International Journal of Research Studies in Science, Engineering and Technology
Volume 3, Issue 10, October 2016, PP 23-37
ISSN 2349-4751 (Print) & ISSN 2349-476X (Online)

Behavior of SCC (Self Compacting Concrete and NCC (Normal Compaction Concrete) Based on Size of Aggregate

[1]M. Sri Durga Vara Prasad, [2]Jagarlamudi.V.Subbarao, [3]Chennupati Sobharani

[1]M.Tech, Department of Civil Engineering, Chinthalpudi Engineering College, Ponnur (M), Guntur (D), A.P, India

[2]M.tech, Asst.prof, department of civil engineering, [3]M.tech,Head of the department, civil engineering

saicecg@gmail.com, sobha.chennupati@gmail.com

Abstract: *Controlled concrete is made with different variations of aggregates like 10mm, 12.5mm, 16mm and 20mm sizes and also made combination with the replacement of cement with Fly ash. But when came to our research for self-compacting concrete maximum size of aggregates used are 16mm only. Self compacting concrete is wide adopted in concrete for the employment of mass construction. Especially it is employed in the place of engorged reinforcement wherever the compaction can't be done simply. Aside from the assorted uses, it offers the speed of development, provides higher workability and therefore the rate of flow within the plane abundant difficult steel reinforcing bars. Self-compacting concrete may be a product wants the addition of admixtures like Viscosity Modifying Agent (VMA) and Air Entraining Agent (AEA) to the concrete mix so as to extend the benefit and therefore the rate of flow become ease and homogeneity. In this research paper, we study the fresh properties of self-compacting concrete with the variation of aggregates sizes like 10mm, 12.5mm, 14mm and 16mm from the total weight of coarse aggregates and also with the various combinations of admixtures. The fresh properties of self-compacting concrete are done such as passing ability, workability, flowability and finally compressive strength were compared with conventional concrete.* ***SCC characteristics such as flowability, passing ability and segregation resistance have been verified using slump flow, L box and V funnel tests.***

Keywords: *admixture, self compacting concrete, workabilty, aggregate, strength.*

1. Introduction

1.1. Self Compacting Concrete

The versatility and the application of concrete in the construction industry need not be emphasized. For two decades the research going on as normal and high strength concrete. As per IS: 456-2000 [code of rule for plain and reinforced] the concrete, which ranging from 25-55 MPa is called standard concrete and more than 55 MPa can called as high strength concrete.

SCC is a new kind of High Performance Concrete (HPC) which has an excellent deformability and segregation resistance. By name it can be defined as a concrete, which can flow through and fill the gaps of reinforcement and the corners of the molds without any need for external vibration. SCC compacts itself due to its self weight and de-aerates almost completely while flowing in the form work. SCC can also be used in situations where it is difficult or impossible to use mechanical compaction of fresh concrete, such as underwater concreting, cast in-situ pile foundations, machine bases and columns or walls with congested reinforcement. The high flow ability of SCC makes it possible to fill the formwork without vibration. Since its inception, it has been widely used in large construction works or projects in Japan. Recently, this concrete has gained wide use for different applications and structural configurations across the world.

Development of SCC is a very desirable achievement in the construction industry in overcoming the problems associated with cast-in place concrete. It is not affected by the skill of workers, shape and the amount of reinforcing bar arrangement of a structure. Due to its high fluidity and resisting power to segregation, it can be pumped over longer distances. It extends the possibility of use of various by products in its manufacturing. The use of SCC doesn't only shorten the construction period, but also ensures quality and durability of concrete. It replaces manual compaction of fresh concrete with a modern semi-automatic placing technology.

1.2. Advantages of Self Compacting Concrete

1. Less noise from vibrators and reduced danger from Hand Arm Vibration Syndrome (HAVS)
2. Safe working environment.
3. Speed of placement, resulting in increased production efficiency.
4. Ease of placement, requiring fewer workers for a particular pour.
5. Better assurances of adequate uniform consolidation.
6. Reduced wear and tear on forms from the vibrator.
7. Reduced wear on mixers due to reduced shearing action.
8. Improved surface quality and few bug holes, requiring fewer patching.
9. Improved durability.
10. Increased bond strength.
11. Reduced energy consumption from vibration equipment.
12. Best suited where reinforcement congestion is a problem.

1.3. Viscosity Modifying Agent

Viscosity modifying agents are added to increase the viscosity of the concrete so as avoid bleeding and segregation as chemical admixtures increase the flow ability of the concrete. To make sure that the concrete is not too runny, has a long setting period and loses its bonding VMAs are used. The addition of VMA depends on the cement being used. Result of VMA addition may vary from cement to cement. Each cement has one particular VMA which acts best with it. This project aims to draw a result based on this for Birla cement OPC 53 grade.

VMA's are admixtures designed for specific applications.

- Reducing the segregation in highly flow able / self-compacting concrete
- Reducing the washout in underwater concreting
- Reducing the friction and pressure in pumpable concrete
- Compensating for poor aggregates grading, especially the lack of finer particles in the sand.
- Reducing the powder content in self compacting concrete
- Reduction in bleeding in the laid concrete.

The main function of VMA is to be modifying the rheological properties of concrete, namely the yield point and plastic velocity.

- The yield point is the force needed to smart he flow of concrete. It is related to workability of the concrete. And can be assessed by the slump cone test.
- The plastic velocity is the resistance to flow under external pressure. Viscosity as we know is the resistance to flow caused by internal friction friction in the material. The speed of flow in the concrete is related to the plastic velocity and can be asses by the T_{50} during slump cone test or the V-funnel test.

1.4. Development of Self-Compacting Concrete In India

The development of Self Compacting Concrete (SCC) is considered as the most sought development in construction industry due to its numerous inherited benefits. In India, this technology is yet to realize its full potential. Central Road Research Institute (CRRI) [2005] New Delhi, has been working on SCC technology since the year 2000 and carried out significant research work on various aspects of SCC starting from selection of suitable ingredients including super plasticizer, viscosity modifying agent, mineral admixtures, mix proportion optimization, evaluation of the characteristic properties at fresh stage and hardened properties such as compressive strength, splitting tensile strength, flexural strength, Young's modulus of elasticity. Further, in-situ performance evaluation of the structural element cast by using SCC in comparison with conventional plasticized concrete of similar strength i.e. 50 MPa at 28 days were carried out by using semi-destructive and non-destructive test methods. Structural behavior of SCC in heavily reinforced T beams was conducted to study cracking pattern, deflection and ultimate load bearing capacity. On the basis of manufacturing cost, SCC is about 20% costlier than the conventional concrete of similar compressive strength which is compensated by several benefits of using it such as saving in electricity, saving in labor cost related to compaction work, increase in productivity etc. SCC technology is considered as an energy conservation technique in construction industry as it eliminates electricity requirement for compaction of concrete and provides ample opportunity to use by product materials such as fly ash, quarry dust etc. With a wide knowledge and experience in this technology, CRRI can provide technical advice/ suggestion related to the manufacturing of SCC.

Self Compacting Concrete (SCC) technology is a boon when Nuclear Power Corporation of India Limited (NPCIL) is planning for vast expansion of power generation within a short period of time. This concept can save time, cost, enhance quality, durability and moreover it is a green concept. In order to speed up the construction activities, to reduce the cycle time and to enhance quality, the innovative concept of self compacting concrete (SCC) is being considered in large scale for the construction work of Kaiga Power project (India).

2. Review of Literature

B. Krishna Rao[1] et presented on the consequence of dissimilar sizes of coarse aggregate on the properties of normal compacting concrete and self compacting concrete and their experimental study carried out to develop SCC (self compacting concrete) by using different sizes of aggregates (20mm; 16mm; 12.5; 10mm). Total eight mixes were investigated for M_{30} grade concrete. In my project, I am starting to prepare the mechanical properties of the NCC and workability properties on SCC of different size of aggregate ratios.

J. Guru Jawahar[2] et al presented on the effect of coarse aggregate blending on fresh concrete properties of self compacting concrete and mainly focused on coarse aggregate blending or balance in a coarse aggregate value of self compacting concrete by using crushed granite stones of sizes 20mm and 10mm to study the issue of fresh concrete properties.

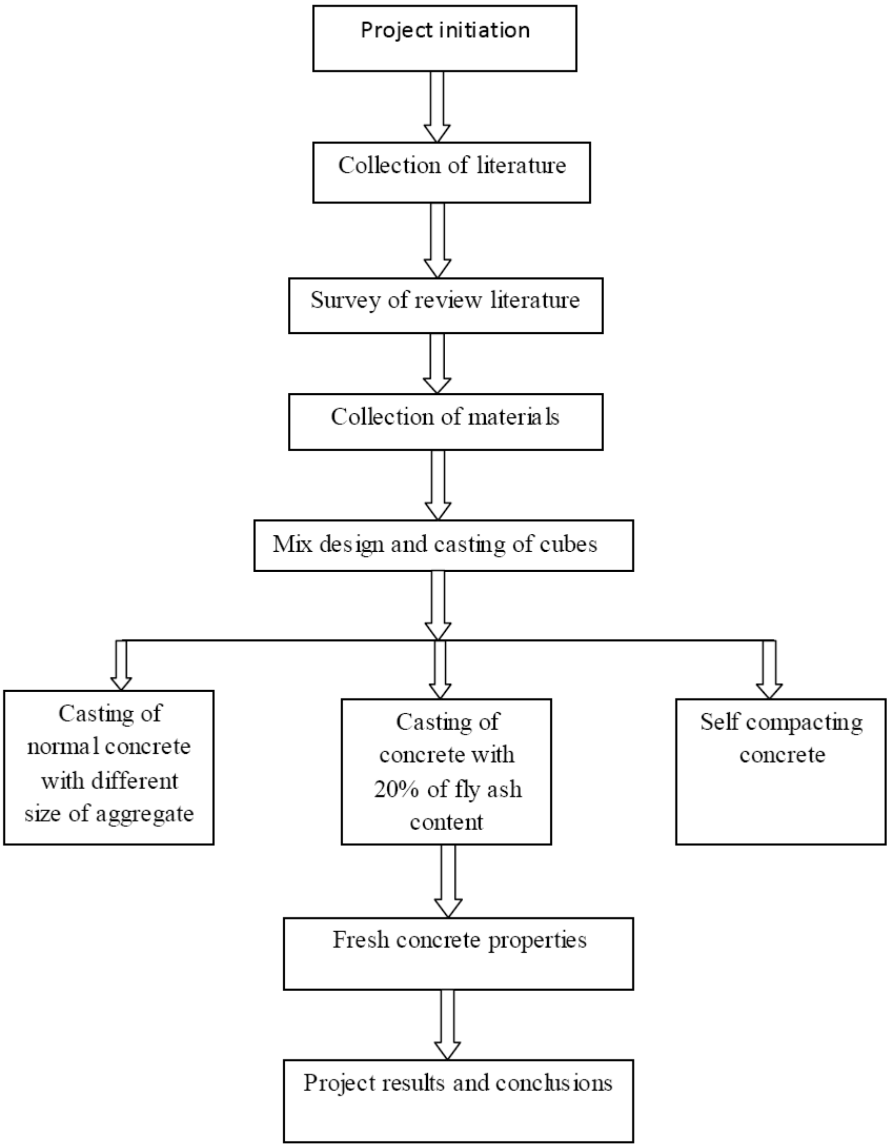
Kishore S.sable[3] et al presented on the comparison of normal compacted concrete and self compacted concrete in shear and torsion and investigated that it is possible and design a steel fiber reinforced self compacting concrete by incorporating fly ash. At the end of 28 days the SCC developed shear strength ranging from 3.56 to 7.29 in and SCC developed torsion strength ranging from 20.50 to 34.76 KN m for 28 days.

Umair baig[4] et al presented on the effect of self compacting concrete and aggregate size on anchorage performance at highly congested reinforcement regions which are mostly at beam column joint area and also an investigation was carried out to understand anchorage performance of reinforcement in self compacting concrete and normal concrete at highly congested regions under uni axial tensile loading. In present work a beam column joint is to preparing for that the normal compacted concrete can be prepared by using 20mm and 16 mm of coarse aggregate size and 10mm and 8mm size of aggregate can be used in self compacting concrete.

Chandak rajeev[5] et al presented on the influence of fine aggregate particle size and fly ash on the compressive strength of mortar for SCC .it is also necessary to replace some of the cement by mineral admixture such as fly ash to achieve an economical and durable concrete. The influence of fine aggregate particle size and fly ash on the compressive strength of mortar for self compacting concrete.

3. Methodology

3.1. Methodology



3.2. Material Used in NCC and SCC

Materials used play very important role in determing the workability of concrete, especially In SCC. The aggregates that are to be used should strictly adhere to the code and in case of coarse aggregate, maximum aggregate size to be used for good workability should 14 mm.

3.3. Cement

The cement used is 53 grades Ordinary Portland cement. The cement selected is as per the IS 12269(1987). The preliminary material test conducted to check the properties of cement are:

- fineness Test
- consistency test
- initial setting time
- Final setting time
- Specific gravity
- Compressive strength

3.4. Fly Ash

Class F fly ash is used as the mineral admixture in partial replacement of cement. The mineral admixture used is conforming with IS 3812(2000). Test that are conducted to determine its properties are:

- Specific gravity test
- Fineness test

3.5. Fine Aggregates

Fine aggregates used are river sand, which is the best for concreting. The fine aggregate conform to IS 383. The sand used as fines is well graded and passing 4.75mm IS sieve. Material testing is done in order to determine the physical properties of the sand being used.

Tests conducted are:

- Specific gravity
- Sieve analysis
- Fineness test
- Test for Silt and Clay

3.6. Coarse Aggregates

The coarse aggregate chosen for SCC was typically round in shape, well graded and smaller in maximum size than that used for conventional concrete. The size of coarse aggregate used in self compacting concrete was between 10mm to 16mm. The rounded and smaller aggregate particles provide better flowability and deformability of concrete and also prevent segregation. Graded aggregate is also important particularly to cast concrete in highly congested reinforcement or formwork having small dimensions. Crushed granite metal of sizes 16 mm to 10 mm graded obtained from the locally available quarries was used in the present investigation. The aggregates used are conforming to IS 383. Like the fine aggregates material testing is done for coarse aggregate also.

- Impact factor Test
- Crushing Strength Test
- Specific Gravity Test
- Absorption Test

3.7. Different Size of Coarse Aggregate Used in the Construction

Fig1.1. *16 mm size aggregate*

Fig1.2. *14 mm size aggregate*

Fig1.3. *12.5 mm size aggregate*

Fig1.4. *10 mm size aggregate*

3.8. Viscosity Modifying Agents

Fig1.3. *VMA sample*

Viscosity Modifying agents like MASTER MATRIX are used in this project. The main role of VMAs is to impart stability to the SCC. They are generally used in tandem with super plasticizer.

4. Experimental Programme and Mix Design

4.1. The Following Phases are the Mixes of NCC with and Without Fly Ash

- **NCC with 50%, 70%, 90% of total weight of aggregates without fly ash content.**

Mix-1:- **3 cubes for each mix contain 50% of total weight of aggregate**.

1) 20 mm → 50%
   16 mm → 50%
2) 16 mm → 50%
   12.5 mm → 50%
3) 12.5 mm → 50%
   10 mm → 50%

Mix-2:- **3 cubes for each mix contain 70% and 30% of total weight of aggregate.**

1) 20 mm → 70%
   16 mm → 30%
2) 16 mm → 70%
   12.5 mm → 30%
3) 12.5 mm → 70%
   10 mm → 30%

Mix-3:- 3 cubes for each mix contains 90% and 10% of total weight of aggregate

1) 20 mm → 90%
   16 mm → 10%

2) 16 mm → 90%
   12.5 mm → 10%

3) 12.5 mm → 90%
   10 mm → 10%

- **NCC with 50%, 70%, 90% of total weight of aggregates with containg fly ash content**

Mix-1:- 3 cubes for each mix contain 50% of total weight of aggregate.

1) 20 mm → 50%
   16 mm → 50%

2) 16 mm→ 50%
   12.5 mm→ 50%

3) 12.5 mm → 50%
   10 mm → 50%

Mix-2:- 3 cubes for each mix contains 70% and 30% of total weight of aggregate.

1) 20 mm → 70%
   16 mm → 30%

2) 16 mm → 70%
   12.5 mm → 30%

3) 12.5 mm → 70%
   10 mm → 30%

Mix-3:- 3 cubes for each mix contains 90% and 10% of total weight of aggregate

1) 20 mm → 90%
   16 mm → 10%

2) 16 mm → 90%
   12.5 mm → 10%

3) 2.5 mm → 90%
   10 mm → 10%

In the second phase to determine the workability properties on self compacting concrete (SCC). The following tests are going to be done with fresh concrete.

1) Slump flow test
2) T50cm slump flow test
3) V-funnel test
4) L-box test
5) U-box test.
6) J-Ring test

- **Plan of self compacting concrete (SSC) for different trails using different coarse aggregate ratio.**

Table4.1. *Plan of SCC*

Size of aggregate.	Trail-1 (Percentage of size of aggregate from total weight of aggregate.)	Trail-2 (Percentage of size of aggregate from total weight of aggregate)	Trail -3 (percentage of size of aggregate from total weight of aggregate)	Trail -4 (percentage of size of aggregate from total weight of aggregate)	Trail-5 (percentage of size of aggregate from total weight of aggregate)
16 mm	50%	0%	25%	25%	25%
14 mm	25%	50%	0%	25%	25%
12.5 mm	25%	25%	50%	0%	25%
10 mm	0%	25%	25%	50%	25%

4.2. Work Ability Criteria for Fresh SCC

Filling ability, passing ability and segregation resistance are the requirements for judging the workability criteria of fresh SCC. These requirements are to be fulfilled at the time of placing of concrete. Typical acceptance criteria for Self-compacting Concrete with a maximum aggregate size up to 16 mm.

Table4.1. *Acceptance criteria for Self-compacting Concrete.*

S.NO	METHOD	UNIT	TYPICAL RANGE OF VALUES	
			Minimum	Maximum
1	Slump flow	mm	600	800
2	Slump flow time	sec	2	5
3	V-funnel	sec	6	12
4	U-Box	$(h_2\text{-}h_1)$mm	0	30
5	L-Box	h_2/h_1	0.8	1.0
6	J-Ring	mm	0	10

4.2.1. Test Methods

It was observed that none of the test methods for SCC has yet been standardized, and neither the tests described are yet perfected or definitive. A brief description of the tests has been presented below. They are mainly ad-hoc methods, which have been devised specifically for SCC.

4.2.1.1. Slump Flow Test and T_{50} Cm Test

The slump flow is used to assess the horizontal free flow of SCC in the absence of obstructions. It was first developed in Japan for use in assessment of underwater Concrete. The diameter of the concrete circle is a measure of the filling ability of Concrete.

Slump Flow is definitely one of the most commonly used SCC tests at present. This test involves the use of slump cone with conventional concretes as described in ASTM C 143 [Standard Test Method for Slump of Hydraulic-Cement Concrete]. The main difference between Slump Flow Test and ASTM C 143 [Standard Test Method for Slump of Hydraulic-Cement Concrete] is that the Slump Flow Test measures the spread or flow of concrete sample, once the cone is lifted rather than the traditional slump (drop in height) of the concrete sample. The T50 test is also determined during the Slump Flow Test. It is simply the amount of time that the concrete takes to flow to a diameter of 50 centimeters.

a. Slump flow apparatus

The mould used is in the shape of a truncated cone with internal dimensions 200mm diameter at the base, 100mm diameter at the top and a height of 300mm. The base plate is of a stiff non- absorbing material of at least 700mm square, marked with center location for the slump cone, and further concentric circle of 500mm diameter. The other apparatus required are trowel, scoop, ruler, and a stop watch.

Fig4.1. *Slump ring*

Fig4.2. *Fresh concrete*

4.2.1.2. L-Box Test

This test, based on a Japanese design for underwater concrete, has been described by Petersson, 1999. This test assesses the flow of concrete, and also the extent to which it is subjected to blocking by reinforcement.

The apparatus consists of a rectangular-section box in the shape of an 'L', with a vertical and horizontal section, separated by a moveable gate, in front of which, vertical lengths of reinforcement bars are fitted. The vertical section is filled with concrete, and then the gate is lifted to let the concrete flow into the horizontal section. When the flow has stopped, the height of the concrete at the end of the horizontal section is expressed as a proportion of that remaining in the vertical section called as H2/H1 ratio or blocking ratio. It indicates the slope of the concrete when the concrete is at rest. This is an indication of passing ability, or the degree to which the passage of concrete through the bars is restricted.

The horizontal section of the box can be marked at 200mm and 400mm from the gate and the time taken to reach these points measured. These are known as the T20and T40times and are indicators of the filling ability.

Fig 4.3. *L-box testing* **Fig4.4.** *L-box testing*

4.2.1.3. V – Funnel Test

This test was developed in Japan and used by Ozawa et al, [1989]. The equipment consists of a V-shaped funnel, The V-funnel test is used to determine the filling ability of the concrete with a maximum aggregate size of 16mm. The funnel was filled with about 12 liter of concrete and the time taken for it to flow through the apparatus measured. After this the funnel was refilled concrete and left for 5 minutes to **s**ettle. If the concrete shows segregation then the flow time increases significantly.

Fig4.4. *V-funnel testing*

4.2.1.4. J – Ring Test

The J – Ring test has been developed at the University of Paisley. The test is used to determine the passing ability of the concrete. The equipment consists of a rectangular section (30mm x 25mm) open steel ring, drilled vertically with holes to accept threaded sections of reinforcement bar. These sections of bar can be of different diameters and spaced at different intervals in accordance with normal reinforcement considerations. The diameter of the ring of vertical bars is 300mm, and the height 100 mm.

The J – Ring can be used in conjunction with the Slump flow test. These combinations judge the flowing ability and the passing ability of the concrete. The slump flow spread was measured to assess flow characteristics. The J – Ring bars can be set at any spacing to impose a more or less severe test of the passing ability of the concrete. The difference in height between the concrete inside and that just outside the J – Ring is measured. This is an indication of passing ability, or the degree to which the passage of concrete through the bars is restricted.

a. Equipment

The mould used is in the shape of a truncated cone with the internal dimensions 200mm diameter at the base, 100mm diameter at the top and a height of 300mm. The base plate is of a stiff non-absorbing material, at least 700mm square, marked with center location for the slump cone, and further concentric circle of 500mm diameter. A rectangular section (30mm x 25mm) open steel ring, drilled vertically with holes is called as J - ring. The holes can be screwed threaded sections of reinforcement bar. The other apparatus required are trowel, scoop, ruler, and a stop watch.

Fig4.4. *J-ring apparatus*

Fig4.5. *J-ring testing*

4.2.1.5. U – Box Test

This test was developed by the Technology Research Centre of the Taisei Corporation in Japan. This test is also called as box-shaped test. It is used to measure the filling ability of self-compacting concrete. The apparatus consists of a vessel that is divided by a middle wall into two compartments, shown by R1 and R2 in an opening with a sliding gate was fitted between the two sections. Reinforcing bars with nominal diameters of 13 mm are installed at the gate with centre-to-centre spacings of 50 mm. This creates a clear spacing of 35 mm between the bars. The left hand section was filled with about 20 liters of concrete. The gate was lifted and the concrete flows upwards in the other section. The height of the concrete in both sections is measured.

Fig4.6. *U-box testing*

Fig4.7. *L-box testing*

4.3. Mix Design

Cement = 432.55 kg/m^3

Water = 186 kg/m^3

Fine aggregate = 786.51 kg/m^3

Coarse aggregate = 1068.46 kg/m^3

Table4.3. *Mix design Ratio for normal concrete*

Cement	Fine aggregate	Coarse aggregate
432.55	786.5	1068.46
1	1.81	2.47

Mix design proportions for normal concrete with 20% of fly ash content :-

Cement = 380.645 kg/m^3

flyash@20% = 95 kg/m^3

Water = 186 ltr

Fine aggregate = 694.96 kg/m^3

Coarse aggregate = 944.103 kg/m^3

Table4.4. *Mix design Ratio for flyash concrete*

Cement	Fine aggregate	Coarse aggregate
380.645	694.96	944.103
1	1.82	2.48

Mix design calculations for M40 grade by using admixtures

Cement = 378.645 kg/m^3

flyash@20% = 95 kg/m^3

Water = 191 ltr

Fine aggregate = 621.23 kg/m^3

Coarse aggregate = 873.23 kg/m^3

Table4.5. *Mix design Ratio for self compacting concrete*

Water content (kg/m^3)	Cement content (kg/m^3)	Fine aggregate (kg/m^3)	Coarse aggregate (kg/m^3)	VMA
191.6	378.3	621.23	873.23	2%

5. Results and Conclusion

5.1. Results

Table5.1. *test results for 28 days of 50% weight of total aggregate*

Size of coarse aggregate	Percentage(%) of aggregates of each size from total weight of aggregates	Compressive strength N/mm^2
20 mm 16 mm	20 mm -50% 16 mm -50%	44.12 N/mm^2
16 mm 12.5mm	16 mm -50% 12.5 mm -50%	46.10 N/mm^2
12.5mm 10 mm	12.5mm -50% 10 mm -50%	46.53 N/mm^2

Table5.2. *test results for 28 days of 70% and 30% weight of total aggregate*

Size of coarse aggregate	Percentage(%) of aggregates of each size from total weight of aggregates	Compressive strength N/mm^2
0 mm 16 mm	20 mm -70% 16 mm -30%	43.11 N/mm^2
16 mm 12.5mm	16 mm -70% 12.5 mm -30%	44.32 N/mm^2
12.5mm 10 mm	12.5 mm -70% 10 mm -30%	45.12 N/mm^2

Table5.3. *test results for 28 days of 90% and 10% weight of total aggregate*

Size of coarse aggregate	Percentage(%) of aggregates of each size from total weight of aggregates	Compressive strength
20 mm 16 mm	20 mm -90% 16 mm -10%	42.33 N/mm^2
16 mm 12.5mm	16 mm -90% 12.5 mm -10%	43.01 N/mm^2
12.5mm 10 mm	12.5 mm -90% 10 mm -10%	44.43 N/mm^2

Table5.4. *test results for 28 days of 50% weight of total aggregate with flyash@20%*

Size of coarse aggregate	Percentage(%) of aggregates of each size from total weight of aggregates	Compressive strength
20 mm 16 mm	20 mm -50% 16 mm -50%	46.13 N/mm^2
16 mm 12.5mm	16 mm -50% 12.5 mm -50%	48.24 N/mm^2
12.5mm 10 mm	12.5 mm -50% 10 mm -50%	51.14 N/mm^2

Table5.5. *test results for 28 days of 70% and 30% weight of total aggregate with flyash@20%*

Size of coarse aggregate	Percentage(%) of aggregates of each size from total weight of aggregates	Compressive strength N/mm^2
20 mm 16 mm	20 mm -70% 16 mm -30%	45.13 N/mm^2
16 mm 12.5mm	16 mm -70% 12.5 mm -30%	47.43 N/mm^2
12.5mm 10 mm	12.5 mm -70% 10 mm -30%	48.61 N/mm^2

Table5.6. *test results for 28 days of 90% and 10% weight of total aggregate with flyash@20%*

Size of coarse aggregate	Percentage(%) of aggregates of each size from total weight of aggregates	Compressive strength N/mm^2
20 mm 16 mm	20 mm -90% 16 mm -10%	43.11 N/mm^2
16 mm 12.5mm	16 mm -90% 12.5 mm -10%	44.62 N/mm^2
12.5mm 10 mm	12.5 mm -90% 10 mm -10%	47.54 N/mm^2

5.2. Test Results of SCC of Fresh Cocnrete

Table5.7. *Trail-1 different ratio of coarse aggregate of total weight of aggregates*

s.no	Type of test conducted	Percentage of size of coarse aggregate	
		Size of aggregate	Percentage of aggregate
		16 mm 14 mm 12.5 mm 10 mm	50% 25% 25% 0%
		Test values obtained	
		Values obtained	Accepted value
1	Slump flow	690	650-800
2	Slump flow time	3	2-5
3	V-funnel ,seconds	9	8-12
4	U-box, mm	11	30(max)
5	L-Box	0.9	0.8 – 1.0
6	J-ring test	6	0-10

Table5.8. *Trail-2 different ratio of coarse aggregate of total weight of aggregates*

s.no	Type of test conducted	Percentage of size of coarse aggregate	
		Size of aggregate	Percentage of aggregate
		16 mm 14 mm 12.5 mm 10 mm	0% 50% 25% 25%
		Test values obtained	
		Values obtained	Accepted value
1	Slump flow	710	650-800
2	Slump flow time	4	2-5
3	V-funnel ,seconds	10	8-12
4	U-box, mm	13	30(max)
5	L-Box	0.92	0.8 – 1.0
6	J-ring test	8	0-10

Table5.9. *Trail-3 different ratio of coarse aggregate of total weight of aggregates*

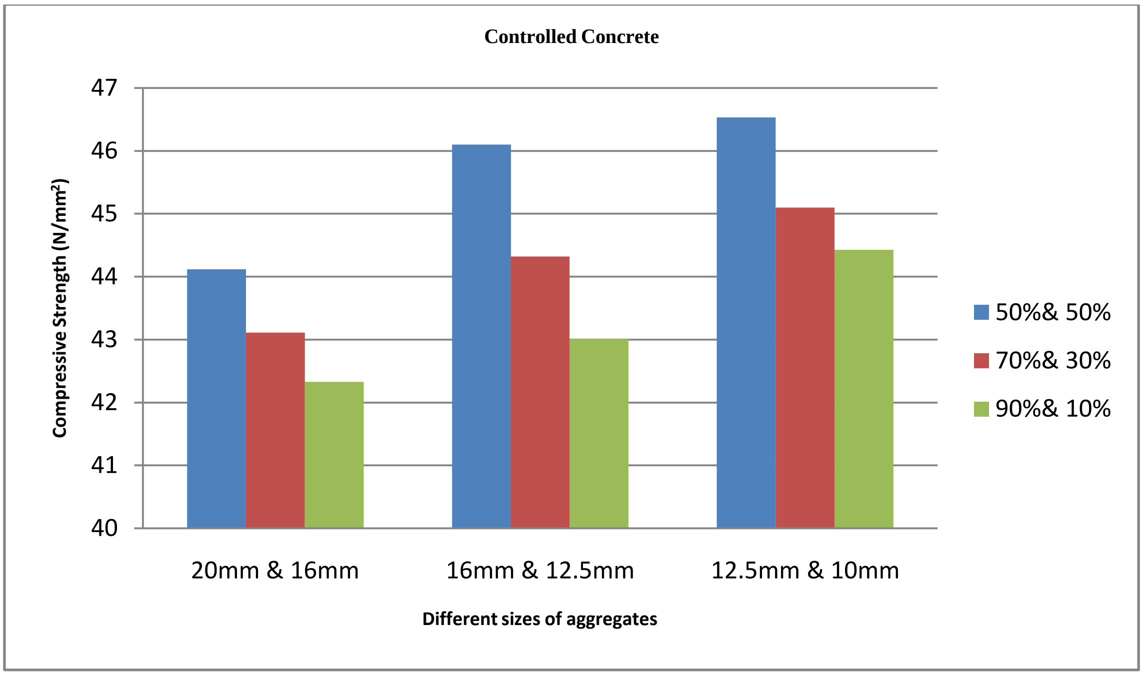
s.no	Type of test conducted	Percentage of size of coarse aggregate	
		Size of aggregate	Percentage of aggregate
		16 mm 14 mm 12.5 mm 10 mm	25% 0 % 50% 25%
		Test values obtained	
		Values obtained	Accepted value
1	Slump flow	700	650-800
2	Slump flow time	3	2-5
3	V-funnel ,seconds	9	8-12
4	U-box, mm	16	30(max)
5	L-Box	0.94	0.8 – 1.0
6	J-ring test	8	0-10

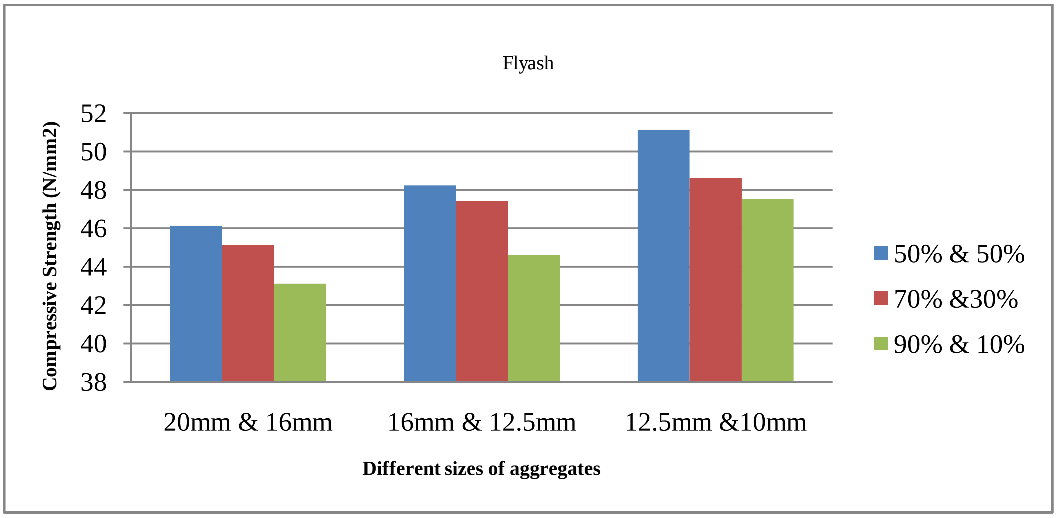
Table5.10. *Trail-1 different ratio of coarse aggregate of total weight of aggregates*

s.no	Type of test conducted	Percentage of size of coarse aggregate	
		Size of aggregate	Percentage of aggregate
		16 mm 14 mm 12.5 mm 10 mm	25% 25% 0% 50%
		Test values obtained	
		Values obtained	Accepted value
1	Slump flow	725	650-800
2	Slump flow time	3	2-5
3	V-funnel ,seconds	11	8-12
4	U-box, mm	14	30(max)
5	L-Box	0.98	0.8 – 1.0
6	J-ring test	8	0-10

Table5.10. *Trail-1 different ratio of coarse aggregate of total weight of aggregates*

s.no	Type of test conducted	Percentage of size of coarse aggregate	
		Size of aggregate	Percentage of aggregate
		16 mm 14 mm 12.5 mm 10 mm	25% 25% 25% 25%
		Test values obtained	
		Values obtained	Accepted value
1	Slump flow	685	650-800
2	Slump flow time	4	2-5
3	V-funnel ,seconds	9	8-12
4	U-box, mm	14	30(max)
5	L-Box	0.89	0.8 – 1.0
6	J-ring test	6	0-10





6. Conclusion

Based on the systematic and detailed experimental study conducted on SCC mixes with an aim to develop performance mixes, the following are the conclusions Arrived.

1. The mixes are designed using the lower size of aggregate yielded better fresh properties than higher size of aggregates.
2. As the strength of concrete increases, the effective size of aggregate has decreased.

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Author's Biography

I'm pursuing my master degree in structural engineering from chinthalpudi engineering college, Jawaharlal Technological University, Kakinada, Andhra Pradesh, India. I've completed my bachelor degree in civil engineering from Pace Institute of Technology and Sciences, Jawaharlal Technological University, Kakinada, Andhra Pradesh, India. My research focuses on advantages and effects of size of aggregate on SCC and NCC.