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The Mechanical Behavior of Self-Compacting Concrete SCC Samples Locally Produce

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Abstract: The main objectives of this research were to obtain a locally self-compacting concrete SCC, a modern concrete with a high property, that enables it to pass and flow through the structural elements and within the steel bars under its own weight only. which was produced and tested in the reinforced concrete laboratory, using local materials in its composition. The mixtures showed no separation or accumulation of the concrete mixture, which enables us to use it in the construction, restoration and structural strengthen at the lowest costs of production.

Three concrete mixtures have been produced using three grades of cement (550, 500 and 450-475 kg/m3), using three types of chemical plasticizers, which has been coded as (3500, NN, and S) and two plasticizers ratios (2%, and 2.5%) of the cement weight, verified by the experiments of the fresh properties of the concrete mixture, determination of the cylindrical strength at the age of 28 days, and the measurement of the stress-strain(б, ξ) for the tested samples. It was found that the self-compacting concrete mixture with cement grade (550kg/m3) using the chemical plasticizer (3500) at (2%) ratio of cement weight, gave the best properties at a water/cement (W/C) ratio of (0.39), with relatively high concrete strength.

Keywords: Self-Compacting Concrete, SCC, Plasticizer, Stress-Strain, Operability, Admixtures.

السلوك الميكانيكي لعينات بيتونية مصنوعة من البيتون ذاتي التوضع SCC والمنتجة محلياً

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المستخلص: الهدف الرئيسي من البحث هو الحصول على بيتون ذاتي التوضع والرص SCC محلي الصنع، يوصف بأنه بيتون حديث ذو قابلية تشغيل عالية، تمكنه من المرور والانسياب من خلال العناصر الإنشائية وضمن فولاذ التسليح الكثيف تحت تأثير وزنه الذاتي فقط، حيث تم إنتاجه واختباره تجريبياً في مخبر البيتون المسلح باستخدام مواد البناء المحلية في تركيبه. وحيث أظهرت الخلطات البيتونية عدم حوث انفصال أو تجمع للخليط البيتوني، مما يمكننا ذلك من استخدامه في أعمال التشييد، الترميم والتدعيم الإنشائي وبأقل تكاليف للإنتاج.

لقد تم إنتاج ثلاثة خلطات بيتونية باستخدام ثلاثة عيارات للإسمنت (550, 500, 450-475 kg/m3) وباستخدام ثلاثة انواع من المضافات الكيميائي والتي تم ترميزها كالتالي (3500, NN, S) وباستخدام نسبتين للملدن (2%, 2.5%) من وزن الإسمنت، تم التحقق منها بإجراء تجارب الخواص الطرية للمزيج البيتوني وتحديد المقاومة الاسطوانية على عمر 28 يوم، وقياس مخطط اجهاد-تشوه (б, ξ) للعينات المختبرة. فمن خلال النتائج تبين أن المزيج البيتوني ذاتي التوضع ذو عيار إسمنت (550kg/m3)، باستخدام المضاف الكيميائي

(3500) وعند نسبة (2%) من وزن الإسمنت، أعطى أفضل نتائج قابلية تشغيل عند نسبة ماء/إسمنت مقدارها (w/c=0.39)، والحصول على مقاومة بيتونية عالية نسبياً تصل حتى (37.6 Map).

الكلمات المفتاحية: البيتون ذاتي التوضع،SCC، الملدن، اجهاد-تشوه، قابلية التشغيل، المضافات.

1- INTRODUCTION.

Self- compacting concrete (SCC) is one of the most important technological developments in the concrete and construction industry at this time. Its use has increased significantly in recent years in structural construction as an alternative to the use of ordinary concrete, due to the high operability that self-compacting concrete. To flow through the structural elements under its own weight, without separating its component, whatever the reinforcement density, in addition to other advantages that characterize of SCC compared to ordinary concrete in terms of high quality, and reducing construction costs. There is no need to use vibrators, as it is able to compacted itself in a complete and regular manner, thus expelling the trapped air and forming smooth and dense concrete surfaces, in addition to reducing the labor required for pouring self- compacting concrete, thus the time required for construction work.

Where the production of this type of concrete was mainly based on experimental laboratory ratios and where these mixtures differed according to properties of materials and internal additives in its composition, but there are a number of special criteria to determine the properties of this concrete, and to avoid getting bad mixtures in terms of strength and operability required.

The American Concrete Institute (ACI Committee, 2007), and the European Code (Bibm e.t, 2005) have conducted a number of tests by conducting experimental mixtures to reach self- compacting concrete, as well as relying on studies previously conducted by researchers around the world.

The researcher (Elham, 2011), evaluated the performance of the fresh properties of the self-compacting concrete SCC prepared using only one type of Plasticizer in different proportions, where the ratio of W/C was 0.26, and have obtained of SCC concrete with high operability properties and high compressive strength up to 80 Map.

The researcher (Timo, W. 2003) was presented a simple method which allows the quantification of the part of the blocked concrete volume with the J-Ring test, also some empirical relationships between different test results were presented which had been found for the tested SCC mixtures.

The researchers (Nídia, D. e.t, 2003), has been used SCC White concrete mainly on pre-cast architectonic elements aesthetic reasons, where the Self-compacting concrete (SCC) was developed to achieve better finish structural elements without vibration need. Four white SCC mixtures with different types of binder were designed using different methods, tests on hardened and fresh concrete were performed, the researchers concluded that it is possible to make different mixtures of SCC with the materials adopted, and the method suggested by the Japan Society of Civil Engineers has proven to give good results.

2- Research Goal:

The research aims to conduct a laboratory practical study to produce self-compacting concrete SCC locally and research in the technic method needed to produce this type of concrete by discussing some study cases.

The objectives of the research are summarized in:

- Researching in the technic method needed to produce local SCC and discussing some of experimental study cases.
- Studying the stress-strain curve (σ-ξ) of laboratory SCC samples.

3- Reference Study:

SCC self-compacting concrete is known as high-flow concrete, which is stable and can spread from the pumped place, fill model and encapsulate reinforcing steel without any mechanical or manual compaction (Salah, A., and Mofeed, A., 2013).

Thus, the mixture is classified as a self-compacting concrete (SCC) if it achieves the following basic operability requirements:

- High fill under its own weight only (Fill ability).
- High separation resistance (stability).
- High flow ability.

Fill ability:

Filling capacity describes the ability of SCC to flow and fill all voids within the model completely and to flow between reinforcing bars under its weight only.

Separation Resistance (stability):

The stability of concrete describes the ability of a mixture to save a homogeneous distribution of its various components during mixing, flowing and pouring.

Flow ability:

Flowability refers to the ease which concrete can pass between various obstructions and the narrow spacing of models without clogging between reinforcing steel bars.

3-1 Self-Compacting Concrete Tests:

There are many test methods used to monitor the operability of SCC in order to verify the mixture formed in the field (ASTM, 2007), and it is worth mentioning that Japan was the first to use these methods since the beginning of the production of this type of concrete in it, in the late eighties, where until now there is no globally approved method to measure the fresh properties of self-compacting concrete, a number of main test methods for filling capacity, separation resistance, and flowability for each mixture had to be applied, to ensure that the requirements were achieved.

The operability of self-compacting concrete depends on several factors, including:

- Facility type.
- Pumping equipment.
- Points of pump the concrete.
- Density of reinforcing steel and the complexity of the model cover.
- Structural design details.

There are many criteria that must be taken into consideration when designing self-compacting concrete mixtures to achieve the required specifications of the mixture (The Syrian Arab Code, 2016), including:

- Geometrical properties of the element.
- Properties of the mixture's materials.
- Casting technology.

According to the American Concrete Institute (ACI Committee, 2007), the slump flow of self-compacting concrete mixtures that are less than (550 mm), requires little vibration, and it is recommended that SCC should not be used with a slump flow less than (550 mm) in applications with a high density of reinforcement.

The European Guide for Self-compacting Concrete (Bibm e.t, 2005) has classified this type of concrete into a number of classes according to the properties and requirements of the concrete.

3-2 The Materials needed to produce SCC:

In order to reach the important requirements that SCC has in terms of high operability, which is the ability to fill the model, the ability to pass through the reinforcing bars, the stability of the mixture and separation resistance, this requires determining the proportions of materials included in procedure concrete mixture to obtain high-quality self-compacting concrete, in addition to the size and proportion of coarse aggregates that a major role in determining the areas of use of self- compacting concrete in light or dense reinforcement applications and the ability to pass through the reinforcing bars within the model (Elham, 2011).

Since the materials used in the SCC mixture are similar to those in the traditional concrete as coarse, fine aggregates and cement, but there are other materials that are added to the SCC mix in order to improve its operability, and to obtain the required quality. The considerations require the proper and good selection of the materials needed to procedure the SCC mixture and their conformity to the required standard specifications to reach the high properties and accepted concrete strength.

The materials used in SCC can be classified according to the following:

- Coarse aggregates.
- fine aggregates.
- fine materials and cement.
- Clean Water.
- Various chemical additives such as plasticizers and others.

4- Technique method to produce self-compacting concrete SCC:

There are many experimental SCC mixtures included in the academic research and engineering guidelines, which depend mainly on estimated ratio and weights of the materials used in the mixtures, which in turn vary according to the different physical, chemical properties and the specifications of those materials, in order to achieve the specific goal of their use. In terms of operability and the required strength, however, all these experimental mixtures have the same stages of their produce it, which are summarized:

- Determine the Slump Flow and T50 (sec) the target.
- Choose the ratio of coarse aggregates
- Estimate the required cement and water content.
- Determine the required mixture.
- Conduct experimental mixtures.
- Carry out the necessary tests to verify the properties of SCC.
- Adjust mixture amount based on test results.
- Perform further tests in order to compare the results, until the needed properties of the mixture are achieved.

5- Experimental study in the laboratory:

In order to obtain a concrete mixture of self-compacting concrete with a specific and acceptable strength, it is necessary to determine the basic properties and specifications of the materials forming the mixture, which in turn define the thermal and mechanical properties of the concrete, then conduct an experimental mixture to reach the desired goal.

5-1 The basic materials used to produce SCC:

Within this paragraph, we include the materials used in the produce SCC (Nídia, D. e.t, 2003), by conducting basic laboratory experiments on these materials, in the laboratories of the Faculty of Civil Engineering at Al-Baath University, based on the technical specifications for additives determined by the producing companies.

- Coarse Aggregates:

In this research, graded, crushed, sharp-edged pebbles with a surface of medium roughness were adopted, taken from the quarries of Hasya area in the countryside of Homs as shown in Figure (1), due to the high quality for these pebbles in the production of reinforced concrete and their conformity to the Syrian Standard Specifications No. (332). year 2007, where the coarse aggregates with a maximum size of 12.5mm was used, (OKAMURA, H. and Ouchi, M., 2003).

Fig (1) Coarse Aggregates

- Fine Aggregates:

Two types of fine aggregates were used Fig (2), as follows:

- Natural sand from quarry of Al-Qaryatayn city.
- Crushed sand from Hasya quarries

Fig (2) Fine Aggregates

- Portland Cement:

Portland cement 32.5 N/mm2 class, conforming to Syrian Standard Specification-1 No. 3800 in 2015 was used as a basic fine material for the mixture, with several grades as shown in Table (1), in order to verify the effect of the cement content on the strength of concrete and the operability of the mixture, and in order to obtain a self-compacting concrete mixture made of local materials available, we can use it in various engineering works, and it fulfills the basic requirements of it in terms of operability and acceptable strength, (Abhishek, J. and G.D. Ransinchung R.N., 2020).

Table (1) Used Cement Grades in the mixtures

Portland cement (Kg/m3)		
450-475	500	**550**

- Water:

Clean water free of harmful substances was used, as for W/C ratio, the concrete mixtures showed a response at the ratio W/C = 0.39, and this ratio was adopted for all (SCC) mixtures.

- Admixtures:

Three types of plasticizers were used, with two percentages (2% and 2.5%) of the cement weight in the experimental mixtures as shown in Table (2). As for the selecting the percentage of plasticizer in the experimental concrete mix, it depended on the start of the concrete mixture response at a specific cement grade, and the ratio w/c = 0.39 is constant, in order to check the quality of each type of plasticizer and its effect on the concrete mixture, and to determine the plasticizer that provides the concrete mix with the required ideal requirements, finally, the ideal proportion of the plasticizer to be used in the procedure the self-compacting concrete SCC is determined ASTM C129 (ASTM, 2003). It achieves the feasibility of its use, and use it in casting concrete elements.

Table (2) plasticizer types

Plasticizer code	S	NN	3500
The Ratio	**2% or 2.5%**		

5-2 Aggregates Mixture

The optimum ratios of course and fine aggregates used in the formation of concrete mixtures are those that achieve the regular analysis curve and fall within the range specified by the ASTM C33 (ASTM, 1999), for selecting aggregates, as the coarse aggregates used conform the permissible range, while the fine aggregates need to mix in specific ratio, table (3).

Good regular analysis reduces the content of cement mortar in the mixture, which increases the pass ability, and increases the compression of the concrete, thus improving the strength of the concrete.

Table (3) Aggregates Mixture Ratio

Aggregates Ratio % (Coarse-Fine)		Fine Aggregates Ratio %	
Fine Aggregates	Coarse Aggregates	Natural sand	Crushed sand
40%	60%	40%	60%

6- Laboratory experiments:

Before starting the necessary lab experiments for the fine and coarse aggregate materials used in the preparation of the concrete mixture, it must be ensured that the moisture content of the aggregates does not huge, which in turn can cause a defect in the preparation of the concrete mix and have a significant impact on the operability of SCC compared to the traditional mixture, so the use of the oven to get rid of excess moisture in the aggregates, where placed in it at a temperature of 110 C, for a period of 24 hours, as shown in the pictures below.

We have conducted a number of experimental concrete mixtures using manual mixing. The ratios and weights used for each mixture were determined with the help of previous research. The process of mixing concrete was in successive stages, according to the following:

- Determining the weights and ratios necessary for the experimental mixture using an accurate scale, Table (4).
- Adding aggregates and cement then mixing them well in the dry state.
- Gradually add water and plasticizer.
- Initiating quality control experiments and ensuring work ability.
- Continuing to mix of SCC during the stages of quality tests.

Table (4) SCC Mixture Ratios

$W/C = 0.39$								
Portland Cement (Kg/m3)								
450-475			500			550		
Admixtures%			Admixtures%			Admixtures%		
3500	NN	S	3500	NN	S	3500	NN	S
2.5%	2.5%		2.5%	2.5%		2%	2%	2

6-1 Experimental mixtures with a cement grade of 550 kg/m3:

In these mixtures, 550 kg/m3 cement grade, a fixed W/C = 0.39 ratio, and three types of plasticizers (3500, NN and S) was used, where the three mixtures responded at 2% plasticizer of cement weight. It was noted that the behavior of the mixture containing the plasticizer "3500" was the best in terms of the operability and homogeneity of the mixture, which was verified by using the above-mentioned operability experiments, and the mixture containing the plasticizer "NN" was less good, it was observed bleeding and a slight separation of the mixture, as for the mixture containing the plasticizer "S" Worst of all, it gave a concrete mixture with imperfect operability as soon as the mixture was mixed and started to solidify, so it was excluded of the later experimental mixtures.

6-1-1 The first mixture of SCC, C=550 Kg/m3, using 3500 plasticizer:

It is the SCC mixture formed using the plasticizer (3500), 2% ratio of the cement weight, W/C = 0.39 and cement grade 550 Kg/m3, where the results of the work ability of the concrete mixture as below:

- Slump Flow (SF) and time T50 (sec):

Put the Abrams cone in the middle of the circle 50 cm, where it was filled with SCC mixture, and then lift it up once, and measure the diameter in both directions:

$$D_1 = 59\ cm, D_2 = 57\ cm$$

$$D_m = 58\ cm$$
$$\mathrm{T}_{50}(\mathrm{sec}) = 5.4\ \mathrm{sec}$$

According to the results shown, figure (3) the concrete has high viscosity, good fill ability and good flowability, it can be classified under the SF1 class, which can be used in low reinforced or unreinforced concrete structures - small sections.

Fig (3) Slump Flow (SF) Test

- J-ring test:

The Abrams cone was placed in the middle of the circle 50 cm, figure (4) surrounded by the J-ring in order to pass the mixture between reinforcing bars (Timo, W. 2003), then follow the same steps of the SF test, where the results were as follows:

$$D_1 = 54\ cm, D_2 = 47\ cm$$
$$D_m = 50.5\ \approx 50cm$$
$$\mathrm{T}_{50}(\mathrm{sec}) = 5.85\ \mathrm{sec}$$

The flow rate of the bars taken:

$$D_J\% = \frac{50}{58} \times 100 = 86\%$$

The mixture is acceptable viscosity, good ability to pass and flow within the reinforcing bars.

Fig (4) J-ring Test

- Separation Resistance (SR) Test:

A sample of the concrete mixture was placed on the sieve 4.75 mm, figure (5) without compaction, then checking the stability and the separation resistance of the mixture, as the following:

$$W_p = 0.257\ kg, \qquad W_c = 4\ kg$$
$$SR(\%) = \frac{W_p}{W_c} \times 100 = \frac{0.257}{4} \times 100 = 6.425\%$$
$$SR(\%) = 6.425\% < 10\%$$

The separation resistance test is acceptable.

Fig (5) Separation Resistance (SR) Test

- Visual Stability Index (VSI) test:

The plasticizer gave mix case without separation in the center of the concrete mixture; therefore, it can take a high stability classification, and the number of the visible stability index VSI = 0 as shown in figure(6) .

Fig (6) Visual Stability Index (VSI) Test

- Cylindrical Strength:

Three cylindrical samples of the mixture, Figure (7), it was observed that there was a low nesting on the surface of one of the samples, that were put in the water tank and taken out 24 hours before fraction it at the age of 7 days to predict the values of the expected strength and the age of 28 days (The Syrian Arab Code, 2012).

Fig (7) SCC Cylindrical "3500“Sample

The behavior of cylindrical samples was measured at the age of 28 days, curve (Stress-Strain σ-ξ) as the following figure:(8)

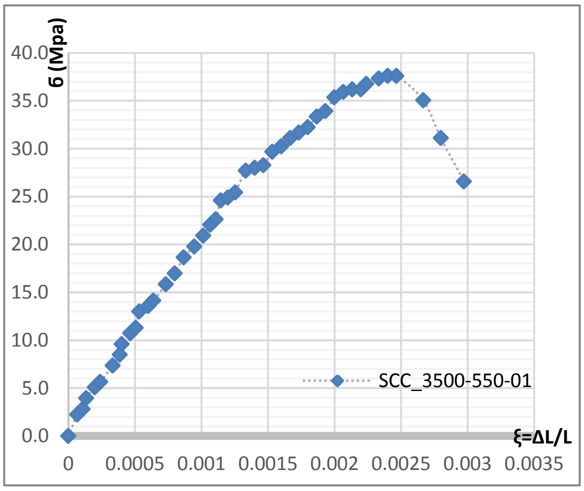

Fig (8) SCC "3500" Stress-strain 6-ξ Curve

6-1-2 The second mixture of SCC, C=550 Kg/m3, using NN plasticizer:

It is the SCC mixture formed using the plasticizer (NN), 2% percentage of the cement weight, W/C = 0.39 and cement grade 550 Kg/m3, where the results of the operability of the concrete mixture as below:

- Slump Flow (SF) and time T50 (sec):

According to the results shown below and Figure (9), the concrete has high viscosity, good fill ability and good flowability, it can be classified under the SF1 class.

$$D_1 = 56\ cm,\quad D_2 = 54\ cm,\quad D_m = 55\ cm$$
$$\mathrm{T}_{50}(\mathrm{sec}) = 6.47\ \mathrm{sec}$$

Fig (9) Slump Flow (SF) Test

- J-ring test:

The results of passing the concrete mixture through the J-ring bars, figure (10), were as follows:

$$D_1 = 54\ cm, D_2 = 55\ cm$$
$$D_m = 54.5\ \approx 54\ cm$$
$$\mathrm{T}_{50}(\mathrm{sec}) = 6.55\ \mathrm{sec}$$

The flow rate of the bars taken:

$$D_J\% = \frac{54}{55} \times 100 = 98\%$$

The mixture acceptable viscosity and a high ability to pass and flow within the reinforcing bars.

Fig (10) J-ring Test

- Separation Resistance (SR) Test:

The separation resistance of the mixture was verified by the test on a 4.75mm sieve as follows:

$$W_p = 0.466\ kg, \qquad W_c = 4\ kg$$

$$SR(\%) = \frac{W_p}{W_c} \times 100 = \frac{0.466}{4} \times 100 = 11.65\%$$

$$SR(\%) = 11.65\% > 10\%$$

Separation resistance test is not acceptable.

- Visual Stability Index (VSI) Test:

There is an aggregated pile without bleeding, it can be classified as low stability, figure (11) and the visual stability index number VSI=2.

Fig (11) Visual Stability Index (VSI) Test

- Cylindrical Strength:

Three cylindrical samples from the second mixture, figure (12) it was noted that there was a large nesting on the surface of one of the samples.

Fig (12) SCC Cylindrical "NN" Sample

The behavior of cylindrical samples was measured at the age of 28 days, curve (stress-strain σ-ξ) as the following figure (13).

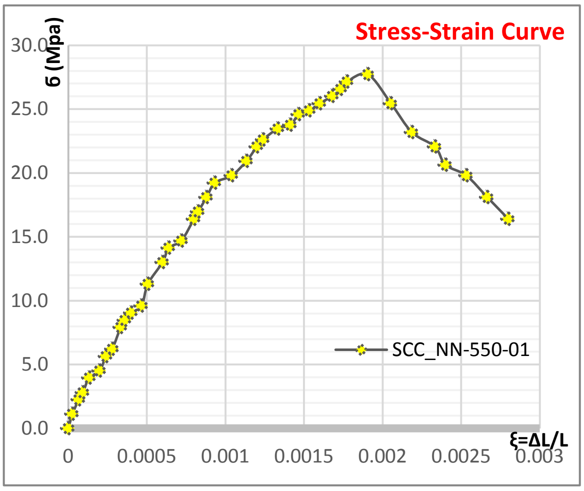

Fig (13) SCC "NN" Stress-strain б-ξ Curve

6-1-3 The third mixture of SCC, C=550 Kg/m3, using S plasticizer:

It is the SCC mixture formed using the plasticizer (S), 2% percentage of the cement weight, W/C = 0.39 and cement grade 550 Kg/m3, where the results of the operability of the concrete mixture as below:

- Slump Flow (SF) and time T50 (sec):

According to the results, it is concrete with a very high viscosity and the ability to fill and flow acceptable, classified under the classified SF2, figure (13). which can be used for many ordinary applications.

$$D_1 = 67\ cm, \quad D_2 = 70\ cm$$
$$D_m = 68.5 \approx 68\ cm$$
$$\mathrm{T}_{50}(\mathrm{sec}) = 8.86\ \mathrm{sec}$$

Fig (13) Slump Flow (SF) Test

- J-ring test:

The results of passing the concrete mixture through the J-ring, figure (14) was as follows:

$$D_1 = 51\ cm, \quad D_2 = 47\ cm$$
$$D_m = 49\ cm$$
$$\mathrm{T}_{50}(\mathrm{sec}) = 9.57\ \mathrm{sec}$$

The flow rate of the bars taken:

$$D_J\% = \frac{49}{68} \times 100 = 72\%$$

Fig (14) J-ring Test

The mixture is very high viscosity and low ability to pass and flow within the reinforcing bars.

- Separation Resistance (SR) Test:

The separation resistance of the mixture was verified by the test on a 4.75mm sieve as follows:

$$W_p = 0.194\ kg, \qquad W_c = 4\ kg$$

$$SR(\%) = \frac{W_p}{W_c} \times 100 = \frac{0.194}{4} \times 100$$

$$SR(\%) = 4.85\% < 10\%$$

Separation resistance test is acceptable.

- Visual Stability Index (VSI) Test:

A halo mortar and large aggregated pile in the concrete center as shown in figure (15), with a bleeding, and the visual stability index number VSI=3.

Fig (15) Visual Stability Index (VSI) Test

- Cylindrical Strength:

The behavior of cylindrical samples was measured at the age of 28 days, curve (stress-strain σ-ξ) as the following figure (16):

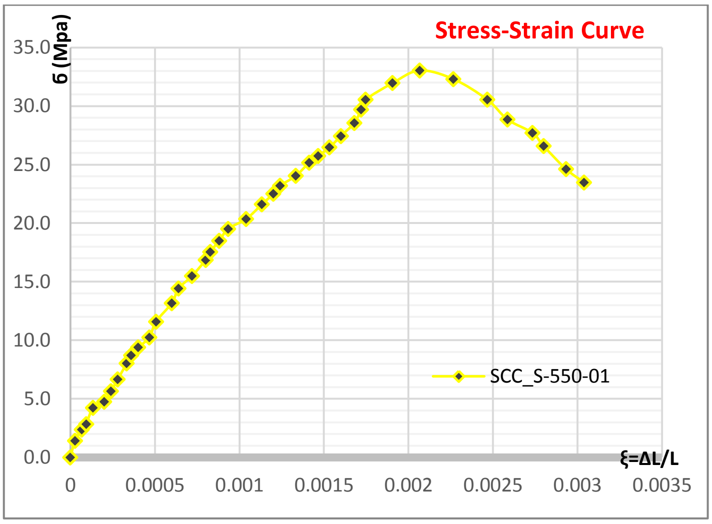

Fig (16) SCC "S" Stress-strain Ϭ-ξ Curve

Figures (17), (18), (19) and (20) below shows a comparison of properties of the operability of the tested mixtures:

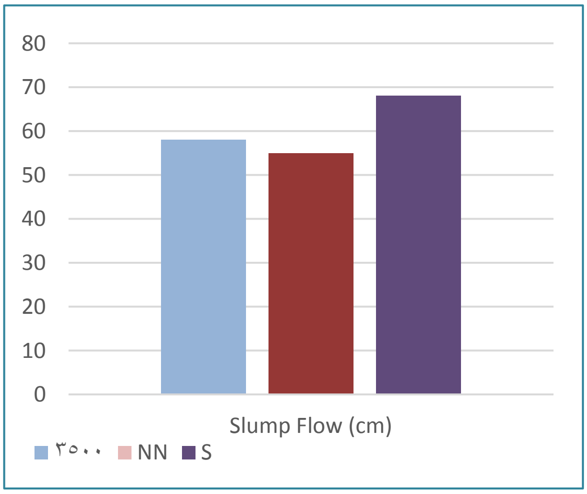

Fig (17) SF (cm) property of the tested samples

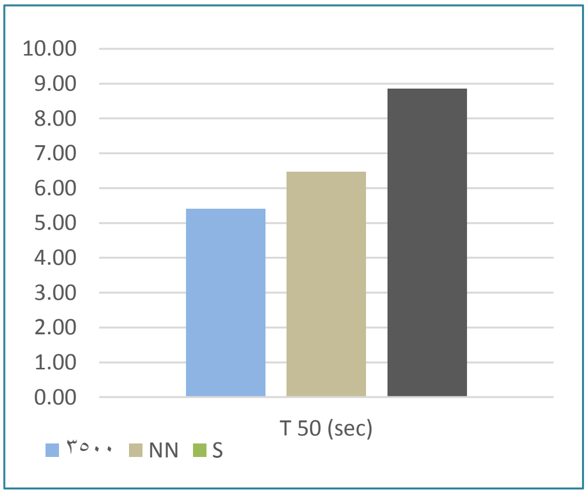

Fig (18) T50 (sec) property of the tested samples

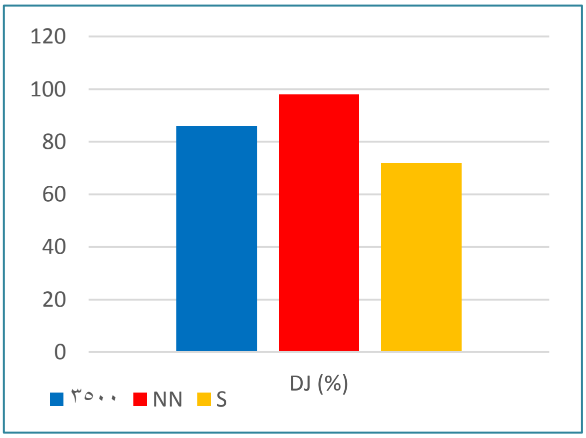

Fig (19) DJ (%) property of the tested samples

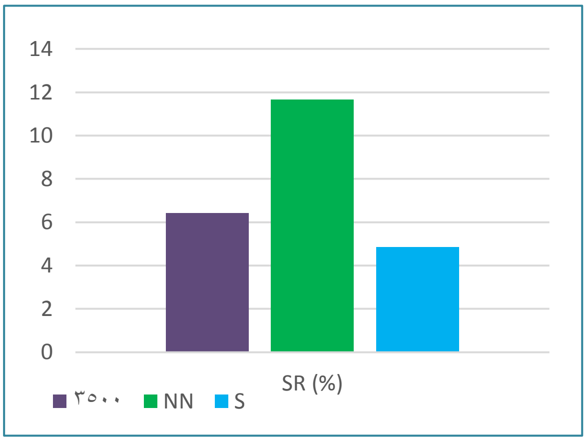

Fig (20) SR (%) property of the tested samples

Figures (21) below show a comparison of properties of the behavior of the tested mixtures:

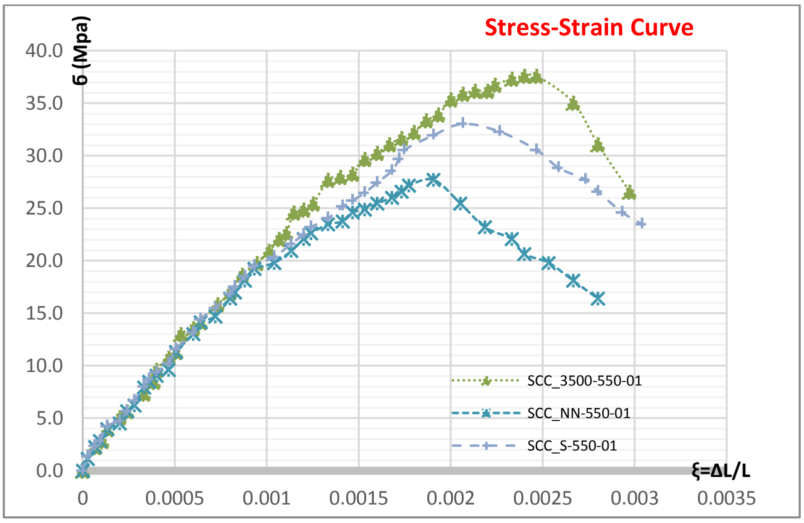

Fig (21) SCC Mixtures Stress-strain б-ξ Curves

6-2 Experimental mixtures with a cement grade of 500 kg/m3:

Within these mixtures, the Cement grade is 500 kg/m3, the W/C = 0.39 ratio, two types of plasticizers (3500, NN), where mixtures responded at 2.5% of plasticizer, and in this case also the behavior of the mixture on the "3500" The best and mixture on the "NN" was less quality.

6-2-1 The first mixture of SCC, C=500 Kg/m3, using 3500 plasticizer:

It is the SCC mixture prepared using the plasticizer (3500), 2.5%percentage of the cement weight, W/C=0.39 and cement grade 500Kg/m3, the results of the operability of the concrete mixture, as shown in table (5):

By verifying them using the fresh tests shown in Figure (22).

Fig (22) Fresh operability tests

According to the results, the mixture has good viscosity, good fill ability, high pass ability and flow within the reinforcing bars, and the mixture separation is acceptable, there is a low bleeding of the mixture, therefore the VSI can be taken VSI=1.

Table (5) SCC Mixture operability properties

Slump Flow SF	52 cm
T50	4.86 sec
J-ring $(D_J\%)$	96 %
(SR%)	4.06%

Slump Flow SF	52 cm
VSI	VSI=1

- Cylindrical Strength:

The behavior of cylindrical samples was measured at the age of 28 days, curve (stress-strain Ϭ-ξ) as the following figure (23).

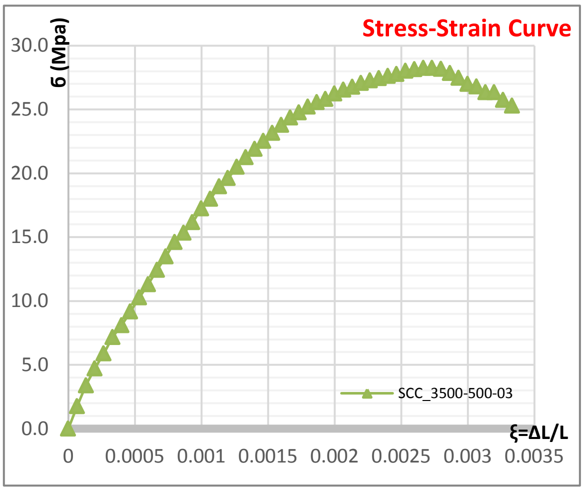

Fig (23) SCC "3500" Stress-strain Ϭ-ξ Curve

6-2-2 The second mixture of SCC, C=500 Kg/m3, using NN plasticizer:

It is the SCC mixture formed using the plasticizer (NN), 2.5% percentage of the cement weight, W/C=0.39 and cement grade 500 Kg/m3, where the results of the operability of the concrete mixture, as shown in table (6):

According to the results, the mixture is high viscosity and good filling, the ability to pass and flow within the reinforcing bars is acceptable, the mixture separation is acceptable, but there is a low bleeding and aggregated pile in the center of the mixture, therefore the visual stability index VSI = 2.

Table (6) SCC Mixture operability properties

Slump Flow SF	54 cm
T50	7.58 sec
J-ring $(D_J\%)$	89 %
)SR%(	5.68 %
VSI	VSI=2

- Cylindrical Strength:

The behavior of cylindrical samples was measured at the age of 28 days, curve (stress-strain Ϭ-ξ) as the following figure (24).

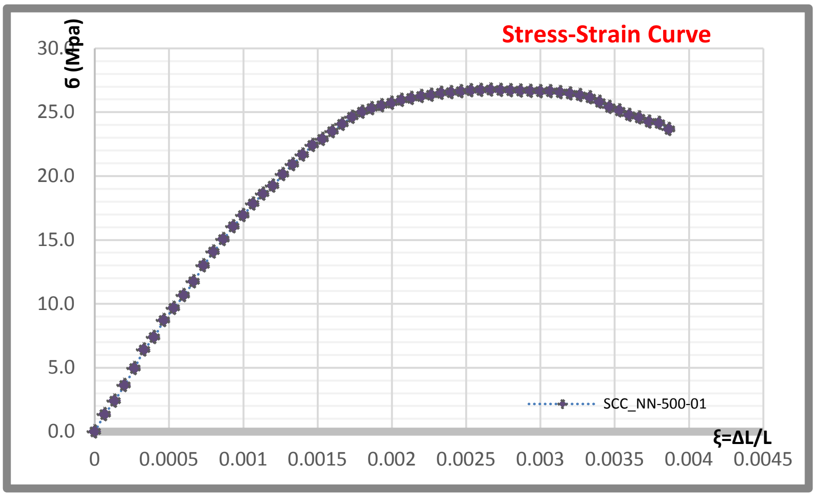

Fig (24) SCC "NN" Stress-strain б-ξ Curve

Figures (25), (26), (27) and (28) below shows a comparison of properties of the operability of the tested mixtures:

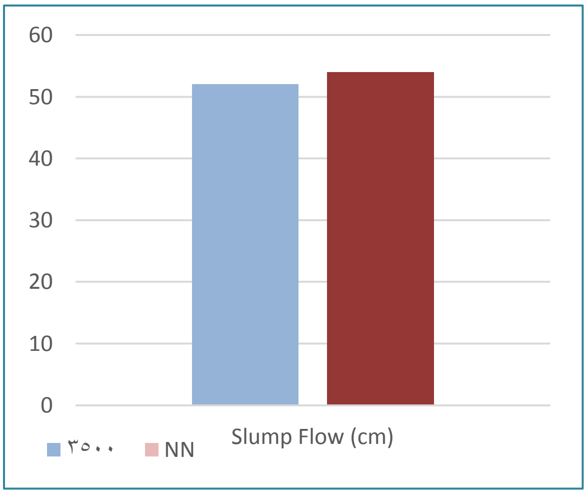

Fig (25) SF (cm) property of the tested samples

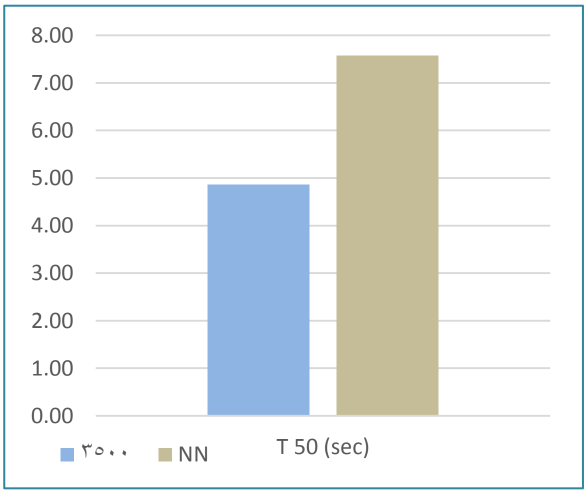

Fig (26) T50 (sec) property of the tested samples

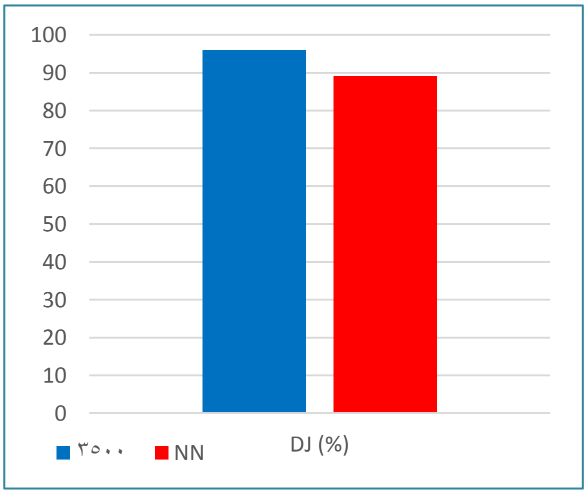

Fig (27) DJ (%) property of the tested samples

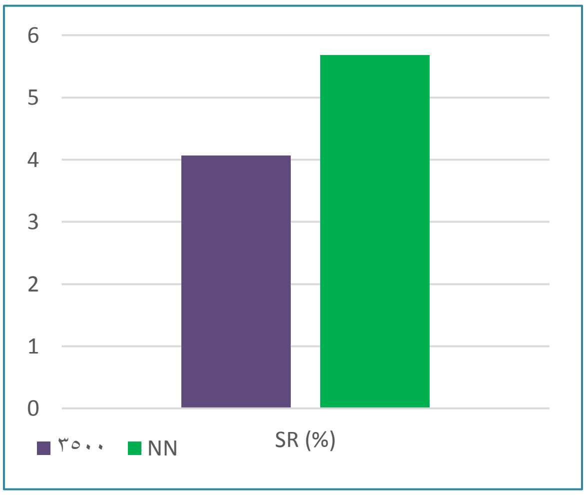

Fig (28) SR (%) property of the tested samples

Figures (29) below show a comparison of properties of the behavior of the tested mixtures:

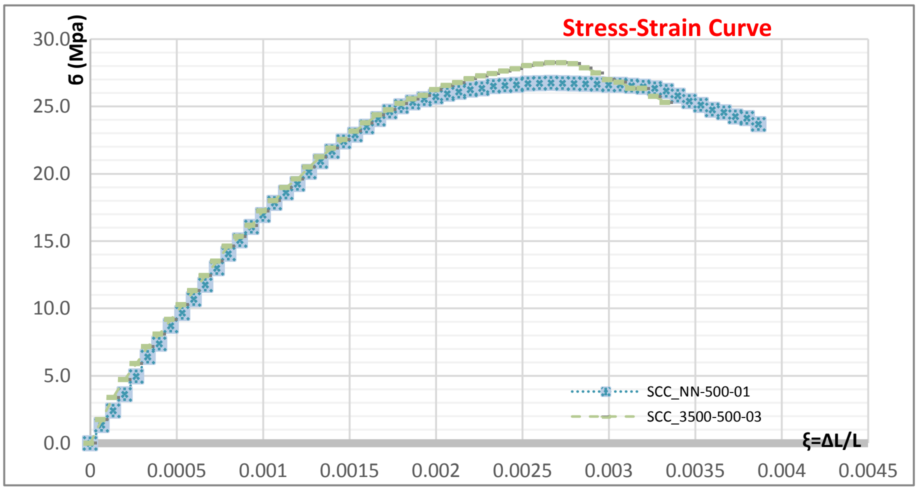

Fig (29) SCC Mixtures Stress-strain б-ξ Curves

6-3 Experimental mixtures with a cement grade of 450-475 kg/m3:

Within these mixtures, the Cement grade starts with 450 kg/m3, then increased to 475 kg/m3, the W/C = 0.39 ratio, and two types of plasticizers (3500, NN), the mixtures did not respond even at 2.5% of plasticizer, none of the mixtures have the ideal properties for the operability of self-compacting concrete, so the mixtures were excluded as shown in figure (30).

Fig (30) mixtures with cement grade 450-475 kg/m3

6-4 The Reference mixtures with a cement grade of 550 kg/m3:

It is the mixture formed from the same aggregates and cement which used in SCC self-compacting concrete, without the use of additional improved materials and the plasticizers didn’t used, in order to obtain a reference concrete of the same proportions and weights of the materials included in the SCC mixtures, where the mixture responded at a ratio of W/C = 0.45, the cement grade is 550 kg/m3, the behavior of cylindrical samples was measured at the age of 28 days, curve (stress-strain б-ξ) as shown in figure (31).

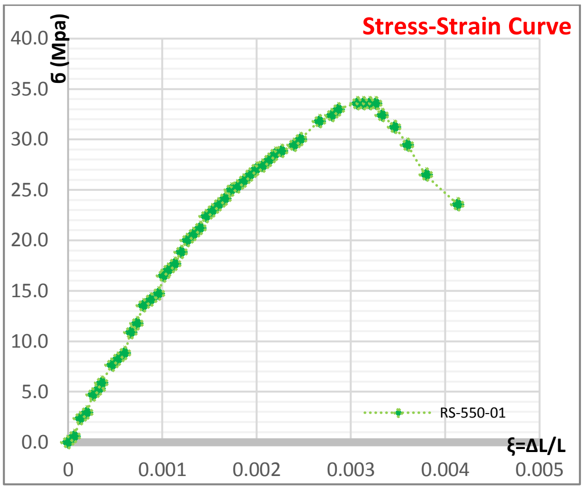

Fig (31) Reference Mixtures Stress-strain б-ξ Curves

Figure (32) below shows Stress-Strain Curves for the SCC and reference samples, which made of the mixtures with cement grade 550 kg/m3.

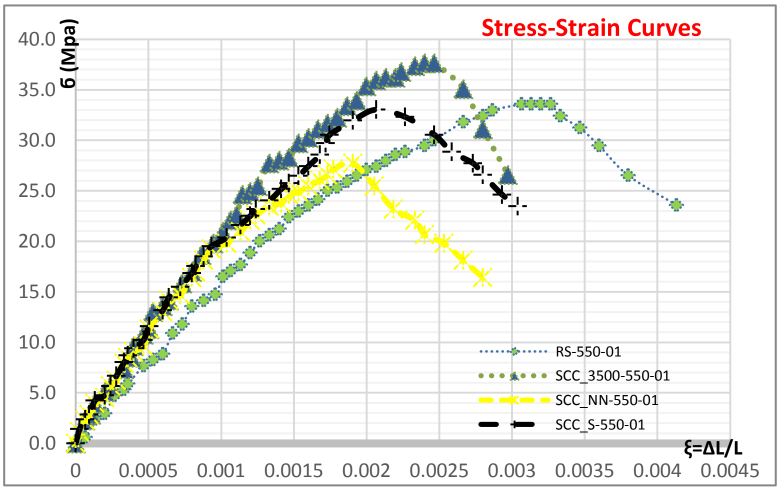

Fig (32) Stress-strain б-ξ Curves

According to the curves shown above, we find an improvement in the stress-strain behavior of the concrete mixtures formed of self-compacting concrete SCC compared with the reference concrete mixture, also we can note that the self-compacting concrete SCC mixture which containing the plasticizer coded with "3500" is the best in terms of operability properties and stress-strain behavior.

7- Results.

- Using a ratio of (2%) of 3500 plasticizer, W/C=0.39, and 550 kg/m3 cement, a locally SCC was produced with a compressive strength rating of up to (37.61Mpa) at 28 days, compared with (28.25Mpa) for the concrete in which it is used and a ratio (2.5%) of the same plasticizer with a cement caliber of 500 kg/m3 and the same ratio of W/C, thus an increase in the strength of up to 33%.

- Using a ratio of (2%) of 3500 plasticizer, W/C=0.39, and 550kg/m3 cement, a locally SCC was produced with a compressive strength rating of up to (37.61 Map) at 28 days, compared with (33.57 Map) for the reference concrete, thus an increase in strength up to 12%.
- Using a ratio of (2%) of 3500 plasticizer, W/C=0.39, and 550kg/m3 cement, a locally SCC was produced with a compressive strength rating of up to (37.61 Map) at 28 days old, compared with (27.71 Map) for self-setting concrete containing (2%) of NN plasticizer, thus an increase in strength up to 35%.

8- Conclusions.

- The production of self-compacting concrete (SCC) locally cannot be done without the use of a plasticizers that reduces water, in order to give the concrete, the required operability of it, without the need to increase the (W/C) ratio.
- By using the plasticizer as a chemical admixture to the self-compacting concrete mixture, we were able to reduce the W/C ratio up to 13%, and therefore increase in the concrete strength, this is well for obtaining concrete with high properties and relatively high strength
- By using the plasticizer coded as 3500, it is possible to produce locally self-compacting concrete using cement only as a representative of other fine filler additives, and to obtain SCC mixtures, with superior flowability, cohesiveness, homogeneity, and high strength, which can be used in the construction, restoration and structural strengthening.
- The improvement of stress-strain behavior of the self-compacting concrete SCC, due to the improve of the axial compressive strength.
- The results of the tests selected to characterize fresh concrete performance were satisfactory.

9- Recommendations.

- In this research, class Portland cement 32.5 N was used, produced by Tartous Company, conforming to the Syrian Standard Specification No. 3800/2015. Therefore, it is recommended to use other types of cement to product of self-compacting concrete.
- In this research, no additional fine materials were used besides cement as a filler such as pozzolanic and hydraulic materials, so it is recommended to use and test the effect of these materials on locally SCC.
- Coarse aggregate with a maximum gauge of 12mm was used to produce SCC, from Hisya area in Homs city. Therefore, it is recommended to use other coarse aggregate and a higher scale for aggregate.

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