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The Effects of Conplast Sp561 on Concrete Properties

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ABSTRACT

Over the years in the construction industry, attempts have been constantly made to alter the physical properties of concrete to suit different construction requirements. Concrete admixtures in form of chemicals at controlled quantities affect these alterations. This work investigated the effect of Conplast SP561 on concrete properties. Six mix proportions of water and Conplast SP561 which include 0.45-0, 0.445-0.005, 0.44-0.01, 0.435-0.015, 0.43-0.02 and 0.425-0.025 were used on 1:2:4 standard mix of concrete at a constant w/c ratio of 0.45. That is, 0%, 1.11%, 2.22%, 3.33%, 4.44%, and 5.55% replacement ratios of water with Conplast sp561 made up the six mix proportions. The fresh concrete was tested for workability and setting time (initial and final) while the hardened concrete cubes were tested for compressive strength and water absorption properties. Each of the six mix proportions had a curing age of 28 days having milestone ages of 7, 14, and 21 days using no percentage replacement of water as the control specimen. Workability exhibited a true slump in four out of the 6 mix proportions, while the last two mixes exhibited a collapse. The setting time and water absorption increased with an increase in the quantity of Conplast SP561 in the mix with their highest values at 822 minutes and 10.43% respectively. Compressive strength increased with an increase in the quantity of SP hitting 28.8N/mm^2 as the highest value. Conplast SP561 can be satisfactorily used in the construction industry as a good superplasticizer.

Keywords: Conplast, SP561 and concrete properties

INTRODUCTION

A composite material made by combining cement, supplementary cementing materials, aggregates, water, and chemical admixtures in suitable proportions and allowing the resulting mixture to set and harden over time is known as Portland cement concrete [1]. World annual concrete production exceeds 4 billiards cubic meters of ready mix and precast concrete of different applications [2]. Over time, it has been found out that the conventional concrete mix of Portland cement, water and aggregates, does not possess certain functional and constructability properties required in the ever-demanding construction industry. The demand for concrete meeting high compressive strength requirements for one is on the high side. To obtain high compressive strength, the concrete in its fresh state must possess adequate workability properties for ease of compaction. Workability is enhanced by an increased w/b ratio. However, increasing the w/b ratio of fresh concrete beyond a certain dosage for a particular mix results in a corresponding decrease in the strength of the hardened concrete. This is so because, in increasing the w/b ratio of concrete, the free water content in the concrete mix equally increases beyond the required, resulting in certain unwanted properties in the mix. Consequently, obtaining a High Compressive Strength (HCS) property through conventional concrete mix becomes a difficult one. These diverse construction requirements, therefore, necessitate the improvement of concrete mixes so as to meet the various requirements on construction sites. Chemical substances are then introduced into the conventional concrete mix to obtain desired properties suitable for certain tasks on construction sites. These chemicals sometimes added are referred to as concrete admixtures. The type of cement, ambient conditions of the environment (especially temperature), cement/water ratio and the dosage of an admixture make its specific effects vary. Admixtures need to be consistent with British standards [3-4]. The water/cement (w/c) reduction capability, pore water reduction, hydrophobic effect, increased density and other added properties of admixtures have increased both the compressive strength and durability of concrete. Raheem *et al.* [5] investigated the outcome of the properties of Corn Cob Ash-cement concrete by admixtures. Concrete properties investigated include compressive strength and workability. The three types of admixtures that were used include a plasticizer, accelerant and retarder. From the obtained results from the investigation, it was concluded that all the admixtures improved the workability of corn cob ash cement concrete and also increased the compressive strength at all curing ages. Furthermore, results from the experiment showed that mixes containing plasticizers exhibited higher workability and consequently, strength at both early and later curing ages. Superplasticisers as a concrete admixture, when introduced in concrete mixes modify certain properties to meet the ever-changing needs of concrete as required [6]. In his work stipulated that 'Superplasticiser (SP) is used to increases the workability of concrete without altering the water/ binder ratio. Or, it can be employed to raise the ultimate strength of concrete mixes by reducing the content of water while adequate workability is maintained. Slump value increases with the dosage of superplasticizer [7]. An inquiry by Osuji and Ikogho [8] on the end result of the Naphthalene Based SP addition process on water reduction and grade C20/25 concrete compressive strength. The research showed the SP addition by the two different processes gave varying water reduction and compressive strength development registering maximum water reduction and compressive strength gains of 22.9% and 80.2% respectively compared to the control. Improved strength, workability, time-saving, and enhanced strength of completed structure are some of the benefits of superplasticizers to the construction engineer (Phatak et al 1992). Superplasticizers help in achieving faster casting and completion of fresh concrete and remove to a large extent, the risk of both bleeding and segregation of aggregates, therefore, the procedure of pumping fresh concrete becomes much swifter [6]. However Neville [9] stipulated that Superplasticizers do not have an effect on the creep, shrinkage, resistance to freezing and thawing and modulus of elasticity property of concrete. They have no influence on the durability property of concrete (particularly, durability on exposure to sulphate is not affected). So far, researchers have been made to ascertain the effects of different types of superplasticisers on various properties of concrete. As Alsadey [10] examined the influence on the strength of concrete by the super-plasticizer, sikament R2002. The varying constituent in that study was the varying doses of the super-plasticizer introduced into the concrete mix. The results of the examination follow that the admixture improved on the workability property of fresh concrete as well as the compressive strength. Ahmad *et al.* [11] stated that the introduction of super-plasticizers (0.8%wt of cement) reduced the water required to produce concrete of grade 25N/mm^2. They concluded that both samples of super-plasticizer used improved the concrete properties investigated.

MATERIALS AND METHODS

This investigation was carried out using a concrete standard mix of 1:2:4 at a constant water/binder (cement) ratio of 0.45. Ordinary Portland Cement (OPC) of grade 42.5N conforming to BS EN 197-1 was used as the binder. 20mm maximum size granite conforming to BS EN 12620 and sea sand locally sourced from Otamiri river in Imo State, Nigeria, conforming to BS EN 12620 were as the coarse and fine aggregates respectively. The gradation curves of the fine and coarse aggregates used in this experiment are shown in Figs 1 and 2 respectively.

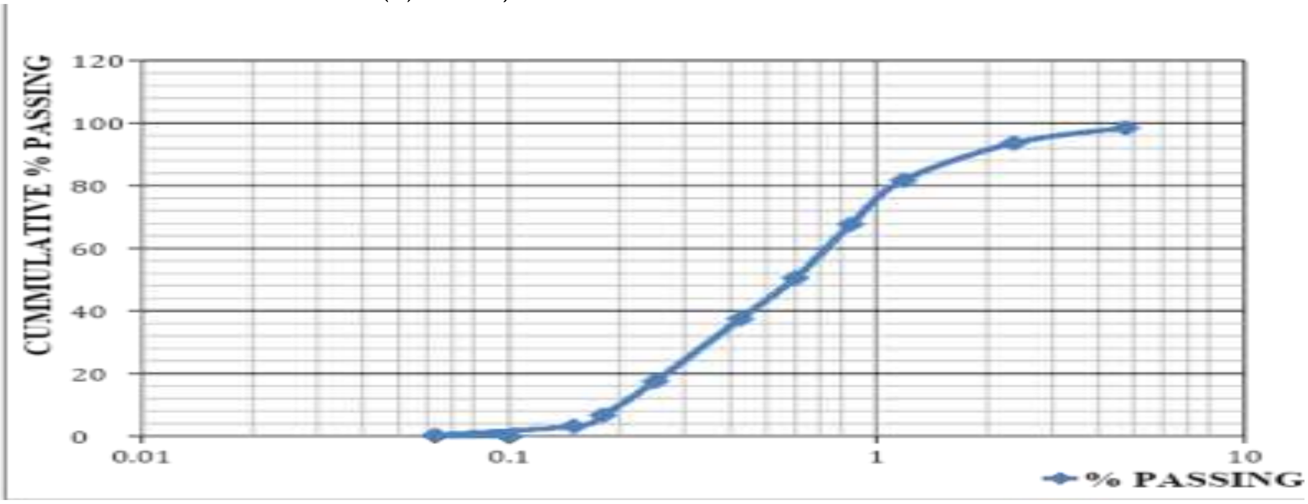

Figure 1: Gradation Curve For Fine Aggregates

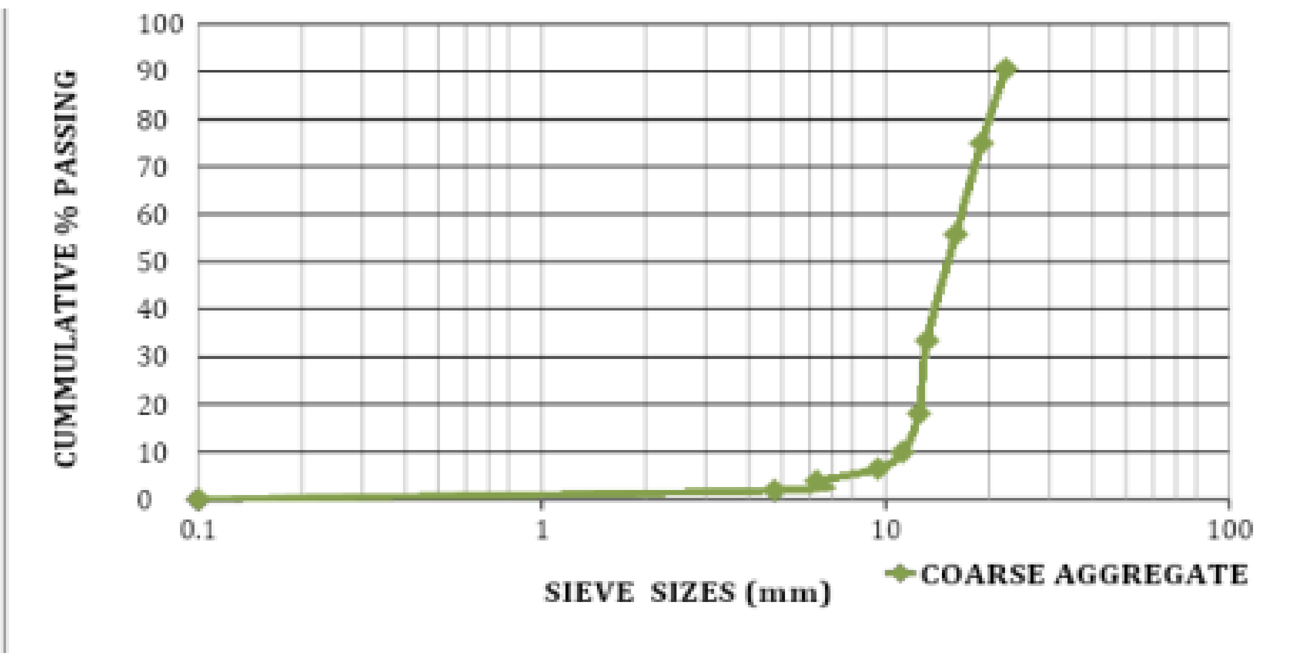

Figure 2: Gradation Curve for Coarse Aggregate

Conplast SP561, a Naphthalene based super-plasticizer superplasticiser, was the only admixture used for this investigation. The quantities of cement, fine and coarse aggregates remained unchanged throughout this experiment. Only the quantities of water and Conplast SP561 vary for the mix proportions. To begin the experimental program, one mix was prepared without introducing the admixture into the mix. This served as the control mix for this experiment. To investigate the effects of Conplast SP561, five other mix proportions were prepared at 1.11%, 2.22%, 3.33%, 4.44% and 5.55% replacement ratios of water with Conplast SP561. A slump test was conducted on each of the six mix proportions to determine the workability of the fresh concrete mixes. Also on the fresh concrete mixes, the Vicat apparatus was used to determine the initial and final setting times. To determine the compressive strength, concrete cubes of dimensions 150x150x150mm were produced for each of the six mix proportions. Then the hardened cubes of concrete were tested at 7, 14, 21 and 28 days of curing ages totaling 72 specimens. To determine the water absorption rate for the six mix proportions, after 28 days of curing, three concrete cubes for each mix proportion were weighed wet and sun-dried for a week and reweighed. Curing was done by immersion and maintained at a room temperature of 26 ± 2°C. All specimens were produced in the Civil Engineering Concrete Laboratory of the Federal University of Technology Owerri, Nigeria.

Mix design

The mix design adopted for this experiment is 1:2:4 concrete mixes for all the mix proportions. The quantities of cement and aggregates are unchanged and at a constant w/c ratio of 0.45. The first mix devoid of any admixture is the control mix. Additional five mixes produced involve the constant reduction of water with a corresponding increase in the quantity of Conplast SP561. The details of the material requirements are shown in Table 1. 12 cubes were produced for each of the six mix proportions i.e three cubes for each curing age of 7, 14, 21 and 28 days, making a total of 72 cubes.

RESULTS

Table 1: Showing the summary of the material requirements for each of the six mixproportions

S/N	mix proportions		% of SP	mass of sand (kg)	mass of coarse agg. (kg)	mass of cement (kg)	mass of SP (kg)	mass of water (kg)
	water	SP						
1	0.45	0	0	30.65	55.73	13.4	0	6.03
2	0.445	0.005	1.11	30.65	55.73	13.4	0.067	5.963
3	0.44	0.01	2.22	30.65	55.73	13.4	0.134	5.896
4	0.435	0.015	3.33	30.65	55.73	13.4	0.201	5.829
5	0.43	0.02	4.44	30.65	55.73	13.4	0.268	5.762
6	0.425	0.025	5.56	30.65	55.73	13.4	0.335	5.695

Table 2 Showing Slump value for each of the Mix Proportion

S/N	Mix Proportion		% Replacement of water with SP	Height of Cone (mm)	Collapse Height (mm)	Slump Height (mm)
	Water	SP				
1	0.45	0	control mix	300	256	50
2	0.445	0.005	1.11	300	205	100
3	0.44	0.01	2.22	300	158	150
4	0.435	0.015	3.33	300	105	200
5	0.43	0.02	4.44	300	Collapse	-
6	0.425	0.025	5.56	300	collapse	-

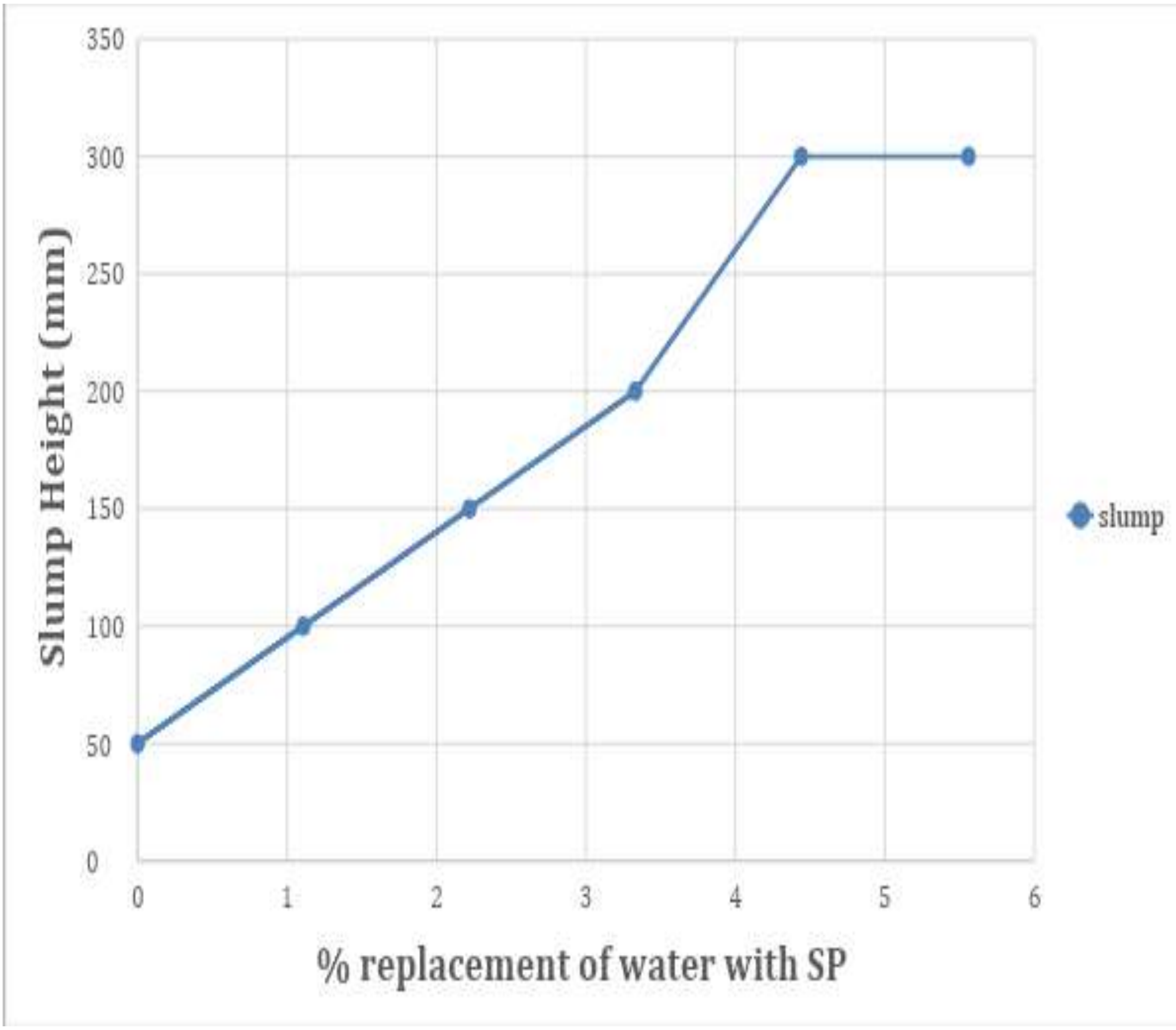

Fig 3: Graph of influence of Conplast SP561 on slump of fresh concrete

Table 3 Showing the Initial and Final setting times of fresh concrete for each of the 6 mix proportions:

S/N	Mix Proportion		% Replacement of water withSP	Consistency (%)	Duration (Initial inminutes)	Duration (Final inminutes)
	Water	SP				
1	0.45	0	control mix	29	75	150
2	0.445	0.005	1.11	27	240	343
3	0.44	0.01	2.22	28	182	380
4	0.435	0.015	3.33	28	330	518
5	0.43	0.02	4.44	28	515	699
6	0.425	0.025	5.56	27	628	822

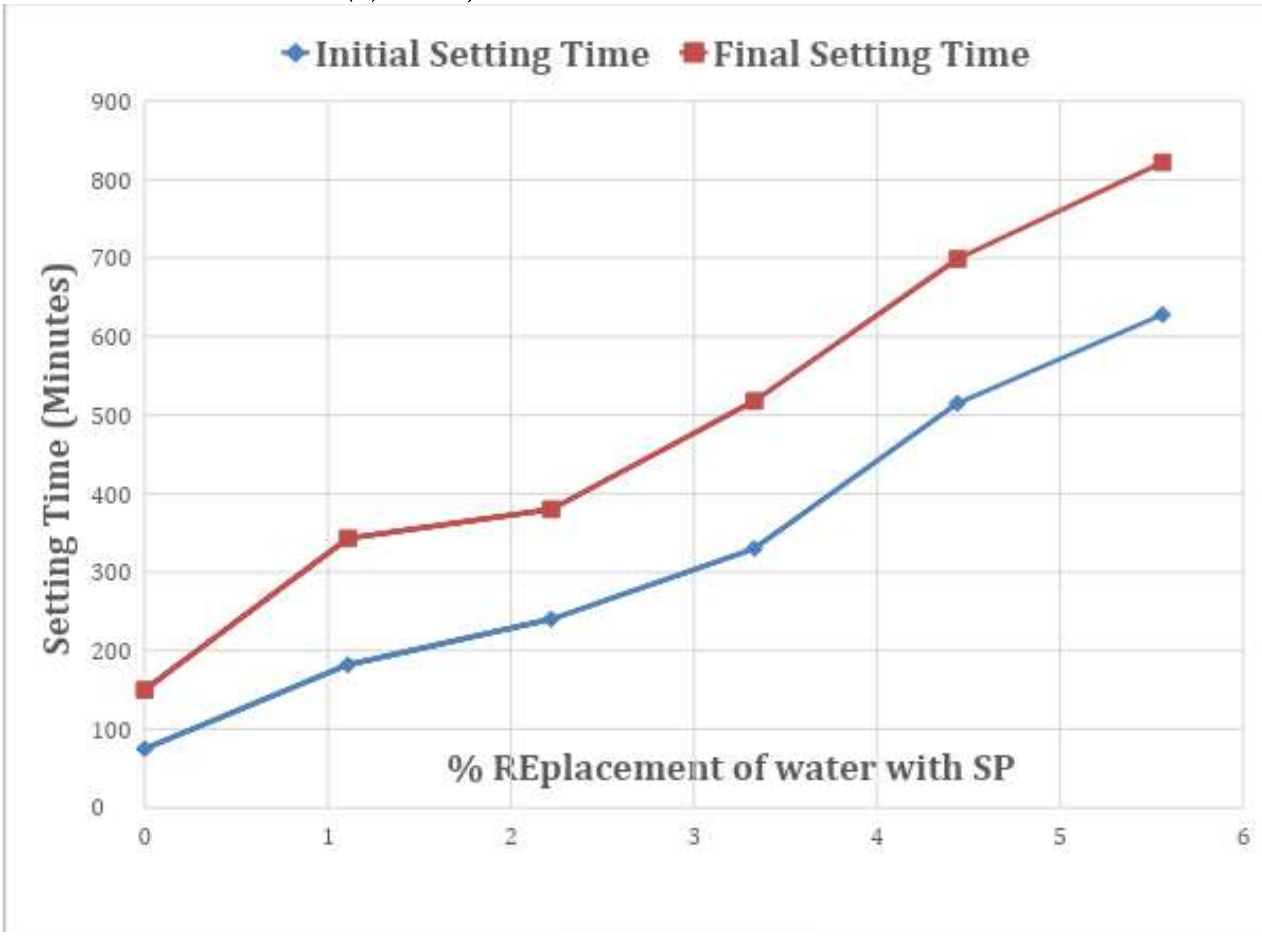

Figure 4 Graph of influence of conplast SP561 on initial and final setting times of fresh concrete.

Table 4 Showing the compressive strengths of hardened concrete cubes after 7, 14, 21 and28 days of curing for each of the 6 mix proportions.

S/N	Mix Proportion		% Replacement of water with SP	7 day Crushing Strength (N/mm^2)	14 day Crushing Strength (N/mm^2)	21 day Crushing Strength (N/mm^2)	28 day Crushing strength (N/mm^2)
	Water	SP					
1	0.45	0	control mix	11.64	16.9	17.8	18.7
2	0.445	0.005	1.11	11.6	17.8	22.2	23.1
3	0.44	0.01	2.22	9.3	20	24.9	25.8
4	0.435	0.015	3.33	8.9	20.4	27.6	28.8
5	0.43	0.02	4.44	4	8.1	14.6	15.3
6	0.425	0.025	5.56	2	6	11.7	12.1

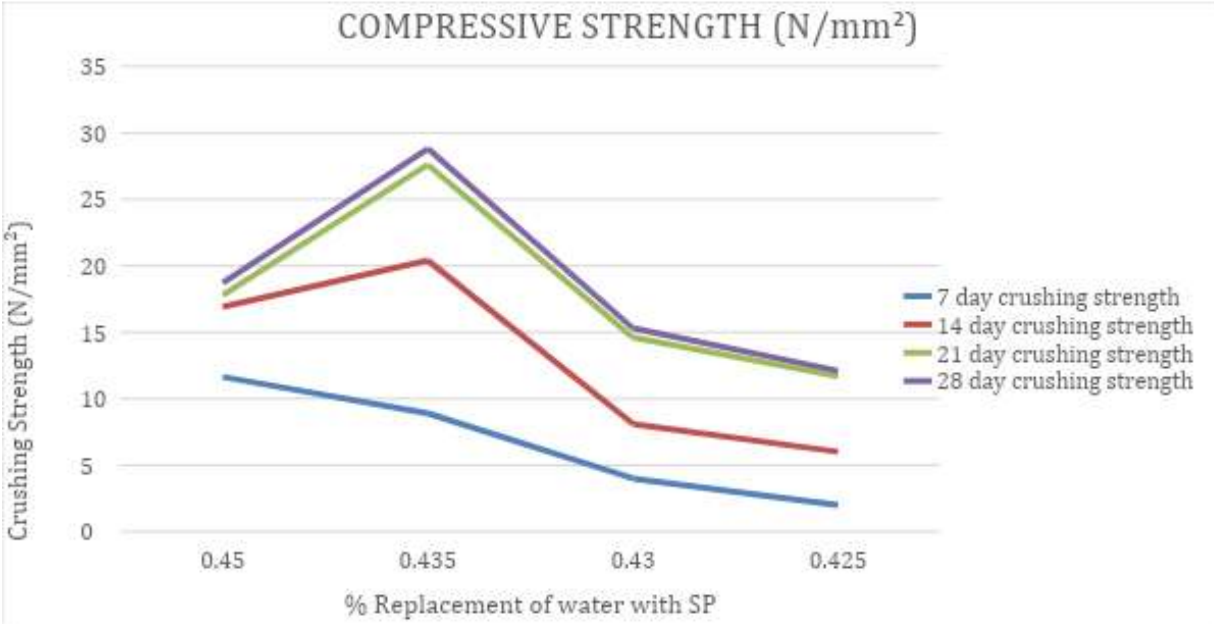

Figure 5 Graph of influence of Conplast SP561 on compressive strength of concrete for 7,14, 21 and 28 curing days.

Table 5 Showing the percentage water Absorption of hardened concrete for each of the 6mix proportions

S/N	Mix Proportion		% Replacement of water withSP	Wet Weight (kg)	Dry Weight (kg)	% Water Absorption
	Water	SP				
1	0.45	0	control mix	8.6	8.45	1.78
2	0.445	0.005	1.11	8.6	8.4	2.38
3	0.44	0.01	2.22	8.7	8.4	3.57
4	0.435	0.015	3.33	8.7	8.25	5.45
5	0.43	0.02	4.44	8.8	8.25	6.67
6	0.425	0.025	5.56	9	8.15	10.43

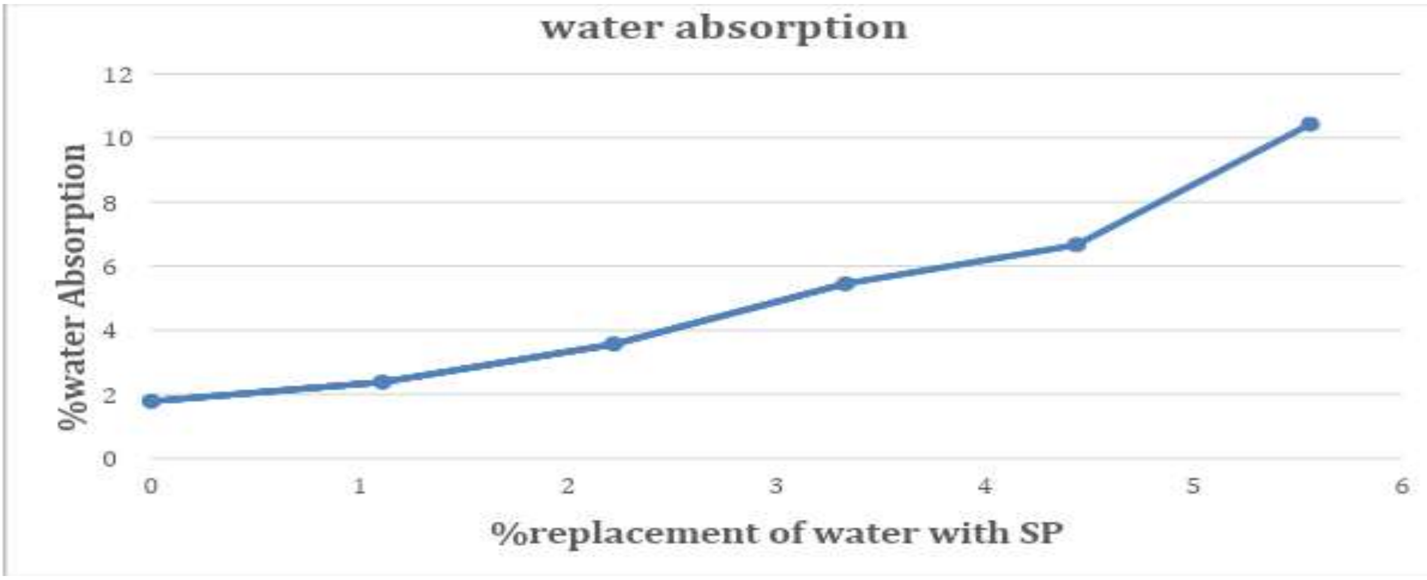

Figure 6 Graph of % water absorption against %replacement of water with SP

DISCUSSION

The objective of slump test is to ascertain the concrete mix proportions workability. The slump test is very vital in ascertaining the variation in the uniformity of a mixed proportion of a given nominal property. It is equally useful to check whether the moisture content is increasing unexpectedly or the changes in the grading of aggregates such as a reduction of the fine aggregates in the mix. This helps to prevent segregation in concrete mixes. The slump test was carried out in accordance with BS EN 12350. The test was finished within 150 seconds to avoid the loss of workability with time. For the casting work in this research that has been divided into 6 batches, the results are presented in Table 2 and plotted in Figure 3. From Table 3 and Figure 4, we can observe that the setting times (both initial and final) of fresh concrete increase with an increase in the substitution of water with Conplast SP561. The admixture significantly affects the setting time of concrete. The initial setting time of concrete indicates when fresh concrete starts losing its plasticity, while the final setting time shows the point in time when the concrete begins to gain strength. At 5.56% substitution, it took almost 24 hours to obtain the final setting time of the fresh concrete. This was conducted in conformity with BS EN 12390. The compressive strength of concrete gives an idea of the general properties of concrete. Here, different results were obtained for different curing ages which include 7, 14, 21 and 28 days. They are presented in Table 4 and Figure 5. As seen in Table 4 and Figure 5, after 7 days of curing, with an increase in water substitution with SP, the compressive strength of the concrete cubes was reduced significantly. At 5.56% substitution, the least value of compressive strength was obtained because, at 7 days, the concrete gained no significant strength. The control mixes have the highest strength of 11.64 N/mm2. At 14 days of curing, the control mix still has the highest strength recorded being 16.9 N/mm2 with the 5.56% substitution having the least strength of 6.0 N/mm2. Notice that the other mix proportions but the last two recorded higher strengths than the control mix at 14-day curing. After 21 days of curing, the control mix recorded the least strength of 17.8 N/mm2 which increased significantly with an increase in water substitution with SP. The 3.33% substitution has the highest strength of 27.6 N/mm2.

After 28 days of curing, the control mix also recorded the least obtained strength of 18.7 N/mm2 and 3.33% recorded the highest being 28.8 N/mm2. The test was carried out in agreement with BS 1881. The rate of water absorption of concrete gives an idea of the durability of concrete. For concrete exposed to a wet environment, the more permeable it is, the more the propensity of undesired and concrete-harmful substances penetrating into the concrete, thereby making the concrete less durable. The result obtained in this work on the percentage water absorption of concrete for the different 6 mix proportions is presented in Table 5 and Figure 6. After three concrete cubes were cured for 28 days each mix proportions were weighed wet and the sun-dried for a week and reweighed. Table 5 and Figure 6 shows the result obtained after the water absorption test. It can be observed that the %water absorption increases with an increase in the substitution of water with SP. The control mix had the least of 1.78% and the 5.56% mix had the highest of 10.43% water absorption rate.

CONCLUSION

Conlplast SP 561 is a good water-reducing agent as it has the capacity to increase the flowability of fresh concrete without an increase in water content. From the results obtained from the slump test, Conplast SP561 increases the workability of concrete until an optimum quantity where further addition of SP can lead to segregation in the mix. The maximum substitution of water with Conplast SP 561 using workability criteria is 3.33%. Conplast SP 561 increases the setting times (initial and final) of fresh concrete significantly. The setting time of fresh concrete containing Conplast SP 561 is dependent on the dosage used for that particular mix, as an increase in the dosage elongates the setting time as observed in Table 3. Therefore, this admixture should not be used where the rapid setting of the fresh concrete is desired.

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