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Effect of Strengthening Axially Loaded Circular Self-Consolidating Short Columns with Expanded Metal Mesh

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Abstract— Superior confinement for concrete column cannot be provided by traditional lateral ties reinforcement due convergence of bends and twists caused due to lateral reinforcement. In this paper, the enhancement in confining the steel bars due to the utilization of metal mesh any case to the regular tie reinforcement is studied. Totally 5 column specimens were cast and cured. A control specimen was prepared and remaining 4 specimens were internally wrapped using Expanded Metal Mesh (EMM). Mesh Apertures are differed having constant mesh thickness. Self-Consolidating Concrete was adopted in place of congested reinforcement. The specimens were tested under uniaxial compression in universal testing machine until failure. The results show that the strength and ductility has been improved for internally confined concrete column specimens.

Keywords: Strength, Ductility, Expanded Metal Mesh, Internal Confinement, Self-ConsolidatingConcrete, Ties.

I. INTRODUCTION

The uneven and non-uniform course of steel bolster impacts the strong which have many structuring properties, for instance, malleability, flexibility, split resistance, durability and in-plane quality. The absence of control offered by ties makes a least mind boggling way for materials, for instance, Expanded Metal Mesh or welded wire work to keep the strong focus. Broadened Metal Mesh were chosen and used to decrease the blockage of stronghold caused as a result of the covering of groups and bends made by even ties in fragments. This is molded by delicate steel having gem opening. This is beneficial because of its simplicity regard, basic availability and suppleness all through during foundation. Self-Consolidating Concrete is extensively used in zones of stuffed steel bars. The condition upgrades the quality and consistency of concrete. Self-Consolidating Concrete generally is of flowable nature not under vibration. EMM can be used as a substitute for standard stronghold. The assistant lead of SCC fragments with EMM as internal detainment is insignificant known and under assessment. In this examination, 5 round short SCC fragments were casted. Out of them, 4 specimens were confined using Expanded Metal Mesh layer with various mesh opening sizes and the mesh thickness has been kept constant. The Concrete columns were experimented under uniaxial compression using Universal testing machine.

The ultimate load carrying capacity, maximum deflection, ductility, stress- strain curves were measured for each specimen and the results have been compared. The effect of variation of mesh openings in lateral ties of SCC columns were studied to provide a best sidelong help using mesh with ties to improve the limitation and the mechanical presentation of SCC short segments.

II. EXPERIMENTAL INVESTIGATION

The test assessment was driven as discussed underneath. Self-Consolidating Concrete with a trademark compressive quality 40 N/mm^2 was prepared. Strong portions of round cross region with an enduring stature of 700 mm and separation crosswise over of 130 mm. These models were inside invigorated with the proportionate proportion of steel support. The new strong properties were perused for satisfying the basic requirements of Self-Consolidating Concrete. The ordinary compressive nature of SCC of M40 grade was found by testing 3 squares and 3 assemblies of M40 assessment of concrete and further affirmed. A total of 5 models were tossed and assuaged for 28 days. 4 models were inside wrapped using metal mesh surrounding the steel bars in a single covering. These specimens after curing period were tested to find out the mechanical behaviour of concrete and compared with the control specimen results.

Table- I: Column specimens Specifications

S.No	Specimen Name	Specifications of Expanded Metal Mesh		No of mesh layers
		Thickness of Mesh (mm)	Mesh opening Size (mm)	
1.	CO1	-	-	-
2.	CO2	2	15 x 30	1
3.	CO3	2	12 x 40	1
4.	CO4	2	16 x 40	1
5.	CO5	2	15 x 50	1

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A. Material Properties

The ordinary Portland cement employed in setting up the concrete is suited as grade 53 complying with Indian Standards 8112 The relative density of the employed Ordinary Portland Cement is found to be 3.09. The fine aggregate used in casting the specimens is a natural siliceous granular material possess a relative density 2.65 and modulus of fineness 2.72 complying under II Zone with Indian Standards 383.

Construction aggregates utilized as of in this experimental investigation comprises of squashed stone going through size 10 mm and underneath. Crushed stone passing through size 10mm and below. The relative density of coarse aggregate is 2.68 and apparent density 1415 kg /m^3 complying with Indian Standards 383. High tough deformed steel bars were employed as main steel and transverse reinforcement respectively. These bars are High tough deformed bars possessing tensile strength (415 N/mm^2). Typical Expanded Metal Mesh sheets of 1.5 x 4 m weighing 20 kg per sheet of various mesh opening sizes and constant mesh thickness were used to wrap the lateral ties. The mesh has a constant thickness of 2 mm with diamond opening. MicroSilica with a relative density of 2.4 included 40% of the weight of cement in concrete to enhance the strength of self-Consolidating concrete. Conplast SP 430 is employed with 1.45% to the weight of concrete to increase the workability of concrete. The dose of Viscosity modifying agent employed with 0.5% to the weight of cement to provide free flow of concrete.

B. Reinforcement details

Steel bars of 4 numbers of diameter size 10 mm were employed *along lengthwise* and 7 numbers of diameter size 8mm employed as lateral reinforcement at a clear spacing of 100 mm. The cover distance was kept at a distance of 20 mm. The metal mesh was encased once surrounding the lateral reinforcement for all concrete columns. Expanded metal mesh sizes used for each column specimen are mentioned in Table 1 and the reinforcement details and specimen details are displayed in Figure.1 and Figure. 2.

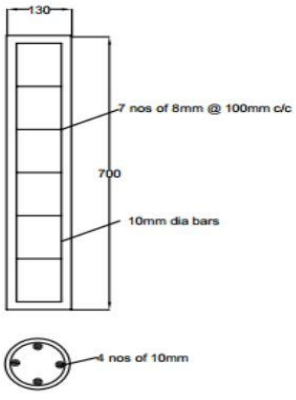

Fig. 1. Cross section features

C. Preparation of SCC Columns

The design mix ratio for SCC M40 concrete was employed from the method designated by Nansu. The mix ratio obtained from the method was 1: 1.99: 2.01: 0.55. The mean strength of Self Consolidating Concrete for cube and cylinder specimens was found to be 42.8 kN/mm^2 and 31.6 kN/mm^2. The experimental techniques employed for the evaluation of concrete fresh state characteristics of Self-Consolidating Concrete are determined and were compared with standards of SCC and confirmed to be less than the acceptable values. Concrete columns were cast and removed from moulds after 1 day. The samples were relieved at room environment for a sum 28 days. Drying of concrete specimens has been carried out after curing process. Fig 4 shows the SCC specimens after curing process.

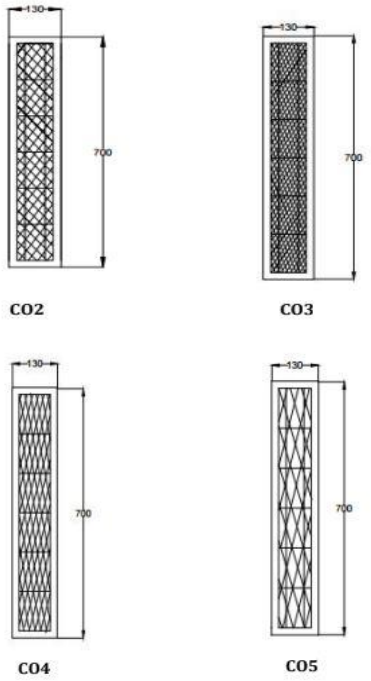

Fig. 2. Specimen details

Fig. 3. Wrapped Samples

Fig. 4. Column Specimens after curing

D. Testing of Concrete Specimens

Fig 5 illustrates the instrumentation and setting up of testing of concrete specimens. Experiments were directed with the utilization of UTM having a limit of 1000 kN under suitable boundary conditions. So as to dodge the development of segments at the top and base surface, the end plates are given to have an even burden conveyance over the section

Fig. 5. Instrumentation and setup of the specimen

Fig. 6. Failure of Column Specimen

III. EXPERIMENTAL RESULTS AND DISCUSSIONS & RESULTS

Table II gives an outline of the results of maximum load bearing capacity, maximum stress and maximum strain values of self-Consolidatingconcrete columns.

Table- II: Experimental data of SCC samples

S. No.	Specimen Name	Mesh Aperture (mm)	Max force carrying capacity (kN)	Max Stress (MPa)	Max strain
1.	CO1	-	295.7	20.89	0.63
2.	CO2	15 x 30	319.42	24.23	0.75
3.	CO3	12 x 40	332.26	25.26	0.9
4.	CO4	16 x 40	349.36	27.82	1.2
5.	CO5	15 x 50	381.76	29.87	1.6

A. Maximum Load bearing limit of Columns

The test data arrived on universal testing machine demonstrated a definitive maximum load bearing limit of concrete increments with increment in the aperture sizes of expanded metal mesh. It is seen from the results that the columns wrapped with mesh on lateral ties experienced 8.98%, 12.96%, 19.56% and 36.12% greater load bearing limits compared to columns with zero mesh around the lateral ties. Fig 7 indicates the graph plotting the maximum load carried by the SCC columns.

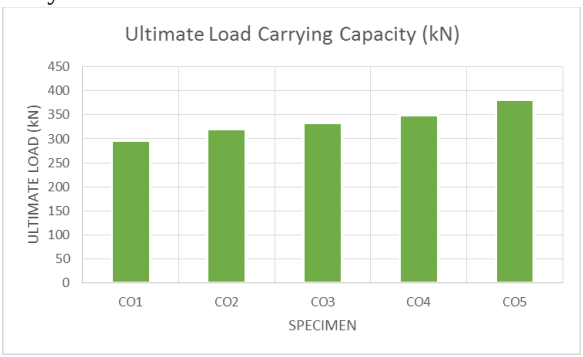

Fig. 7. Load Carrying capacity of Column specimens

B. Stress – Strain Curve – SCC Samples

The reaction of restricted specimens with that of control specimen were organised as Stress vs Strain graphs for each specimen as shown in Fig 8.

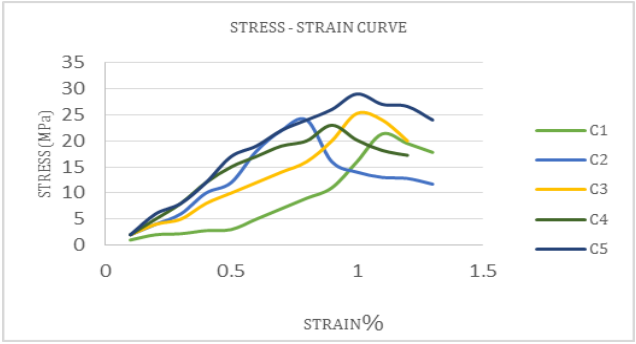

Fig. 8. Stress vs Strain curves - Column specimens

The Stress vs Strain curves rely on proportion in percentage of steel restraint in lateral ties given. The results indicated that the maximum stress and maximum strain for mesh wrapped concrete was moderately greater when compared with that of unwrapped concrete columns.

C. Ductility

The ability of any structural members to deform excessively at large loads without any failure is implied by means of ductility. The results showed that columns with internal confinement have improved ductility over the control specimen. Fig 9 shows the test results of Ductility of SCC concrete columns.

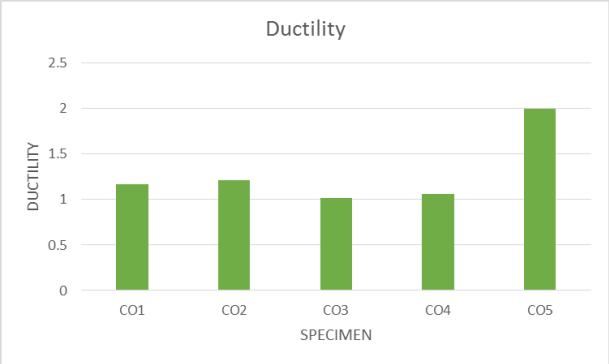

Fig. 9. Ductility of Column specimens

This enhancement in ductility is due to the confinement provided by the Expanded Metal Mesh layer in SCC columns. Table III summarizes the test results of deflection at max force, deflection and ductility of column samples.

Table- III: Ductility of column specimens

S.No	Specimen Name	Deflection at maximum load (mm)	Deflection at first yield (mm)	Ductility
1.	CO1	8.9	7.6	1.17
2.	CO2	5.2	4.3	1.21
3.	CO3	8.6	8.4	1.02
4.	CO4	7.4	7	1.06
5.	CO5	14.8	7.4	2

IV. CONCLUSION

The inferences are drawn dependent on the outcomes of experimental program:

1) Expanded Metal Mesh layer around the lateral ties improved the compression behaviour of the self-Consolidating concrete column when used as an additional reinforcement.

2) The maximum load carried by the columns confined with the mesh layer are 8.98%, 12.96%, 19.56% and 36.12% is greater than the unconfined column.

3) The concrete columns wrapped with lateral reinforcement and metal mesh layer shows improved pliable conduct when compared to the concrete column with no wrapping of mesh.

4) The stress vs strain curve of concrete specimens shows that the stress strain values with enlargement of apertures of metal mesh when compared to that of control specimen.

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