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A STUDY ON THE PERFORMANCE OF SELF COMPACTING CONCRETE

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Abstract — *the objective of the work is to carry out an experimental investigation on the Self Compacting Concrete. The structural strength parameters of SCC Cubes, Cylinders with partial replacement of cement by micro silica are tested with fresh and hardened concrete. The tests on fresh and hardened SCC improved flow characteristics and workability. The project is implemented by using micro silica, engineering properties of OPC cement and the design mix of M40 grade of concrete. The flow test results, the 7th and 28th compressive strength, Split tensile strength and shrinkage test of conventional concrete and self compacting concrete with micro silica replacement of 5%, 10%, 15%. Finally the results are tabulated and comparisons are plotted using graphs.*

Keywords- *micro silica; opc cement; compressive strength; flow tests, split tensile strength; shrinkage test*

I. INTRODUCTION

Industrial waste material, in this case, micro silica, by product of industrial manufacture of ferrosilicon and metallic silicon in high temperature electric arc furnaces are added as a partial replacement of cement in concrete structure. Fresh Self compacting concrete is tested for its flow parameters, Concrete cubes, cylinders and flexural beams were casted, using various replacement levels of 5%, 10%, and 15% of OPC with micro silica, check and compare their strength on 7 and 28 days respectively.

II. OBJECTIVE OF THE PROJECT

The objective of this research is to study the Flow properties, analyze the COMPRESSIVE STRENGTH, SPLIT TENSILE STRENGTH AND SHRINKAGE properties of micro silica added Self compacting concrete and utilization of Industrial waste in efficient manner.

- To find non-conventional concrete that has better workability, flow and filling properties and with better strength parameters when compared to the conventional concrete.
- Understand the various advantages and applications involving partial replacement of cement.
- Compare the performance of conventional concrete cubes, cylinders, and beams with partial replacement with micro silica at 5%, 10%, 15%.

III. METHODOLOGY

- Collection of Micro silica
- Mixing of cement, micro silica and sand
- Mixing of concrete
- Testing of Fresh Concrete
- Casting of Cubes, Cylinders, Beams
- Curing of Cubes, Cylinders, Beams
- Testing of Cubes, Cylinders, Beams
- Comparing the results

IV. FLOWABILITY OF FRESH CONCRETE

4.1. Slump Cone Test

The slump flow is used to assess the horizontal free flow of SCC in the absence of obstructions. The test method is based on determining the slump. The diameter of the concrete circle is a measure for the filling ability of the concrete. The mould for the test is in the frustum of a cone having 30cm height, 20cm bottom diameter and 10cm top diameter.

Figure 1. Slump flow test

4.2. V-Funnel Test

V-funnel test is used to determine the filling ability of the concrete with a maximum aggregate size of 20mm. If the concrete shows segregation then the flow time will increase significantly.

Figure 2. V-Funnel test

4.3. L-Box Test

The test assesses the flow of the concrete, and also the extent to which it is subject to blocking by reinforcement. The apparatus consists of a rectangular-section box in the shape of an 'L', with a vertical and horizontal section, separated by a moveable gate.

Figure 3. L- Box test

4.4. J-Ring Test

The J-ring test can be used to determine the passing ability of self-consolidating concrete. To characterize filling ability and passing ability, the horizontal spread of the concrete sample is measured after the concrete passes through the gaps in the bars of the J-ring and comes to rest.

Figure 4. J Ring Test

4.5. Experimental Flow Test Results

Table 1. Flow test results of Fresh concrete

Mix	Slump[mm]	V-funnel[s]	L-Box	J-Ring
SCC-C	665	14	0.91	6
5% MS	660	11	0.87	5
10% MS	670	9	0.89	9
15%MS	680	9	0.90	8

V. MECHANICAL PROPPERTIES OF SELF COMPACTING CONCRETE

5.1. Compressive Strength

Compression test according to IS: 516 (1959) is carried out on the 150 x 150 x 150 mm cubes. For the evaluation of compressive strength, all the cube specimens are subjected to compressive load in a compression testing machine at 7 days and 28 days.

The compressive strength of the specimen is calculated using the following equation,

$$f_c = P/A$$

Where,

f_c = Compressive strength (N/mm^2)
P = maximum load apllied to the specimen (N)
A = cross-sectional area of the specimen

Figure 5. Testing of Cube

5.2. Split Tensile Strength

Splitting tensile strength is an indirect method used for determining the tensile strength of concrete. Tests are carried out on 150mmx300mm cylinders conforming to IS 5816: 1976 to obtain the splitting tensile strengths at the age of 28 days. In the splitting tensile test, the concrete cylinder is placed with its axis horizontal, between plates of the testing machine, and the load is increased until the failure occurred by splitting in the plane containing the vertical

diameter of the specimen. The maximum load applied to the specimen is recorded and the split tensile strength of the specimen is calculated using the following equation,

$f_t = 2P/\pi DL$,

Where,

f_t = split tensile strength (N/mm^2)
P = maximum load applied to the specimen (N)
D = diameter of the specimen (mm)
L = length of the cylinder (mm)

Figure 6. Testing of Cylinder

5.3. Linear shrinkage of Concrete

This procedure for determining linear shrinkage of concrete with a maximum nominal aggregate size of 19mm or less, for specimens prepared in the laboratory or in the field according to ASTM C 157/C157M-04 Standard Test Method for Length Change of Hardened Hydraulic Cement Mortar and Concrete.

The drying shrinkage test with respect to time was noted for 1,7,14 and 28days respectively. The specimen size used for concrete is 75*75*285 mm as per ASTM C-157(2008). The formula used to measure the change in length:

$\Delta L_x = [(CRD – initial\ CRD) / G] * 100$

Where,

ΔL_x = change in length (%),

CRD = Comparator dial reading

G = Gauge length.

Figure 7. Shrinkage Test

VI. RESULTS AND DISCUSSIONS

6.1. Compressive Strength

Table 2. Compressive Test on Cube (N/mm^2)

MIX	7 day compressive strength (N/mm^2)	28 day compressive strength (N/mm^2)
SCC-C	29.377	49.04
5% MS	27.509	49.7
10%MS	28.427	51.2
15%MS	27.3	47.6

6.2. Split Tensile Strength

Table 3. Split Tensile Strength of Concrete (N/mm^2)

MIX	AVG. SPLIT TENSILE STRENGTH ON 28 DAYS (N/mm^2)
SCC-C	3.85
5% MS	3.82
10% MS	3.78
15% MS	3.95

6.3. Shrinkage Test

Table 4. Shrinkage Test Results

Mix	1 day	7 days	14days	28 days
SCC-CC	5.87	4.332	3.187	-4.532
5% MS	4.307	3.562	2.252	-4.427
10% MS	1.318	0.916	-0.498	-5.45
15% MS	2.107	1.723	-3.000	-5.65

VII. GRAPHICAL COMPARISON OF MICROSILICA ADDED SCC

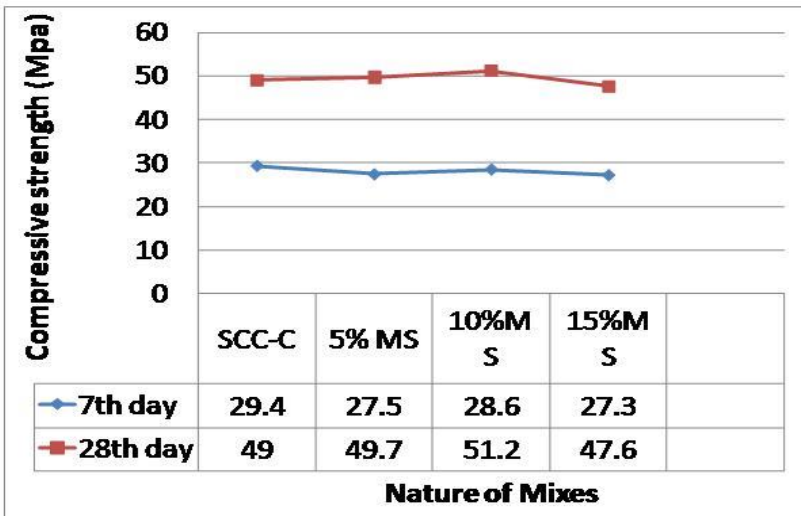

Figure 8. Compressive Strength 7day, 28 day results

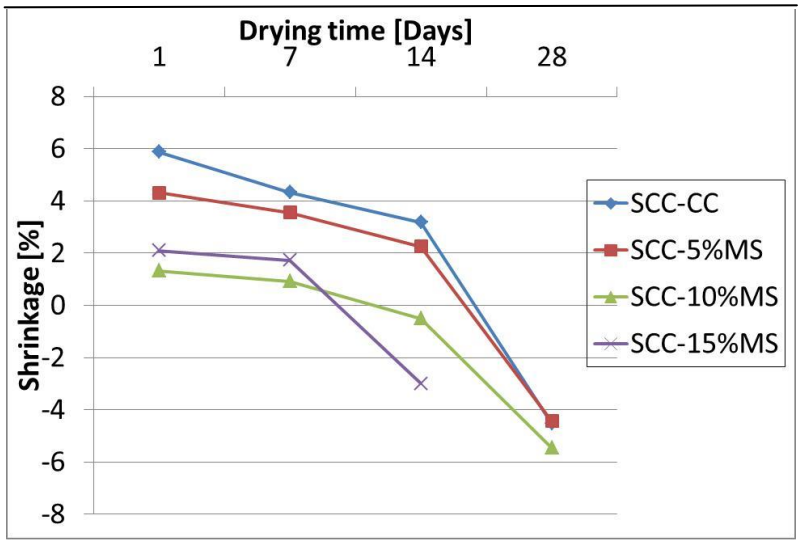

Figure 9. Shrinkage Test at 1day, 7 days, 14days and 28 days

VIII. CONCLUSION

From the above results, micro silica mix SCC met some promise for use in reinforcing concrete as well as mass concrete structure in building construction. The flow test results (Slump flow test) of the fresh concrete meets the requirements of clause J-3, Annex-J of IS456:2000 and IS 1199-1959. The compressive strength of the concrete cubes at 28 days curing indicates that 10% and 15% replacement levels meet the requirement of IS:456, Clause 6.1, 9.2.2, 15.1.1, 36.1 and Table2 for heavy weight concreting and light weight concreting. The split tensile strength of concrete cylinders at 28 days curing indicates that 10% and 15% replacement levels meet the requirement of IS 5816:1999. The shrinkage test of the beams at 28 day curing indicates 10% and 15% replacement of SCC using W/C ratio of 0.47 are suitable for the production of concrete structures. Further areas of research are recommended.

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