Comparison of the Performance of Self Compacting Concrete

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Abstract

Self-Compacting Concrete Originally developed in Japan, SCC technology was made possible by the much earlier development of Superplasticisers for concrete. To compare the performance of SCC with Fly Ash 20%, Silica Fume 10%, Rice Husk Ash (5%, 10%, and 15%) as a partial replacement of cement, due to the high increase in construction which has brought a heavy demand for ingredients of concrete such as cement and sand, and these materials are becoming costly and scarce. The use of self-compacting concrete (SCC) is spreading worldwide because of its very attractive properties in the fresh state as well as after hardening. By using Super plasticizer (High Range Water Reducing Admixture) to increase the workability & admixture should bring about the required water reduction & fluidity but should also maintain the dispersing effect. The Using M40 grade of concrete with curing period of 7days, 14days and 28days.To Study the workability and mechanical properties of Self-Compacting Concrete & Compare to Conventional Self-Compacting Concrete. The laboratory testing included slump flow test, L-Box test, V-Funnel test, compressive strength test, and splitting tensile strength test.

Keywords- Self-Compacting Concrete, Silica Fume, Rice Husk Ash, Fly Ash, Super Plasticizer, Material Testing

I. INTRODUCTION

Self-compacting Concrete (SCC) that is able to flow and consolidate under its own weight, completely fill the formwork even in the presence of dense reinforcement, while maintaining homogeneity and without the need for any additional compaction. In principle, a self – compacting or self – consolidating concrete must:

- Have a fluidity that allows self – compaction without external energy
- Remain homogeneous in a form during and after the placing process and
- Flow easily through reinforcement

Self – consolidating concrete has recently been used in the pre – cast industry and in some commercial applications, however the relatively high material cost still hinders the wide spread use of such specialty concrete in various segments of the construction industry, including commercial and residential construction.

Compared with conventional concrete of similar mechanical properties, the material cost of SCC is more due to the relatively high demand of Cementation materials and chemical admixtures including high – range water reducing admixtures (HRWRA) and viscosity enhancing admixtures (VEA). Typically, the content in Cementation materials can vary between 450 and 525 $kg/m^3$for SCC targeted for the filling of highly restricted areas and for repair applications. Such applications require low aggregate volume to facilitate flow among restricted spacing without blockage and ensure the filling of the formwork without consolidation. The incorporation of high volumes of finely ground powder materials is necessary to enhance cohesiveness and increase the paste volume required for successful casting of SCC. The SCC essentially eliminates the need for vibration to consolidate the concrete. This results in an increase in productivity, a reduction in noise exposure and a finished product.

II. MATERIAL STUDY AND TEST RESULTS

A. General

The self-compacting considered here is prepared by the following ingredients ASTM Type II Portland cement, fine sand (approximately 150-500 μm), and Naphthalene super plasticizer 553.

B. Cement
Ordinary Portland Cement 53 grade cement can be used.

C. Fly Ash
SCC is produced with high quantity of powder or fine materials. In majority of cases SCC is used with Fly Ash.
Where Class-F Fly ash normally produced burning anthracite or bituminous coal, usually has less than 5% CaO. Class F fly ash has pozzolanic properties only. This fly ash is pozzolanic in nature, and contains less than 20% lime (CaO).

D. Silica Fume (SF)
Silica fumes also referred to as micro silica or condensed silica fume, is another material that is used as a pozzolonic admixture. It is a product obtained from reduction of high purity quartz with coal in an electric furnace in the manufacture of silicon or ferrosilicon alloy.

The use of silica fume in conjunction with super plasticizer has been the backbone of modern high performance concrete. For higher strengths, the use of silica fume is essential. Highly reactive pozzolan used to improve mortar and concrete.

E. Rice Husk Ash (RHA)
Rice husk Ash, is obtained by burning rice husk in controlled manner without causing environmental pollution. Rice husk Ash exhibits high pozzolanic characteristics and contribute to high strength and high impermeability of concrete. Rice husk Ash essentially consist of amorphous silica (90%SiO2).India produces about 122 million ton of paddy every year .Each ton of paddy producers about 40Kg of RHA.

F. Fine Aggregate
Fine aggregate should be properly graded to give minimum void ratio and be free from deleterious materials like clay, silt content and chloride contamination etc. It can be natural or manufactured. The grading must be uniform throughout the work. The moisture content or absorption characteristics must be closely monitored as quality of SCC will be sensitive to such changes.
Particles smaller than 0.125mm (125µ) size are considered as fine which contribute to the powder content. Fine aggregates shall conform to the required of IS 383. The sand was washed and screened at site to remove deleterious materials and tested as per the procedure given in IS: 2386-1968 and the results were tabulated.

G. Coarse Aggregate
The coarse aggregate chosen for SCC is typically round in shape, is well graded, and smaller in maximum size than that used for conventional concrete typical conventional concrete could have a maximum aggregate size of 40 mm or more. In general, a rounded aggregate and smaller aggregate particles aid in the flow ability and deformability of the concrete as well as aiding in the prevention of segregation and deformability of the concrete as well as aiding in the prevention of segregation. Gradation is an important factor in choosing a coarse aggregate, especially in typical uses of SCC where reinforcement may be highly congested or the formwork has small dimensions. Gap – graded coarse aggregate promotes segregation to a greater degree than swell-graded coarse aggregate. As with conventional concrete construction, the maximum size of the coarse aggregate for SCC depends upon the type of construction. Typically, the maximum size of coarse aggregate used in SCC ranges from approximately 10 mm to 20 mm.

H. Chemical Admixture
Admixtures may be defined as the materials other than the basic ingredients of concrete i.e. cement, aggregates and water added to the concrete mix immediately before and during the mixing process to modify one or more specific properties of concrete in fresh and hardened state.

Superplasticiser are an essential component of SCC to provide necessary workability. To improve the workability of self-compacting concrete we have to add some plasticizers (water reducers) as a chemical admixture.

While naphthalene based superplasticiser are popularly used in conventional concrete, SCC is associated more with polycarboxylic ether based superplasticiser. These have been most recently developed, and are sometimes referred to as “new generation” super plasticizers. The difference in functional mechanism between these two types and general compatibility of the latter with major types of cement could be reasons for this trend.

In my project, I am going to use polycarboxylic ether based super plasticizer Naphthalene Super Flow complying with ASTM C-494 type F.

I. Compressive Strength of Concrete
Compressive strength of concrete is defined as the load, which causes the failure of a standard specimen. (Ex 150 mm cube according to ISI) divided by the area of cross section in uniaxial compression under a given rate of loading. The test of compressive strength should be made on 150mm size cubes.

Place the cube in the compression-testing machine. The green button is pressed to start the electric motor. When the load is applied gradually, the piston is lifted up along with the lower plate and thus the specimen application of the load should be 300 KN per minute and can be controlled by load rate control knob. Ultimate load is noted for each specimen. The release valve is operated and the piston is allowed to go down. The values are tabulated and calculations are done.

J. Split Tensile Strength

A concrete cylinder of size 150mm dia×200mm height is subjected to the action of the compressive force along two opposite edges, by applying the force in this manner .The cylinder is subjected to compression near the loaded region and the length of the cylinder is subjected to uniform tensile stress.

Horizontal tensile stress=$2P/\pi DL$

Where, P=the compressive load on the cylinder.

L=length of the cylinder

D=dia of cylinder

III. TEST RESULTS

A. Test Results for Workability

SCC- Trial mix details are explained below

Trail 1 = C+FA+CA+W + 0.4 % SP

Trail 2 = C+FA+CA+W + 0.9 % SP

Trail 3 = C+FA+CA+W + 1.2 % SP

The following table shows the SCC Trial mix Workability test results.

MIX	*Slump Flow (mm)*	*L-Box Test (mm)*	*V-Funnel Test (sec)*
Trail 1	*520*	*0.6*	*1.25*
*Trail 2**	*590*	*0.7*	*2*
Trail 3	*670*	*1*	*2.5*

Best Trail mix = SCC

SCC Mix = C+FA+CA+W+1.2% SP

The following table shows the comparison of compressive strength of Conventional Self-Compacting Concrete, and Mixing Self-Compacting Concrete.

Type	*7 days (N/mm2*	*14 days (N/mm2)*	*28 days (N/mm2)*
SCC	*27.66*	*30.85*	*47.47*
Mix-1	*28.83*	*31.38*	*48.9*
Mix-2	*29.67*	*32.55*	*48.57*
Mix-3	*28.9*	*32.35*	*46.57*

The Split Tensile Strength of Conventional Self-Compacting Concrete, and Mixing Self-Compacting Concrete.

Type	*7 days (N/mm2*	*14 days (N/mm2)*	*28 days (N/mm2)*
SCC	*3.02*	*3.6*	*4.12*
Mix-1	*3.09*	*3.54*	*4.08*
Mix-2	*3.16*	*3.62*	*4.21*
Mix-3	*3.08*	*3.6*	*4.11*

IV. CONCLUSION

To increase the stability of fresh concrete using increased amount of fine materials in the mixes. Some of the cement replacement material has positive effects on self- compacting concrete; mechanical and fresh properties. The amount of aggregates, binders and mixing water, as well as type and dosage of super plasticizer to be used are the major factors influencing the properties of SCC. Slump flow, V-funnel, L-flow, U-box and compressive strength, Split tensile strength tests were carried out to examine the performance of SCC. The maximum Expected compressive strength, Split tensile strength for self-compacting concrete can be obtained by addition of 20% of fly ash, 10% of Silica Fume & 10% Rice Husk Ash mix as compared to addition of 5% & 15% of cement replacement by Rice Husk Ash.

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