Study of Sorptivity of Self-Compacting Concrete with Different Chemical Admixtures

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Abstract

The influence of chemical admixtures on the properties of Self-Compacting Concrete (SCC) was investigated. All types of used admixtures were the same percentage of 1.4

Index terms— self-compacting concrete; sorptivity; absorption; durability; superplasticizer

1 Introduction

elf-Compacting Concrete (SCC) not only increases the reliability of structures but also reduces the number of workers required at the construction site and streamlines the construction. In pre-cast product plants as well, Self-Compacting Concrete is highly effective in reducing the noise as it requires no vibration [6]. SCC is a highly flowable, yet stable concrete that can spread readily into place and fill the formwork without any consolidation and without undergoing any significant separation. In general, SCC results in reduced construction times and reduced noise pollution [7].

SCC is defined as concrete that is able to flow and consolidate under its own weight, completely fill the formwork even in the presence of dense reinforcement, whilst maintaining homogeneity and without the need for any additional compaction [2]. Super plasticizer enhances deformability and with the reduction of wate / powder segregation resistance is increased [10] [11].

Sorptivity, which is an index of moisture transport into unsaturated specimens, has been recognised as an important index of concrete durability, because the test method used for its determination reflects the way that most concretes will be penetrated by water and other injurious agents and it is an especially good measure of the quality of near surface concrete, which governs durability related to reinforcement corrosion [12]. The sorptivity coefficient is essential to predict the service life of concrete as a structural and to improve its performance [13]. It was reported that the sorptivity of air-cured fly ash concrete, cured for 28, 90 and 180 days, increases with increase in fly ash content. In normal concrete has been shown that the condensed silica fume, under normal curing environments, to both increase strength and reduce sorptivity [14]. ii. Fine Aggregates Natural sand with medium size was used as a fine aggregate. Its physical properties were tested as specific gravity of 2.65 t/m3, fineness modulus of 3.65, absorption of 1%, unit weight of 1.68 t/m3, and voids ratio 31.7%. Sieve analysis had been conducted which its results are shown in Table (2).

2 II.

3 Experimental Investigation

4 Chemical Admixtures

Four commercial products were used, they comply with ASTM C494-90 type "G" [3]

5 b) Mixing procedure and moulding

The coarse and fine aggregates were initially fed into the concrete mixer, and then Portland cement and 3/4 of (water + admixture) were poured into the mixer. While the mixer was operated, the remaining water was added as necessary. The mixing time was 5.0 minutes started from the time when all the mixed materials had been charged into the mixer.

After casting, all the moulded specimens were covered with plastic sheets and were left in the casting room for 24 hours "25oC and 75 % R.H. Afterwards, they were de-moulded and transferred to the moist curing room at 100% relative humidity until required for testing.

6 c) Concrete Mixtures

An experimental program was undertaken to obtain workability, strength and durability for all mixes. Five mixes were made in this paper. For all mixtures, the graded coarse and fine aggregates were weighted in room dry condition, the coarse aggregate was then immersed in water for 24 hours, the excess water was decanted and the water retained by the aggregates was determined by the mass difference. A predetermined amount of water was added to the fine aggregate that was then allowed to stand for 24 hours. The water to cement ratio was maintained at 36%, coarse aggregate content (dolomite) was 875 kg/m3 with 15 mm, fine aggregate content (natural sand) was 950 kg/m3, tap water has been used for mixing and curing, tap water that used in all of the tests was clean drinking fresh water from impurities. Portland cement was used; the quantity of cement was 500 kg/m3. The mixture proportions of the mixtures are as shown in Table (4).

7 L-Box

It is a widely used test, and gives a good assessment of passing ability. The vertical section of apparatus was filled with concrete without tamping till level at top. After 1 minute; the sliding gate raised vertically to allow the concrete to flow out into horizontal section freely.

When the concrete stopped flowing, the heights of the concrete were measured; H1 in the vertical section, and H2 at the end of the horizontal section. The ratio of (H2/H1) is the blocking ratio. The apparatus is shown in fig. The cubes of size 150×150×150 mm were used to determine the absorption at age of 28 days. The specimens dried in oven at temperature 105oC until the weight became constant, this weight was noted as dry weight (Wd). Then the cubes were immersed in water for 3 days then weighted, this weight was noted as wet weight (Ww). The %Absorption was computed by b. Sorptivity Sorptivity measures the rate of penetration of water into the pores in concrete by capillarity suction when the cumulative volume of water that has penetrated per unit surface area of exposure is plotted against the square root of time of exposure. The resulting graph could be approximated by a straight line passing through the origin. The slope of this straight line is considered as a measure of rate of movement of water through the capillary pores.

The cubes of size 150×150×150 mm were used to determine the sorptivity at age of 28 days [5]. The specimens dried in oven at temperature 105oC then side surfaces were sealed, and the end of the specimens opposite the absorbing surface was covered to impede evaporation from this surface during the test.

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9 Results and Discussion

10 a) Properties of Fresh Concrete

Concrete mixes at fresh state were tested as slump flow diameter, L-box and V-funnel, table (6) provides an overview of test results. Figures (5-7) provide a comparison of different tests for concrete mixes. The slump flow diameter test was carried out according to EFNARC. The results measured are shown in table (6). In general, the slump flow diameters of mixes are in the range of 654:690 mm. Figure (5) shows the different values for each mix. ii. L-Box

The L-Box test was carried out according to EFNARC. The results measured of blocking ratio are shown in table (6). In general, the blocking ratios of mixes are in the range of 0.8:0.9. Figure (6) shows the different values for each mix. iii. V-funnel and V-funnel at T=5 minutes The V-funnel test was carried out according to EFNARC. The results measured of flow time are shown in table (6). In general, the flow times of mixes are in the range of 7:11 sec after 10 sec; and in the range of 8:14 sec after 5 minutes. Figure (7) shows the different values for each mix.

11 b) Properties of Hardened Concrete

Concrete mixes at hardened state were tested as compressive strength, flexural strength and splitting tensile strength at different ages "7 & 28 days", Table (7) provides an overview of test results. Figures (8)(9)(10)(11)(12) provide a comparison of different tests for concrete mixes. The compressive strength test carried out by ASTM C39. Its results are shown in Table (7). The compressive strengths for all mixtures are at range of 149 to 437 kg/cm2 after 7 days and at range of 212 to 506 kg/cm2 after 28 days. Figure (8) shows a comparison of achieved compressive strength for each mix.

12 ii. Flexural Strength

The flexural strength test carried out by ASTM C78. Its results are shown in Table (7). The flexural strengths for all mixtures are at range of 30.5 to 53.0 kg/cm2 after 28 days. Figure (9) shows a comparison of achieved flexural strength for each mix. The tensile strength test carried out by ASTM C496. Its results are shown in Table (7). The tensile strengths for all mixtures are at range of 21.98 to 36.14 kg/cm2 after 7 days and at range of 24.06 to 42.22 kg/cm2 after 28 days. Figure (10) shows a comparison of achieved tensile strength for each mix. iv. Absorption

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The water absorption test carried out by ASTM C642. Its results are shown in Table (7). The water absorption percentages for all mixtures are at range of 4.02% to 8.433% after 28 days. Figure (11) shows a comparison of water absorption percentages for each mix. The sorptivity test carried out by ASTM C1585. Its results are shown in Table (7). The sorptivity values for all mixtures are at range of 0.1896 to 0.3035 mm/?min after 28 days. [1] [2] [3] [4] [5]

Figure 1: -

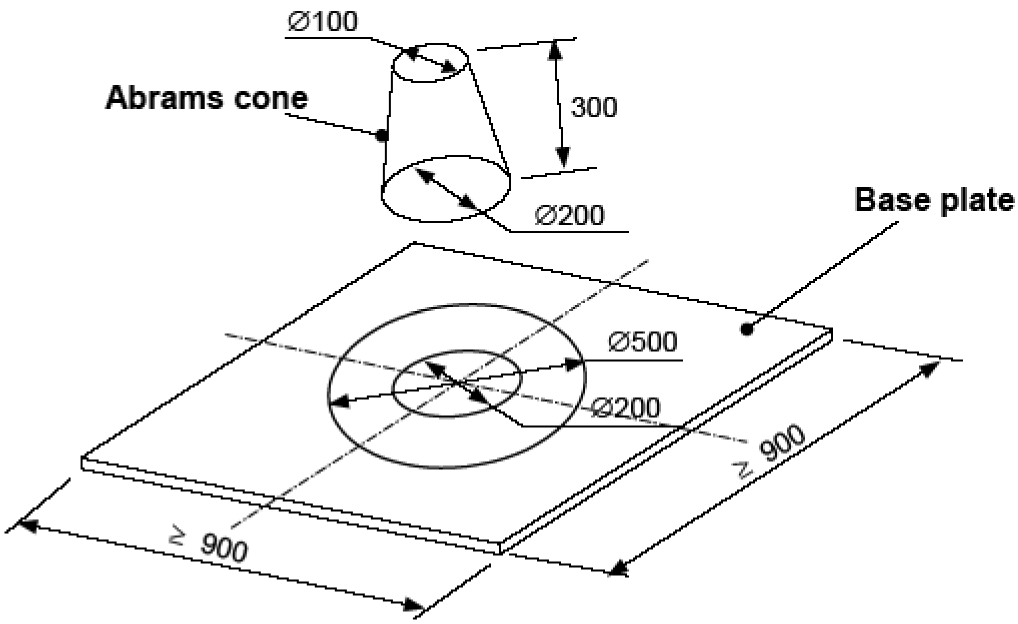

Figure 2:

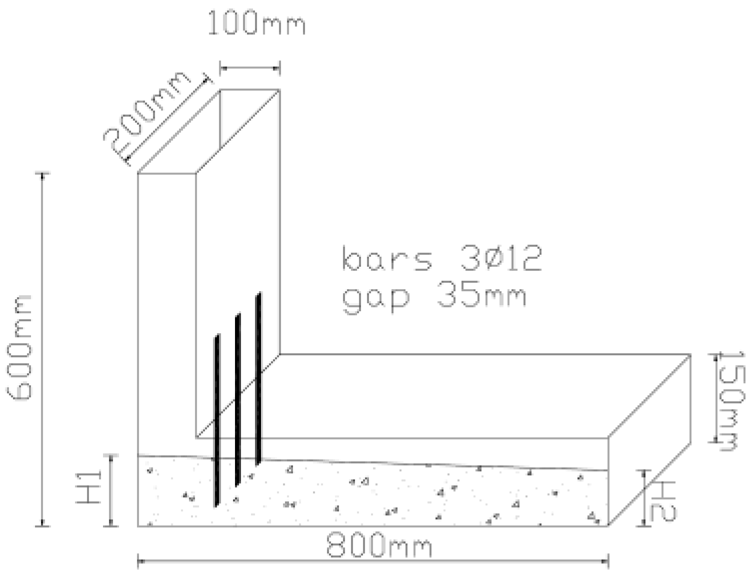

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Figure 3: Figure 1 :

2

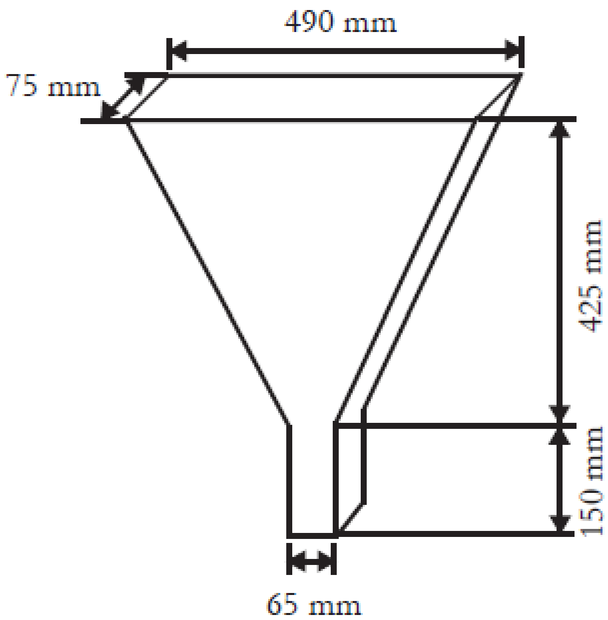

Figure 4: Figure 2 :

3

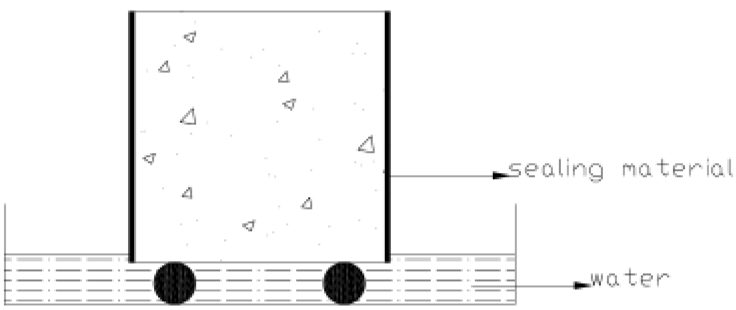

Figure 5: Figure 3 :

1

Description	Value
Physical Properties	
1-Specific gravity	3.15
2-Fineness passing 90 µm%	93%
3-Surface area cm 2 /gm	3315
Chemical Analysis	
1-Lime Calcium Oxide (CaO)	60 : 67 %
2-Silicon Dioxide (SiO 2)	17 : 25 %
3-Aluminum Oxide (Al 2 O 3)	3.0 : 8.0 %
4-Calcium Sulphate (CaSO)	0.50 : 6.0 %
5-Magnesium Oxide (MgO)	0.10 : 4.0 %
6-Sulphur trioxide (SO 3)	2.75 %
7-Alkalis	0.40 : 1.25 %
8-Loss in ignition %	3 %
Compressive Strength (Cubes)	
1-Age 2 days MPa	20.2
2-Age 7 days MPa	32.9
3-Age 28 days MPa	44.7

Figure 6: Table 1 :

2

Dolomite of 15 mm maximum size was used. Its physical properties were tested as specific gravity of 2.72 t/m3, fineness modulus of 6.66, absorption 1%, the surface area of 2.06 cm2/gm, and crushing factor is equal to 12.50 %. Sieve analysis had been conducted which its results are shown in Table (3).

Figure 7: Table 2 :

3

Figure 8: Table 3 :

4

Sieve Size (mm) 40		20	10	5	2.5 1.25 0.61 0.31 0.15			
% Passing	100 100 100 90				70	50	20	5
Sieve Size (mm) % Passing	0 99 4	20 95	10 35	5 5	2.5 0	1.25 0.61 0.31 0.15 0 0 0 0		

Figure 9: Table 4 :

5

Figure 10: Table 5 :

6

Figure 11: Table 6 :

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[Note: i. Compressive Strength]

Figure 12: Table 7 :

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9
IV. Conclusions 8.433
Using Addi Crete BVS 100, Compressive
8 strength decreased by (10.00%) at age of 7 days, and
increased by (2.92%) at age of 28 days; Tensile strength
7 increased by (42.40%) at age of 7 days, and increased
by (49.66%) at age of 28 days; Flexural strength
5.495 increased by (46.01%) at age of 28 days. % Absorption 6 decreased by (3.42%) at age of 28 days, Sorp

associations representing producers and
applicators of specialist building products),
0 Specification and Guidelines for self-compacting
C concrete, February 2002, Hampshire, U.K. M1 M2
Mixes

Figure 13:

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[Admixtures for concrete, mortar and grout -Part 2: Concrete admixtures -Definitions, requirements, conformity, marking and lab *Admixtures for concrete, mortar and grout -Part 2: Concrete admixtures -Definitions, requirements, conformity, marking and labeling*, EN 934-2: European Standard.

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