EXPERIMENTAL STUDY ON HIGH PERFORMANCE OF SELF COMPACTING CONCRETE

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ABSTRACT

Self-compacting concrete (SCC) represents one of the most significant advances in concrete technology for decades. Inadequate homogeneity of the cast concrete due to poor compaction or segregation may drastically lower the performance of mature concrete in-situ. SCC has been developed to ensure adequate compaction and facilitate placement of concrete in structures with congested reinforcement and in restricted areas. Self-compacting concrete demands large amount of powder (cementitious and pozzolanic materials) content and fines for its cohesiveness and ability to flow without bleeding and segregation. In the present investigation, part of the cementitious material is replaced with pozzolanic material-Fly Ash, and the properties of self-compacting concrete (M30) in fresh and Hardened states were studied. Initially material study is carried out for the materials such as Portland Pozzolana Cement, Fly Ash, Fine Aggregate, Coarse Aggregate, Water, and Chemical Admixtures. Based on the material properties, the trial mix proportions are arrived for M30 grade SCC with varying Fly Ash percentages. Portland Pozzolana Cement (PPC) was partially replaced with various percentages of class F Fly Ash (FA), such as 0%, 10%, 20%, 30% and 40%. Properties of fresh concrete are investigated by means of slump flow test, J-ring test, and L-box test. Properties of hardened concrete are investigated by means of compression test on cubes and splitting tensile test on cylinders for 7 , 14 and 28 days curing periods

Keywords: Self- compacted concrete; fly ash;

INTRODUCTION

Self-compacting concrete (SCC) was first developed in 1986 in Japan to achieve durable concrete structures. For several year, the problem of the strength performance of concrete structures is a major topic of interest for construction engineers to make durable concrete structures.

Self Compacting Concrete (SCC) is concrete which flows to a virtually uniform level under the influence of gravity without segregation during which it desecrates and completely fills the form work and the spaces between the reinforcement without any need for induced compaction. Self compacting concrete demands large amount of powder content and fines for its cohesiveness and ability to flow without bleeding and segregation.

Self compaction concrete also referred as “self consolidated concrete and “silent concrete”. SCC is obtained by limiting the water-cement ratio (w/c), adding an effective plasticizer, increasing sand-aggregate ratio and adding some mineral pozzolanic admixtures such as fly ash, GGBFS, silica fume, stone powder etc. The use of SCC will lead to mass production and improved quality, durability,

and reliability of concrete structures as well as eliminate human error. It will replace manual compaction of fresh concrete and improve safety in the sites.

PROPERTIES OF SELF- COMPACTED CONCRETE IN FRESH STATE

Self –compacted concrete is defined as a category of high performance concrete that has excellent deformability in the fresh state and high resistance to segregation, and can be placed and compacted under its self weight without applying vibration.

FILLING ABILITY

The property of self - compacted concrete to fill all corners of a form work 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.

EXPERIMENTAL PROGRAMME

The objective of the experimental study that was conducted were,

i. Preparation of trial mix for M30 grade self compacting concrete with and without partial replacement of cement by fly ash.
ii. To study the properties of Self Compacting Concrete in fresh and hardened state.
iii. To study the effect of fly ash on fresh and hardened state properties of self compacting concrete.
iv. To study the compressive, flexural and split tensile strength gain at 7 days, 14 days, and 28 days.

MATERIALS: -

CEMENT:

Ordinary Portland cement (OPC) of 53 grade available in the market was used in the investigation. The cement was tested for various proportions and found to be confirming to various specification. The specific gravity was 2.96 .

COARSE AGGREGATE

Crushed angular metal of 12.5 mm size from a locals source was used as coarse aggregate .The specific gravity of 2.62 and fineness modulus 2.77 was used.

FINE AGGREGATE

River sand was used as fine aggregate. The specific gravity 2.61 and fineness modulus 2.483 was used in the investigation

VISCOSITY MODIFYING AGENT

(Glenium stream -2) was used to ensure the homogeneity and the reduction of the tendency of highly fluid mix to segregate.

ADMIXTURE

Modified polycarboxylated ether-based super plasticizer(Glenium B233) was used as the super plasticizer.

FLY ASH

Fly ash is finely divided residue resulting from the combustion of powdered coal and transported by the flue gases and collected by electric precipitator. Fly ash is the most widely used pozzolanic material all over world. ASTM broadly classify fly ash into two classes that are, Class F: Fly ash normally produced by burning anthracite or bituminous coal, usually has less than 5% CaO. Class F fly ash has pozzolanic properties only.

Chemical Composition of Fly Ash :-

Chemical compound	Fly ash F (%)
$SiO_2+Al_2O_3+Fe_2O_3$	86.7
SiO_2	54
Mgo	0.1
Total Sulfur as SO_3	0.11
Na_2O	2.16
Loss of ignition	4

Physical characteristics of Fly Ash:-

Colour = Whitish gray
Specific gravity =2.1
Specific surface = 2000 to 2200cm^2/g
Moisture = Nil

TEST METHOD FOR SELF-COMPACTED CONCRETE

The following test were used to characterize the workability properties of self compacted concrete for the final acceptance of the self compacted concrete mix proportions.

MARSH CONE TEST:

Marsh cone test was conducted to select the better combination of water, cementitious materials and chemical admixtures. Mortar

mixture was prepared and the saturated point was determined using a marsh cone with a nozzle having an opening of 5mm diameter and 50mm length. The time taken for the first 200ml of cement paste to flow through the cone was measured. This is called flow time. Three flow times were measured for each paste and mean value was used

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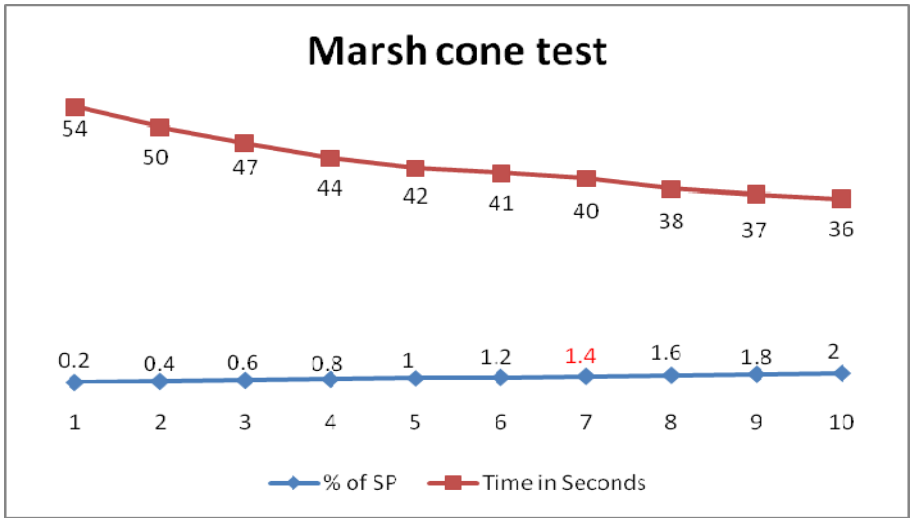


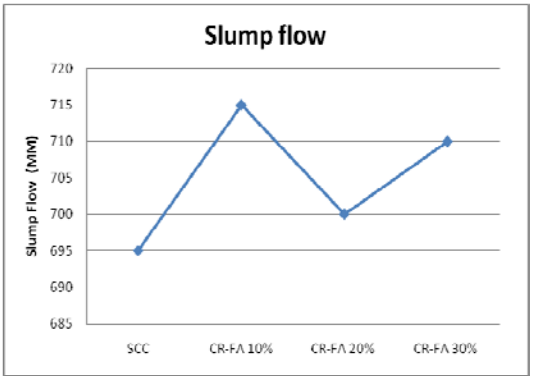
SLUMP FLOW TEST

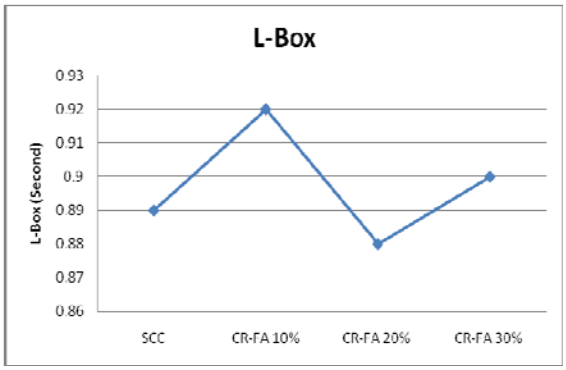
The slump flow was used to assess the horizontal free flow and the filling ability of self-compacted concrete in the absence of obstructions. The test also indicates the resistance to segregation. The higher the flow value, the greater its ability to fill the formwork under its own weight. It is recommended to maintain slump flow value as 650 mm and 800mm.

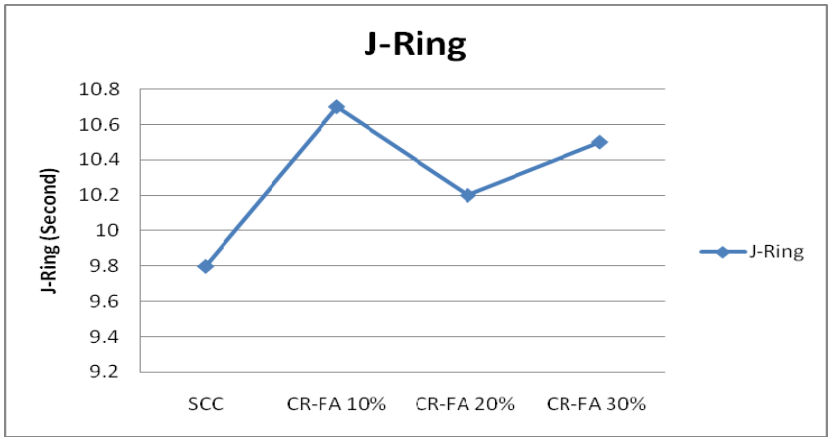
L-BOX TEST

The test assesses the flow of the concrete in presence of reinforcement obstructions. When the concrete stops flowing , the heightH1 and H2. Calculate H2/H1, the blocking ratio. If the concrete flows as freely as water , at rest it will be horizontal. The European union research team suggested a minimum acceptable value 0.8 to 1.

MIX	Slump flow	L-Box	J-Ring
SCC	695	0.89	9.8
CR-FA 10%	715	0.92	10.7
CR-FA 20%	690	0.88	10.2
CR-FA 30%	710	0.90	10.5







COMPRESSIVE STRENGTH

Compressive strength of concrete is used as a qualitative measure for other properties of hardened concrete. The compressive strength of SCC depends on the mix design. Standard cubes of dimensions 150 × 150 × 150 mm^3 are cast and cured in a curing tank. The 7days and 14 days and 28 days strengths are determined on these specimens. At the end of 7days and 14 days, and 28days the specimens are taken out and tested in a compression test machine. The rate of loading was 140 kg/cm^2/min. The load at which the cube crushes is noted as the ultimate load and the load from which the compressive strength of the concrete cube specimen is calculated.

SPLIT TENSILE STRENGTH

Standard cylinders of diameter 150 mm and height 300 mm are cast and cured in a curing tank. The 7 days and 14 days and 28 days strengths are determined on these specimens – at the end of the 7days and 14 days and 28days the specimens are taken out, and are tested in a compression-testing machine. The rate if loading was 140 kg/cm^2/min. The load at which the specimen fails is noted as the ultimate load from which the compressive strength of the concrete cylindrical specimens is calculated.*6.4.*

COMPRESSIVE STRENGTH AND SPLIT TENSILE STRENGTH TEST RESULTS

Table -1 Compressive and Split tensile strength-Control concrete

S.NO	Age of testing (days)	compressive strength (N/mm^2)	Split tensile strength (N/mm^2)
1	7	19.54	2.1
2	14	25.3	2.54
3	28	30.29	2.84

Table 2. Compressive and Split tensile strength-FA-10%

S.NO	Age of testing (days)	compressive strength (N/mm^2)	Split tensile strength (N/mm^2)
1	7	18.61	2.11
2	14	25.13	2.74
3	28	30.14	3.1

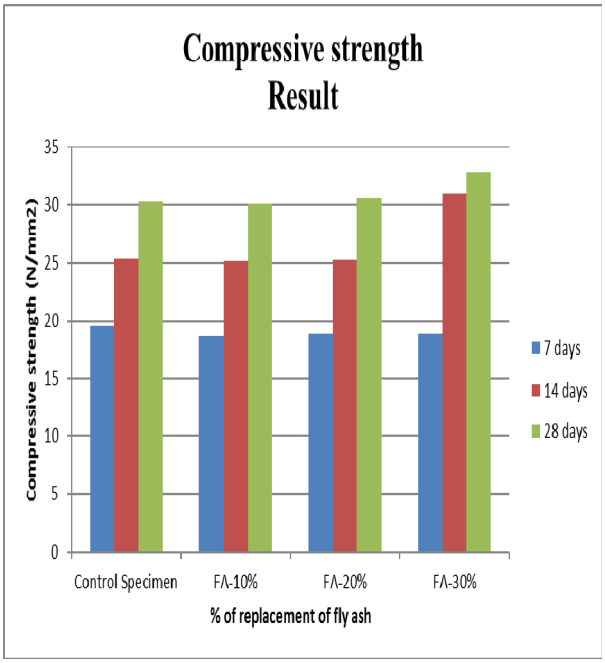
Table 3. Compressive and Split tensile strength-FA-20%

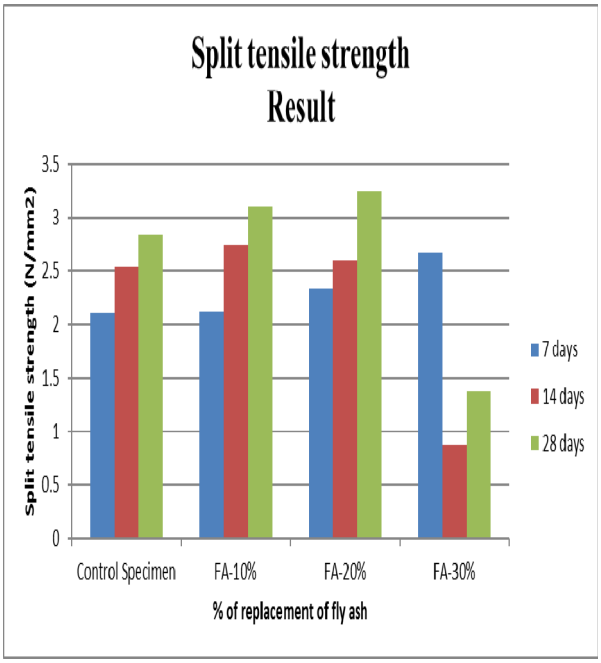
S.NO	Age of testing (days)	compressive strength (N/mm^2)	Split tensile strength (N/mm^2)
1	7	18.79	2.34
2	14	25.2	2.61
3	28	30.56	3.24

Table 4 Compressive and Split tensile strength-FA-30%

S.NO	Age of testing (days)	compressive strength (N/mm^2)	Split tensile strength (N/mm^2)
1	7	18.8	2.68
2	14	30.99	0.87
3	28	32.77	1.37

These results are converted into flow chart for comparative study of strength of various percentage replacement of cement by fly ash.





CONCULSION

The replacement of cement by Fly ash F up to 30% , with 1.4% of super plasticizer & 0.1% of VMA by the weight of powder ratio, the structural behaviour of Self Compacting Concrete have been investigated Following conclusions and recommendation are made based on the result of study conducted.

- SCC with the partial replacement of cement by fly ash up to 30% gives the better results in both fresh and hardened states.
- Addition of fly ash generally improves the workability but the main problem with the fly ash is slow pozzolanic activity that leads to a low initial strength gain. However, the strength increases later due to the reaction of fly ash with calcium hydroxide.
- Fly ash has been shown to be effective addition for SCC providing increased cohesion and reduced sensitivity to changes in water content. However, high levels of fly ash may produce a paste fraction which is so cohesive that it can be resistant to flow.

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