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Compressive Strength Development of Concrete From Nigerian OPC Using Conplast SP430

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Abstract— **This research project was aimed at determining the effect of Conplast SP430 on the compressive strength development of concrete using the dosage range as specified by the manufacturers of Conplast SP430 (0.7L-2L/100kg of cement). Cubes of 150mm x 150mm x 150mm were used for the production of all samples with a mix ratio of 1:2:4 and water/cement ratio of 0.45. All samples were compacted in 3 layers of 35 blows each using a 16mm rod for the compaction. The compressive strength tests were conducted for concrete samples of different dosages at 7 and 28 days to determine the compressive strength of hardened concrete. The results showed that the highest compressive strength at 28 days was achieved at the lowest Conplast dosage (0.276L/33.49kg of cement) with a strength value of 31.78KN/mm^2 greater than that of the control while the highest compressive strength for 7 days was achieved at 0.32L/33.49kg of cement with strength value of 21.62KN/mm^2. It was also observed from this research experiment that water-curing for the superplasticized samples was not possible.**

Keywords: Compressive Strength, Superplasticizer, Conplast SP 430, Ordinary Portland Cement (OPC).

I. Introduction

An ever-evolving world needs constantly developing construction ways. In the present world, concrete is one of the most widely used construction materials. This can be due not alone to the large choice of applications that it offers. However, besides its behavior, strength, affordability, durability, and flexibility play vital roles. Therefore, construction works rely greatly on concrete as a secure, strong, and basic material. It is utilized in all sorts of buildings from residential to commercial, and infrastructure from roads to bridges, e.t.c. concrete is used for the development of foundations, columns, beams, slabs and different load-bearing components

Concrete is a composite material made by mixing cement, fine and coarse aggregates and water in right proportion and then allowing the resulting mixtures to set and harden over time. Therefore, concrete hardening and forming of concrete depends greatly on the mixing water and aggregates used. Concrete has to be solid mass that achieves the complete potential hardened properties, as that makes the anticipated strength to be achieved. Concrete performance plays a vital role in the development of infrastructure including commercial, industrial, residential and other special reinforced concrete structures. Adams (1919) stated that the water-cement ratio and degree of compaction are two factors by which the strength of concrete are assumed to be primarily dependent on when other constituents of it have been properly achieved.

Compressive strength of concrete is the strength of hardened concrete measured by the compressive test. The compressive strength of concrete is a measure of the concrete's ability to resist loads which tend to compress it. It is measured by crushing concrete specimen in compression testing machine. The compressive strength is the parameter that represents the concrete strength in the structural design.

The need to design in the most safe and economical way has led to the desire to use regular constituent materials of concrete as cheap as possible but to be able to get higher strength of concrete. This has led to the improvement in the compressive strength of concrete by often times adding extra materials that are cheap to an extent to the same mix ratio of concrete or reducing some of the original constituent materials by some proportion and be able to get the same strength or even higher compressive strength values of concrete but all of these have to be researched, experimented and approved to be safe for construction purpose.

Lots of research works have been carried out on how to improve the compressive strength of concrete. Falade (1999) researched on the effects of separation of grain sizes of fine aggregate on properties of concrete containing granite fine upon seven grain size ranges of granite fines with consideration to investigating appropriately their workability, density, compressive and flexural strengths. He concluded that the compressive strength increased with decrease in grain size. King (2007) considered supporting a sustainable future with micro-silica concrete while using silica fume to enhance the properties of high performance through plastic properties, strength and durability. It was concluded in the research that micro-silica can be used to produce high strength and high-performance concrete provided that a suitable admixture is incorporated into the mix to reduce water content.

Admixture such as superplasticizer is an ingredient other than Portland cement, water and aggregates that are associated with the production of concrete for increasing strength and durability. Mamlouk and Zaniewski (2006) claimed superplasticizer is capable of providing a low water-cementitious material ratio that is beneficial with early strength gain, high-strength concrete and reduced porosity.

Conplast SP430 which complies with BS 5075 Part 3 is to be used for the production of cement concrete in this study for Forsoc (2020) claimed that it is a chloride free super-plasticizing admixture based on selected sulphonated naphthalene polymer that is supplied as a brown solution which instantly disperses in water. Conplast SP430 disperses the fine particles in the concrete mix, enabling the water content of the concrete to perform more effectively. The very high levels of water reduction possible, allows for major increase in strength to be obtained.

II. MATERIALS AND METHODS

The materials used in this research are:
Cement, Granite, River Sand, Conplast SP 430, Water.

A. Cement

Ordinary Portland cement; Dangote cement Grade 42.5N which is produced in Nigeria and complies with BS EN 197-1 (2019) was used for casting all samples. It is a Type 1 Portland cement which is suitable for general concrete construction. The cement comes in 50kg per bag.

B. Granite (Coarse Aggregate)

Normal weight aggregate was used for this experiment with a maximum nominal size of 25mm which was of irregular shape and with specific gravity of 1.38. A total mass of 133.95kg of granite was used to produce concrete specimens throughout the course of the experimental phase of this project. The particle size distribution for granite was done using sieve analysis. The granite used for this project passed the 25mm sieve and retained on 4.75mm test sieve containing only so much finer material. The coarse aggregate was procured from a local trader at a quarry in Ozuoba, Rivers State complying with BS EN 12620 (2013). The aggregates were washed with potable water and sun-dried before use to remove impurities which might be present on the aggregates and could have effect on the final result of the experiment. The particle size distribution of the coarse aggregate is shown in fig 4.1.

Fig 4.1: Drying of coarse aggregate after being washed with potable water

C. Chemical Admixture

High performance super-plasticizing admixture; Conplast SP430 which is a chloride free superplasticizing admixture belonging to the superplasticizer family of sulphonaed naphthalene polymer from Forsoc, Fars Iran limited which conforms with BS EN 934 (2012), BS 5075 part 3 and ASTM C494 as Type A and Type F, depending on the use, was used for this experiment. It is supplied as a brown solution which instantly disperses in water. The chemical was bought from Lagos, Nigeria. Picture of the chemical admixture is shown fig 4.2 below.

Fig 4.2: 20Litre Conplast SP430 that was purchased

D. Water

Almost any natural water that is drinkable and has no pronounced taste or odor can be used for mixing concrete. Excessive impurities in mixing water not only affects setting time and concrete strength, but may also cause efflorescence, staining, corrosion of reinforcement, volume instability and reduced durability. Potable water was used for this experiment. This water is available in the university of Port Harcourt campus conforming to the requirement of water for concreting and curing.

E. Sand

River sand from Choba sandfill was used for this experiment. The source river sand was sun-dried for 48 hours to remove every trace of moisture. The fine aggregate has 4.75mm maximum size with irregular particle shape and rough texture with specific gravity of 1.6. A total mass of 66.97kg of sand was used to produce the entire concrete specimen for this project experiment. The particle size distribution for the sand was done using sieve analysis. It was ensured that the sieves were clean and not contaminated with clay or other materials.

It should be noted that wooden cubes were used for this experiment. Wooden cubes of 150x150x150(mm) was used for casting all samples. All cubes were oiled before casting was done. And it was ensured that they were not wet by any other liquid before being oiled. All cubes were oiled to ensure concrete doesn’t stick to the cubes upon removal of the concrete cubes which would affect the weight result of the cubes as well as the compressive strength test result.

Fig 4.3: Wooden moulds for casting all samples

METHOD

A. Mix Design

The mix design which was adopted for this project work is of grade M25 concrete (concrete with minimum compressive strength of 25N/mm^2 after 28 days) with a mix ratio of 1:2:4 and water cement ratio of 0.45 which was used for both the control samples and specimen samples. Superplasticizer dosage within the range of 0.7 to 2.00 liters/100kg of cement.

B. Particle size distribution test

The test was carried out in accordance with BS EN 933 (2012) for the sand. A sample of 1kg was weighed and poured into the various BS sieves with aperture sizes of 75, 300, 1.18, 2.0, 4.75, 6.70, 13.20, and pan.
After vigorous shaking horizontally, the samples retained on each sieve was then recorded as weight samples retained. The fineness modulus was then determined by dividing the sum of the cumulated percentage by 100. The gradation of the sand was then obtained from the graph which was plotted on percentage passing against sieve sizes.

C. Casting of Cubes

Cube of 150mmx150mmx150mm size was used to produce the test samples. Compaction was done in 3 layers each of 35 blows using a 16mm rod for the compaction.

D. Curing of Cubes

The control samples were immersed in water for curing age of 7days, and 28days. However, the samples with superplasticizer were not immersed in water because an initial experiment that was carried out in the course of this project research, all samples with superplasticizers melted in the curing tank. Therefore, air curing method was adopted for the second attempt for all superplasticizer samples.

E. Compressive Strength Test

The test specimens (cubes) were removed from curing tank after specified curing age and excess water was wiped out from the surface. The loading was carried out in accordance with BS EN 12390 (2019).

The test was carried out after 7 and 28 days for each sample produced using two samples for every mix design of the superplasticizer sample and the control. The test was carried out in accordance with BS 1881-116, using a universal compression machine.

The strength parameters were set after which the start button was pressed and the machine automatically starts the compression process on the sample until failure occurs on the sample at which point the compressive strength stops.
The maximum load and compressive strength at which failure occurred was then recorded. After average results are obtained, the optimum compressive strength was compared with the optimum strength of normal concrete without superplasticizer.

F. Calculation for quantity of materials used

Mix ratio = 1:2:4
w/c ratio = 0.45
Total ratio = 1 + 2 + 4 + 0.45
Bulk density of concrete = 2,400kg/m^3
Cube dimension = 150mm x 150mm x 150mm
Volume of cube = 0.15 x 0.15 x 0.15 = 0.003375m^3
For 28 cubes, total volume = 0.003375 x 28 = 0.0945m^3
Mass of concrete = 2,400 x 0.0945 = 226.8kg
Adjustment factor = 1.1 x 226.8kg = 249.48kg
∴ Total mass of concrete = 249.49kg
Individual mass of materials to be used:
Water = $\frac{0.45}{7.45} \times 249.48 = 15.07kg$
Cement = $\frac{1}{7.45} \times 249.48 = 33.49kg$
Sand = $\frac{2}{7.45} \times 249.48 = 66.97kg$
Granite = $\frac{4}{7.45} \times 249.8 = 133.95kg$
∴ Mass ratio of materials = 15.07kg: 33.49kg: 66.97kg: 133.95kg
For superplasticizer:
Dosage = 0.7 – 2L/100kg of cementitious material.
Dosage would be spread over 6 ranges
Interval of dosage range = $\frac{2-0.7}{5} = 0.26L$ interval
For 33.49kg of cement, dosage range would be 0.23 – 0.67L/33.49kg
Dosage range therefore would be = $\frac{0.67-0.23}{5} = 0.088L$ interval
∴ Dosages used = 0.23L, 0.32L, 0.41L, 0.50L, 0.59L, 0.67L
Dosages are to be converted to mass for the project work in order for ease of measurement. From the production manual of Conplast SP430, the specific gravity of the superplasticizer is 1.2
In other to get the density of our superplasticizer, we know that:

$$speicific\ gravity\ of\ substance\ A = \frac{density\ of\ substance\ A}{density\ of\ water}$$

We also know that the density of water is 1kg/m^3.

$$\therefore 1.2 = \frac{density\ of\ conplast\ sp430}{1kg/m^3}$$

∴ Density of Conplast SP430 = 1.2kg/m^3
Also, we know that; $Density = \frac{Mass}{Volume}$
From, the above expression, the individual masses of the dosages are as shown in table 4.1

Table 4.1; Table showing the corresponding mass values of dosages of Conplast SP430 used for the experiment

Volume of dosage	**Corresponding mass value**
0.23L	0.276kg
0.32L	0.384kg
0.41L	0.492kg
0.50L	0.6kg
0.59	0.708kg
0.67L	0.804kg

G. Experimental Procedure

The following procedures were taken in carrying out the casting and crushing of the cubes in the course of this experimental work:

1. The cubes used for the experiment were wooden fabricated cubes of dimensions 150mm x 150mm x 1500mm.
2. The method of batching for this experiment was by weight and not by volume in other to achieve a more precise result especially in terms of material proportion.
3. Particle size distribution test was carried out for both fine and coarse aggregate conforming to BS EN 933-2 (2012).
4. Each material for the concrete mix were measured with a manual weighing balance before mixing.
5. The superplasticizer was measured and added to the water for the mix.
6. Each cube was oiled before adding concrete mixture in them to avoid the concrete sticking to the cubes which cause damages to the concrete cubes upon removal.
7. Each cube was filled with concrete mix in 3 layers, each layer being compacted with 35 blows.
8. 16mm steel rod was used for tapping and it was ensured that the rod entered the previous layer while tapping subsequent layers.
9. After filling the cubes with concrete mix to the top layer, trowel was used to smoothen the surface and after some minutes just before the casted cubes become completely hardened, they were labelled at the surface for proper identification.
10. All control cubes casted were demoulded after 24hours, and only the control cubes were placed in curing tanks for water curing while cubes with superplasticizers were left in the cubes for 48hours before being removed from the cubes and were air-cured. The choice of air-curing for the superplasticized samples was due to the fact that initial cubes casted and cured in water tanks all melted and the entire process of getting materials for the project was start afresh.
11. All cubes were cured till time of testing and before testing, the cubes were wiped of water and the weight of each cubes were measured.
12. Cubes were tested for 7 and 28 days.
13. The top surface of the cube was placed sideways in the testing machine; that is, the marked surface which is the top of the cube faced me as I placed it in the machine and not facing the plates.
14. It was ensured that the cubes were placed centrally between the plates.
15. The load was applied without shock, increased continuously at a rate of approximately 140kg/sqcm/min until the specimen failed and no further load could be applied.
16. The maximum load applied to the specimens were all recorded.

III. EXPERIMENTAL RESULTS AND DISCUSSIONS

A. Particle Size Distribution

Sieve analysis is a procedure to assess the particle size distribution of granular materials by allowing the material to pass through a series of sieves of progressively smaller mesh size and weighing the amount of materials that is stopped by each sieve as a fraction of whole mass. The graphical representations of sieve analysis for both fine and coarse aggregate are as presented in Figs 4.1 and 4.2 respectively.

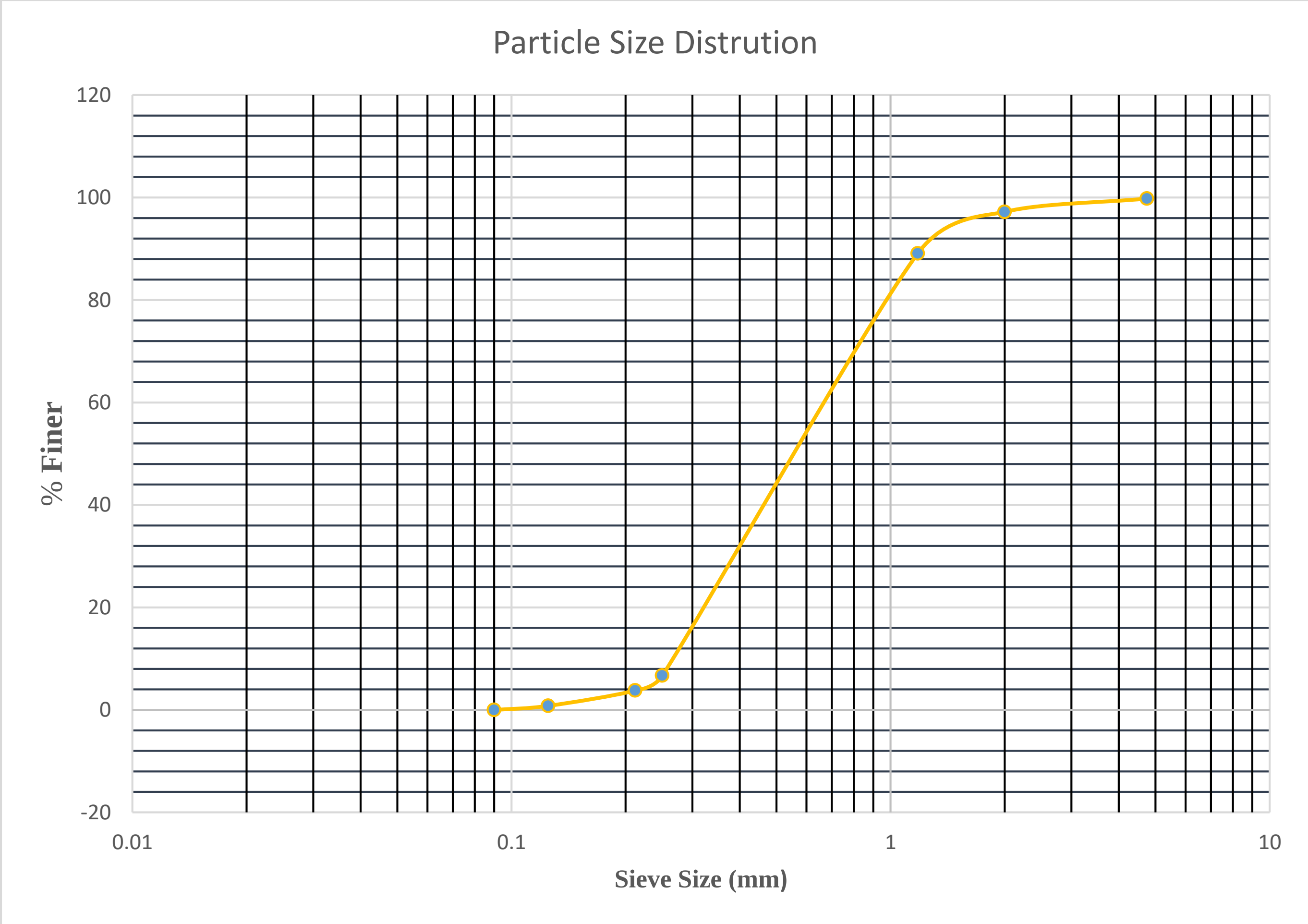

Fig 4.1: Sieve analysis graph of fine aggregates

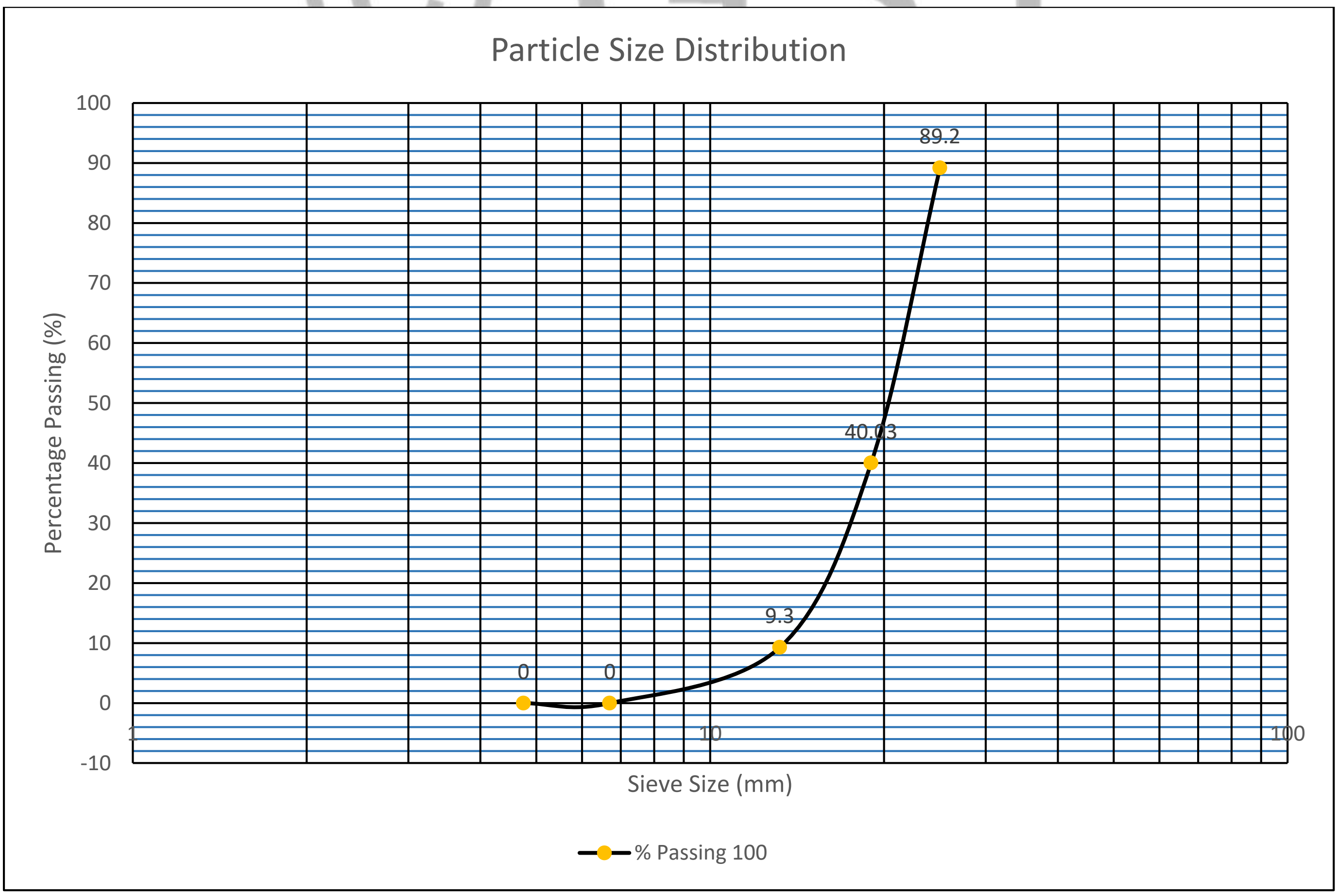

Fig 4.2: Sieve analysis graph for coarse aggregate

B. Specific Gravity

Specific gravity of a substance is a measure of how dense the substance is. The specific gravity test results of the fine aggregate used in this study is hereby presented in Table 4.3. As can be deduced from Table 4.3, the specific gravity of the fine aggregate is 2.618. In general, the specific gravity of fine aggregate is around 2.65. A specific gravity value of 2.618 for this fine aggregate, is an indication of test properly done.

Table 4.3: Table showing the specific gravity of sand

S/NO	TEST NO.	1	2
	OBSERVATION		
1.	Weight of density bottle alone (W_1)	26.69	26.73
2.	Weight of density bottle + oven -dry soil (W_2)	60.73	52.43
3.	Weight of density bottle + oven-dry soil + distilled water (W_3)	100.80	95.72
4.	Weight of density bottle + water (W_4)	79.82	79.82
5.	$W_3 - W_2$	40.07	43.29
6.	$W_4 – W_1$	53.13	53.09
7.	$(W_4 – W_1) – (W_3 - W_2)$	13.06	9.80
8.	$W_2 – W_1$	34.04	25.70
9.	$Gs = (W_2 – W_1) + [((W_4 – W_1) – ((W_3 - W_2)]$	2.606	2.622
10.	Average specific gravity	2.618	

C. Compressive Strength

The compressive strength of the concrete cube test provides an idea about all the characteristics of how strong the concrete is. By this single test, one can judge whether concreting has been done properly or not. The compressive strength values gotten from the crushing test carried out for all samples used for this experiment for 7 and 28 days are presented in Tables 4.4 and 4.5 respectively to compare the strength value of control samples with that of the superplasticized samples.

Table 4.4: Table showing compressive strength values of specimens after 7 days

Specimen Identification	Mix Ratio	Conplast Dosage (*Kg*)	Density of specimen (g/cm^3)	Weight of specimen (*Kg*)	Load (*KN*)	Stress (*KN/mm²*)
NC	1:2:4	-	2.55	8600	547.3	24.32
NC	1:2:4	-	2.44	8250	581.5	25.84
NS1	1:2:4	0.276	2.37	8000	499.6	22.2
NS1	1:2:4	0.276	2.37	8000	420.6	18.69
NS2	1:2:4	0.384	2.37	8000	397.8	17.68
NS2	1:2:4	0.384	2.37	8000	574.8	25.55
NS3	1:2:4	0.492	2.28	7700	445.7	19.81
NS3	1:2:4	0.492	2.46	8300	428.6	19.05
NS4	1:2:4	0.600	2.37	8000	265.7	11.81
NS4	1:2:4	0.600	2.37	8000	516.5	22.96
NS5	1:2:4	0.708	2.34	7900	421.0	18.71
NS5	1:2:4	0.708	2.46	8300	370.7	16.48
NS6	1:2:4	0.804	2.31	7800	432.8	19.24
NS6	1:2:4	0.804	2.28	7700	295.6	13.14

Table 4.5: Table showing compressive strength values of specimens after 28 days

Specimen Identification	Mix Ratio	Conplast Dosage (*Kg*)	Density of specimen (g/cm^3)	Weight of specimen (*Kg*)	Load (*KN*)	Stress (*KN/mm²*)
NC	1:2:4	-	2.12	8350	605.2	26.90
NC	1:2:4	-	2.16	8250	653.2	29.03
NS1	1:2:4	0.276	2.47	7550	737.7	32.79
NS1	1:2:4	0.276	2.44	7800	692.4	30.77
NS2	1:2:4	0.384	2.24	7850	656.4	29.17
NS2	1:2:4	0.384	2.31	7950	652.6	29.00
NS3	1:2:4	0.492	2.33	7700	670.4	29.80
NS3	1:2:4	0.492	2.36	8150	592.6	26.34
NS4	1:2:4	0.600	2.28	7150	290.0	12.89
NS4	1:2:4	0.600	2.41	7300	353.7	15.72
NS5	1:2:4	0.708	2.28	7700	547.30	24.32
NS5	1:2:4	0.708	2.27	7650	571.10	25.38
NS6	1:2:4	0.804	2.30	7750	472.00	20.98
NS6	1:2:4	0.804	2.28	7700	337.70	15.01

Taking the average stress of each specimen for the different ratios for 7days:

NC = $\frac{NC+NC}{2} = \frac{24.32+25.84}{2}$ = 25.08KN/mm^2

NS1 = $\frac{NS1+NS1}{2} = \frac{22.20+18.69}{2}$ = 20.45KN/mm^2

NS2 = $\frac{NS2+NS2}{2} = \frac{17.68+25.55}{2}$ = 21.62KN/mm^2

NS3 = $\frac{NS3+NS3}{2} = \frac{19.81+1905}{2}$ = 19.43KN/mm^2

NS4 = $\frac{NS4+NS4}{2} = \frac{11.81+22.96}{2}$ = 17.39KN/mm^2

NS5 = $\frac{NS5+NS5}{2} = \frac{18.71+16.48}{2}$ = 17.60KN/mm^2

NS6= $\frac{NS6+NS6}{2} = \frac{19.24+13.14}{2}$ = 16.19KN/mm^2

Taking the average stress of each specimen for the different ratios for 28days:

NC = $\frac{NC1+NC1}{2} = \frac{26.90+29.03}{2}$ = 27.97KN/mm^2

NS1 = $\frac{NS1+NS1}{2} = \frac{32.79+30.77}{2}$ = 31.78KN/mm^2

NS2 = $\frac{NS2+NS2}{2} = \frac{29.17+29.00}{2}$ = 29.09KN/mm^2

NS3 = $\frac{NS3+NS3}{2} = \frac{29.80+26.34}{2}$ = 28.07KN/mm^2

N4 = $\frac{NS4+NS4}{2} = \frac{12.89+15.72}{2}$ = 14.31KN/mm^2

NS5 = $\frac{NS5+NS5}{2} = \frac{24.32+25.38}{2}$ = 24.85KN/mm^2

NS6= $\frac{NS6+NS6}{2} = \frac{20.98+15.01}{2}$ = 18.00KN/mm^2

Taking the average load for each specimen for the different ratios for 7 days:

NC = $\frac{NC+NC}{2} = \frac{547.30+581.50}{2}$ = 564.40KN

NS1 = $\frac{NS1+NS1}{2} = \frac{499.60+420.60}{2}$ = 460.10KN

NS2 = $\frac{NS2+NS2}{2} = \frac{397.80+574.80}{2}$ = 486.30KN

NS3 = $\frac{NS3+NS3}{2} = \frac{445.70+428.60}{2}$ = 437.15KN

NS4 = $\frac{NS4+NS4}{2} = \frac{265.70+516.50}{2}$ = 391.10KN

NS5 = $\frac{NS5+NS5}{2} = \frac{421.00+370.70}{2}$ = 395.85KN

NS6= $\frac{NS6+NS6}{2} = \frac{432.80+295.60}{2}$ = 364.20KN

Taking the average load for each specimen for the different ratios for 28 days:

NC = $\frac{NC+NC}{2} = \frac{605.20+653.30}{2}$ = 629.25KN

NS1 = $\frac{NS1+NS1}{2} = \frac{737.70+692.40}{2}$ = 715.05KN

NS2 = $\frac{NS2+NS2}{2} = \frac{656.40+652.60}{2}$ = 654.50KN

NS3 = $\frac{NS3+NS3}{2} = \frac{670.40+592.60}{2}$ = 631.50KN

NS4 = $\frac{NS4+NS4}{2} = \frac{290.00+353.70}{2}$ = 321.85KN

NS5 = $\frac{NS5+NS5}{2} = \frac{547.30+571.10}{2}$ = 559.20KN

NS6= $\frac{NS6+NS6}{2} = \frac{472.00+337.70}{2}$ = 404.89KN

Table 4.6: Table showing the mean values of compressive strength for all specimen

Specimen ID	**Mix Ratio**	**Conplast Dosage (*Kg*)**	**Load (7Days) (*KN*)**	**Load (28Days) (*KN*)**	**Stress (7Days) (*KN/mm^2*)**	**Stress (28Days) (*KN/mm^2*)**
NC	1:2:4	-	564.40	629.25	25.08	27.97
NS1	1:2:4	0.276	460.10	715.05	20.45	31.78
NS2	1:2:4	0.384	486.30	654.50	21.62	29.09
NS3	1:2:4	0.492	437.15	631.50	19.43	28.07
NS4	1:2:4	0.600	391.10	321.85	17.39	14.31
NS5	1:2:4	0.708	395.85	559.20	17.60	24.85
NS6	1:2:4	0.804	364.20	404.89	16.19	18.00

The compressive strength graph for 7 and 28 days are presented in Figs. 4.3, 4.4 and 4.5 which shows how each sample behaved. A downward trend is observed in the 7 days graph and also lower values for all superplasticized samples lesser than the control mix value. But from the 28 days graph, we can observe from Fig 4.4 that some of the superplasticized samples showed greater strength than the control mix.

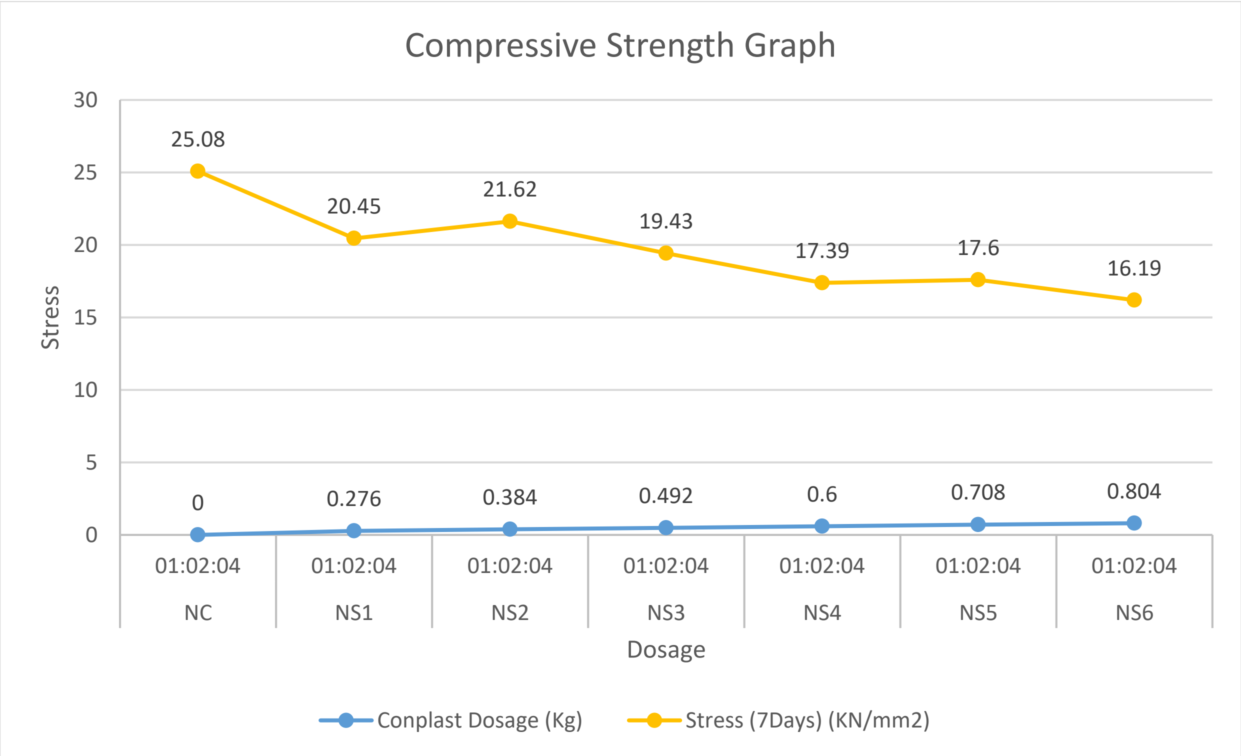

Fig 4.3: Compressive Strength Graph For 7 days

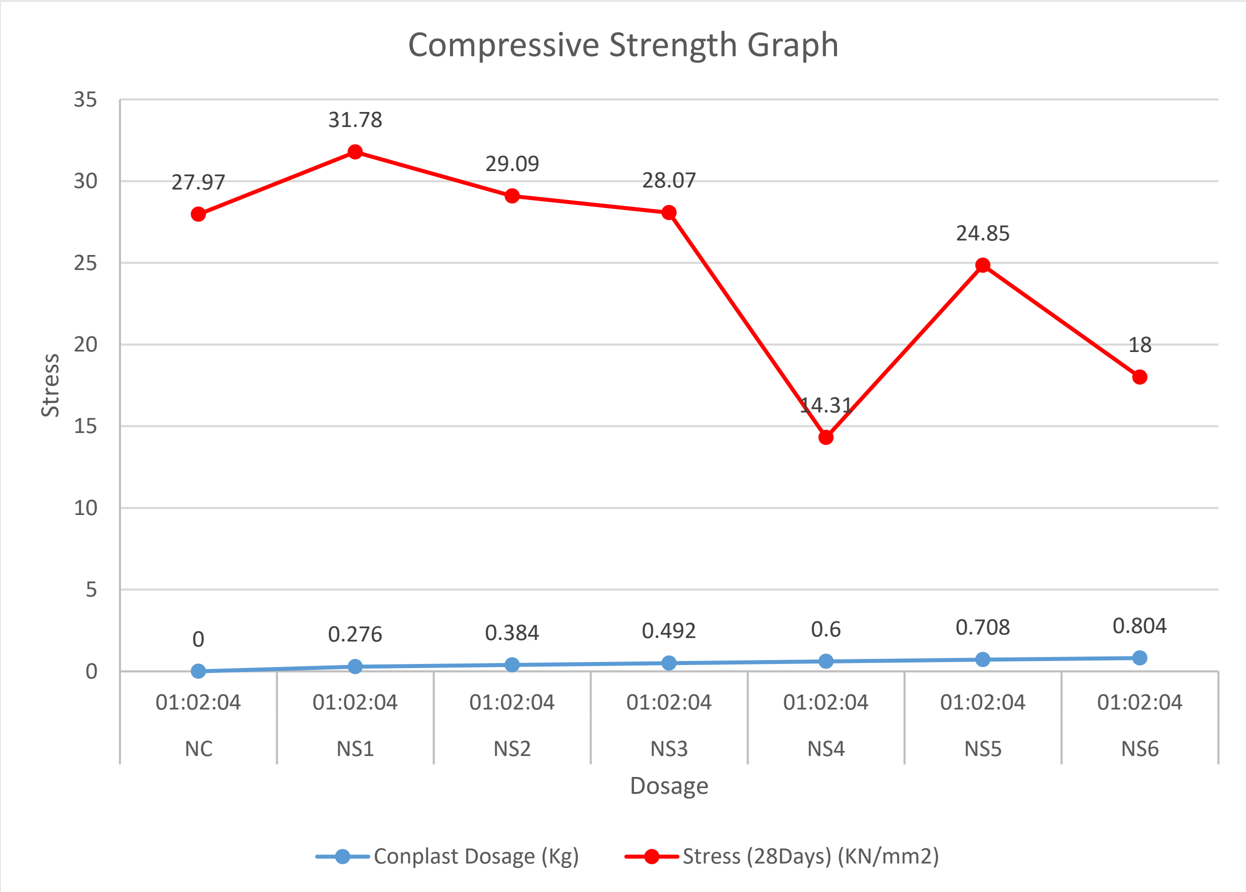

Fig 4.4: Compressive Strength Graph For 28 days

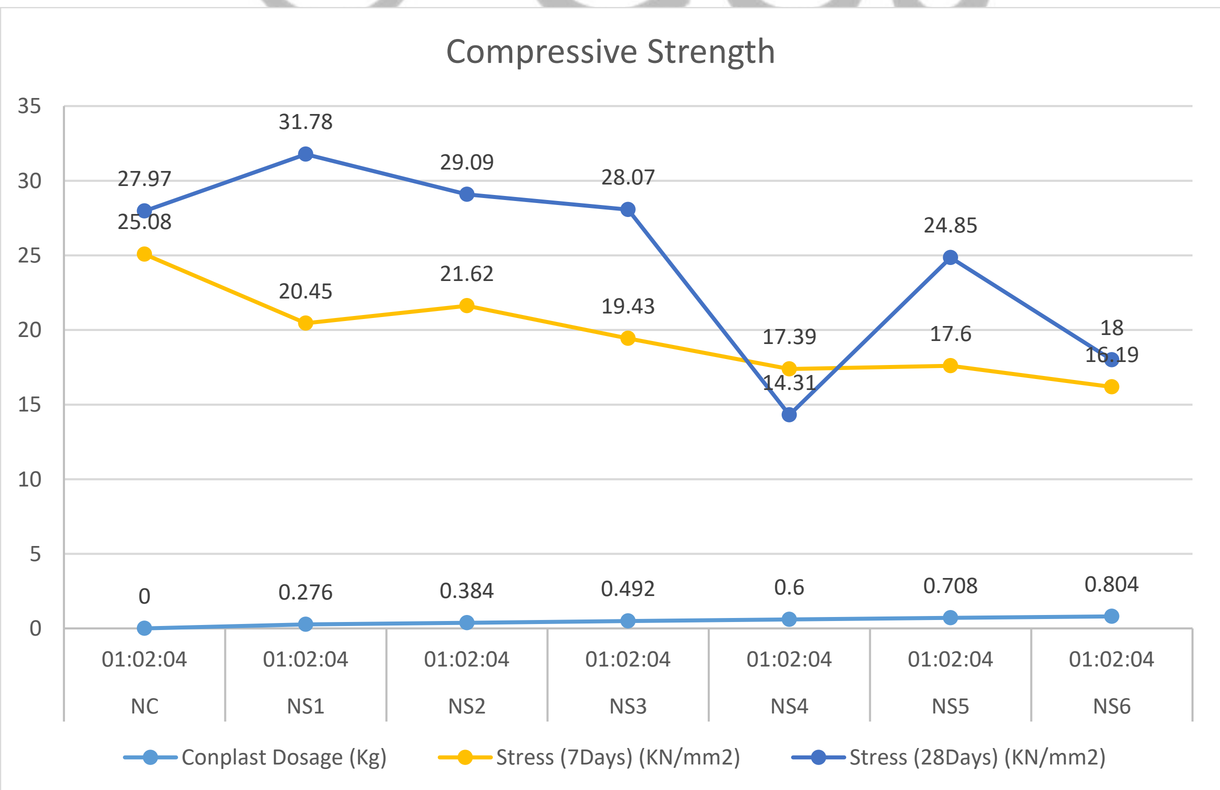

Fig 4.1 Compressive Strength Graph For 7 and 28 days

From the compressive strength result, we can make two observations; first, there is a slow strength gain for samples with superplasticizers as all have lower strength than the control in the 7-day crushing test result. But we can see that there is a bit of fluctuation in the pattern of strength with increase in the dosage of superplasticizer for the 7-day crushing test result with NS2 having the highest strength value among all superplasticized samples and then the strength value decreases afterwards. NS1 has the highest strength among all samples with superplasticizers for the 28-day crushing test result and higher than that of the control. However, NS4 shows a huge decline in the compressive strength of the suprerplasticized samples and also shows a reduction in strength than its 7-day strength value unlike all other superplasticized samples having higher values for 28-days. With this, we can say NS1 dosage which is the least dosage applied, is suitable for concrete construction while NS4 has to be very unsafe to use for concreting purpose.

VI. Conclusion

From the experiment carried out, several observations were made;

1. The samples with superplasticizer were slow to form a well hardened concrete mass unlike that of the control. This slow pace of hardened form can lead to delay in completion time of a project work.
2. Upon addition of superplasticizer to the mixing constituents, it was noticed that the sample looked as though the water present was dried up thereby forming a semi-hard concrete. But upon tamping, all the liquid in the mix seemed to become settled at the top of the cube.

Asides these, several questions are left begging upon, which time and resources would not permit us to find out; would the strength of the control be higher than that of NS1 if it was air-cured like all superplasticizer samples? Why did the samples with superplasticizers melt when cured in a water tank? Upon the first trial when all samples melted in the curing tank, a second trail was done in which the samples were allowed to air-cure for 4 days before being placed in a water tank but it was observed that they started melting gradually as well after few minutes of being immersed in the water tank. This led to the decision of air-curing all superplasticizer samples.

The use of superplasticizer requires good quality control for proper dosage in order to get good result. Also, the use of superplasticizer in concreting activity should be used in the lowest dosage so as to avoid loss of strength and bleeding. Further research should be done to determine if air-cured control would give a higher strength value than that of the NS1 dosage of superplasticizer.

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