IJITE INTERNATIONAL JOURNAL OF INNOVATIVE TRENDS IN ENGINEERING (IJITE) ISSN: 2395-2946
ISSUE: 47, VOLUME 28, NUMBER 03, 2017

Self-Compacting Concrete

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Abstract - Self compacting concrete is that concrete which areable to flow and fill each and every part and corner of formwork, even in the presence of dense reinforcement, purely by means of its own self weight and without the need for any vibration or any other type of compaction. Its development must ensure a good balance between deformability and stability. The compatibility of SCC is affected by the characteristics of materials and mix proportion so it becomes necessary to evolve a procedure for mix design of SCC. The paper presents on experimental procedure for design of self compacting concrete mix with different ratios of Fly Ash, Coarse Aggregate and Fine Aggregate using Cement OPC-43 grade, Potable Water, Super plasticizer& Silica fume. The test result acceptance characteristics of self-compacting concrete such as slump flow; V-funnel and L-box are presented. Further compressive strength at the ages of 7, 28, and 90 days and result are included here.

Keywords: Self-compacting concrete; Fly ash; Super plasticizer; viscosity modifying agent; mix design; compressive strength, split tensile strength, flexural strength.

I. INTRODUCTION

Self-Compacting Concrete (SCC) has properties that differ considerably from conventional concrete. SCC is highly workable concrete that able to flow through the dense reinforcement and complex structures under its own weight and adequately fill all voids without segregation, excessive bleeding, or other separation of materials and without the need for vibration or other mechanical consolidation.

SCC, was first introduced due to the Recent remarkable changes in the construction environment are demanding improved technology for the production of high performance concrete with far greater workability, high strength and long durability. Okamura proposed the concept of self-compacting concrete in 1986 and the prototype was first completed in the world in 1988.The motive for development of self-compacting concrete was the social problem on durabilityof concrete structures that arose around 1983.

Researchers have set some guidelines for mixture proportioning of SCC, which include (1) reducing the volume ratio of aggregate of cementitious material; (2) increasing the paste volume and water-cement ratio (w/c); (3) carefully controlling the maximum coarse aggregate particle size and total volume; and (4) using various viscosity modifying admixture (VMA).

II. OBJECTIVE

The objective of this project is to check properties of SCC like flow ability, passing ability, segregation resistance and strength with low w/c ratio (0.39-0.44) and super plasticizer Polycarboxylate Ether (PCE).

MIX DESIGN TO BE STUDY: M25 *(I.S. CODE 10262)*

MATERIAL USED

1. CEMENT
2. AGGREGATES :

A) Coarse aggregate

B) Fine aggregate

1. WATER(potable water)
2. CHEMICAL ADMIXTURES i.e. Super plasticizer and Viscosity Modifying Agent.

   MINERAL ADMIXTURES i.e. Fly Ash and Silica Fume etc.

CEMENT

In study, Ordinary Portland Cement conforming to IS: 8112 -1989 (43-Grade) OPC

Specification wasused; the physical properties of the cement used are shown in Table 1.

AGGREGATE

Locally available river sand of specific gravity 2.64, fineness modulus 2.91, and conforming to Zone II was used as fine aggregate. The crushed granite stone with the maximum size of 12 mm and the specific gravity of 2.65 was used as coarse aggregate. Both the aggregates used conformed to IS: 383-1970 (Specification for coarse and fine aggregates from natural sources for concrete.

SUPERPLASTICIZER

Super plasticizers are a water-reducing admixture that causes a significant increase in flow ability with little effect on viscosity. It reduces the water requirement by 30%.

Table 1.Physical Properties of OPC-Cement

Physical property	Results obtained
Fineness	2940 cm2/gm
Normal consistency	29%
Vicat initial setting time (minutes)	64
Vicat final setting time (minutes)	192
Compressive strength 3-days (MPa)	23.91 MPa
Compressive strength 7-days (MPa)	36.95 MPa
Compressive strength 28-days (MPa)	45.86 MPa
Specific gravity	3.12

FLY ASH

Fly ash is the most commonly used pozzolana in concrete. It reduces free drying shrinkage and restrains the shrinkage cracking width.

SILICA FUME

Silica fume arealso called as micro-silica, it is a finely divided residue resulting from the production of elemental silicon or Ferro-silicon alloys that are carried from the furnace by exhaust gases. It gives good cohesion, improved resistance to segregation. Silica fume is also very effective in reducing or eliminating bleeding.

Table2. Chemical properties of Fly ash

S.No	Constituents	Percentage (%)
1.	Silica	62.96
2.	Alumina	19.38
3.	Iron oxide	8.10
4.	Calcium oxide	2.5
5.	Loss of ignition	0.89

MIX PROPORTION for SCC

Mix design	M25
Cement	300 kg/m3
Fly ash	235 kg/m3
Water	190 kg/m3
Fine aggregate	831 kg/m3
Coarse aggregate a) 20 mm agg.	385 kg/m3
b) 10 mm agg.	385 kg/m3
HRWRA	0.6%
VMA	0.4%
W/C ratio	0.36
Super plasticizer(PCE)	13.5kg

NOTE: -

a) Ordinary concrete mix design as per IS 10262: 1999

b) There is no fix method for SCC design mix.

c) It is only trial and error method.

III. TEST METHODS

Self-compacting concrete is characterized by filling ability, passing ability and resistance to segregation. Many different methods have been developed to characterise the properties of SCC. No single procedure has been developed to define all the relevant workability aspects, and hence, each mix has been tested by more than one test method for the different workability parameters.

Slump flow Test, the slump flow test is used to assess the horizontal free flow of SCC in the absence of obstructions. On lifting the slump cone, filled with concrete, the concrete flows as shown in fig. The average dia. of the concrete is a measure for the filling ability of the concrete. The time T50cm is a secondary indication of the flow. It measure the time taken in seconds from the instant cone is lifted to the instant when the horizontal flow reaches diameter of 500 mm. The followability of fresh concrete can be tested with the V-funnel test, whereby the flow time is measured. The funnel is filled about 12 liters of concrete and the time taken for it to flow through apparatus is measured. Further T5min is also measured with V-funnel which indicates the tendency for segregation, wherein the funnel can be refilled with concrete and left for 5 minutes to settle. If the concrete indicates segregation, then the flow time will increase significantly.

The passing ability is determined by using the L-box test andthe vertical section of the L-box is filled with concrete and then the gate lifted to let the concrete flow into the horizontal section. The height of concrete at the end of horizontal section is expressed as a proportion of that remaining in the vertical section (H2/H1). This is an indication of passing ability. The specified requisite is the ratio between the heights of the concrete at each end or blocking ratio to be less than or equal to 0.8.

SLUMP FLOW TEST-

It is used primarily to assess filling ability, suitable for laboratory and site use

Mould in the shape of truncated cone with the internal dimension 200mm at the base, 100 mm diameter at the top and a height of 300 mm

The SCC sample is poured in to the slump cone then the diameter of slump flow is measured

The greater the slump flow value.

The higher its ability to fill formwork under its own weight.

IV. OBSERVATIONS

TRIAL-1

HRWA	VMA	Actual Slump SFa	Expected Slump SFe	Result
0.4%	Nil	660mm	700mm	Failed

TRAIL-2

HRWA	VMA	Actual Slump SFa	Executed Slump SFe	Result
0.4%	0.2%	700mm	700mm	Failed

TRAIL-3

HRWA	VMA	Actual Slump SFa	Executed Slump SFe	Result
0.4%	0.3%	700mm	700mm	Failed

TRAIL-4

HRWA	VMA	Actual Slump SFa	Executed Slump SFe	Result
0.4%	0.4%	700mm	700mm	OK

COMPRESSIVE STRENGTH

Cube is used to find out the compressive strength. The average of at least three standard specimens made from the same concrete sample and tested at the same age.

The concrete cubes, after 7, 14, 28 days of curing will be tested for their compressive strength

CUBE SPECIMEN FORMATION-

COMPRESSIVE STRENGHT (fc)=P/A

Where P= Load at failure in kg and

A= Surface area of bearing cube in cm2

V. OBSERVATIONS

CHECKING FOR COMPRESSIVE STRENGTH-

Compressive Strength result as on 7th day of casting:

Specimen identification	Weight of specimen(kg)	Density(kg/m3)	Avg. density (kg/m)	Failure load (kN)	Compressive strength (N/mm2)	Avg. compressive strength (N/mm2)
A1	8.15	2436		840	22.56	
A2	8.08	2429	2435.3	840	22.45	22.95
A3	8.21	2441		850	23.84	

Compressive strength result as on 28th day of casting:

Specimen identification	Weight of specimen (kg)	Density (kg/m3)	Avg. density (kg/m3)	Failure load (kN)	Compressive strength (n/mm2)	Avg. compressive strength (N/mm2)
A1	8.25	2442		1180	33.24	
A2	8.15	2437	22.95	1145	33.89	33.36
A3	8.24	2441		1160	33.94	

VI. VARIOUS ADVANTAGES OF SCC

- Improved quality of concrete and reduction of onsite repairs
- Faster construction time
- Greater freedom in design
- Facilitation of introduction of automation into concrete construction
- Improvement of health and safety is also achieved through elimination of handling of vibrators
- Substantial reduction of environmental noise loading on and around a site
- Ease of placement results in cost savings through reduced equipment and labour requirement.

VII. APPLICATIONS OF SCC

- Delhi Metro Rail Corporation
- LNG Tank, OSAKA GAS COMPANY
- AKASHI-KAIKYO BRIDGE ANCHOR
- ARLANDA AIRPORT CONTROL TOWER, STOCKHOLM, Sweden
- CAPITAL GATE IN Abu Dhabi
- BURJ KHALIFA IN Dubai

VIII. CONCLUSION

At same grade of concrete we find self-compacting concrete with certain changes as decrease only 10% of final cost

Use of self-compacting concrete is very simple and no skill labor is required

By practical we concluded self-compacting concrete give us smooth outer surface as plaster so plaster cost is reduced

By practical we achieve more strength & workability so SCC can be used in dry area

We use fly ash and reduce 15% cement content in concrete

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