AN EXPERIMENTAL STUDYON SELF COMPACTING CONCRETE USING FLY ASH, SILICAFUME AND SUPERPLASTICIZER

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ABSTRACT

Self-Compacting concrete is a concrete which gets compacted under its self-weight. It's commonly abbreviated as Self Compacting concrete and defined as the concrete which can placed and compacted into every corner of a formwork; purely means of its self-weight by eliminating the need of either external energy input from vibrators or any type of compacting effort. Self compact ability and stability are susceptible to ternary effects of chemical and mineral admixture type and their content.

1. INTRODUCTION

1.1 GENERAL

Self-compacting concrete (SCC) 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. The hardened concrete is dense, homogeneous and has the same engineering properties and durability as traditional vibrated concrete.

Self-compacting concrete offers a rapid rate of concrete placement, with faster construction times and ease of flow around congested reinforcement. The fluidity and segregation resistance of SCC ensures a high level of homogeneity, minimal concrete voids and uniform concrete strength, providing the potential for a superior level of finish and durability to the structure. SCC is often produced with low water-cement ratio providing the potential for high early strength, earlier demoulding and faster use of elements and structures.

1.2 HIGH VOLUME FLYASH

The quantity of fly ash produced from thermal power plants in India is approximately 80 million tons each year, and its percentage utilization is less than 10%. Majority of fly ash produced is of Class F type. The disposal of remaining fly ash has become a serious problem. One of the practical methods for conserving and economizing cement and also to reduce the disposal problem of fly ash is to popularize the high volume fly ash concrete system. High volume fly ash concrete is a concrete where in 50 to 60% fly ash is incorporated. Due to very low water content of high volume fly ash concrete, the use of super plasticizer becomes necessary for obtaining workable concrete. Use of air-entraining admixtures is also concurrently used.

1.3 NEED FOR THE PROJECT:

- Principally, to find the two key fresh properties of SCC – filling ability and passing ability - for mix design purposes in the lab.
- A range of results for the chosen tests to identify suitable SCC.
- The Guidelines of standards for the test methods are verified.
- The hardened concrete properties of self compacting concrete with different replacement materials are ascertain.

1.4 Materials:

The materials which are used for producing the HVFC are as follows

Cement:

Ordinary Portland cement is the common form of cement.

Specific gravity of cement is 3.14. The cement was brought from JSW cements, Salem.

Fly ash:

Class F fly ash collected from thermal plant -mettur with a specific gravity of 2.12 determined as per IS 1727:1967 confirms to (ASTM C 618).

Water:

Clean potable water conforming to IS 456-2000 was used, Generally water has a pH of 7. The specific gravity of water is 1.

Fine aggregate:

Ordinary river sand is used as the fine aggregate of Zone II as per IS 383-1987. The specific gravity of fine aggregate is 2.53.

Coarse aggregate:

The ordinary coarse aggregate is sieved in 20mm sieve and the aggregate passing through the sieve is used as coarse aggregate. The specific gravity of coarse aggregate is 2.68.

Superplasticizer:

The super-plasticizer used for the concrete in this project is Conplast. The specific gravity of Conplast is 1.22.

3 MIX DESIGN

The design of M_{30} grade concrete is done by using the IS 10262 -2009 codal provision as follows:

DATA:

Cement = 575 kg
Fine Aggregate = 904.8 kg
Coarse aggregate = 755 kg
Water = 192 liters
Super Plasticizers = 1.2%

3.1 Mix Proportion:

Table:3.1Mix Proportion

Cement	Fine aggregate	Coarse aggregate	Water	Super plasticizer
1	1.5	2.83	0.4	0.02

4. EXPERIMENTAL INVESTIGATION

4.1 COMPRESSIVE STRENGTH TEST FOR BEAM

The specimens are beams of size 2200mm X 150mm x 100mm, reinforced with 2 numbers of 12mm diameter HYSD bars in tension and 2 numbers of 8mm diameter HYSD bars in compression zone as hanger rods. The specimen is also provided with shear reinforcement in the form of 6mm diameter mild steel bar two legged stirrups at 120mm centre for control beam. Three specimens were tested for each percentage at 7 and 28days and average of three was taken.

Calculation

F= P/A N/mm^2

Where, P= load at which specimen fails N

A= Area over which the load is applied in mm^2

F= Compressive stress in N/mm^2

Figure 4.1Flexural failure of the tested Beam

4.2 TESTS FOR BEAMS

The experimental setup is shown in Figure 5.13. All beams were tested in reaction type loading frame of capacity 500 KN. The span of the beams kept as 2000 mm with simply supported end condition and was tested under two point loading applied at one third span points through a stiff beam. Deflections of the beams were measured by three LVDTs at midspan, one third span and one fourth span.

Figure 5.13 Testing of Beam Specimen

6.7 CRACKING BEHAVIOUR

6.7.1 BEHAVIOUR OF FLEXURAL FAILURE OF BEAMS

In the under reinforced section beam, the member approaches failure due to gradual reduction of compression zone, exhibiting and cracks, which develop at the soffit and progress towards the compression face. When the area of concrete in compression zone is insufficient to resist the resultant compressive force, ultimate flexural failure of the member takes place through the crushing of concrete. Large deflection and wide cracks are the characteristics futures of the under reinforced section at failure. This type of behaviour is generally desirable since there is considerable warning before the impending failure. Generally over reinforced member failed sudden crushing of concrete, the failure being characterized by small deflection and narrow cracks. Cracks due to bending moment are widest at the bottom and narrower at the top compression side.

Figure 6.4 Flexural failure of the tested Beam

6.7.2 SHEAR FAILURE OF BEAMS

The nominal shear is less than designed shear strength of concrete beam, the minimum shear reinforcement shall be provided. The nominal shear is exceeds designed shear strength of concrete beam, the shear reinforcement shall be provided. The effect of shear stress is greatest in web of the beam and is maximum at the neutral axis and decrease to zero at the extreme edges. Shear forces tend to cause diagonal cracks radiating from the top and at 45˚ to the plane of the beam. These are steeper where bending moment prevail and are more inclined where the shear are largest. In this experimental work the specimens are behaving like same manner in the shear failure mode. Cracks due to shear are widest in the region of the neutral axis and become thinner towards the upper and the lower of the beam.

Figure 6.5 Shear Failure of Tested Beam

Figure 6.6 Strain Measuring Points

6.8 MODE OF FAILURE

- All Reinforced cocnrete beams failed in flexure zone.
- After the first crack load, the reinforcement started yielding and more number of cracks have formed in the flexure zone and extended towards the point loads with increment in loads.
- At the ultimate load, the failure of all reinforced concrete beam occurred with crushing of concrete in compression zone.
- In the Specimens SP 4 and SP1 more number of cracks formed in flexure zone.

6.9 CRACK PATTERN

The crack patterns of the specimens are shown in Figure 6.7. all the beams were tested under two point loading. During testing time the initial crack load, first crack location and the ultimate failure load were taken. All the beams failed under flexure failure. The initial crack started from the middle bottom of the beam and run through middle of the beam. The major cracks have formed in the flexural region and extended towards the point loads.

Figure 6.7 Crack Pattern

Figure 6.8 Crushing at mid span

5. RESULTS AND DISCUSSIONS

5.1 GENERAL

The results of the experimental investigation on six beam specimens are presented in this chapter. The behaviour of the specimens in terms of crack development, failure mode and ultimate loads were observed during the test. The salient test values of all beam specimens are given in Table 5.1.

Table 5.1 Test Results on Beam Specimens

Specimen	Initial Crack Load (KN)	Ultimate Load (KN)
SP 1	10	42.968
SP 4	8	45.684

Load Vs Deflection

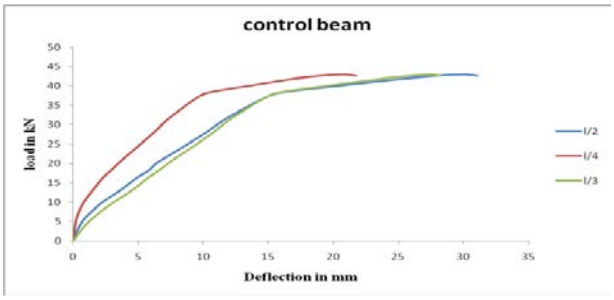

Figure 6.1 Load Deflection Curve for Control Beam Specimen

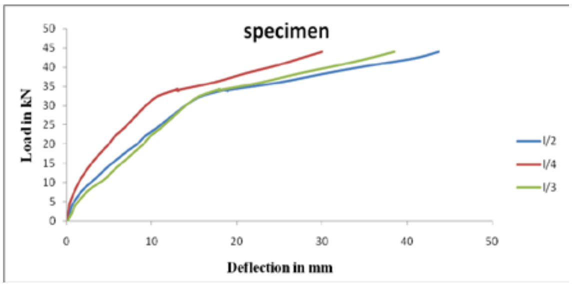

Figure 6.2 Load Deflection Curve for OptimumBeam Specimen SP 4

The initial crack load for the Control beam specimens is 10 KN and Optimum Beam Specimen SP 4 is 8KN and 10 KN, it is indicate that the initial crack load of the specimens are mariginally same.

Specimen SP 4 having high deflection at the mid span than the Control Beam Specimen, Hence the Stiffness of the Specimen SP 4 is lower than that of control Beam.

CONCLUSION

The following are the conclusions obtained based on the experimental work carried out.

The physical and mechanical properties of fly ash, silica fume and Viscosity Modifying Admixtures have been found to be favourable for use in cement concrete as indicates by the compressive strength of concrete specimen tested.

- Flow ability of self-compacted concrete is reduced with elapsed time, superplasticizer dosage and presence of steel reinforcement
- The flexural strength of Self compacting concrete specimen beam increases nominally and remains unaffected compared to that of control specimen.
- The load corresponding to first crack is nominally more in Self Compacting Concrete specimen beam compared to that of Control beam.
- The maximum deflection is exhibits by the exhibits by the Self Compacting concrete beam indicating that the control beam specimen is less ductile.
- The Self Compacting concrete specimen have high ductility index higher than that Control beam, which indicates 35 % fly ash and 10% silica fume is

contributing to the improvement of ductility index.

- The energy absorption capacities of Self Compacting concrete specimen more than the control specimen. Self Compacting Concrete specimen offered more resistance to applied load to compare than Control Specimen.
- The rate of strain exhibited by the concrete in compression zone is nearly same for the specimens. This may be due to the marginal increase in flexural strength.
- Finally it is clear that cement can be partially replaced by 35 % fly ash and 10% silica fume gives better results without affecting the major compromise on strength and Self Compacting Concrete increases Workability and reduces the workman ship.

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