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Sorptivity and Water Absorpotion of Steel Fibers Reinforced Ternary Blended Concrete

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ABSTRACT

Because of the difficulties associated with the absorption test, on the one hand, and, on the other, because permeability test measures the response of concrete to pressure, which is rarely the driving force of fluids entering concrete, there is a need for another type of test. Such a test measures the rate of absorption of water by capillary suction of unsaturated concrete. In this paper, an attempt is made to study the properties of steel fibre reinforced concrete with ternary blends. The mix design was carried out for M30 grade concrete as per IS: 10262-2009. Concrete has good potential in durability.

KEYWORDS: Capillary suction, soroptivity, absorption, ternary blended

INTRODUCTION

It is generally accepted that the durability of mortar and concrete depends largely on the movement of water and gas through it. The uptake and transport of water and gaseous substances into cementitious material is therefore extremely important. It is the connectivity of pores that is of importance when considering the ability of a porous material to transport fluids through it. After initial hydration the solid phase is built up via hydration products and the pore size distribution altered. As hydration products are formed, sections of the capillary pore space will be enclosed and cut off from the main pore network, thus reducing the connectivity of the pores. As this process continues, all long-range connectivity can be lost.

Sorptivity, or capillary suction, is the transport of liquids in porous solids due to surface tension acting in capillaries and is a function of the viscosity, density and surface tension of the liquid and also the pore structure (radius, tortuosity and continuity of capillaries) of the porous solid (2). It is measured as the rate of uptake of water.

Sorptivity values typically vary from approximately 5 mm/ min0.5**, for well-cured M30-M50 concretes, to 15 – 20** mm/ min0.5 **for poorly cured M20 concrete. A diagram of the test is shown in Figure 2. The lower the water sorptivity index, the better is the potential durability of the concrete.**

Table 1: Acceptance limits for durability indexes

Acceptance Criteria		OPI (log scale)	Sorptivity (mm/h)
Laboratory concrete		> 10	< 6
As-built Structures	Full acceptance	> 9,4	< 9
	Conditional acceptance	9,0 to 9,4	9 to 12
	Remedial measures	8,75 to 9,0	12 to 15
	Rejection	< 8,75	> 15

Materials

The cement used was normal portland 53 Grade OPC cement, the composition of which is given in table 1.The sand used was from Bodeli from orsang river with zone 2. The sieve analysis result are given in table 2. The kapachi used is black trap from Sevalia, Timba. It was found the aggregate used in the study were confirming to the specification laid down in IS 383- 1970. Specific gravity, water absorption and gradation of sand (FM) test were carried out as per IS 2386 (part I and Part III) – 1963. Physical test for specific gravity, water absorption, gradation, impact, crushing value were carried out for coarse aggregate as per IS -2386 (I, II & IV) 1963 and are so as in table 3.

Casting of Specimen

The mix design was carried out for M30 grade concrete as per IS: 10262-2009 which yielded a proportion of 1:1.86: 2.41 with a w/c ratio of 0.45 and 1% steel fibers 30 mm length and .7 mm thickness with corrugated shape giving and aspect ratio of 42. The steel fiber was added by volume fraction. The density of steel fibers was 78500 N/ m3 . The dosage of super plasticizer used was 0.78% (by weight of cement).

The cement, sand and coarse aggregates were weighed according to the proportion of 1:1.86: 2.41 and dry mixed. Before mixing, 30% of cement was replaced by (FA + SF) or (FA+GGBFS) or (FA+MK) according to the proportions such as (0+0), (30+0), (25+5), (20+10), (15+15), (10+20), (5+25) and (0+30) respectively. The required amount of water was added to this dry mix and intimately mixed. The calculated quantity of super plasticizer was now added and mixed thoroughly. After this, 1% steel fibres by volume was added to the mix and the different concrete mixes were agitated thoroughly to get a homogeneous mix. Then the mix was placed layer by layer in the moulds to cast the specimens. The specimens were prepared both by hand compaction as well by imparting vibrations through vibrating table. The specimens were finished smooth and kept under wet gunny bags for 24 hours after which they were cured for 90 days. After curing, they were tested for their respective strengths as per IS specifications. Standard cube specimens of 150 x 150 x 150 mm were cast.

Methodology:

Water absorption test:

The cubes after casting were immersed in water for 90 days curing. They were then weighted and this weight was noted as the wet weight of the cube. These specimen were then oven dried at the temperature 1050C untill the mass became constant and again weighed. This weight was noted as the dry weight of the cube.

% water absorption = [(WW – DW) / DW] x 100

Where,

WW = wet weight of cube,

DW = dry weight of cube.

Soroptivity test:

The cubes after casting were immersed in water for 90 days curing. The specimen used to determine sorptivity were cubical samples of size 150 x 150 x 150 mm after drying in oven at temperature of 100 + 10 0C. The samples were stored until the weight loss was negligible.

The samples were placed in a recipient in contact with level of water capable to submerge them about 5 mm as shown in the photographs. After 1 hour time (A predefined period of time) the samples were removed from the receipient. Essentially, the sorptivity test determines the rate of capillary rise absorption by a concrete cube which rest on a small support in a manner such that only lowest 2 to 5 mm of the cube is submerge.

It has been shown that there exists a relation of the form

$i = S\ t\ 0.5$

t= time measured in minutes at which the mass is determined or time measure to see the rise in the water level in the concrete.

i= measured in mm.

In the test, several measurements are taken over a period of upto one hours and a straight line is fitted to the plot of the increase in mass or rise of water front, verses the square root of time.

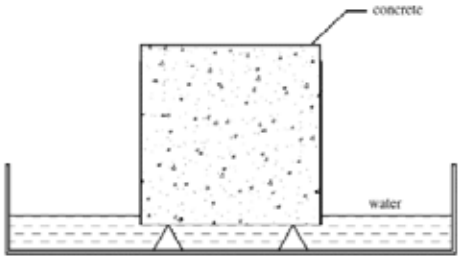

Figure 2: Schematic diagram of water sorptivity test

TABLE 6.40 Average water absorption and sorptivity of 3 cubes after 90 days curing at room temperature for all the blends

	FA+SF				FA+GGBS				FA + MK			
	wet wt.	dry wt.	% absorption	soroptivity value	wet wt.	dry wt.	% absorption	soroptivity value	wet wt.	dry wt.	% absorption	soroptivity value
(0+0) Ref. Mix	86.30	85.00	1.53	3.86	86.30	85.00	1.53	3.86	86.30	85.00	1.53	3.86
(30+0)	86.00	85.00	1.18	3.73	86.00	85.00	1.18	3.73	86.00	85.00	1.18	3.73
(25+5)	86.00	85.20	0.94	3.23	86.20	85.20	1.17	3.6	86.20	85.20	1.17	3.45
(20+10)	85.00	84.30	0.83	3.07	86.50	85.60	1.05	3.39	88.60	87.80	0.91	3.12
(15+15)	86.00	85.30	0.82	3.01	86.00	85.20	0.94	3.07	88.00	87.40	0.69	2.86
(10+20)	86.30	85.80	0.58	2.78	86.20	85.60	0.70	2.9	89.80	89.00	0.90	2.99
(5+25)	86.50	85.90	0.70	2.88	86.50	85.80	0.82	2.91	85.80	85.00	0.94	3.23
(0+30)	86.60	85.80	0.93	3.29	86.50	85.60	1.05	3.43	86.00	85.00	1.18	3.36

VARIATION OF WATER ABSOPTION AFTER EXPOSING 90 DAYS CURING

VARIATION OF SOROPTIVITY FOR AFTER 90 DAYS CURING

Discussion and observation

1.It is observed that the water absorption and soroptivity of ternary blended steel fibre reinforced concrete shows lower water absorption and soroptivity at (10+20) replacement with (FA+SF) combination. There after the water absorption and soroptivity shows a increasing trend. This observation is true for 90 days strength, where percentage decrease in water absorption and soroptivity is found to be 0.58% and 2.78 mm/min0.5 with respect to reference mix.

This may be attributed to the fact that at a replacement level of (10+20) with (FA+SF) combination, most of the pores in the concrete matrix gets filled up there by rendering a dense microstructure. Also it may be due to the fact that at a replacement level of (10+20) with (FA+SF) combination the higher pozzolanic reaction takes place which can induce the later age water absorption and soroptivity. The pozzolanic reaction forms secondary hydrated products or C-S-H gel which is responsible for the additional water absorption and soroptivity. Thus the synergistic effect of (FA+SF) plays an important role.

Thus it can be concluded that the water absorption and soroptivity of ternary blended steel fibre reinforced concrete shows lower water absorption and soroptivity at a replacement level of (10+20) with (FA+SF) combination.

2.It is observed that the water absorption and soroptivity of ternary blended steel fibre reinforced concrete shows lower water absorption and soroptivity at (10+20) replacement with (FA+GGBFS) combination. There after the water absorption and soroptivity shows a increasing trend. This observation is true for 90 days strength, where percentage decrease in water absorption and soroptivity is found to be 0.70% and 2.9 mm/min0.5 with respect to reference mix.

This may be attributed to the fact that at a replacement level of (10+20) with (FA+GGBFS) combination, most of the pores in the concrete matrix gets filled up there by rendering a dense microstructure. Also it may be due to the fact that at a replacement level of (10+20) with (FA+GGBFS) combination the higher pozzolanic reaction takes place which can induce the later age water absorption and soroptivity. The pozzolanic reaction forms secondary hydrated products or C-S-H gel which is responsible for the additional water absorption and soroptivity. Thus the synergistic effect of (FA+GGBFS) plays an important role.

Thus it can be concluded that the water absorption and soroptivity of ternary blended steel fibre reinforced concrete shows lower water absorption and soroptivity at a replacement level of (10+20) with (FA+GGBFS) combination.

3.It is observed that the water absorption and soroptivity of ternary blended steel fibre reinforced concrete shows lower water absorption and soroptivity at (15+15) replacement with (FA+MK) combination. There after the water absorption and soroptivity shows a increasing trend. This observation is true for 90 days strength, where percentage decrease in water absorption and soroptivity is found to be 0.69% and 2.0 mm/min0.5 with respect to reference mix..

This may be attributed to the fact that at a replacement level of (15+15) with (FA+MK) combination, most of the pores in the concrete matrix gets filled up there by rendering a dense microstructure. Also it may be due to the fact that at a replacement level of (15+15) with (FA+MK) combination the higher pozzolanic reaction takes place which can induce the later age water absorption and soroptivity. The pozzolanic reaction forms secondary hydrated products or C-S-H gel which is responsible for the additional water absorption and soroptivity. Thus the synergistic effect of (FA+MK) plays an important role.

Thus it can be concluded that the water absorption and soroptivity of ternary blended steel fibre reinforced concrete shows lower water absorption and soroptivity at a replacement level of (15+15) with (FA+MK) combination.

Experimental results:

Following tables gives the water absorption and soroptivity test results of different ternary blended steel fibre reinforced concrete for 90 days curing.

Conclusion

I. Water absorption and soroptivity of ternary blended steel fibre reinforced concrete shows lower water absorption and soroptivity at a replacement level of (10+20) with (FA+SF) combination, (10+20) with (FA+GGBFS) combination and (15+15) with (FA+MK) combination.

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