Scientific Journal Impact Factor (SJIF): 1.711

e-ISSN: 2349-9745
p-ISSN: 2393-8161

International Journal of Modern Trends in Engineering and Research
www.ijmter.com

USE OF FLY ASH FOR MANUFACTURING OF SELF COMPACTING CONCRETE

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Abstract— Self-compacting concrete (SCC), also referred to as self-consolidating concrete, is able to flow and consolidate under its own weight and is deaerated almost completely while flowing in the formwork. It is cohesive enough to fill the spaces of almost any size and shape without segregation or bleeding. This makes SCC particularly useful wherever placing is difficult, such as in heavily-reinforced concrete members or in complicated work forms. The objective of this proposed project is to study the different test adopted on self compacting concrete like slump flow test, U-tube, L box, J ring and compare the same with conventional concrete. And also to compare the Compressive Strength values of self-compacting and normal concrete specimens for 3 days, 7 days, and 28 days. And to study the effect of super plasticizer, VMA and fly ash on concrete. All SCC mixtures exhibited greater values in compressive strength after being tested, compared to normal concrete. The compressive strength of SCC is found to be higher than that of normal concrete. This was possible due to the use of mineral and chemical admixtures, which usually improve the bonding between aggregate and cement paste, thus increasing the strength of concrete.

Keywords- Self-compacting concrete (SCC), Compressive Strength, Conventional concrete, VMA, Fly ash

I. INTRODUCTION

The concept of self-compacting concrete was proposed in 1986 by Professor Hajime Okamura (1997), but the prototype was first developed in 1988 in Japan, by Professor Ozawa (1989) at the University of Tokyo. Self-compacting concrete was developed at that time to improve the durability of concrete structures. Since then, various investigations have been carried out and SCC has been used in practical structures in Japan, mainly by large construction companies. Investigations for establishing a rational mix-design method and self-compact ability testing methods have been carried out from the viewpoint of making it a standard concrete. Self-compacting concrete is cast so that no additional inner or outer vibration is necessary for the compaction. It flows like “honey” and has a very smooth surface level after placing. 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 mineral admixtures in different proportions.

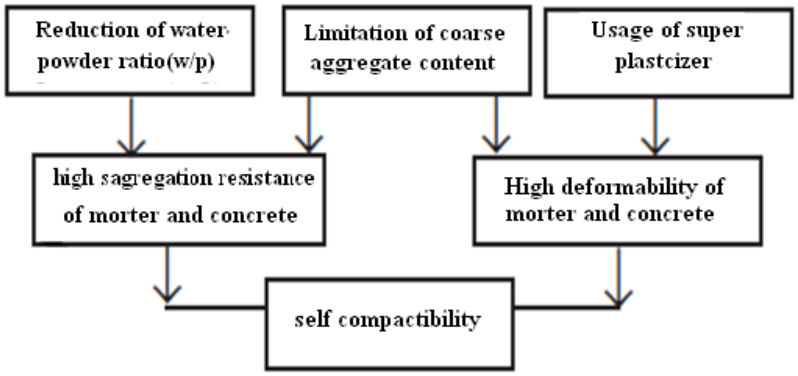
II. SELF-COMPACTING CONCRETE (SCC)

Self Compacting Concrete is an innovative concrete that does not require vibration for placing and compaction. It is able to flow under its own weight, completely filling formwork and achieving full compaction, even in the presence of congested reinforcement.

2.1 BASIC PRINCIPLE

The SCC is that which gets compacted due to its self-weight and is deaerated (no entrapped air) almost completely while flowing in the form work. In densely reinforced structural members, it fills

completely all the voids and gaps and maintains nearly horizontal concrete level after it is placed. With regard to its composition, SCC consists of the same components as conventionally vibrated normal concrete, ie, cement, aggregates, water, additives or admixtures. However, the high dosage of super-plasticizer used for reduction of the liquid limit and for better workability, the high powder content as 'lubricant' for the coarse aggregates, as well as the use of viscosity-agents to increase the viscosity of the concrete have to be taken into account. Super plasticizer enhances deformability and with the reduction of water/powder segregation resistance is increased. High deformability and high segregation resistance is obtained by limiting the amount of coarse aggregate. These two properties of mortar and concrete in turn leads to self-compact ability limitation of coarse aggregate content. Figure shows the basic principles for the production of SCC.



2.2 PERFORMANCE OF SCC

- This concrete is extremely soft and flow able.
- SCC remains homogeneous and cohesive without segregation, separation or bleeding.
- With the application of polycarboxylate based superplasticizers an outstanding fluidity at lowest water/cement ratios could be achieved.
- Special mix design considerations due to its high content of fines and adapted grading curve
- Special high performance superplasticizers are necessary to produce SCC, in order to ensure a fluid concrete with controlled workability, a very high water reduction and a stable and cohesive concrete.

2.3 PROPERTIES OF SCC IN FRESH STATE

- **Filling ability**: The property of Self Compacted Concrete to fill all corners of a formwork under its own weight is known as filling ability.
- **Passing ability**: The property of Self Compacted Concrete to flow through reinforcing bars without segregation or blocking.
- **Resistance to segregation**: The property of Self Compacted Concrete to flow without segregation of the aggregates.

2.4 Engineering properties of SCC

Self-compacting concrete and traditional vibrated concrete of similar compressive strength have comparable properties and if there are differences, these are usually covered by the safe assumptions on which the design codes are based. However, SCC composition does differ from that of traditional concrete so information on any small differences that may be observed. Durability, the capability of a concrete structure to withstand environmental aggressive situations during its design working life without impairing the required performance, is usually taken into account by specifying environmental classes. This leads to limiting values of concrete composition and minimum concrete covers to reinforcement. In the design of concrete structures,

engineers may refer to a number of concrete properties, which are not always part of the concrete specification. The most relevant are:

- Compressive strength
- Tensile strength
- Creep
- Shrinkage
- Fire resistance

III.CONCRETE MIX DESIGN

3.1 DESIGN STIPULATIONS

Grade Designation : M25 and **M30**
Type of Cement : OPC 53 grade
Maximum Nominal Aggregate Size : 20 mm
Degree of Supervision : Good

Test Data for Materials	
Cement Used	:OPC 53 grade
Sp. Gravity of Cement	:3.15
Sp. Gravity of Water	:1.00
Chemical Admixture	:Super plasticizer and VMA
Sp. Gravity of 20 mm Aggregate	:2.8
Sp. Gravity of 10 mm Aggregate	:2.78
Sp. Gravity of Sand	:2.65
Free (Surface) Moisture of 20 mm Aggregate	:Nil
Free (Surface) Moisture of 10 mm Aggregate	:Nil
Free (Surface) Moisture of Sand	:Nil
Sieve Analysis of Individual Coarse Aggregates	:Separate Analysis Done
Sieve Analysis of Combined Coarse Aggregates	:Separate Analysis Done
Sp. Gravity of Combined Coarse Aggregates	:2.8
Sieve Analysis of Fine Aggregates	:Separate Analysis Done

3.2 MIX PROPORTION FOR CONVENTIONAL AND SCC M25 AND M 30 GRADE

Ingredients of Concrete	Unit	M25	M30	SCC M25	SCC M30
Mass of Cement	kg/m^3	390.25	421	270	300
Mass of fly ash	kg/m^3	---------	---------	180	195
Mass of Water	kg/m^3	160	160	180	180
Mass of Fine Aggregate	kg/m^3	647.5	638.3	920	904
Mass of Coarse Aggregate	kg/m^3	1270.56	1252.5	862	846
Mass of 20 mm	kg/m^3	1270.56	1252.5	432	423
Mass of 10 mm	kg/m^3	---------	---------	430	423
Mass of superplasticizer	kg/m^3	---------	---------	4.5	4 .6
Mass of V.M.A	kg/m^3	---------	---------	0.9	0.95
Water Cement Ratio		0.41	0.38	0.37	0.37
Total density of fresh concrete	kg/m^3	2468	2472	2465	2425

IV.TEST RESULT

4.1 TEST RESULT ON FRESH CONVENTIONAL CONCRETE

Method	Unit	M25	M30
Slump-cone test	mm	75	82
Compaction factor test		0.9	0.76

4.2 TEST RESULT ON FRESH SCC CONCRETE

Method	Unit	Test Result		Typical range of values
		M25	M30	
Slump-flow by Abrams cone	mm	690	660	650-800
J-ring	mm	8	10	0-10
V-funnel	Sec	1	13	6-12
L-Box	(h_2/h_1)	0.98	0.93	0.8-1.0
U-Box	(h_2-h_1) mm	22	18	0-30

4.3 TEST RESULT ON HARDEN CONCRETE

Interval (testing period)	Average comp. strength (N/mm^2)				Density (Kg/m^3)	
	M25	SCC M25	M30	SCC M30	SCC M25	SCC M30
3 Days	12.93	11.94	16.6	15.55	2444.437	2454.313
7 Days	17.58	17.43	21.06	22.52	2459.250	2459.250
28 Days	29.2	30.80	31.98	35.47	2459.250	2464.190

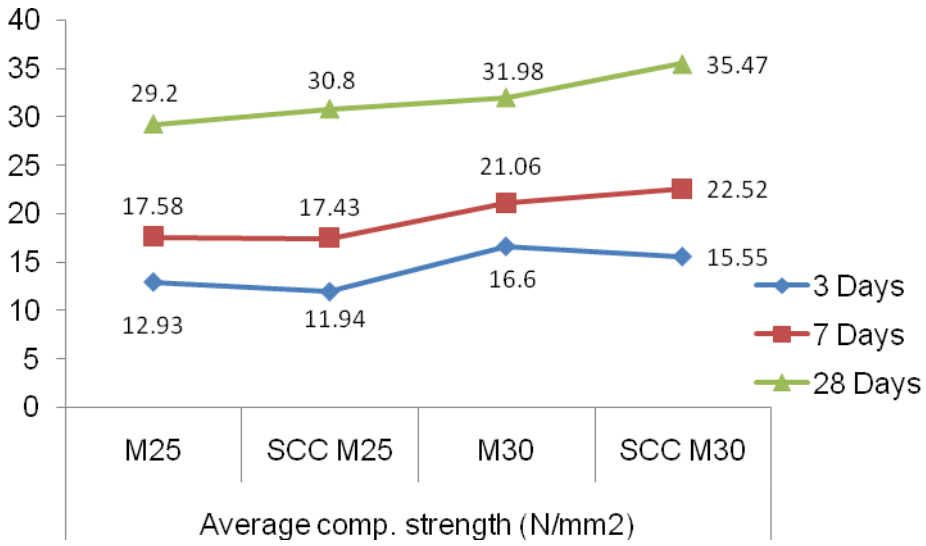


Figure 1. Comparison of Average Compressive Strength of Normaly Vibrated Conventional Concrete and SCC of M25 and M 30 grade

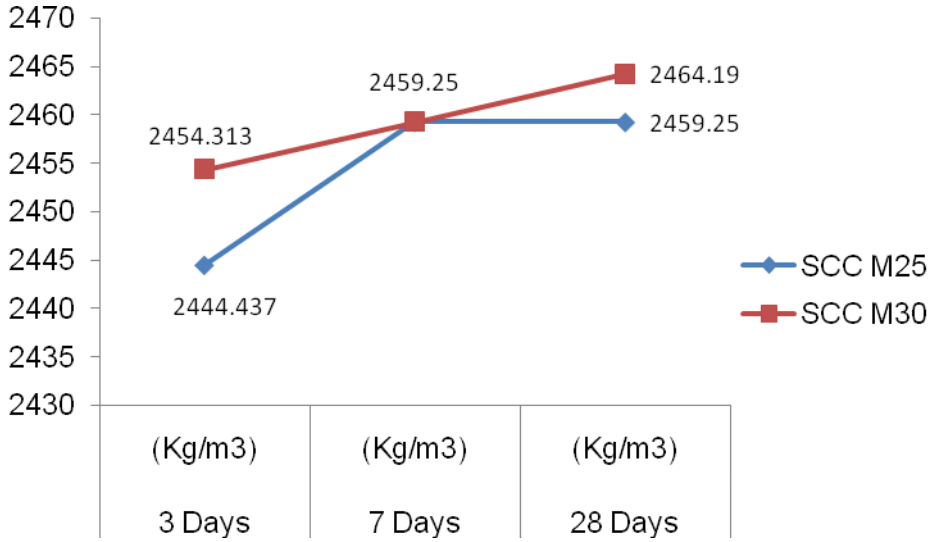


Figure 2. Comparison of Density of Normaly Vibrated Conventional Concrete and SCC of M25 and M 30 grade

V.CONCLUSIONS

a) It has been verified, by using the slump flow and U-tube tests v funnel, L box and j ring test on fresh concrete that self-compacting concrete (SCC) achieved consistency and self-compactability under its own weight, without any external vibration or compaction.
b) Self-compacting concrete can be obtained in such a way, by adding chemical and mineral Admixtures, so that compressive strengths are higher than those of normal Vibrated concrete.
c) It is also found that the 3 days compressive strength is somewhat less than that of normal concrete. But after 7 days the compressive strength of concrete is increases fastly as compared to normal concrete.
d) It is also concluded that Fly ash substitution generally results in favorable outcomes and is highly recommended for all SCC mixes. Addition of fly ash in SCC increases filling and passing ability of concrete Substitution of these waste materials with cement shall also help to conserve the valuable natural resources. And Super plasticizers can produce at the same w/c ratio much more workable concrete than the plain ones.
e) The elimination of vibrating equipment improves the environment protection near construction and precast sites where concrete is being placed, reducing the exposure of workers to noise and vibration.
f) The density of SCC is nearly more than that normal vibrated concrete. Also, because of the special admixtures used, SCC has achieved a density between 2400 and 2500 kg/m3.
g) In SCC, There is no chances of honeycomb, hence it give superior surface finish.

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