects and applied loading itself. However, tensile strength of mortar is very low in comparison to its compressive strength.

In splitting tensile strength test same machine is used which are used in compressive strength test, the concrete block will be placed at an angle of 45^0. The axes of the specimen are to be carefully aligned with the centre of the lower pressure plate of the testing machine. Then an upper pressure plate is to be lowered till the distance between the pressure plate and the top surface of the specimen achieved. No packing used between the face of the pressure plates and block.

The load will be applied without shock and increased gradually at the rate of 35 kg/cm^2/min until the specimen was crushed. The splitting tensile strength testing machine Shown in fig. 5

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Fig 5 Setup of Splitting tensile strength

C. Water absorption test

The 70.6 mm x 70.6 mm x 70.6mm size cube after casting were immersed in water for 28 days curing. These specimens were then oven dried for 24 hours at the temperature85°C until the mass became constant and again weighed. This weight was noted as the dry weight (W1) of the cylinder. After that the specimen was kept in water at 85°c for 24 hours. Then this weight was noted as the wet weight (W2) of the cylinder.

- % water absorption = [(W2– W1) / W1] x 100
- Where, W1 = Oven dry weight of cubes in grams
  W2 = After 24 hours wet weight of cubes in grams.
  The water absorption test setup in Fig.6

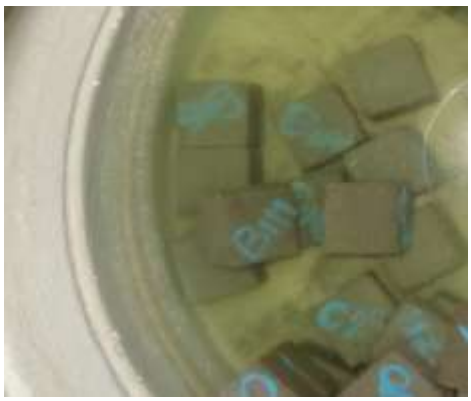

Fig 6 Water absorption test

Experimental Results

From Table 6 and Fig.7 Shows the result of the Compressive Strength test for Mortar Mix (1:6) at 7 and 28 days

Table 6 Experimental Results for Compressive Strength Test for all Mortar Mix (1:6) at 7 & 28 Days

Mortar Mix	Average Compressive Strength (N/mm^2)	
	7 days	28 days
A0	3.14	10.33
C1	3.95	11.07
C2	4.08	11.40
C3	6.85	13.34

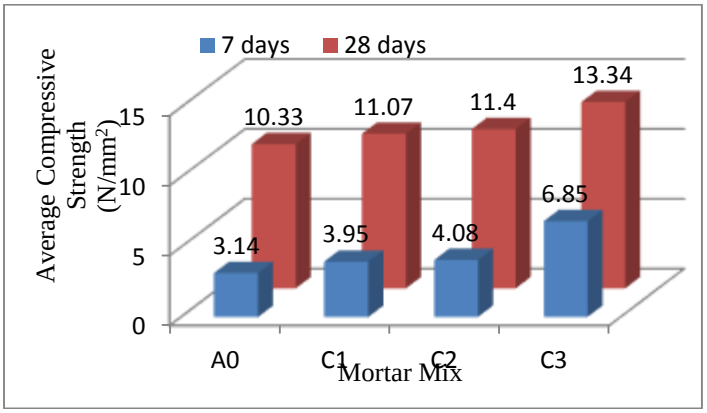

Fig 7 Mortar Mix V/S Average Compressive Strength (N/mm^2) at 7 and 28 days

From Table 7 and Fig.8 shows the result of the Splitting tensile Strength test for Mortar Mix (1:6) at 7 and 28 days.

Table 7 Comparative Experimental Results for splitting tensile Strength Test for all Mortar Mix at 7 & 28 Days

Mortar Mix	Average Splitting tensile Strength (N/mm^2)	
	7 days	28 days
A0	0.33	1.30
C1	0.47	1.37
C2	0.52	1.53
C3	0.76	2.03

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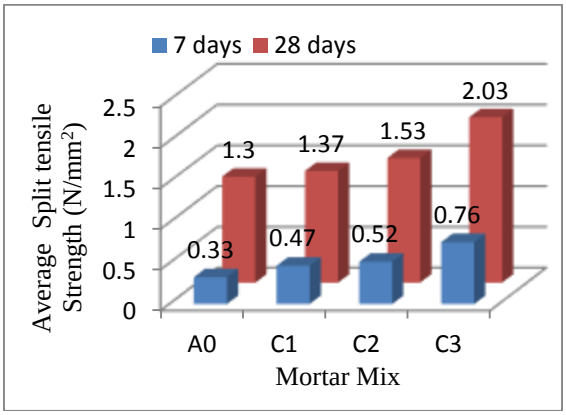

Fig 8 Mortar Mix V/S Average Splitting tensile Strength (N/mm^2) at 7 and 28 days

From Table 8 and Fig.9 shows the result of % Water absorption for Mortar Mix (1:6) at 28 days.

Table 8 Experimental Results for Average % Water Absorption at 28 Days

Mortar Mix	Average % Water Absorption At 28 Days
A0	14.18
C1	9.01
C2	7.92
C3	7.10

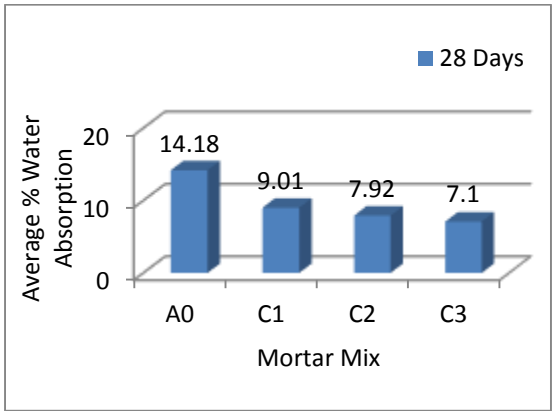

Fig 9 Mortar Mix V/S Average % Water Absorption at 28 Days

Conclusion

- In Polypropylene fiber mortar, the maximum compressive strength increased 118.15 % at 7 days and 29.14 % at 28days without any chemical agents or any other additives.
- For Polypropylene fiber mortar, the maximum splitting tensile strength increased 130.30 % at 7 days and 56.15 % at 28 days respectively.
- From the above results it is observed that addition of 0.30% by cement weight polypropylene fibers in mortar giving good compressive strength compare to plain mortar at early stages. And in splitting tensile test, tensile strength of polypropylene fiber in some certain quantity in mortar mix gives high tensile strength compare to plain mortar. From the above results, it is clear that fiber addition in mortar gives high tensile strength which prevents the cracks. As mortar is weak in tension fiber in certain quantity gives high tensile strength as well as good compressive strength to the mortar.
- It is observed that addition of 0.30% by cement weight polypropylene fibers in mortar giving lower Water Absorption at 28 Days.

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