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Behavior of Self-Compacting Concrete with Different Fineness Moduli of Fine Aggregate

Ahmed Sultan Ali
Civil Engineering Department-
Al -Nahrain University /Iraq – Baghdad
ahmed_sltn2007@yahoo.com

Abstract:

The main objective of the present paper is to investigate the effect of fineness moduli (FM) of fine aggregate on fresh properties (flow ability. Passing ability and segregation resistance), and hardened properties (compressive strength, split tensile strength, flexural strength and ultrasonic pulse velocity UPV) of self-compacting concrete (SCC). Four values of FM 2.3, 2.5, 2.7 and 3.1 were used, according to acceptance range of ASTM C33-03 for FM for fine aggregate, which recommended range for FM is 2.3 to 3.1.

Four series of mixes were casting , each series consist of two mixes represent normal strength and high strength SCC, each series of mixes made from fine aggregate have the same FM. Flow ability, passing ability.and segregation resistance of fresh SCC, both with normal and high strength decreases with increasing the fineness moduli. High strength SCC more effected than normal strength concrete due to increase the volume of particles.

Great enhancement in compressive strength split tensile strength and flexural strength in both normal and high strength SCC when the FM is 2.5. Increase FM to 2.7 and 3.1 not lead to increase in strengths. The UPV values of normal and high strength SCC mixes have a good general condition. SCC mixes with FM 2.5 possess excellent general conditions

Keywords: Self-Compacting Concrete, Fineness Modulus, Flexural Strength, UPV

1. Introduction

The main factor make the concrete is a successful and commonly used materials, it can be take any shape is cast in it with structural properties. The using of vibrations through compaction it is essential to produce concrete with required strengths in compression, splitting and flexural and durability of concrete.

Casting concrete without vibrations is done in mass and shaft concrete, but the difficulties to obtain desired strength and consistency for the above concrete make it not interest. Producing concrete able to flow under its own weight through heavily congested reinforcement, and occupy different shapes of forms and retain homogeneity without segregation is the solution for the above problems.[1]

The concrete having filling ability, passing ability, and segregation resistance is called self-compacting concrete SCC. Aggregate represent 70 -80 per cent of the volume of the concrete, they give a body to the concrete, reduce shrinkage, and effect economy.

Other concrete ingredients except cement are natural materials, and can be vary to any extent in many of their properties. The using the large size of aggregate, sometime up to 80 mm lead to significant reduction in cement and water content in the mix, and reduction of drying shrinkage. The maximum size of aggregate that can be used in any given conditions may be limited by the following conditions [2]:

(i) Thickness of section
(ii) Spacing of the reinforcement
(iii) Clear cover, and
(iv) Maxing, handing and placing.

The using of 20mm maximum size of aggregate in SCC generally considered satisfactory fresh and hardened properties. Self-compacting concrete contain 10-15 per cent of fine aggregate larger than traditional concrete. Fig. 1 Show the approximate compositions of traditional concrete and SCC.

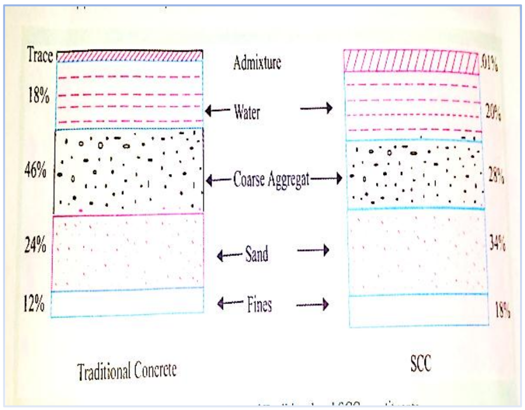

Figure 1: The approximate compositions of traditional and SCC constituents [1]

Fine aggregate contain particles less than 150 micron, this particles contribute to the powder content. A single factor computed from the sieve analysis is sometime used. This is the fineness modulus, is define as 1/100 of the sum of the cumulative percentage retained on the sieves of the standard series.

Fineness modulus cannot be used as a single description to the grading of aggregate. The importance of fineness modulus it does clearly appear when using it to measuring slight variation of aggregate from the same source. When developing a mixture proportions for concrete, the FM of the sand would be used to balance the amount of coarse aggregate needed so that cement and water content is reduced [3].

FM can also be used as a part of an aggregate production quality control program. FM values plotted in a control chart provide a simple check of consistency of aggregate production. ASTM C33-03 recommends that sand be rejected or the mixture design be adjusted, if the FM varies more than 0.2 [4].

In general a smaller value of fineness modulus indicates a finer aggregate, and higher value indicates to coarser aggregate[3]. Finer aggregate is valuable for used in SCC. ASTM C33 provides guidelines for gradation and FM for fine aggregate that can be used in concrete; that recommended range for FM is 2.3 to 3.1.

Three ways are used to make SCC mixes, these ways are: powder type, viscosity modifying agent, and combined type. In powder type SCC make by increasing the powder content in the mix, therefore the behavior of SCC with different values of fineness modulus must be considered [1].

Many researches study the effects of fineness modulus of fine aggregate on the fresh and hardened properties of traditional concrete. Myron (1999) [5] investigate a comparison of three maximum size grading of sand-gravel and sand-crushed stone mixtures in concrete has revealed that for each type and size of coarse aggregate a constant value for fineness modulus will be obtained for any workable mixture from lean to rich. Mater (2001)(6) study ideal and optimum fineness modulus are used in combination with the geometrical gradation of aggregates to establish the mix proportioning of mass concrete. The ideal and optimum fineness modulus are experimentally determined for each maximum size of aggregate (MSA) by making concrete mixtures with aggregates of different fineness modulus and determining which of the mixtures give the highest compressive strength. Very limited researches study the effect of FM of fine sand on the properties of SCC mixes, especially the fresh properties. Abeer (2013)[7] try to assess the fresh properties of SCC by using fine aggregate from different grading zone, and their effect on its compressive strength.

2. Research Significant

This study reports on experimental investigation on the influence of different fineness moduli of fine aggregate (2.3, 2.5, 2.7and 3.1) on fresh properties such as: filling ability, passing ability and segregation resistance and hardened properties such as compressive strength, split tensile strength, flexural strength and ultrasonic pulse velocity test UPV of normal strength and high strength SCC after 7 and 28 days of water curing.

3. Experimental Investigation

Eight mixes have a same composition and proportions of materials, but different in a fineness moduli of fine aggregate were casting. These mixes are listed in table [1].

Table1: .Description of the specimens used.

Series	Description
A_1	HSSCC with FM of fine aggregate 2.3
B_1	NSSCC with FM of fine aggregate 2.3
A_2	HSSCC with FM of fine aggregate 2.5
B_2	NSSCC with FM of fine aggregate 2.5
A_3	HSSCC with FM of fine aggregate 2.7
B_3	NSSCC with FM of fine aggregate 2.7
A_4	HSSCC with FM of fine aggregate 3.1
B_4	NSSCC with FM of fine aggregate 3.1

HSSCC: High Strength Self-Compacting Concrete

NSSCC: Normal Strength Self-Compacting Concrete

3.1 Materials

3.1.1 Cement

Ordinary Portland cement (Type I) was used for casting all specimens throughout the research program. The physical and chemical properties of the cement used which complies with the requirements of the Iraqi specification (I.Q.S No. 5/1984) [8].

3.1.2 Coarse aggregate

To avoid the bad effects, due to present of flaky and elongated particles, crushed aggregate was used. The maximum size of coarse aggregate was 12 mm; water absorption and sulfate content were 2.63 and 0.05% respectfully. These results were within the requirements of the Iraqi specification (I.Q.S No. 45/1984) [9].

3.1.3 Fine aggregate

Four samples of fine aggregate were prepared, these samples have a same properties, but different in particles size distribution (grading), to give a various values of fineness moduli. Four values of FM 2.3, 2.5, 2.7 and 3.1 were used, according to acceptance range of ASTM C33-03 for FM of fine aggregate, which recommended range for FM is 2.3 to 3.1. The grading of the sand conformed to the requirement of ASTM C33- 03, as shown in table 2 and figure 2.

All the fine aggregate samples passing from 4.75 mm sieve, the specific gravity, absorption, and sulfate content were 2.6, 0.73, and 0.07% respectfully. The physical and chemical properties of the fine aggregate used within the requirements of the Iraqi specification (I.Q.S No. 45/1984) [9].

Table 2: Sieve analysis of Fine Aggregate.

Sieve size (mm)µ	% Passing by weight				ASTM C33-03	IQS No.45/1984
	FM 2.3	FM 2.5	FM 2.7	FM 3.1		
10	100	100	100	100	100	100
4.75	99	98	97	96	95 - 100	90 – 100
2.36	94	92	90	86	80 - 100	85 – 100
1.18	85	82	85	76	50 - 85	75 – 100
600 µm	56	52	45	40	25 – 60	60 – 79
300 µm	28	24	21	14	12 - 40	12 – 40
150 µm	9	7	4	2	0 - 10	0 – 10

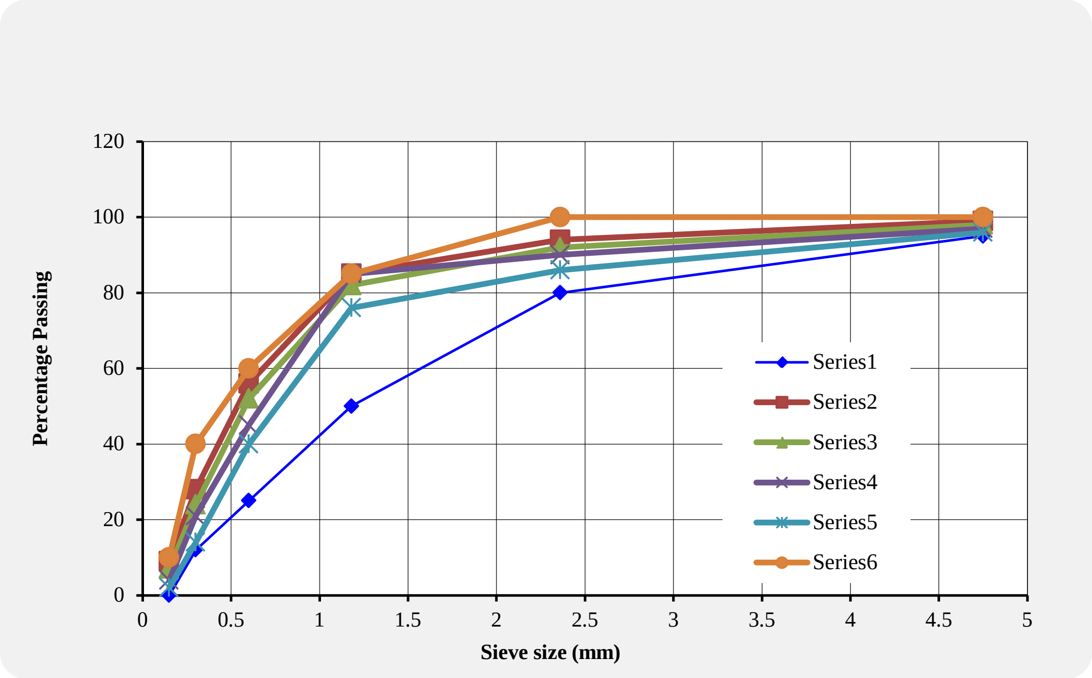

Figure 2: Sieve Analysis of Four Samples of Fine Aggregate

3.2 Admixtures

3.2.1 Silica fume

Silica fume is added to the self-compacting concrete mixtures to increase the powder content and also, improve the rheological and mechanical properties (as a pozzolanic material). The physical and chemical properties of silica fume used are complies with the requirements of ASTM C1240 [10].

3.2.2 Superplastisizer

An ASTM C494 [11] type F high range water reducing admixtures was used to maintain a high workability of SCC mixes. Structro 335; high performance concrete Superplastisizer was light yellow to reddish colored liquid, with chloride content less than 0.1%. The specific gravity was 1.2 at 20^0C.

3.2.3 Viscosity-Modifying Admixtures VMA

Structro 480 is suitable for used in SCC, as a high performance cohesion admixture have a superior for rheological behavior and suspending power. Most the VMA_s when incorporation in SCC mixes led to increased shear stress at higher shear rate [12]. Structro 480 was used to avoid increasing in shear stress. Structro 480 was opaque liquid having < 0.1% chloride content with specific gravity of 3.4 at 20 ^{0}C.

3.3 Mix design

The European Guide lines for self-compacting concrete (EFNARC 2005) [13] requirements were followed for the mix design. The 28 days compressive strength is 32 MPa and 45 MPa, for normal and high strength SCC respectfully.

The self compactibility of the mixes was evaluated by using slump flow test, V-funnel test, L-box test, and segregation resistance test with the requirement of EFNARC (2005). Acceptance criteria for self-compacting concrete listed in Table 5.

Table 5: Acceptance criteria for self-compacting concrete

Property measured	Test method	Recommended value
Flowability/filling ability	Slump flow T50 V-funnel Orimet	Average flow diameter 650–800 mm Time to empty apparatus: 2–5 s Time to empty funnel: 6–12 s Time to empty apparatus: 0–5 s
Passing ability	U-box L-box J-ring	Difference in height between two limbs: 0–30 mm Ratio of heights at beginning and end of flow: 0.8 – 1.0 Difference in heights at beginning and end of flow: 0–10 mm
Segregation potential	Settlement column test	Segregation ratio: >95

Four series of mixes, each series consist of two mixes for normal and high strength self-compacting concrete. The details of these series are listed in table 6.

The quantities of cement, aggregates and the water content were kept constant. The fineness moduli of fine aggregate were varying, and then the effect of fineness moduli of fine aggregate on properties of SCC was studied. Two mixes in each group with fineness modulus of fine aggregate 2.3, 2.5, 2.7, and 3.1were examined. The quantities of each mix are listed in table 7.

Table 6: Compositions of the mixes

FM	Series Code	Powder Kg/M$_3$		Water Kg	W/C Ratio	W/P Ratio	Aggregates Kg/M^3		Chemical Admixtures	
		Cement	Silica				Sand	Gravel	SP	VMA
2.3	A$_1$	487	141	197	0. 4	0.31	720	755	0.82	0.35
	B$_1$	365	105	185	0.5	0.39	885	815	0.71	0.29
2.5	A$_2$	487	141	197	0.4	0.31	720	755	0.81	0.33
	B$_2$	365	105	185	0.5	0.39	885	815	0.70	0.27
2.7	A$_3$	487	141	197	0.4	0.31	720	755	0.80	0.32
	B$_3$	365	105	185	0.5	0.39	885	815	0.70	0.26
3.1	A$_4$	487	141	197	0.4	0.31	720	755	0.79	0.30
	B$_4$	365	105	185	0.5	0.39	885	815	0.68	0.25

3.4 Preparation of the specimens

The specimens of the present study include standard cylinders of 300 mm height and 150 mm in diameter, and premises of 100*100*500 mm. The specimens were cast with the same mix proportions, but varying in fineness modulus of fine aggregate. Compressive strength, split tensile strength, flexural strength, and ultrasonic pulse velocity (UPV) test were tested at 7 and 28 days.

3.5 Test methods

3.5.1 Fresh properties tests

In self –compacting concrete three fresh properties must be fulfilled. These properties are filling ability, passing ability, and segregation resistance. **Filling ability:** it means: the ability of the SCC in fresh state to flow and occupy the all space of the formwork under its own weight without vibration at certain time. This test is done by using V-funnel test (Fig. 3).

Resistance to segregation: The ability of SCC mixes to remain homogeny through during transportation and placing

3.5.2 Hardened tests

The hardened properties tests are; compressive strength, splitting tensile strength, flexural strength, and UPV tests.

Compressive strength test was performed on standard cylinder (300 x 150) mm, according to ASTM C39-02 (14) at 7 and 28 days. Split tensile strength test was performed on cylinder (300 X 150) mm according to ASTM C 496, 2004 [15]. Flexural strength test was carried out on 100 x 100 x 500 mm simply supported prisms with a clear span of 400 mm, under the third points loading according to ASTM C 78-02[16] , and UPV test was done according to ASTM C 597-02[17], on directed transmission method

4. Results and Discussion

4.1 Fresh properties

Three major properties; filing ability, passing ability and segregation resistance must be fulfilled for SCC fresh properties; the results of tests used to assess these properties are listed in table 7.

Passing ability: is the ability of SCC mixes tom flow through obstacles such as steel reinforcement without segregation and bleeding. This test was done by using the U-Box test (Fig. 4).

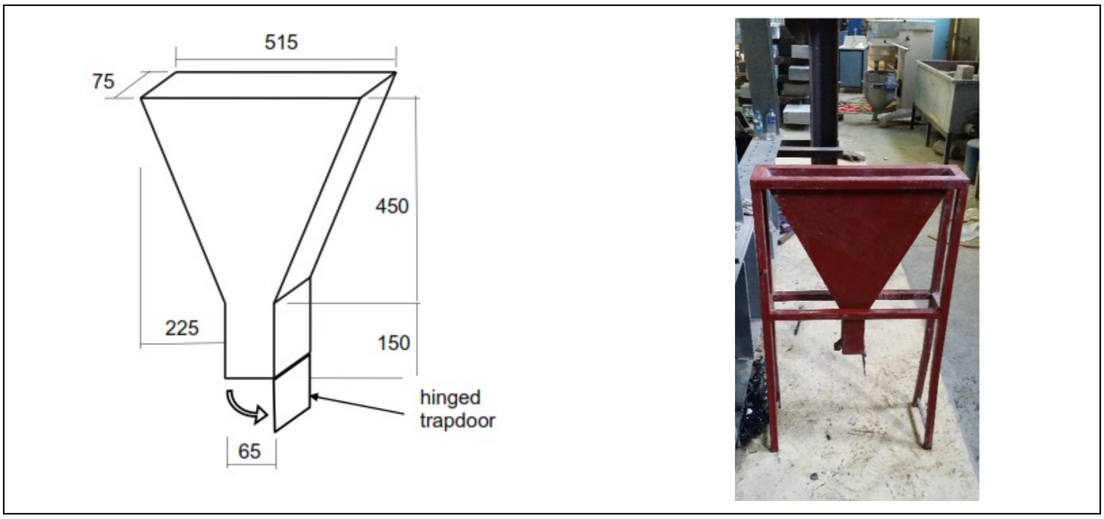

Figure 3: V-funnel test

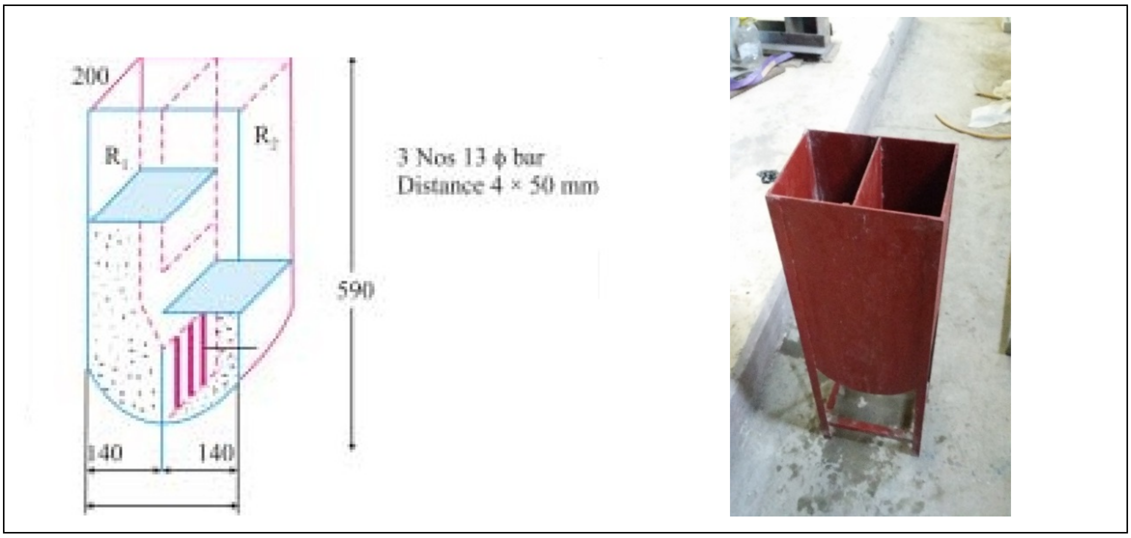

Figure 4: U-Box test

Table 7: A result of self compatibility for SCC mixes

FM	Series	Self compactibility values				
		Slump flow mm	V-Funnel sec	U-Box mm	L-Box mm	SR %
2.3	A_1	769	11	18	0.96	22
	B_1	678	09	10	0.91	20
2.5	A_2	772	11	16	0.95	22
	B_2	687	08	09	0.94	19
2.7	A_3	782	10	12	0.91	21
	B_3	688	07	07	0.84	18
3.1	A_4	789	10	10	0.90	20
	B_4	690	07	07	0.89	18

The self compactibility values listed in table 7, complies with the acceptance criteria for self-compacting concrete listed in table 5.

4.1.1 Slump-flow test

The results of slump-flow test are listed in table 7 and shown in fig. 5. These results show that the slump flow increase with increasing fineness modulus of fine aggregate, for normal strength and high strength SCC mixes. This behavior related to the increase of FM is combined by decreasing in surface area of fine aggregate particles, and lead to have more free water. Series four (A_4 and B_4) have maximum percentages of increase 2.6% and 1.78% compared with control mixes (A_1 and B_1), for normal and high strength SCC.

All results of slump-flow for NSSCC and HSSCC series which lies in class SF2 (600-750) mm, according to EFNARC (2005), these values of slump are prefer to use in wall and columns.

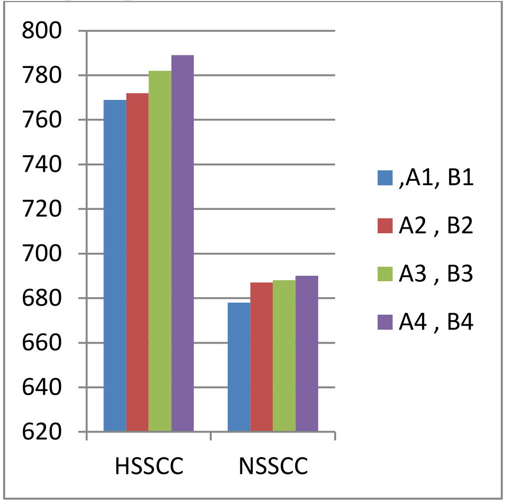

Figure 5: Slump-flow test results (mm) with variation of FM for HSSCC and NSSCC mixes

4.1.2 V-Funnel test

V-funnel test is used to assess the viscosity of SCC; results of this test are listed in table 8 and shows in fig. 6. Results of V-funnel test with different FM indicate to; an increase in FM leads to decreasing the time to empty the V-funnel apparatus. This behavior due to increase particles friction causes decrease the viscosity of SCC mixes. The values of V-funnel test for NSSCC more effected than HSSCC mixes, the percentages of decrease are; 22.2% compared with 9% for HSSCC

4.1.3 L-box test

L-box test is used to assess the passing ability of SCC; the results of this test for NSSCC and HSSCC with different FM of fine aggregate are listed in table 8, and shown in fig. 7. These results indicates to; increase the FM than 2.3 (control mixes A1 and B1), the passing ability measured by blocking ratio (H2/H1) decreased. This decrease refer to increase friction between SCC particles constrains the flow of fresh SCC trough obstacles (Reinforcement bars). The percentages of decrease in L-box results are 30% and 44.5%, for normal and high strength SCC respectfully, the greater decreasing in L-box values is in HSSCC due to an increase in the volume of particles than normal strength SCC.

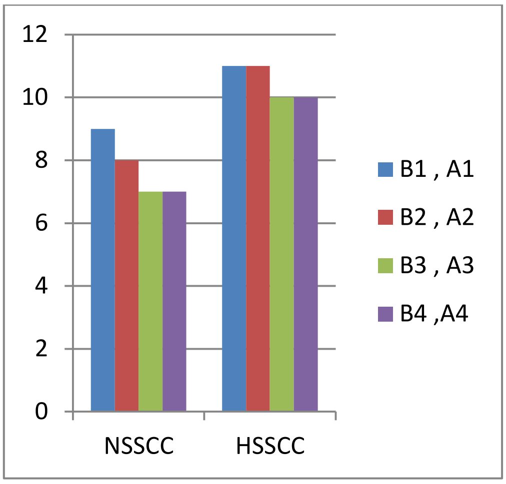

Figure 6: V-funnel test results (sec) with variation of FM for NSSCC and HSSCC mixes

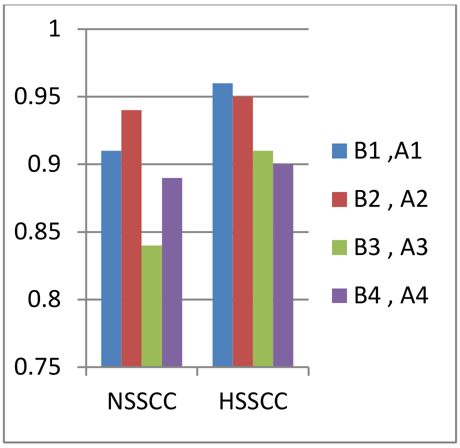

Figure 7: L-box test results (mm) with variation of FM for NSSCC and HSSCC mixes

4.2 Hardened properties

The values of compressive strength, split tensile strength, flexural strength and ultrasonic pulse velocity tests, for 7 and 28 days are listed in table 9.

These values represent the effects of variation the fineness modulus of fine aggregate on the most mechanical properties for normal and high strength self-compacting concrete.

Table. 9:. Compressive strength, split tensile strength, flexural strength and UPV tests results for the eight mixes at 7 and 28 days.

FM	Series	Compressive strength MPa		Split tensile strength MPa		Flexural strength MPa		UPV Km/Sec	
		7days	28days	7days	28days	7days	28days	7days	28days
2.3	A_1	33	45	2.9	3.85	3.09	4.22	3.99	4.4
	B_1	22	32	2.18	3.17	2.07	3.01	3.5	4.1
2.5	A_2	36	48.5	3.15	4.35	3.38	4.55	4.2	4.75
	B_2	23	33	2.28	3.27	2.16	3.09	3.65	4.4
2.7	A_3	35	48	3.07	3.92	3.28	4.5	3.6	4.7
	B_3	25	34	2.1	3.15	2.34	3.19	3.8	4.25
3.1	A_4	30	44	2.65	3.02	2.81	3.7	3.7	4.2
	B_4	21	31	1.89	2.87	1.97	2.9	2.91	4.0

4.2.1 Compressive Strength

The compressive strength values at 7 and 28 days for normal and high strength SCC mixes are listed in table 9, and fig. 8 shows the variation in compressive strength with age for high strength SCC A_1, A_2, A3 and A_4 for 7 and 28 days. The higher strength can be noted at 7 days in A_2 when the fineness modulus of fine aggregate increase from 2.3 to 2.5.

The increase in strength values is 9.1% and 7.8% respectfully. This increase in strength indicates to the increase in FM lead to decrease in surface area of fine aggregate particles, and then enhancement the transition zone between aggregate and cement paste.

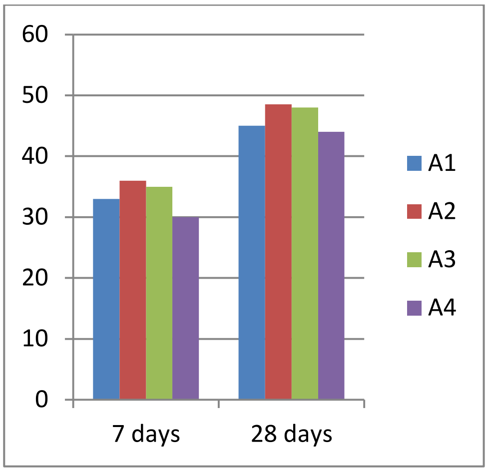

Figure 8: Variation in compressive strength with age for HSSCC mixes A_1, A_2, A_3 and A_4

Fig.9. shows the variation in compressive strength with age for B_1, B_2, B_3, and B_4 (when all these mix normal strength SCC).

Compressive strength decrease significantly for A_3, B_3, A_4, and B_4 when the FM increases from 2.5 to 2.7 and 3.1. Clearly decrease in strength for high strength SCC mixes A_3 and A_4 at 7 and 28 days. This behavior may be tribute to; higher value of FM indicates to coarser aggregate and this lead to bad effects due to the increase in cement paste.

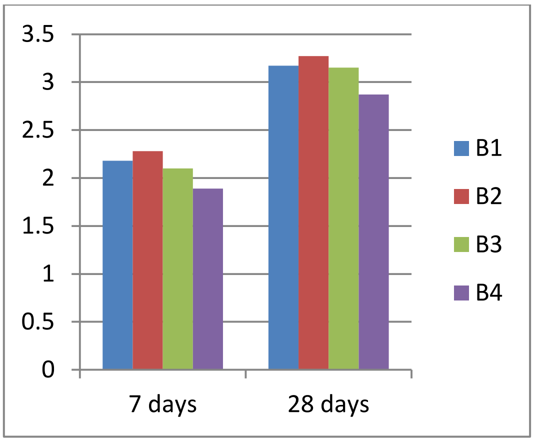

Figure 9: Variation in compressive strength with age for NSSCC mixes B_1, B_2, B_3 and B_4

4.2.3 Split tensile strength

Table 9 and figs. 10 and 11showes the results of split tensile strength for all mixes at 7 and 28 days. The mixes A_2 and B_2 with 2.5 FM have a greater split strength compared with other mixes, the per cent of increase is 13% compared with normal strength SCC.

The nixes A_3, B_3, A_4, and B_4 with FM 2.7 and 3.1 have a clearly reduced in split tensile strength.

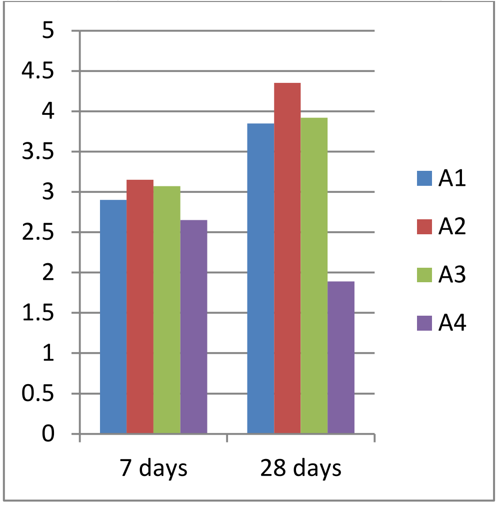

Figure 10: Variation in split tensile strength with age for HSSCC mixes A_1, A_2, A_3 and A_4

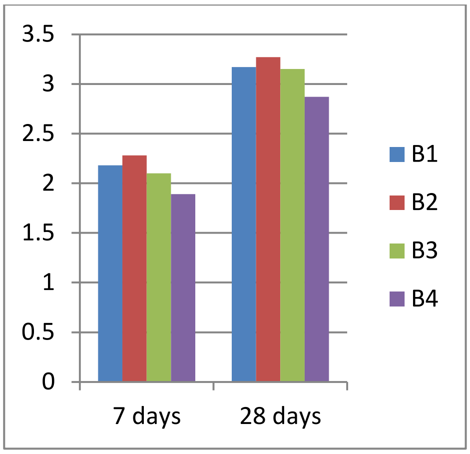

Figure 11: Variation in split tensile strength with age for NSSCC mixes B_1, B_2, B_3 and B_4

4.3.3 Flexural strength

Table 9, shows the results of flexural strength of control mixes A_1, B_1 and other mixes with various FM of fine aggregate, figs. 12 and 13 shows the variation in flexural strength with age for all mixes.

It can be clearly seen that the flexural properties has been enhanced with 2.5 FM of fine aggregate. This behavior may be tribute to the significant distribution of the cement paste, when the surface area of the fine aggregate decreased. On other hand, the increase in powder content due to coarse the fine aggregate lead to increase the reaction with $Ca(OH)_2$. This reaction liberates more calcium silicate hydrate (C-S-H), those enhancement the flexural properties.

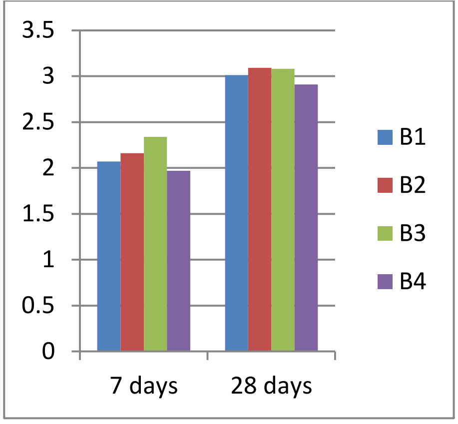

Figure 12: Variation in flexural strength with age for NSSCC mixes B_1, B_2, B_3 and B_4

The pozzolanic reaction with finer particles leads to greater enhancement in microstructure of the concrete mixes, due to pore size and grain size refinement (18).

The flexural strength values for A_3, B_3, A_4 and B_4 decrease with increase the FM of fine aggregate. The decrease in flexural strength due to the increase in cement paste, lead to numerous microcracks in transition zone, these cracks developed under loading.

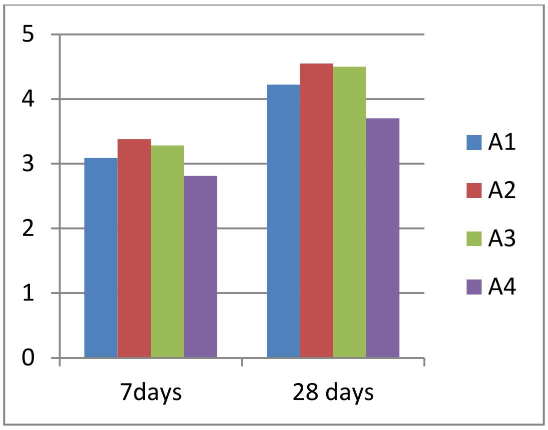

Figure 12: Variation in flexural strength with age for HSSCC mixes A_1, A_2, A_3 and A_4

4.2.4 Ultrasonic Pulse Velocity

Ultrasonic pulse velocity test is one of the non-destructive test can be used to assess the quality of concrete.

The values of UPV are listed in table 9 and shows in fig_s. 14and 15, the mixes A_2 and B_2 have the maximum values of UPV both in 7 and 28 days, and possess excellent general conditions.

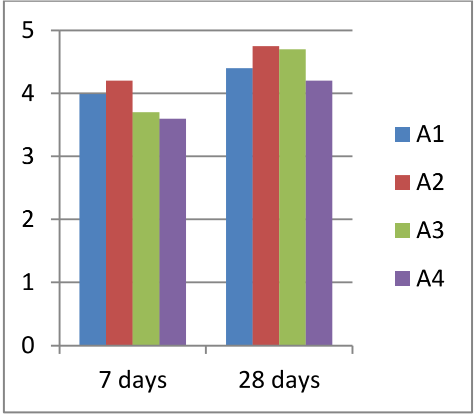

Figure 14: Variation in UPV with age for HSSCC mixes A_1, A_2, A_3 and A_4

This behavior is due to the enhancement in microstructure and minimizing the cracks in transition zone. Increase the FM from 2.5 to 2.7 and 3.1lead to slide decrease in UPV especially in HSSCC mixes A_3 and A_4, and possess good general conditions (19).

In general the high strength SCC mixes A_1, A_2, A3 and A_4 les effect when increase the fineness modulus compared with normal strength SCC mixes, due to an increase in powder content lead to increase in density of concrete, and enhancement the microstructure , also minimize the cracks.

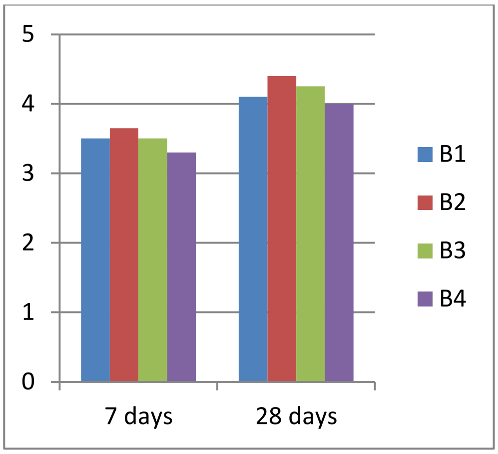

Figure 15:. Variation in UPV with age for NSSCC mixes B_1, B_2, B_3 and B_4

5. Conclusions

On the basis of tests conducted and results obtained from different mixes, for normal and high strength SCC with different fineness moduli of fine aggregate (2.3, 2.5, 2.7, and 3.1). The flowing conclusions can be drawn:

1- It is possible to made NSSCC and HSSCC from fine aggregate with FM varying from 2.3 to 3.1with good properties in fresh and hardened state.
2- The flow ability, passing ability and viscosity of fresh SCC decreases with increasing FM values for HSSCC mixes than NSSCC mixes.
3- Higher compressive strength can be obtained with FM of 2.5, both in NSSCC and HSSCC at 7 and 28 days.
4- HSSCC mixes have least effect on compressive strength when the FM varying up to 3.1
5- All mixes possess good tensile strength in 7 and 28 days. The mixes with FM 2.5 have the highest split tensile strength.
6- The flexural strength has been improved with increasing FM of fine aggregate from 2.3 to 2.5 for A_2 and B_2.While the increase the FM than control mixes to 2.7 and 3.1 lead to decrease in flexural strength for NSSCC and HSSCC.
7- All mixes have been a UPV values at 28 days greater than 4.0 Km/Sec, hence the mixes possess excellent general conditions: this behavior due to minimizing cracks in microstructure of the concrete.
8- Fine aggregate with FM 2.5 for mixes A_2 and B_2 have greater values of UPV. Increasing FM to 3.1 or decrease it to 2.3 (control mixes) lead to reduction in UPV values.

6. References

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تصرف الخرسانة ذاتية الرص بمعاملات نعومة مختلفة للركام الناعم

أحمد سلطان علي
قسم الهندسة المدنية
جامعة النهرين

الخلاصة

ان الهدف الرئيسي من الدراسة الحالية هو دراسة تاثير معاملات النعومة للركام الناعم على خصائص الخرسانة الطرية والتي تشتمل على قابلية الانسياب وقابلية الملىء ومقاومة الانعزال وعلى خصائص الخرسانة المتصلبة متمثلة بمقاومة الانضغاط ومقاومة الشد بالانشطار ومعاير الكسر وسرعة الموجات فوق السمعية للخرسانة ذاتية الرص. تم استخدام اربع قيم من معاملات النعومة للركام الناعم هي 2,3 , 2.5 , 2.7 و 3.1 طبقا للحدود المقبولة بموجب المواصفة الامريكيةASTM C33-04 لمعامل النعومة والتي تحدد المدى المقبول لمعامل النعومة من 2.3 الى 3.1 .اربع مجاميع من الخلطات تم صبها كل مجموعة تتكون من خلطتين بنفس المكونات ولكنها تختلف بمعامل النعومة للركام الناعم. اثبتت التجارب المختبرية التي اجريت بان خاصية الانسياب وخاصية المليء ومقاومة الانعزال للخرسانة ذاتية الرص عالية المقاومة وذات المقاومة الاعتيادية تقل بزيادة قيم معاملات النعومة للركام الناعم وذللك بسبب زيادة حجم الحبيبات. تحسن كبيرفي قيم مقاومة الانضغاط ومقاومة الشد ومقاومة الانحناء وكذلك على سرعة الموجات فوق السمعية للخرسانة ذاتية الرص الاعتيادية والعالية المقاومة عند معامل نعومة للركام الناعم مقداره 2.5 . زيادة معامل النعومة الى 2.7 و 3.1 لايؤدي الى زيادة في قيم المقاومات. سرعة الموجات فوق السمعية للخرسانة ذاتية الرص جيدة بشكل عام في حين انها تكون ممتازة عند معامل نعومة 2.5 .