ENCHANCING THE MECHANICAL PROPERTIES OF SELF–COMPACTING CONCRETE – MEANS TO ACHIEVE A BETTER ECONOMY INCONCRETE CONSTRUCTION.

ABSTRACT

Traditional concrete mixtures that include aggregates from naturally occurring sources offer advantages in terms of strength, workability, and water absorption, as well as a wide range of application possibilities. There is the need to further investigate the enhanced mechanical characteristics of Self-compacting concrete as compared to ordinary conventional concrete.

An experimenton the mechanical properties, comprising compressive strength, split tensile strength, flexural strength, and also density of self-compacting concrete SCC and the corresponding properties of normal conventional concrete (NCC) is outlined in this paper.

Based on the various test results, it is concluded that self-compacting concrete provides better characteristics in terms of durability, strength, and economy in concrete production, although their use should be dependent on the percentage volume of superplasticizer admixture added to achieve higher strength properties in the utilizationto substitute conventional concrete (control). In terms of the compressive, flexural, and tensile strength of concrete produced in comparison with both the control and self-compacting concrete, the results still point out clearly that the self-compacting concrete mixes offer the highest compressive, tensile, and flexural strength.The study included 12 cubes, 12 cylinders, and 12 rectangular prisms for the self-compacting concrete, whilst the same numbers were made for the normal conventional concrete. Three (3)

specimens each for both mixes were tested on 7,21,28 and 56 days with equivalent cement to aggregate volumes being 1:2:4 (1:6) for the normal conventional concrete and 1: 3.75:2.25(1:6) for the self-compacting concrete.The compressive strength of the self-compacting concrete as compared to the normal concrete (control) offered a percentage increase of 90.44% on the 7th day, a further increase to 98.82% on the 21st day, and reduced to 43.86% on the 28th day and 33.07% on the 56th day. This marginal increase shows that self-compacting concrete offers better compressive strength than conventional concrete even under the same curing parameters and aggregate ratios. For the split tensile strength, the self-compacting concrete showed a percentage increase of 71.96% on the 7th day, 80.56% on the 21st day, the highest being 98.99% on the 28 days and reduced to 49.55% on the 56th day as compared to the normal concrete (control). This shows that the self-compacting concrete has a better tensile capacity than the conventional concrete(control). This means the self-compacting concrete is the least brittle and has a higher tensile strength than the normal concrete (control).The flexural strength recorded a declining differential percentage increase of 93.24% on the 7th day, 56.59% on the 21st day, 46.53% on the 28th day, and 28.01% on the 56th day. This shows that the self-compacting concrete has a higher ability of composites to resist bending deflection when the force is applied. Hence this was an indirect measure to compare the tensile strength of both the self-compacting concrete and normal concrete(control) and was determined by a third point loading or centre point loading test of the specimen in which the self-compacting concrete specimen proved a higher flexural strength.

Since the self-compacting concrete does not need any vibration during casting, comparing the densities of both self-compacting concrete and the normal concrete (control), the self-compacting concrete shows a higher percentage increase in densities of all specimens. The self-compacting concrete exhibited a higher percentage increase in densities of all the concrete specimens which indicates good durability and less porosity of the concrete.

Keywords: Strength characteristics, Self-compacting concrete, Normal Conventional Concrete,cubes, cylinders, prisms.

I. INTRODUCTION

Concrete is composed of aggregates embedded in a cement matrix which fills the space between the aggregates and binds them together. Concrete is a very strong building material and the use of concrete predates back before the Roman Empire. It was widely used in the Middle East, Greece, and Egypt for buildings before the Romans made wide use of it for road construction (Ede and Aina, 2015). In each of these usages the components of concrete varied and from the mid-eighteenth century till date concrete has been the most common building material. Concrete has very good compressive strength and resistance to fire, but the tensile strength is just about 10% of the compressive strength and has been responsible for many recent kinds of research aimed at improving the general strengths of concrete (Zongjin, 2011; Ede and Abgede, 2015). As there has not been a better alternative over the years modern structures in developed and developing nations are mostly built in concrete. Joseph and Raymond (2014) found that concrete develops an average of 26 % of the 28 days strength in 1 day and 85 % in 21 days and concluded that concrete develops strength rapidly at an early age compared to later ages.

Self-Compacting Concrete (SCC), which flows under its own weight and does not require any external vibration for compaction, has revolutionized concrete placement. It is a solid blend that has a low yield pressure, high deformability, great isolation obstruction, and moderate consistency (Felekoğlu et al, 2007). It is a solid that streams under its own weight and requires outer vibration to go through compaction. The advancement of self-compacting concrete (SCC) is an attractive accomplishment in the development business to conquer issues related to cast setup concrete. Self-compacting concrete is not affected by the skills of workers, the shape and number of reinforcing bars, or the arrangement of a structure and, due to its high fluidity and resistance to segregation it can be pumped longer distances (Bartos, 2000). Where it is difficult to use compacting vibrators for the consolidation of concrete it is essential to use self-compacting concrete. SCC was first introduced in the late 1980s by Japanese researchers, is highly workable concrete that can flow under its own weight through restricted sections without segregation and bleeding (Tang, 2017).

For SCC, it is generally necessary to use superplasticizers in order to obtain high mobility. Adding a large volume of powdered material or viscosity-modifying admixture can eliminate segregation. The powdered materials that can be added are fly ash, silica fume, limestone powder, glass filler, and quartzite filler (Guatham et al., 2015). Since self-compatibility is largely affected by the characteristics of materials and the mix proportions, it becomes necessary to evolve a procedure for the mix design of SCC. Investigations for establishing a rational mix-design method and self-compatibility testing methods have been carried out from the viewpoint of making it standard concrete. SCC is cast so that no additional inner or outer vibration is necessary for the compaction (Sukumar et al., 2008). It flows like “honey” and has a very smooth surface level after placement. With regard to its composition, self-compacting concrete consists of the same components as conventionally vibrated concrete, which are cement, aggregates, and water, with the addition of chemical and or mineral admixtures in different proportions (Zhu et al., 2016).

Koehler and Fowler (2007) proposed a mixed proportioning system for SCC and in this system, the coarse aggregate and fine aggregate contents were fixed and self-compatibilitywas achieved by adjusting the water /powder ratio and superplasticizer dosage. The coarse aggregate content in self-compacting concrete is generally fixed at 50 percent of the total solid volume, the fine aggregate content is fixed at 40 percent of the mortar volume, and the water /powder ratio is assumed to be 0.9-1.0 by volume depending on the properties of the powder and the superplasticizer dosage (Bibm, 2005). The required water /powder ratio is determined by conducting several trials. In practice, the fresh state of SCC shows high fluidity, self-compacting ability, and segregation resistance all of whichinfluence the reduction of risk of honeycombing of concrete (Lofty et al., 2015). The dependability and durability of reinforced concrete structures can greatly be increased with the above good properties of SCC produced. The constituent materials, used for the production of Self-Compacting Concrete (SCC) shall generally comply with the requirements of BS-EN 206.

Three distinct fresh concrete properties essentially define SCC and are fundamental to its performance both in the plastic and hardened state. These properties are also interrelated and must be maintained for a required period after mixing (Kim et al., 2010). To achieve these properties, material selection, proportioning, and quality control including production control are critical. The three essential fresh properties required by SCC are:

I. Filling Ability: The concrete must have the ability to flow and fill all parts within the formwork under its weight without leaving voids. As it is highly fluid it can flow considerable distances both horizontally and upwards and fill vertical elements from the bottom.

II. Passing Ability: The concrete containing the required aggregate size must have the ability to flow through restricted spaces between reinforcements and other embedded objects under its weight without blocking or segregation.

III. Segregation Resistance: The concrete must be able to satisfy both the filling ability and passing ability requirements while it remains homogeneous both during transport, placing, and after placing.

Concrete has considerable compressive or crushing strength, but is somewhat deficient in shearing strength, and distinctly weak in tensile or pulling strength (Golewski, 2019). The compressive strength (CS) of concrete denotes the level of uniaxial compressive stress, which refers to the concrete properties of concrete after hardening (Sabet et al., 2013). Self-compacting concrete (SCC) is widely used because it can be placed easily in complicated formwork and with a high degree of reinforcement without the need for vibration (Nepomuceno et al., 2017).

2. MATERIALS AND METHODS

2.1 Materials

The concrete mix comprised ordinary Portland cement which satisfied the requirement of BS 12:1991; river sand as fine aggregate; crushed granite as coarse aggregate (12mm); and potable water. In addition, a superplasticizer was added to the concrete to produce self-compacting concrete. Figure 1 shows the coarse aggregates used in the study.

2.1.1 Superplasticizer

Superplasticizers are an essential component of modern concrete since they improve workability at low water-to-cement levels, allowing to productionof long-lasting and environmentally friendly concrete. Superplasticizers are high-range water reducers that comply with ASTM C 1017 and are used in concrete to provide high-slump streaming concrete with a low-to-normal slump and water-cement ratio. Flowing concrete is a very fluid and workable concrete that requires minimal to no vibration to compress and is generally free of bleeding and segregation.

The type of superplasticizer used for this research was MC-Power flow 6425

Figure 1: Coarse aggregates (gravel)

2.2 Sieve Analysis

Tests of particle size distribution of the aggregates and silt content in fine aggregates were conducted per BS 812 Part 103 (1985).

2.3 Design of test specimens

Tables 1 and 2 present the details of test specimens for different mixes as outlined in the following:

Type A – cement, sand, gravel.

Type B– cement, sand, gravel and superplasticizer.

Table 1: Details of compressive strength test specimens.

Type of test specimen	Curing days					**Mix ratios**
		7	21	28	56	
A (control)	Cement, river sand, gravel	3	3	3	3	1:2:4, w/c 0.55
B	Cement, river sand, gravel, superplasticizer.	3	3	3	3	1:3.5:2.5 concrete mix, w/c ratio 0.28, superplasticizer of 1.4%
Total Number of cubes		24				

Table 2: Details of Split tensile strength test specimens.

Type of test specimen	Curing days					**Mix ratios**
		7	21	28	56	
A (control)	Cement, river sand, gravel	3	3	3	3	1:2:4, w/c 0.55
B	Cement, river sand, gravel, superplasticizer.	3	3	3	3	1:3.5:2.5 concrete mix, w/c ratio 0.28, superplasticizer of 1.4%
Total number of cubes		24				

Table 3: Details of Flexuralstrength test specimens.

Type of test specimen	Curing days					Mix ratios
		7	21	28	56	
A (control)	Cement, river sand, gravel	3	3	3	3	1:2:4, w/c 0.55
B	Cement, river sand, gravel, superplasticizer.	3	3	3	3	1:3.5:2.5 concrete mix, w/c ratio 0.28, superplasticizer of 1.4%
Total Number of cubes		24				

2.4 Preparation of Concrete Test Specimens

2.4.1 Mix Design

Concrete mix proportions of 1:2:4 (cement; fine aggregates; coarse aggregate) by weight with a water/cement ratio of 0.55 were used to prepare the control concrete and a mix proportion of 1:3.5:2.5 (cement; fine aggregates; coarse aggregate) by weight with water /cement ratio of 0.28, and 1.4**%** of cement weight for the Superplasticizer to prepare the Self-Compacting concrete. The concrete mix design was per IS: 10262 (1982). The cement content of 380 kg / m^3 was used to meet a minimum requirement of 300 kg / m^3 to avoid the balling effect. 12.5 mm is the average size of the coarse aggregate. A sieve analysis and silt test conforming to BS 1377 (part 1): 1990 were carried out for both the fine and coarse aggregate. A silt test was conducted on the fine aggregatesper BS 1377 (part 2):1990.

2.4.2 Mixing, Casting and Curing

Mixing of the concrete was done mechanically in a concrete mixer. The proportionsof fine aggregates and cement were first batched into the concrete mixer, followedby the coarse aggregates, mixing of the constituent materials was done inthe dry state for about two minutes, and then batched water was progressively added to the dry mixed materials in the mixer.

Mixing was standardized and had a consistent hue in a plastic mix. For thorough mixing, the time for blending was 1.5 to 2 minutes per rotation. The concrete mixer's output was 15 to 20 mixtures per hour.A slump test was conducted to determine the workability of the concrete. A total of 24 concrete cubes measuring 150mm x 150mm x 150mm, 24 cylinders measuring 150mm x 300mm,and 24 prisms measuring 150mm x 150mm x 500mm were cast to study the compressive strength, split tensile strength, and flexural strength of the concrete mixes. Concrete for each test specimen was cast in four layers and each layer was compacted by tampering 25 strokes using a rod. Figure 2 shows the concrete cubes, cylinders, and prisms.

Curing of the test cubes, cylinders, and prisms was done by covering specimens with a sack and keptat an ambient average laboratory temperature of 28ºC and 100 percent relative humidity to avoid micro–cracking of the test specimens**.**

(a) Concrete test cubes, cylinders and Prisms

Figure 2: Concrete test specimens

2.5 Testing of Specimens

2.5.1 Compressive Strength

The test specimens were first weighed to determine the density of each concrete mix. The test was conducted in 150mm x 150mm x 150mm concrete cubes in a compression testing machine after a curing period of 7 days, 21 days, 28 days, and 56 days for 7th, 21st,28th, and 56th-day strength, respectively. The cubes were loaded monotonically until failure at a rate of 140kg/cm^2 per minute per British Standards BS 1881: part 116 (1983). Figure 3a shows a concrete cube specimen under test.

The compressive strength of concrete was calculated using the formula in equation 1;

$f_{cu} = P/A$ Eq 1

where:

f_{cui} = Compressive strength of concrete (N/mm^2)

P = maximum compressive load (N)

A = Cross-sectional area of cube (mm^2)

2.5.2 Split Tensile Strength

The split tensile test was carried out on 150mm x 300mm concrete cylinders and provided an indirect way of determining the tensile strength of the concrete. The test was carried out on the cylindrical samples after 7 days, 21 days, 28 days, and 56 days for 7th, 21st,28th, and 56th-day strength, respectively. The specimen was placed length-wise in a compression test machine as shown in Figure 3b, and loading was applied along its length until failure per BS 1881; part 116:1983. The tensile strength of the concrete was computed using the formula:

$$f_t = 2P / \pi DL \qquad \text{Eq 2}$$

where:

f_t = tensile strength of concrete (N/mm^2)

P = maximum applied load (N)

D = diameter of cylinder (mm)

L = Length of cylinder (mm)

2.5.3 Flexural strength

The flexural strength or modulus of rapture test was carried out on 150mm x 150mm x 500mm concrete prisms and provided an indirect way of determining the tensile strength of the concrete. The test was carried out on plain concrete prism after 7 days, 21 days, 28 days, and 56 days of curing for 7th,21st,28th, and 56th day strength, respectively. The specimen was placed length-wise in a beam test machine as shown in Figure 3c, and loading was applied at the center of the prism across its length until failure with supports at ends leaving a clearance of 100mm at both ends.

This test wasper BS 1881; part 116:1983. The tensile strength of the concrete was computed using the formula:

$f_t = 1.5\ [PmaxL/BD^2]$ Eq 3

where:

f_t = tensile strength of concrete (N/mm^2)

P = maximum applied load (N)

D = depth of prism (mm)

B = breadth of prism (mm)

L = span of beam (mm)

(a) Concrete cube under test

(b) Split concrete cylinder under test

(c) Concrete Prisms under test

Figure 3: Concrete specimens in test machine

3.0 RESULTS AND DISCUSSION

3.1 Sieve Analysis

Figure 4 shows the particle size distribution for the coarse aggregate and fine aggregate. The results show that the coarse granitic aggregate lies within 6.3mm and 37.5mm. On the other hand, the fine aggregate component falls within 0.15mm and 10mm.

The effective size (D_{10}) of fineaggregate was 0.46mm. while the effective size was 14.5mm for the coarse crushed granitic aggregate. The coefficient of uniformity($C_u = D_{60}/D_{10}$) was 1.66 for the crushed coarse aggregate and 1.96 for fine aggregates. These values of C_u less than 5 indicated the aggregate was poorly graded soil materials.

The coefficient of curvature ($C_c = D_{30}^2 / D_{10} D_{60}$) for the different aggregates was as follows: Crushed coarse aggregate = 1.27; Fine aggregates = 1.0. With a C_c of between 1.0 and 3.0, the grain sizes would be expected to be so arranged that dense packaging was possible (BS 410:1986; BS 812: 1973 1990; Neville, 1986). With a C_c value of 1.27, the crushed coarse aggregate would result in denser and stronger concrete compared with all the other aggregates whose C_c value was 1.0 and coincident with the lower limit.

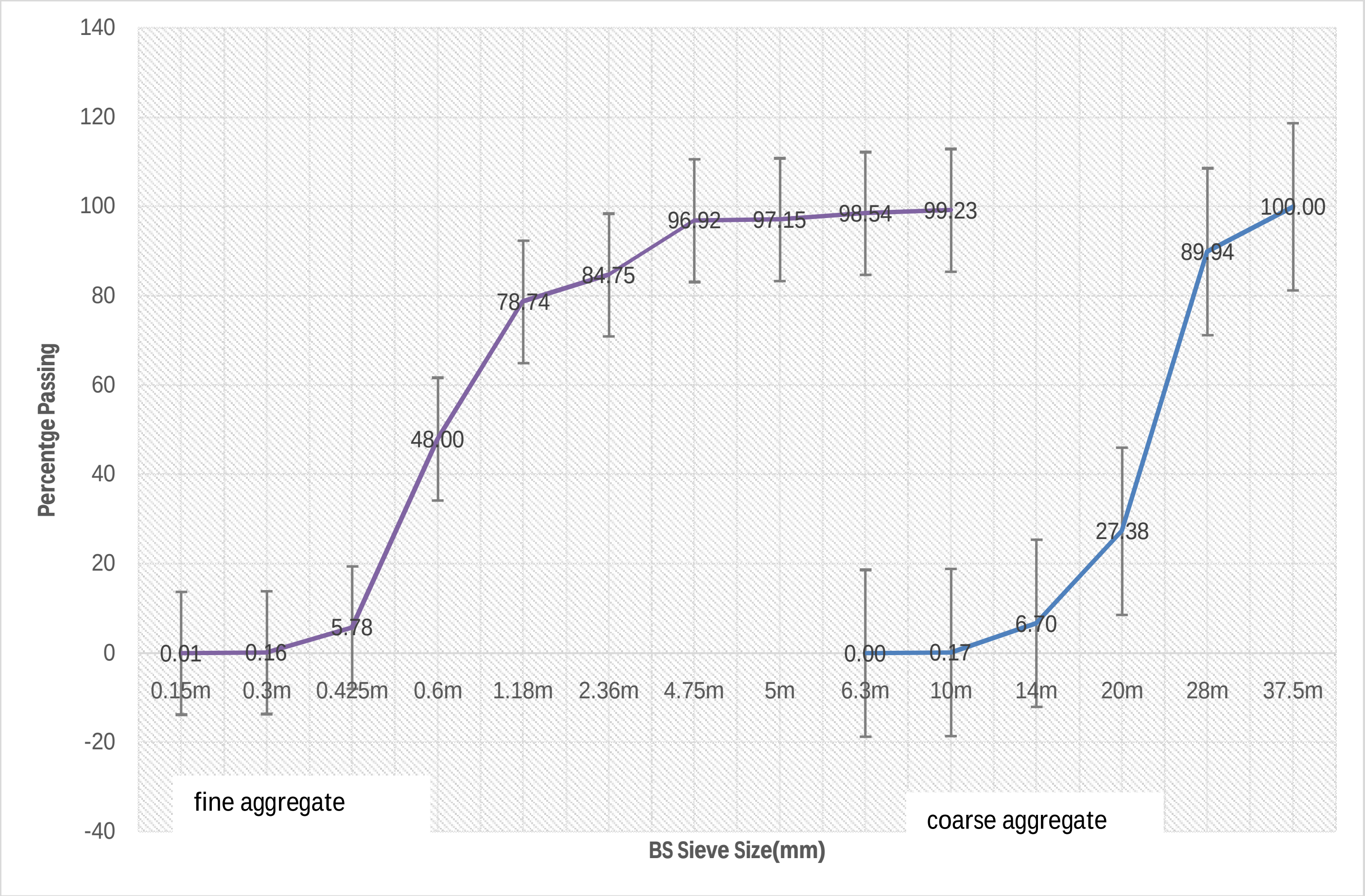

Fig 4 Particle Size Distribution of virgin coarse aggregate, and Fine aggregates.

3.2 Silt Content

The test results of silt content in the fine aggregates are presented in Tables 4 and 5, respectively. The average silt content recorded was 3.33 percent in the fine aggregates respectively These values were less than the permissible maximum silt content limit of 8 percent of sand for concrete production (BS 882:1992).

3.3 Density

The results of density assessment of the various mixes are presented in Table 5-7. For all the mixes, the density of concrete increased as curing continued from 7 to 28 days. The percentage changes in the density of mixes concerning the control are shown in brackets where (–ve) denotes decrease and (+ve) denotes increase. It can be observed from the table that the density of all the mixes meets the standard requirements of the normal weight of concrete.

Table 4: Silt Content in River Sand

DETERMINATION OF SILT CONTENT				
OBSERVATION SHEET				
Number	**Description**	**Sample No**		
		Sample 1 (ml)	Sample 2 (ml)	Sample 3 (ml)
1	Level of content (ml)	150	150	150
2	Depth of sand without silt -V1 (ml)	80	80	80
3	Thickness of visible silt V2 (ml)	2	4	2
4	Volume of Water (ml)	70	70	70
5	Percentage by volume of Silt depth to sand thickness (%) $\frac{V2}{V1} \times 100$	2.5%	5%	2.5%
	Average Content	**3.33%**		

Table 5: Density of concrete Cube mixes

MIXES	**AVERAGE DENSITY** (kg/m^3)			
	7 DAYS	21 DAYS	28 DAYS	56 DAYS
Fine Aggregates, coarse aggregate and cement (type A - CONTROL)	2075.36	2255.86	2319.18	2416.58
Fine Aggregates, coarse aggregate, cement and superplasticizer (type B)	2424.9 (+16.84)	2187.73 (-3.02)	2380.68 (+2.65)	2483.52 (+2.77)

(Percentage change from control (Type A) in brackets)

Table 6: Density of concrete Cylinder mixes

MIXES	**AVERAGE DENSITY** (kg/m^3)			
	7 DAYS	21 DAYS	28 DAYS	56 DAYS
Fine Aggregates, coarse aggregate and cement (type A - CONTROL)	2298.29	2226.04	2226.04	2279.71
Fine Aggregates, coarse aggregate, cement and superplasticizer (type B)	2300.28 (+0.09)	2330.28 (+4.68)	2330.28 (+4.68)	2600.94 (+14.09)

(Percentage change from control (Type A) in brackets)

Table 7: Density of concrete Prism mixes

MIXES	**AVERAGE DENSITY** (kg/m^3)			
	7 DAYS	21 DAYS	28 DAYS	56 DAYS
Fine Aggregates, coarse aggregate and cement (type A - CONTROL)	2410.60	2404.93	2597.67	2558.88
Fine Aggregates, coarse aggregate, cement and superplasticizer (type B)	2604.94 (+8.06)	2604.94 (+8.32)	2617.53 (+19.86)	2644.2 (+3.33)

(Percentage change from control (Type A) in brackets)

3.4 Compressive strength

The compressive strength test for concrete measures the load-bearing capacity of the concrete before failure. Concrete compressive strength goes from 15N/mm^2 to 30N/mm^2 for general loading on light structures and beyond for heavily loaded structures.

Table 8. Average Compressive strengths of concrete mixes

SPECIMEN	7 Days	21 Days	28 days	56 days
Type A Control	15.59	17.02	24.28	26.91
Self-compacting concrete	30.00 (+90.44)	33.84 (+98.82)	34.93 (+43.86)	35.81 (+33.07)

Note: Figures in brackets denote the percentage change of mix strength from the control mix (Type 1).

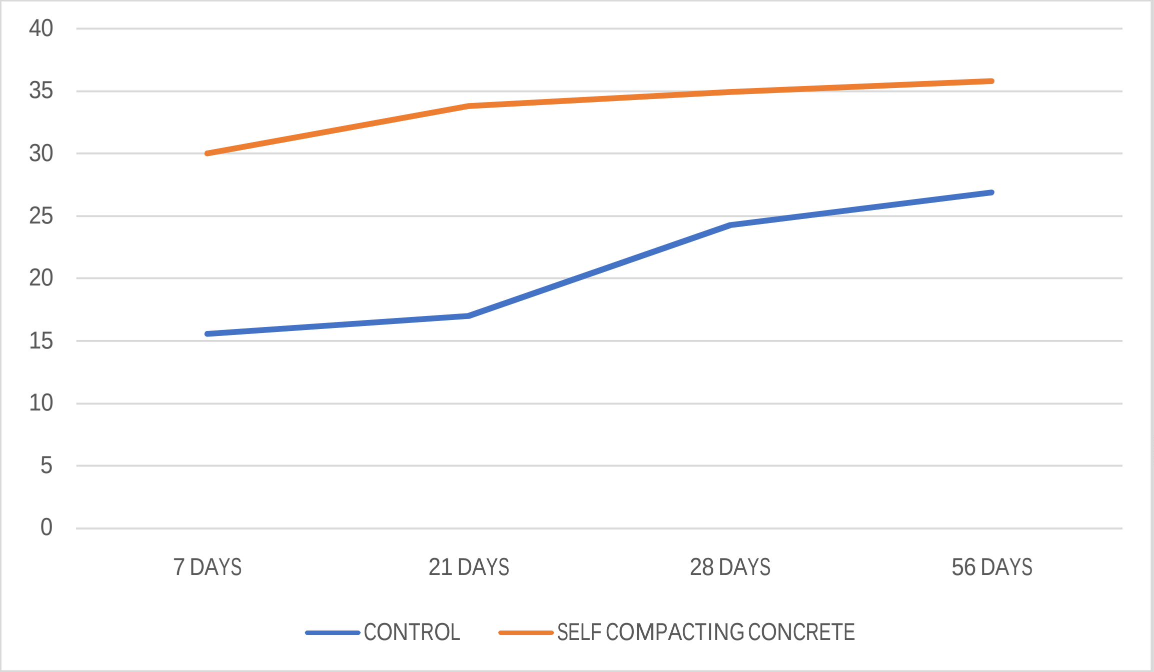

Figure 5. Compressive strengths of the concrete specimens at different ages

Table8presentsthe results of average compressive strength for the various concrete mixes. They illustrate a general increase of strength with increasing curing days with the highest strength occurring as expected on the 56th day for all mixes. The results are also illustrated in Figure 5. This trend indicates a continuous hydration of the cement matrix in the mixes. The results also present the percentage changes in compressive strength of the self-compacting concrete from the control mix (Type A). The table shows that the self-compacting concrete gave the highest or best compressive strength for all mixes.

3.5. Split tensile strength

The split tensile test for concrete measures the tensile strength capacity of the concrete. Generally, the direct concretetensile strength and the split cylinder tensile strength vary from 5 to 13 percent, and the flexural strength from 11 to 23 percent of the concrete cube compressive strength. (Jackson and Dhir, 1996). These ratios may vary even further depending on the composition of the concrete mix.

Table 9. Average split tensile strengths achieved by concrete specimens

	7 Days	21 Days	28 days	56 days
Type A Control	1.89	2.16	2.97	4.42
Self-compacting concrete	3.25 (+71.96)	3.90 (+80.56)	5.91 (+98.99)	6.61 (+49.55)

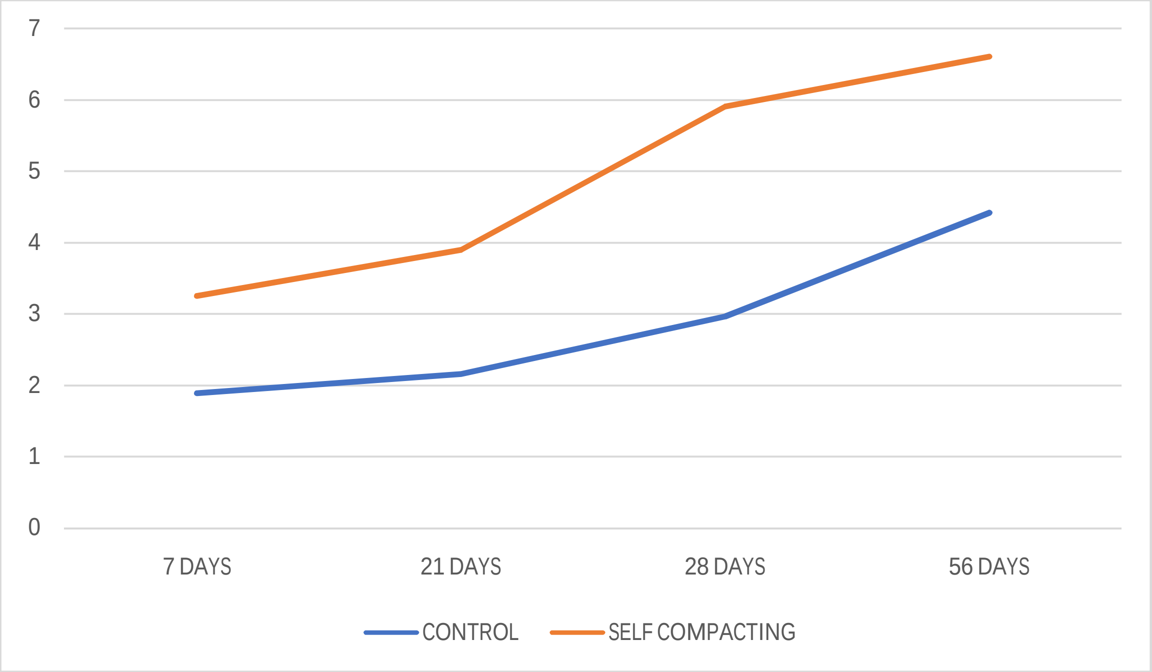

Figure6.Split tensile strengths of the concrete specimens at different ages

The split tensile strength of the concrete generally increased with the curing days as illustrated in Table 7 and Figure 6. A comparison of the influence of the various aggregate replacements on the concrete mix shows that the Self-Compacting Concrete (Type B) mix which comprises ordinary Portland cement, coarse aggregate, river sand, and superplasticizer provided the best option as the percentage of tensile strength was highest relative to the control mix.

3.6. Flexural Strength

Flexural Strength or modulus of rapture dictates how a material behaves when bent, whether it will hold or break. This measures the durability and resistance of materials under study. Generally, flexural strength is a measure of a material's resistance to deformation under bending forces, hence the deflection and cracking behavior of concrete depend on the flexural tensile strength of concrete (Ahmed Mohd et al., 2016). Standardized testing methods such as 3-point and 4-point bending tests are used to determine a material's flexural strength, with variations in testing to suit different materials and provide insight into their characteristics under bending loads.

Table 10. Average Flexural strength achieved by concrete specimens

	7 Days	21 Days	28 days	56 days
Type A Control	4.198	7.4249	8.4302	11.7695
Self-compacting concrete	8.1124 (+93.24)	11.6266 (+56.59)	12.3524 (+46.53)	15.0664 (+28.01)

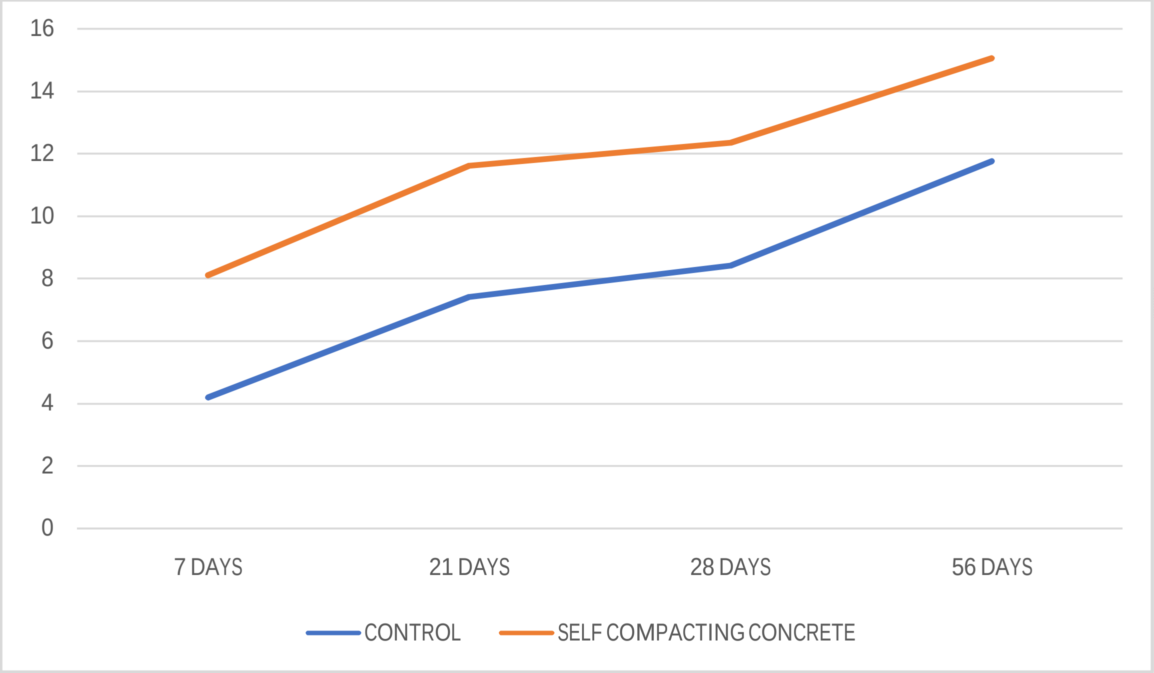

Figure 7. Flexural strength of the concrete specimens at different ages

4. DISCUSSIONS OF TEST RESULTS

The compressive strength of the self-compacting concrete as compared to the normal concrete (control) offered a percentage increase of 90.44% on the 7th day, a further increase to 98.82% on the 21st day, and reduced to 43.86% on the 28th day and 33.07% on the 56th day. This marginal increase shows that self-compacting concrete offers better compressive strength than conventional concrete even under the same curing parameters and aggregate ratios.

For the split tensile strength, the self-compacting concrete showed a percentage increase of 71.96% on the 7th day, 80.56% on the 21st day, the highest being 98.99% on the 28 days and reduced to 49.55% on the 56th day as compared to the normal concrete (control). This shows that the self-compacting concrete has a better tensile capacity than the conventional concrete(control). This means the self-compacting concrete is the least brittle and has a higher tensile strength than the normal concrete (control).

The flexural strength recorded a declining differential percentage increase of 93.24% on the 7th day, 56.59% on the 21st day, 46.53% on the 28th day, and 28.01% on the 56th day. This shows that the self-compacting concrete has a higher ability of composites to resist bending deflection when the force is applied. Hence this was an indirect measure to compare the tensile strength of both the self-compacting concrete and normal concrete(control) and was determined by a third point loading or center point loading test of the specimen in which the self-compacting concrete specimen proved a higher flexural strength.

Since the self-compacting concrete does not need any vibration during casting, comparing the densities of both self-compacting concrete and the normal concrete (control), the self-compacting concrete shows a higher percentage increase in densities of all specimens. The self-compacting concrete exhibited a higher percentage increase in densities of all the concrete specimens which indicates good durability and less porosity of the concrete.

5. CONCLUSION

Based on the various test results, it is concluded that self-compacting concrete provides better characteristics in terms of durability, strength, and economy in concrete production, although their use should be dependent on the percentage volume of superplasticizer added to achieve higher strength properties inthe utilizationtosubstitute conventional concrete (control). In terms of the compressive, flexural, and tensile strength of concrete produced incomparison with both the control and self-compacting concrete, theresults still point out clearly that the self-compacting concrete mixes offer the highest compressive, tensile,and flexural strength.

6. RECOMMENDATIONS FOR SCC AS PREFERED OPTION

Conventional concrete which uses naturally sourcedconventional aggregates devoid of any superplasticizers or admixtures remained the best recommendation for all types of concrete works, regardless of the mix ratio until the emergence of the self-compacting concretewhich from research can offer inexpensive alternatives with the inclusion of admixtures/superplasticizers. However, in using these replacement materials it is recommended that:

(i) Self-compacting concrete offered higher compressive strengths of about 35.81 N/mm² at 56 days than the normal concrete of 26.91 N/mm², split tensile strength of about 6.61 N/mm² for self-compacting concrete, and 4.42 N/mm² for normal control concrete indicating a percentage increase of (+49.55%) and a flexural strength of 15.07N/mm² at 56 daysfor self-compacting concrete and 11.77N/mm² for normal concrete representing 28.01 percent increase which means the self-compacting concrete must be recommended for heavy load bearing reinforced concrete structures.

(ii) Since self-compacting concrete offers higher strengths in terms of compressive, tensile, and flexural using similar aggregate volumes, self-compacting concrete is deemed to be very economical and less expensive and lightweight to heavy structures and mass concrete. However, the concrete ratios can be increased accordingly using the same volume of superplasticizer dosage and volume of cement to give an average strength for such works.

(iii) Since self-compacting concrete attained very high strengths at the earlier ages, 7 and 21 days, the formwork can be removed earlier days than the normal control concrete which needs more time to cure and attain its required strengths.

(iv) Self-compacting concrete must be recommended as quality concrete for heavy-duty structures and those exposed to the weather since it has very low permeability and minimized voids due to its high density recorded.

(v) Self-compacting concrete should be recommended because of its easy-to-use requirements as the elimination of internal or external vibration for compaction, better flowability, workability, and pumpability.

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