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Effect of Compaction on Circular Concrete Filled Steel Tubes under Axial Compression

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Abstract

In this experimental investigation total 18 no's of specimen were casted by varying method of compaction, cross section and different grade of infill concrete. Keeping Area (A), thickness(t) and length as constant. It is difficult for compaction in long steel tube columns with the help of needle vibrators so in this experimental investigation the effect of method of compaction is studied for short columns with and without compaction and the load carrying capacity is compared with codal provisions (Euro Code 4, 1994, American concrete institute, 1999., American institute of steel construction, 1999).

Key words: *Method of Compaction, Strength Loss Factor, Axial Load I*

INTRODUCTION

Concrete filled steel tube (CFT) columns are used in the primary lateral resistance systems of both braced and unbraced building structures. There exist applications in Japan and Europe where CFTs are used as bridge piers. Moreover, CFTs may be utilized for retrofitting purposes for strengthening concrete columns in earthquake zones. The CFT structural member has a number of distinct advantages over an equivalent steel, reinforced concrete, or steel reinforced concrete member. The orientation of the steel and concrete in the cross section optimizes the strength and stiffness of the section. The steel lies at the outer perimeter where it performs most effectively in tension and in resisting M30, M40) without considering lateral ties. compaction of concrete consider with tamping rod by

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placing in successive layers, each being compacted with 25 numbers of uniform blows. Lin-Hai Han(2003) had conducted an investigation on influence of concrete compaction on Circular concrete filled steel tubes under axial compression and his study is limited to circular cross section only. But in our experiment not only Circular concrete filled steel tubes are also considered. And influence of compacted and non-compacted concrete filled steel tubes are studied by varying cross section and by different grades of infill concrete. It is difficult for compaction in long steel tube columns with the help of needle vibrators so in this experimental investigation the effect of method of compaction is studied for short columns with and without compaction and the load carrying capacity is compared with codal provisions (Euro Code 4, 1994, American concrete institute, 1999., American institute of steel construction, 1999).

Scope of the Study

Most of the experimental works has been carried out on load carrying capacity on CFT subjected to Axial Compression. Very little parametric study has been done regarding the load carrying capacity of CFT by using different method of compaction keeping Parameters constant and different infill concrete. The experimental work is limited to circular sections and infill concrete.

OBJECTIVES OF THE STUDY

The objectives of the study are summarized as follows:

1) To study the effect of compaction on grade of concrete infill steel tubes.
2) To study the effect of compaction on axial shortening.

METHODOLOGY

1) Conducting axial compression test for CFT circular sections with different grades of concrete.
2) Specimens are tested in CTM of 2000kN capacity for determining ultimate load, axial deformation and buckling modes
3) Comparison of ultimate load of specimen of CFTs for different method of compaction The methodology adopted in the study area is as shown in **figure.1** bending moment

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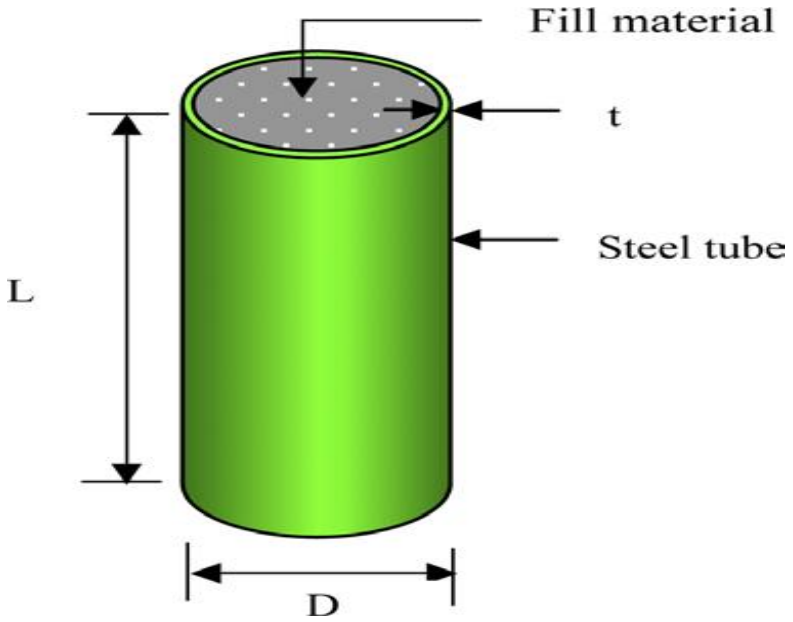


Fig 1: showing concrete filled steel tube

EXPERIMENTAL DETAILS

Raw Materials

Cement: For the experimental work Portland slag cement was used, Portland slag cement is less reactive than OPC and gains strength little more slowly during first 28 days and adequate curing is essential. The composition and properties are governed by IS: 455-1989.

Coarse Aggregates

10mm down size crushed granite aggregates are used in the present work.

Fine Aggregate

Natural river sand is used confirming to IS: 383-1970

Water

Water used in concrete shall be free from sewage, oil, acid, strong alkalies or vegetable matter, and also shall be free from clay and loam. The water used is potable, and is satisfactory to use in concrete. Tap water supplied in the Basavakalyan Engineering College is used for casting and curing of concrete specimen used in the experimental work.

Cold-Rolled Steel Tubes

The cold rolled steel sections are produced from strip steel conforming to IS: 1079-1973. Experimental results are as follows. Yield stress fy = 200 N/mm2, Modulus of elasticity Es = 2 x

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105 N/mm2 (values are as per data provided by steel tube suppliers).

Superplasticizer

Fosroc Conplast WL is the integral water proofing liquid admixture for concrete & mortar .

Concrete Mix Design

Concrete Mixes with targeted characteristic strengths of 20, 30 and 40 MPa using locally available Portland Slag Cement (PSC), crushed granite jelly (12.5 mm down) and river sand and Fosroc Conplast WL are used in the present investigation. Mix designs of these three grades of concrete are based on the guidelines of IS: 10262-2009.Standard cubes (150mm X 150mm X 150mm) were used to determine the compressive strength of the concrete.

Preparation of Steel Tubes

Mild steel tubes are used in the present investigation. These tubes are seam welded and the edges of the tubes are finished. The edges of the steel tubes are finished horizontally flat after cutting to avoid eccentricity while loading. Outer surfaces of all the steel tubes are painted to avoid the corrosion. The insides of the tubes are wire brushed to remove any rust and loose debris present. The deposits of grease each specimen are put on the outer surface of the tubes. Area of Steel for Circular CFTs are approximately equal.
Table 2:

Table 1: Details of Mix Design

Sl. No.	Mix Designation	Cement in Kg/m3	Proportion C:FA:CA	W/C Ratio	Super Plasticizer %(by Wt of cement)	Compressive strength at 28 days (N/mm2)	Slump (mm)
01	M20	370	1:1.89:2.62	0.55	0.5	26.90	140
02	M30	390	1:1.78:2.30	0.45	1.0	35.50	125
03	M40	410	1:1.70:2.06	0.40	1.5	45.87	110

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Table 2: Details of steel tube specimen

Shape	Diameter Or Size (mm)	Thickness T (mm)	D/t Ratio	Length L (mm)	L/D Ratio	Yield Stress Fs (N/mm2)	Modulus of elasticity of steel (Es) N/mm2
Circular	63	1.25	50.4	360	5.71	200	200000

Placing of the Concrete and Compaction in CFTs

In order to ensure proper compaction for compacted CFT samples, higher degree of workability i.e., 100-140 mm slump is adopted for the concrete mix. This is accomplished by using super plasticizer as admixtures.

Bottom end of the steel tube is covered with polythene sheet tightly and concrete is poured from top. Concrete is filled in steel tube in approximately three equal layers and each layer is compacted with 25 blows using a steel tamping rod. Top of the concrete is trimmed using a trowel and steel tube was kept undisturbed until it was taken out from stand to keep in water for curing.



Fig. Placing of Concrete & Compaction in CFTs

RESULTS AND DISCUSSIONS

Change in load carrying capacity for Circular CFTs with different grades of concrete for compacted and non-compacted concrete

Concrete inside the steel tube of a CFT column is completely confined due to the surrounding steel tube. This completely confined concrete shares external axial load along with the steel tube. It is observed that the load

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carrying capacity increases by infilling the concrete in hollow steel tubes. An increase in grade of infill-concrete increases the axial strength and decreases the axial shortening of the CFT for a given cross sectional area. An increase in load carrying capacity of an uniform compaction is uniform throughout cross section of specimen, leads to increase in overall load carrying capacity. From experimental results it is found that axial load carrying capacity increases with increase in grade of concrete and is more significant for circular columns as compared to square and rectangular column. Strength loss factor is proposed here in accounts in load carrying capacity due to non compaction of concrete in CFT's with increase in grade of concrete strength loss factor increases.

Hence for higher grades of concrete infill needs better workability or else such concrete contribution in CFT's will be lower if compaction is not made. It is also absorbed that the percentage increasing in axial strength for circular concrete filled steel tubes for M40 is 19.9% and 5.8% more compared to M20 and M30 grade of infill concrete.

Table 3: Comparison of ultimate load carrying capacity for CFTs with different grade of infill concrte for compacte and non-compacted

Shape	Grade	Axial load(kN)		Axial load(kN) at (20mm) Shortening		Strength loss factor =(Pcomp-Puncomp)/Pcomp %
		Compacted	Non-Compacted	Compacted	Non-Compacted	
Circular	M20	135.0	110.2	132.5	98.2	0.184
	M30	165.3	11.3	158.5	87.0	0.325
	M40	192.3	118.7	173.0	88.8	0.383

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Effect of compaction on Load carrying capacity of CFT

It is observed that for certain values of longitudinal strain the concrete began to increase in volume due to micro cracking, which induced concrete confinement by the steel tube. This confinement increased the overall load resisting capacity of the concrete filled CFTs. However this increase was noted only for Circular tubes. It is observed that the load carrying capacity of CFT specimen depends upon the nature of compaction done while filling the infill concrete in steel tubes. It is observed that the load carrying capacity of compacted circular M20 grade infill concrete is increased 22.5% compared to non-compacted circular specimen, similarly the load carrying capacity of compacted circular M30 grade infill concrete is increased 48.5 % compared to non-compacted circular specimen and similarly the load carrying capacity of compacted circular M40 grade infill concrete is increased 62.0 % compared to non-compacted circular specimen.

CONCLUSIONS

1) It is observed that the load carrying capacity of hollow steel tubes can be increased by increase in grade of concrete in-fill.
2) The load carrying capacity of M4CNCS1 is higher as compared to M2CNCS1 & M3CNCS1 by 12.51% and 3.72% respectively.
3) The load carrying capacity of M4CCS1 is higher as compared to M2CCS1 & M3CCS1 by 42.44% and 16.33% respectively.
4) The load carrying capacity of M20 grade non compacted circular specimen is more.
5) For CFTs other than circular samples compaction has higher influence in load carrying capacity of specimen.

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