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Effect of Superplasticizer on Workability and Properties of Self-Compacting Concrete

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Abstract-
From recent issues of stability, particle suspension, particle segregation, flow characteristics and cohesiveness in concrete, Superplasticizer has played an important role in this part. This research examined the effect of superplasticizer on workability and properties of self-compacting concrete (SCC). Three types of superplasticizers Conplast SP 561, Conplast SP 430 and Conplast SP 264 at different percentages (0, 10, 20 and 30%) with the same water cement ratio of 0.3, with M30 grade of concrete. The workability slump, v-funnel and l-box the test carried out on fresh concrete. Compressive strength test was carried out on the hardened concrete. All mix were satisfactory but the mix with conplast SP 430 had better workability and strength.

Key words: self-compacting concrete (SCC), workability, superplasticizer, compressive strength

1. Introduction

Self-compacting concrete is a flowing concrete which uses superplasticizer in its mixes, which ease and increase the flow rate of self-compacting mixes and does not require vibration. Without segregation in the form work the SCC mix achieves compaction by its own weight. Self-compacting concrete was conceptualized in 1986 by [13] at a time when there were difficulties in concrete-related industries. It was developed in 1988 to achieve durable concrete structures. The first generation of SCC was characterised using high dosage chemical admixtures and content binder, superplasticizer enhances stability of mix and flow. SCC is used in restricted area, heavily reinforced section, repair application and complex form work or shapes. Compared to conventional concrete, SCC contains different flow properties and uses higher fine particle content in its mix. Where well particle dispersion is required superplasticizer is used which give essential properties of filling, passing and segregation resistance when placed. Superplasticizer serves as dispersant, improve flow characteristic and improves the performance of the hardened fresh paste [14]. The fresh and hardened properties of SCC where studied by [7] on the suitable type of viscosity modifying agent to be use in producing SCC. Segregation and jamming of aggregate where observe to be absent in all mix. [10] assessed the strength properties of cassava peel ash concrete. Cassava peel ash was partially replaced with cement at varying percentages. It was seen that the concrete can be used for light construction works where high strength is not a major requirement. [2] used sulphonated Naphthalene formaldehyde, poly carboxylate ether and modified polycarboxylate ether as superplasticizer to test the mechanical and workability properties of self-compacting concrete. [12] researched concrete durability of palm oil fuel ash at 14, 28 and 90 days of water absorption on the specimen also tested for acid and sulphate resistance, from the result it is observed mixes with ash had low resistance to the acid and sulphate test compared to SCC with palm oil fuel ash which had high values. [1] concluded from the result gotten from the fresh and hardened properties of effect of superplasticizer at 0.25, 0.30 and 0.35% with 10% fly ash as a mineral admixture in replacement of cement, that increase of the superplasticizer dose lead to marginal reduction in unit weight but addition with gaining self-compatibility of the mixes. [8] prepared three self compacting mixes and one control mix with all having the same water cement ratio to test for influence of VMA in Bahrain. The test on the fresh and hardened properties prepared show that material supplied locally where reliable as conventional concrete. [9] researched optimal design and interaction assessment of plastered typha strawbale. The contact effect between the plaster and the stacked straw bale of masonry needs to be established, design optimization for durability and stability of masonry need to be obtained. from the result it was observed that the collapse or response of the earth-based plaster straw bale wall are higher than the stress analysed and computed by sap 2000 of 18.836 and 64.2KN/m^2 respectively.

2. Methodology

In this experimental study the cement used is purchased in sealed 50Kg bags, locally available natural sand and coarse aggregate (granite) from local dealers at Sango-Ota, Ogun state. The superplasticizers (conplast SP264, SP430 and SP561) used in the mix where obtained from pure-chem. The properties and characteristics of the superplasticizer used for the self-compacting concrete are stated below. The water used in this research meets the requirement of ASTM C1602, Potable water was gotten from the school water supply system.

2.1 Characteristics of the Superplasticizers

Conplast SP264: This is liquid in nature with a dark brown colour based on lignosulphonates, with no chloride content (IS456), specific gravity of 1.170 - 1.190 at 27°C. Conplast SP 264 has a dual function of improving both water efficiency while mixing and initial setting time of concrete mix is delayed. It provides increase in strength, density and workability. It conforms to IS:9103-1999 with ASTM C494 Type D.

Conplast SP430: high range water reduction up to 25% is given by this superplasticizer also with loss of workability. It has a specific gravity of 1.20 at 20°C, no chloride content and air entrainment of 2% over control (IS:9103-1999 and BS:5075). It as advantage of increased workability, strength, improved quality, high cohesion and chloride free.

Conplast SP561: It is a chloride free admixture base on selected synthetic polymer. Its supplied as brown solution with specific gravity of 1.18 at 25°C and no chloride content with air entrainment of less than 2%. Conforms to BS 5075, BS: EN 934-2 with ASTM C494 as type B/D and G depending on dosage used.

Table 1: Test properties and method of Evaluating SCC

Characteristic	Test method	Measured Value	Permissible Range Method	
			Min	Max
Flow ability/Filling ability	Slump-flow	Total spread	600	800
Viscosity/flow ability	V-funnel	Flow time	8	12
Passing ability	L – box	Passing ratio	0.8	1

2.2 Mix design

The mix proportion is based on getting each appropriate constituent for the mix there by creating high degree of flow ability, while maintaining a low water cement ratio (Okamura and Ouchi)

Table 2: Mix constituent (kg/m^3)

Mixes (%)	Cement	Coarse Agg.	Fine Agg.	Water	Sp. (%)	W/P
0%	500	650	850	177	-	0.35
10%	450	650	850	177	2	0.35
20%	400	650	850	177	2	0.35
30%	350	650	850	177	2	0.35

The self-compatibility using the following test for the fresh mix was evaluated. The Slump Flow measures the horizontal patty of the concrete to determine the mean spread. In accordance to ASTM C 1611, the slump flow of the mixes where tested there by determining the flow ability of each mix, then measured and reported in table 3. The higher the slump values the greater the filling and flowing ability. The V-Funnel is time taken for the concrete to flow through the v-funnel apparatus is known as the V-funnel test. Table 3 shows mixes for both cases of normal concrete and SCC mixes with different percentages of superplasticizer. L-Box is the extent to which the concrete flow is subjected to blocking by reinforcement can be called the l-box test. It shows the ratio of h2/h1 EFNARC, 2002.

3. Result and discussions

Test result carried out on both Fresh and Hardened Properties

Test conducted on the varying superplasticizer percentages of 10, 20, 30% self-compacting mixes and control with no superplasticizer content (NCC) are presented in the table below. Characteristic properties of the workability of SCC include the passing, filling and segregation resistance which all relate to the slump flow, V-funnel and L-box test.

Table 3: Test values for workability test with different percentages of Superplasticizers

S/N	Mix	Slump Flow (mm)			V-Funnel (sec)			L-box (h2/h1)		
		10%	20%	30%	10%	20%	30%	10%	20%	30%
1	NCC		400			14			0.99	

2	SCC(SP 264)	590	650	670	12	11	10.5	0.92	0.9	0.85
3	SCC (SP 430)	650	695	780	10	8	6.5	0.88	0.85	0.82
4	SCC (SP 561)	755	610	595	7.5	11	12	0.8	0.87	0.95

Table 4: Test values for Compressive Strength with different percentages of Superplasticizers

S/N	Mix	Percentages	Curing Days		
			7	14	28
1	NCC	0%	26.49	31.60	40.24
2	SCC(SP 264)	10%	28.72	35.66	41.62
		20%	29.27	38.21	44.45
		30%	31.15	40.96	48.91
3	SCC (SP 430)	10%	30.66	43.39	50.23
		20%	31.12	43.73	51.85
		30%	32.10	46.00	53.32
4	SCC (SP 561)	10%	34.17	46.90	55.67
		20%	32.03	45.72	53.05
		30%	30.66	43.23	51.77

Table 3 shows the result of the workability test, conducted to achieve self-compacting concrete. The mix with different types of superplasticizer had different varying percentages from 10-30% respectively. It was observed that all mixtures yielded improved workability compared to the control mix, the concrete mixture with conplast SP 430 had a good slump flow through out the varying percentage. The diameter obtained is between 650 and 780mm, the L-box test confirmed that the mix flowed without blocking in reinforcement which is explained by the high fluidity and absence of segregation. It is observed form conplast SP 561 that at a certain percentage (20-30) had a decrease in slump flow. Based on the result obtained from the investigation, compressive behavior of the different superplasticizer mix has been tested on concrete cubes specimen of 150*150*150 for all percentages, it observed that the mix with conplast SP 264 compressive strength increased with increase in percentage of superplasticizer. As seen in the table 3 the self-compacting concrete mixes (conplast SP 430) had enhanced effect on compressive strength at all ages compared to the conplast SP 561 had a decrease in the compressive strength as seen in the table 4.

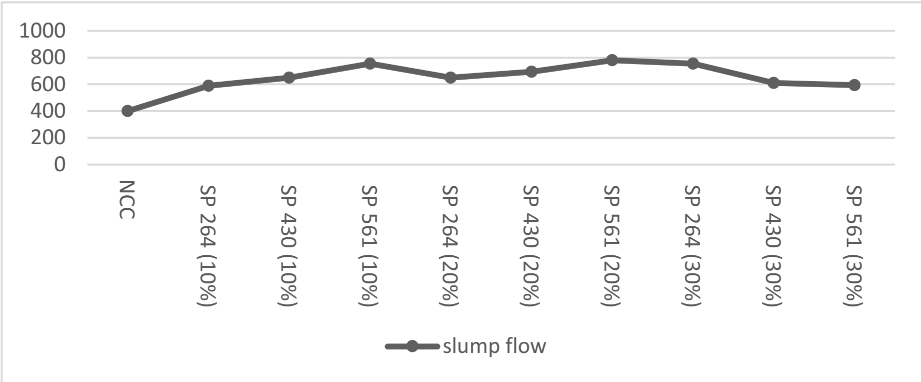

Fig 1. Showing the slump flow of the various superplasticizer

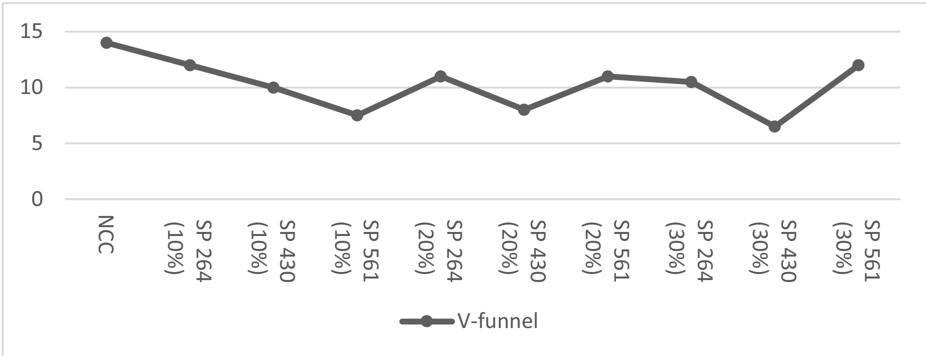

Fig 2. Showing the filling ability of various superplasticizer and percentage

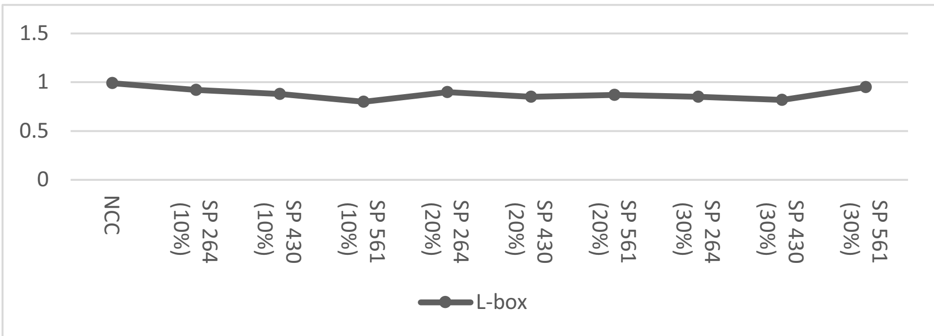

Fig 3. Showing the passing ability of various superplasticizer

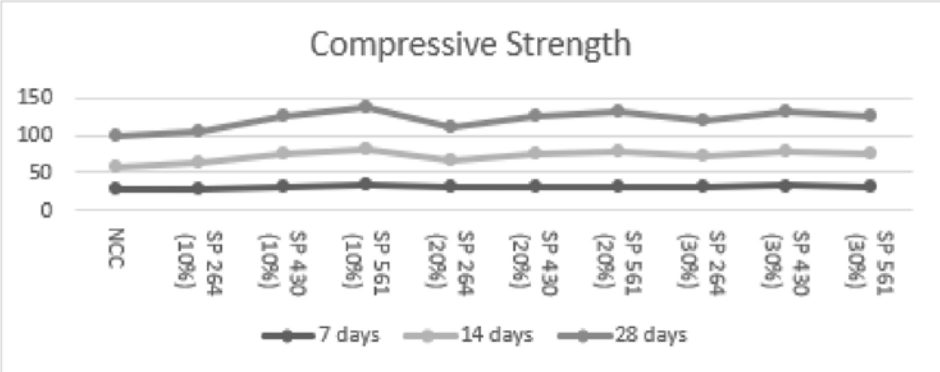

Fig 4. showing the compressive strength of various superplasticizer mix at varying percentage.

4. Conclusion

This research work focusses on the effect of superplasticizer on Self Compacting Concrete. An Increase in the dosage/percentage of Conplast SP 561 resulted in a decrease in the workability and compressive Strength of the self-compacting concrete. While despite the increase in dosage of Conplast SP 430 all the percentage mix had a satisfactory performance in the fresh and an increase in compressive strength with respect to the curing age respectively. In general, the use of superplasticizer improves the performance of self-compacting concrete in the fresh state. Through all the superplasticizer used for the study it was observed that conplast SP 430 is a better superplasticizer than the rest of the superplasticizer selected the fresh and hardened result acquired.

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