Structural Behavoir of Self Compacting Concrete Confined With Ferrocement under Axial Compression

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ABSTRACT

This Project involves an investigation about the structural behavior of Self Compacting Concrete column confined with Ferro Cement, which is a form of RC using closely spaced multiple layers of mesh (or) small diameter rods completely infiltrated with or encapsulated in mortar ,used to enhance the ductility and load carrying capacity. A total of 6 numbers of columns specimen were tested in this experimental investigation. The specimens are of size 700mm height and 130mm diameter. The concrete grade of M40 is used.. The columns are to be tested under concentric axial compressive force. The effect of tie yield strength, tie spacing on column strength, ductility and energy absorption capacity can be obtained from stress strain curves and total displacement curves.

KEYWORDS: *Self compacting concrete, strength, ductility, energy absorption capacity*.

INTRODUCTION

Self-compacting concrete (SCC), which flows under its own weight and does not require any external vibration for compaction, has revolutionized concrete placement. Such concrete should have relatively low yield value to ensure high flowability, a moderate viscosity to resists segregation and bleeding and must maintain its homogeneity during transportation, placing and curing to ensure adequate structural performance and long term durability.

The concept of self-compacting concrete was proposed in 1986 by Professor Hajime Okamura, but the prototype was first developed in 1988 in Japan, by Professor Ozawa (1989) at the University of Tokyo. SCC was developed at that time to improve the durability of concrete structures. The desired shape may be built from a multi-layered construction of Chicken wire or other steel mesh, and if needed reinforced with steel wire or steel bars. Over this finished framework, an appropriate mixture of cement, sand and water is spread out. During hardening, the Ferro cement is kept moist, to ensure the cement is able to set and harden.

The wall thickness of Ferro cement constructions lies in general between 10 and 30 mm (3/8 to 1-1/8 inch).Like other applications of cement, a considerable amount of time may be necessary for the material to fully cure and reach its final strength. Curing time is dependent upon the span or application load, and Ferro cement can take a month before it is ready for use. As the cement hydrates, it becomes increasingly strong.

AIM OF THE PROJECT

The aim of the project is to experimentally investigate the strengthening of self-compacting concrete column using ferrocement in order to obtain,

- Ductility of the member.
- Load carrying capacity of the member.

MATERIALS USED

Cement : The cement used in all mixture was commercially available Ordinary Portland Cement (OPC) of 43 grade confirmed to IS: 8112-1989. The initial and final setting times were found as 80 minutes and 453 minutes respectively.

Fine Aggregate : Locally available Natural River sand of size below 4.75 mm confirming to zone II of IS 383-1970 is used as Fine aggregate.the Laboratory tests were conducted for fine aggregate to determine its physical properties as IS: 2386 (Part III).

Coarse Aggregate : Coarse aggregate used in this study consist of crushed stone of size 12mm and below. Laboratory tests were conducted on coarse aggregate to determine the different physical properties as per IS: 383-1970.

Silica Fume : Silica Fume is a by-product of electric arc furnace used for the production of silicon metal or alloy, having specific gravity of 2.2 and bulk density of 720kg/m3.

Reinforcement: High Yield Strength Deformed Steel bars of 6mm and 12mm diameter were used for the study.12mm bars were used as longitudinal reinforcement and 6mm bars were used for lateral ties.

Super plasticizers: Master Glenium sky 8233 used as a super plasticizer.

Mix Design Procedure for Self Compacting Concrete:

1. Using Non Su et al, method the calculation of quantity of fine and coarse aggregate is determined. The volume of fine aggregate in total aggregate is usually ranges from 50% to 57%. The bulk density of FA and CA and packing factor required for determine the quantity of CA and FA. The packing factor ranges from 1.1 to 1.2
2. For determine the cement content, the compressive strength of cement at 28 days is required. To gain the required strength correction factor is introduced. (EFNARC guide lines: cement value ranges from 350 to 450 kg/m^3).
3. Assume the W/C ratio for calculating water content required for cement. (EFNARC guide lines: W/P ranges from 0.8 to 1.1 by volume, water content should be less than 200 lit/m^3)

MIX DESIGN FOR SCC

Aggregate size = 10 mm
Specific gravity of coarse aggregate = 2.66
Bulk density of loose coarse aggregate = 1383 kg/m^3
Specific gravity of fine aggregate = 2.6
Bulk density of loose fine aggregate = 1415 kg/m^3
Specific gravity of cement = 3.15
Volume ratio of fine aggregate = 54%
Volume ratio of coarse aggregate = 46%
Specific gravity of super plasticizer= 1.064
Air content in SCC = 2%
Design strength of SCC = 40 N/mm^2

Step 1: Determination of coarse and fine aggregate

Assumed packing factor(PF) = 1.2
Amount of fine aggregate needed per unit volume of SCC, W_s = PF * W_s L* S/a
= 675 kg/m^3
Amount of coarse aggregate needed per unit volume , W_g = PF * W_g * (1-S/a)
=723 kg/m^3

Step 2: Determination of cement content

Assuming each kg of cement can provide a comp. strength in 28 day = 0.11 N/mm^2
Amount of cement required per unit volume= f_c/20 kg/m^3 = 485 kg/m^3

Step 3: Determination of mixing water content required by cement

Taking water/cement ratio = 0.36
Amount of water needed = 142 kg/m^3

Step 4: Mix proportion

Cement	Fine Agg	Coarse Agg	Super plasticizer	Water
394 kg/m^3	855 kg/m^3	712 kg/m^3	9.7 kg/m^3	184 kg/m^3
1	1.4	1.5	0.02	0.38

SELF COMPACTABILITY TESTS ON SCC MIXES Various tests were conducted on the trial mixes to check for their acceptance and self compactability properties. The tests included Flow test and V-funnel tests for checking the filling ability and L-box test for the passing ability. The mixes were checked for the SCC acceptance criteria given in Table.

Table: 1 SCC- Acceptance criteria

Method	**Properties**	**Range of values**
Flow value	Filling ability	650-800mm
V-funnel	Viscosity	6-12 sec
L-box	Passing ability	0.8-1.0

Table: 2 SCC - Test Results of SCC Mixes

Flow (mm)	**V-funnel time (s)**	**L-box h2/h1**	**Segre gation**	**Remark**
720	8.6	0.90	NO	SCC
710	8.9	0.88	NO	SCC
705	9.7	0.87	NO	SCC

The all mixes satisfied the acceptance criteria for self-compacting concrete. Hence, these mixes are chosen as the successful mixes. The cube specimens of size 150 x 150 x 150mm were cast for the successful mixes and are tested for the 7-day and 28-day compressive strengths.

Experimental Program

The experimental program contains two steps, and the first step involved the rheological properties of SCC, while the second step involved the structural behaviour of SCC. In order to perform the second step the columns are to be made with SCC and strengthening by hybrid confinement. The specimen is to be test under axial compression with column size of 750mm height and 130mm diameter by varying degrees of confinement. In order to find the compression behaviour, energy absorption capacity and the effect of confinement, the columns with hybrid confinement and grade M40 are to be tested. From the stress-strain values the strain ductility and load displacement curve is to be plotted, through which the energy absorption capacity and ductility of the member is to be studied..

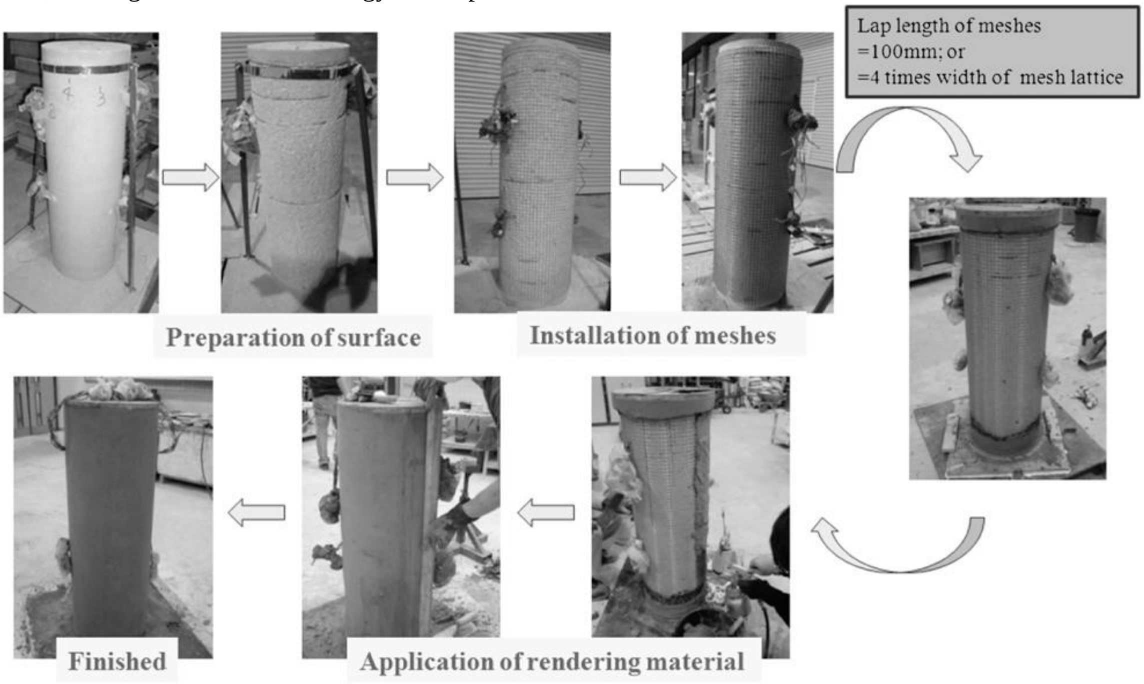

Fig.1: Strengthened specimens with ferrocment.

RESULT AND DISCUSSION

Several trial mixes were prepared by changing the volume ratio of fine and coarse aggregate and Mix (1:1.4:1.5) which satisfies the fresh concrete properties as per EFNARC guidelines is selected for control concrete. Compared to the control concrete, the cube strength for 7^{th} day increased by 21% and 34% when cement is replaced by 10% and 15% of silica fume respectively. When 20% silica fume is replaced for cement, there is a decrease in average cube compressive strength by 16% in comparison with the control concrete. Whereas the average cube compressive strength increased by 7% for SCC_SF10%, SF15% for SCC_SF15% and decreased by 16% for SCC_SF20% when compared with SCC.

CONCLUSION

From the experimental investigation self-compacting concrete made by using silica fume as a mineral admixture had been studied. Increase in percentage of silica fume (10%, 15% and 20%) reduces the flow of concrete. SCC with 10% replacement of cement with silica fume showed good results both in compression and tension. Expecting good results for self-compacting concrete column strengthened by ferrocement.

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