Effect of Superplasticizer in Fresh Properties of Self Compacting Concrete with Silica Fume

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Abstract

Self-compacting Concrete (SCC) is a new category of concrete which flows under its own weight. It does not require any external vibration for compaction. Due to many advantages of this concrete, it is suitable for the situations where congested reinforcement is used. In this research work self-compacting concrete is developed using different percentages of silica fume,30% ,40% and 50% by weight of cement as partial replacement of cement. The strength has been assessed. The research presents result of an experimental programmed carried out, aimed at investigating of fresh properties of SCC contain silica fume and superplasticizer. The hardening state properties of the concrete were evaluated. Finally, some hardened state properties of the concrete were assessed, the water cement ratio was maintained 0.5 for all the mixes. Properties included workability, compressive strength, all were evaluated. The result indicated that the medium volume contain of silica fume can be used in SCC to produce good strength concrete with this type of superplasticizer that originated from waste material. High absorption values are obtained with increasing amount of silica fume however almost all the specimen exhibits absorption of less than 5%. The result of mechanical properties compressive strength for 2% have shown significant performance compare with the control mixes.

Keyword: *Self-compacting, concrete, Superplasticizer, silica fume, fresh properties compressive* Strength.

Introduction

Self-Compacting Concrete (SCC) has been described as the most innovative development in concrete industry due to many advantages like faster construction, reduction in site for thinner concrete sections ,improved durability, suitability for congested reinforcement; self-compacting concrete becomes popular in civil Engineering construction This concrete is a relatively new type of concrete that differs from the normal contains a superplasticizers, silica fume which contributes significantly to increasing the ease and rate of its flow and another advantage is that the superplasticizer is very cheap and available compare with the normal one because it originated from waste material . this type of concrete can fill any part of formwork under its own weight, without compaction or external vibration. This differs from conventional concretes in structural elements of complex and difficult shapes, e.g., congested area, in which the conventional concrete maybe difficult to compact, especially in the congested reinforcement area. However, this type of concrete offers many health and safety advantage. The elimination of vibratory compaction on site means that the workers are no longer exposed to vibration and related impact, e.g., waste energy spoil hand, besides providing a noiseless working environment. It was first introduced in late 1980s in Japan when the researchers realized that poor compaction was the major contribution to the disintegrated of quality construction work. Since then, researches have been conducted for establishing rational mix design methods in order to be self- compactable. (Aslani and Nejadi, 2012). SCC mixes can be possible with the use of local coarse aggregate without much effect for the mix designs. The fresh concrete must show good fluidity and good cohesiveness to make self-compacting concrete a s good concrete (Murthy et al, 2012). self-compacting concrete is required nowadays to the point of application and the final operation is require small manpower not like traditional concrete as the use of a large quantity of cement increase cost an result in higher temperature, but the using of addition such as blast furnace slag, silica fume, reduce the cost and could be increase the slump of the concrete mix without increase cost especially by the used of superplasticizer. (Aslani and Nejadi, 2012)

Factors Influencing Dosage of Superplasticizer

The important of admixture in concrete is crucial. The type and dosage have a major influence on nearly all the fresh properties of SCC, such as workability, loss of workability with time, passing ability through reinforcement, filling ability and stability, and even the one-day compressive strength and surface condition of the hardened concrete. Too much superplasticizer is not only uneconomical but also causes severe segregation, whereas insufficient not produce self-compacting properties. Pamnani et al, (2013). For flowing concrete and high strength concrete, the dosages of superplasticizer are often determined by weight of cementations materials. This can be used as a general guide not give the optimum dosage which can only be gained through trial mixes on the concrete. However, proper mortar tests enable the trial ranges to be narrowed. There are many factors which influence the required dosage of superplasticizer, such as the proportion and type of CRM, the water/powder ratio, the sand content, the amount of viscosity agent if used, and the mixing procedure. (Neville, 1995).

Khatib 2008) investigated the effect of different dosage of admixture on concrete strength for the control mixes .using either a relatively low or high dosage of admixture reduce the strength the as mentioned in above paragraph low dosage of admixture may lead to the creation of pore if concrete is to be compacted or flow under it on weigh and high dosage of admixture will lead to segregation as in the below graph there is shape decrease in strength as the absorption increase from 1% to 2% .for absorption greater than two percent there is much different reduction of strength with increase in absorption (saddique &Khatib, 2010).

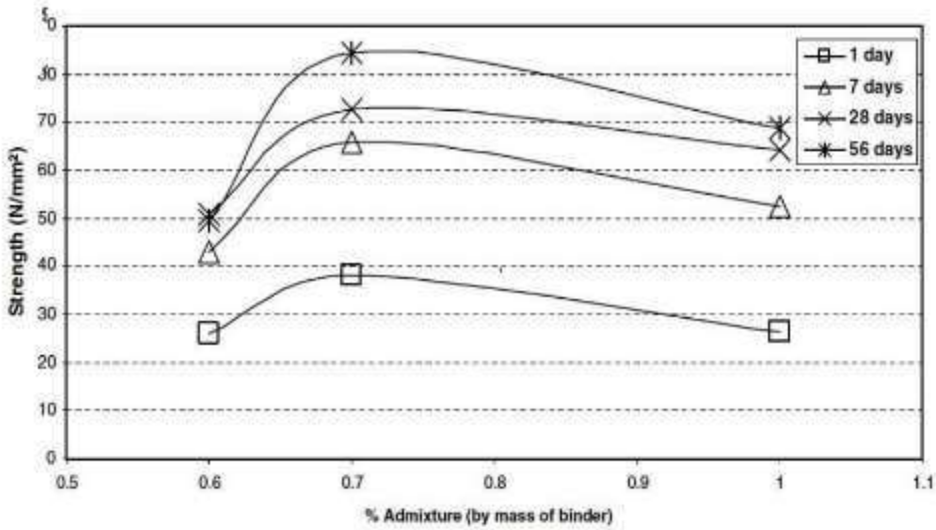

FIG 2.10 Influence of admixture dosage on strength. Adapted from Khatib, 2008).

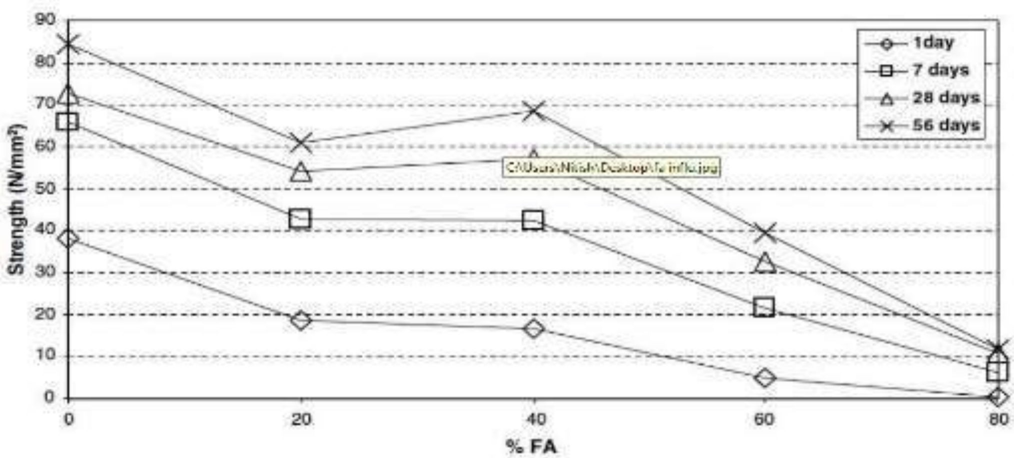

FIG 2.10.1 Influence of FA content on strength of self-compacting concrete adapted from Khatib, 2008).

Effects of Superplasticiser in Self-Compacting Concrete:

The main aim of the long molecule is to bind around the cement particles and give the high negative charges so that they resist each other.

The compressive strength properties of self-compacting concrete are affected by fresh behavior which dominated primarily by the dispersing of its components. With conventional concrete the cement particles group together to form flocs and therefore internal friction Occurs within the mix, hindering its flow-ability as the particles will not be able to flow past each other with ease. Super-plasticizers or high-range water-reducing admixtures contribute to the achievement of denser packing and lower porosity in concrete by increasing the flow-ability and improving the hydration through greater dispersion of the cement particles, and thus assisting in producing SCCs of high strength and good durability. (Neville, 1995).

Methodology

Materials and Methods

This section describes the materials that will be used in the whole experimental, the mixing, casting, and curing procedures of concrete. All materials use throughout this study will be the same. They were in accordance with relevant BS EN standards and were confirmed to be suitable for the scope of this study.

Cement:

Cement ordinary Portland cement is general purpose cement is one of the important concrete components that bind the concrete ingredients all together. In order to attain more workable mix, an increased paste is required to realize the required deformability. The correct select of cement type is normally depend on the particular requirements of each application or what is presently being used by the producer rather than the specific requirements of Self-compacting concrete (Dumne, 2014).

The cement use in this experiment work is general purpose ordinary Portland cement used for casting the cubes for all samples mixes. The cement is of uniform color that is grey with high greenish shade and was free from any impurities.

FINE AGGREGATE:

The fine aggregate (sand) use in the experimental programmed is locally sand from river which package in bag for general purpose used as fine aggregate. The finest module of the aggregate used was like 2.44mm.

Water:

Mixing water for concrete should be in good quality; it should not contain undesirable organic substances or inorganic ingredients above allowable amount. In the Nigeria, water used in concrete mix shall conform to BS EN 1008. Therefore, tap water will be used throughout the mixing and curing procedures for the concrete in this study.

Silica fume.

Silica fume also referred to as micro silica or condensed silica fume, is another material that is used as an artificial pozzolanic admixture. It is a product resulting from reduction of high purity quartz with coal in an electric and furnace in the manufacture of silicon or ferrosilicon alloy. Silica fume rises as oxidized vapors. It cools, condenses and is collected in cloth bags. It is further processed to remove impurities and to control particle size. Condensed silica fume is essentially silicon dioxide (more than 90%) in non-crystalline form. It is extremely fine with particle size less than 1 micron and with an average diameter of about 0.1 micron, about 100 times smaller than average cement particles.

Coarse Aggregate:

The coarse aggregate used was graded aggregate 20mm maximum size and locally available river sand were used as natural coarse and fine aggregate respectively. Comprising crushed stone with a nominal size ranging from 5 to 20 mm. The physical properties of coarse aggregate like bulk density, specific gravity, gradation and fineness modulus are tested in accordance with BS 8882;

Admixture Superplasticiser:

The admixture superplasticizer used for this experimental work was NJ100 is hydrocarbon super admixture base on grafted acrylic ester is also originated from waste material. Which will use throughout the mixes except for FIRST one which is the control mix as Shows the detail in the table below.it was originated from Poly Ethylene acrylic acid (PEAA) collected from waste material Hexadecyl alcohol (HDA), Hexadecyl amine (HDM), Vinyl acetate (VA), Benzoyl peroxide (BzPO) and P-Toluene sulfonic acid monohydrate (PTSA) are from Aldrich Chemicals is used for evaluating the performance of the synthesized polymeric additives (Sonebi 2004).

Casting Curing and Testing:

Cubes of 100mm in size used for determination of weight, density, and compressive strengthened 50mm by 25mm will used for determination of water absorption that is the 100mm cube divided in to two. Which will make the total number of 13 cubes two cubes divided in to half for and water absorption Before casting the workability test make by the used of j ring and L box. Specimen's cubes will then cast in steel mould. The specimen keep covered in controlled chamber at 20 ±2ºC FOR 24hours. Thereafter; cubes also place in the curing tank at 20^{c} $_{C}$omfort different age of curing 7days, 14day, 28day respectively. After then remove from the tanks take the weight, density, compressive strength water absorption. For the determination of water absorption and capillary cubes were taking from curing tanks after certain age to place in an oven at 100ºC until constant mass achieved this about 5days.the cubes allow to cool in an air tight bag container.

Mixing:

Tilting drum mixers will used throughout this study with capacities of 120 by, 90 litres, chose depending on the volume of the concrete batch needed. The concrete mixes in accordance with BS 1881-125:1986. The aggregates will add in the following order: initially about half of the coarse aggregate, then the fine aggregate and the residue of the coarse aggregate. The mixer was then started for 15 to 30 seconds. The mixing continued after adding about half of the total water for two to three minutes. All the cementations' materials add and the mixing was continued. Then the remaining water was added after 30 seconds, continuing mixing until two to three minutes after all the materials added.

Total of 8 mixes will make to investigate the engineering properties of self-compacting concrete containing silica fume and superplasticizer. investigated, workability using j rings and L box, density, weight, compressive strength water absorption. Detail of mixes are given in the table below for different proportional silica fume of 30%, 40%, and 50% replaced with cement and superplasticizer in different percentage for control 2%, respectively.

Result and Discussion

low compressive strength value is expected at the early age of curing. Based on the experimental result the low value is due to the high percentage of the silica fume applied to the mix the rate of hydration is very high. Furthermore, the observations from table result show that compressive strength of Self-Compacting Concrete contains silica fume and superplasticizer is increases relatively faster up to 7 days thereafter its rate becomes slower for same water-cement ratio. Generally, In conclusion the superplasticizer dose increases the compressive strength of concrete mix at both early and longest days of curing.it has been observed that consistent increase in compressive strength could attributed due to addition of novel superplasticizer in concrete containing 30silica fume with constant water-cement ratio. Furthermore, one can say that compressive strength increases rather than decreases though there is increase in workability of mix.

Time ranging 06-12 seconds is considered adequate for SCC (EFNARC 2002). The L- box flow times were in the range of 4-10second except for the control mix. The result of the investigation indicated that all SCC mixes meet the requirements of allowable flow time. based on the experimental result examined of the different mixes replaced by silica fume was further increase in workability as shown in mixes containing high percentage of silica fume the flow is within 800-900mm compare with the control mixture. Generally, the use of silica fume in concrete reduces the water demand for a given workability. Therefore, concrete containing silica fume will cause an increase in workability at constant water binder ratio. Furthermore, based on the investigation mixes containing high percentage of silica fume that is 40%-50% the workability is very high which it even led to segregation as you see in mix contain 50% flash.

As in the result table above as the dosage of super plasticizer increases, the slum flow increases. This is expected because as the super plasticizer dosage increase the fluidity of the concrete also increase the L-box values increase as superplasticizer dosage increases this interpret that as the dosage increase concrete is more able to flow through reinforcement or congested side to fill everywhere on its weight.

Compressive Result: With Silica Fume

	7days	14days	28days
Fly Ash (%)	Comp Strength (MPa)	Comp Strength (MPa)	Comp Strength (MPa)
30	22.9	33.57	46.5
40	12.93	21.65	28.22
50	7.89	8.47	11.94

Density Ing/M3

mixed no.	7days	14days	28days
1	2.259	2.268	2.267
2	2.255	2.268	2.261
3	2.275	2.301	2.286
4	2.278	2.281	2.29

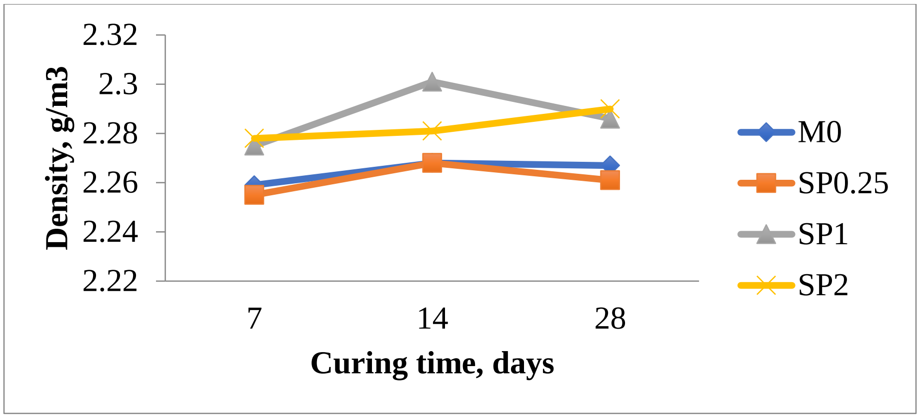

Figure 3. The effect of concentration of SP on the density of SCC.

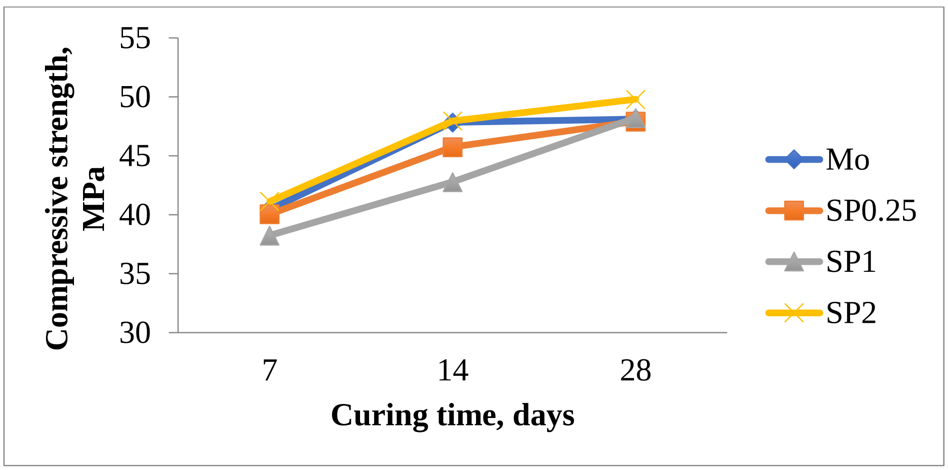

Figure 1. the effect of concentration of SP on the strength of SCC

Compressive strength tests:

In order to investigate the effect on compressive strength when silica fume is added in to self-compacting concrete as cement replacement .in the cubes mixes contain different proportion of silica fume and novel super plasticizer were prepared and kept at curing thank for 7days 14days and 28days respectively the test was conducted on ASTH OF Capacity 3000KN.from the result table show below it is concluded that 28days strength of almost all the mixes is slightly higher than the corresponding 7days and 14days strength this is due to continuous hydration of cement with concrete.

Compressive strength result: with superplasticizer

	7days	28days	56days
Superplasticizer (%)	Comp Strength (MPa)	Comp Strength (MPa)	Comp Strength (MPa)
0	40.47	47.85	48.13
1	40.06	45.75	47.93

2	38.25	42.79	48.22
3	41.14	47.97	49.8

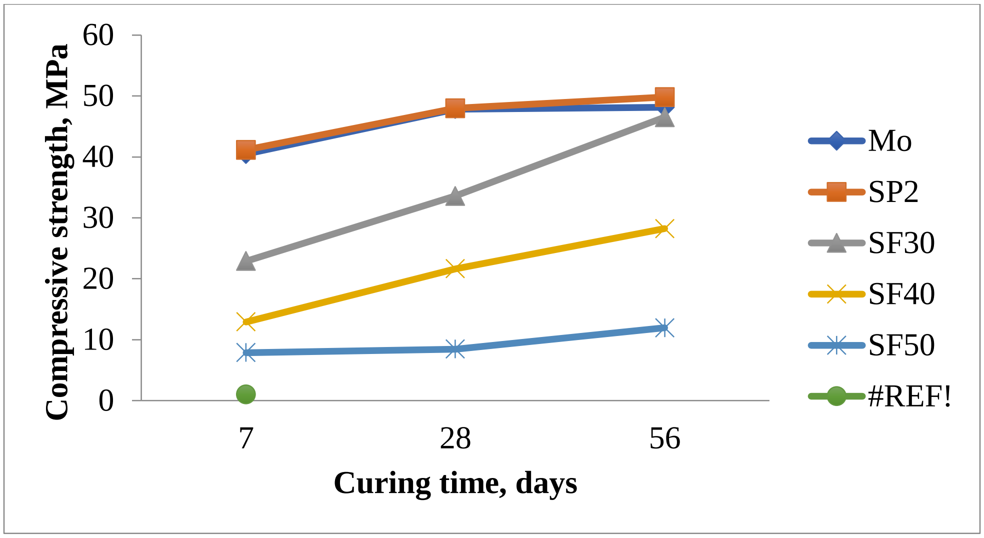

Figure 3 The Strength of Effect Of Sfin Present Of Superplasticiser

Compressive strength result: with superplasticizer

Superplasticizer (%)	7days Comp Strength (MPa)	14days Comp Strength (MPa)	28days Comp Strength (MPa)
0	40.47	47.85	48.13
1	40.06	45.75	47.93
2	38.25	42.79	48.22
3	41.14	47.97	49.8

Conclusion:

Based on the result investigation saturated water absorption is increase with the increase of silica fume 30%-40% replacement of cement. when the mixes immersed in water tank for curing for 7days 14days and 28days respectively the average reduction in weight increase and the weight decrease when the silica fume was increasing especially high content of silica fume 50%. The medium water absorption level in self-compacting concrete is good indicators of limited open porosity that can contain high flow of water in to the concrete.

Based on the result analysis the novel superplasticizers modified used has substantial influence on the fresh properties of self-compacting concrete a small change in the dosage make a substantial change in the SCC properties that is flowing ability, passing ability, stability, and segregation resistance as in the result findings, the increase in superplasticizer dosage from 0.25% to 2% the workability increase so the required slump flow meet the criteria of EFNARC also the result of mechanical properties compressive strength for 0.25% ,1% and 2% have shown significant performance compare with the control mixes.

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