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A Study on Behaviour of Circular Stiffened Hollow Steel Column Filled With Self Compacting Concrete Under Monotonic Loading

KEYWORDS: circular steel tubes, SCC, silica fume, super plasticizer

Thanuja H.P	E.Ramesh Babu	Dr N S Kumar
Post Graduate Student-Structural Engineering Department Civil Engineering, Ghousia College of engineering, Ramanagara.	Associate Professor of civil engineering Department Civil Engineering, Ghousia College of engineering, Ramanagara.	Professor, Director of R&D, of civil engineering Department Civil Engineering, Ghousia College of engineering, Ramanagara.

ABSTRACT *In this experiment,Investigation on the behaviour of Circular Stiffened Hollow Steel Column filled with Self Compacting Concrete (SCC) subjected to monotonic loading is studied. In this study typical Twenty Four combinations of variable lengths and D/T ratios is considered. Three different length of specimen that is 238.2mm, 421mm & 538mm and three different diameter of specimen that is 15.88mm, 26.9mm, 42.1mm with same thickness 1.6mm are selected, in order to know the behaviour and buckling load of above said columns and tests were conducted under monotonic loading.*

From the experimental result it can be concluded that

1.As length increased, load carrying capacity decrease.

2. As diameter increases load carrying capacity increased

3. Load carrying capacity of steel tubes filled with SCC higher than the empty steel tube.

4.when compared to the Unstiffened Steel Tube Stiffened Steel Tube is stronger ,and load carrying capacity of stiffened steel tube is also higher.

I.INTRODUCTION

Composite sections are becoming increasingly popular in construction. Harnessing the strength of two different materials to form a composite section can be beneficial in terms of both structural performance and cost. An example of a widely used composite section in construction is composite column, this form of construction has become very popular in recent years, where steel beam and concrete column act compositely to resist load. There has also been a recent surge in popularity of composite columns.

Concrete Filled Steel Tubes (CFSTs) are used in many structure application including column, supporting platform of offshore structures, roofs of storage tanks, bridge piers, and column in seismic zones. Concrete filled steel box column offer excellent structural performance, such as high strength, high ductility and large energy absorption capacity. Application of the CFST concept can lead to over all saving of steel in comparison with conventional structural steel systems. In CFST composite construction, steel tubes are also used as permanent formwork and to provide well distribution reinforcement.

Stiffened steel tubes: Steel tubes of 26.9 mm diameter are stiffened with 6mm dia rod at two sections with a spacing of 1/3 height or length from ends of column specimen.

Fig.1.Stiffened steel tube

Self Compacting Concrete: Self Compacting Concrete (SCC) is a fluid mixture, which is suitable for placing difficult conditions and also in congested reinforcement, without vibration. In principle, a Self Compacting or Self Consolidating concrete must:

- Have a fluidity that allows self compaction without external energy
- Remain homogeneous in a form during and after the placing process and
- Flow easily through reinforcement

Super plasticizer: Super plasticizer is essential for the creation of SCC. The job of SP is to impart a high degree of flow ability and deformability, however the high dosages generally associate with SCC can lead to a high degree of segregation. Conplast SP 430 is utilized in this project, which is a product of FOSROC Company having a specific gravity of 1.222.

Silica fume: Silica fume is a byproduct of producing silicon metal or ferrosilicon alloys. One of the most beneficial uses for silica fume is in concrete. Because of its chemical and physical properties, it is a very reactive pozzolan. Concrete containing silica fume can have very high strength and can be very durable. Silica fume is available from suppliers of concrete admixtures and, when specified, is simply added during concrete production. Placing, finishing, and curing silica-fume concrete require special attention on the part of the concrete contractor.

2.METHODOLOGY

The following specimens are tested using in UTM by applying monotonic load or axial compression load for studying the behavior of the column section to determine buckling load and deformation for various types of the section or specimen given below.

1. Hollow steel tubes -(9 specimen)

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2. SCC filled steel tubes-(9 specimens)
3. Hollow stiffened steel tubes-(3specimen)
4. SCC filled stiffened steel tubes-(3specimen)

Monotonic loading is carried out for all the specimen to determined strength & deformation.

Fig .2.1. Hollow steel tubes of different length 238.2mm, 421mm, 538mm and different diameters 15.88mm, 26.9mm, 42.1mm with 1.6mm thickness.

Fig. 2.2. SCC filled steel tubes of different length 238.2mm, 421mm, 538mm and different diameters 15.88mm, 26.9mm, 42.1mm with 1.6mm thickness.

Fig .2.3. Hollow stiffened steel tubes with different length such as 238.2mm, 421mm, 538mm with 26.9mm diameter &1.6 mm thickness.

Fig .2.4: SCC filled stiffened steel tubes with different length such as 238.2mm, 421mm, 538mm with 26.9mm diameter &1.6 mm thickness.

3.EXPERIMENTAL RESULTS AND DISCUSSION

Material properties:

Totally twenty four specimens consisting of nine square hollow steel tube, nine SCC filled steel tube, three stiffened hollow steel tube & three stiffened SCC filled steel tube for M30 grade of concrete 25% silica fume and super plasticizer (6% of cement quantity) used as in filled. Three different length i'e 238.2mm, 421mm, 538mm & different diameter i'e 15.88mm, 26.9mm, 42.1mm with same thickness 1.6mm.

Steel specimens : In this study following different length and different diameter with same thickness specimens are selected as listed in table 1.

Table 1. Specimens of Hollow Steel Sections

Length	Diameter (mm)	Thickness(mm)	L/D	D\T
238.2 mm	15.88	1.6	15	9.925
	26.9	1.6	8.855	16.8125
	42.1	1.6	5.65	26.312
421 mm	15.88	1.6	26.511	9.925
	26.9	1.6	15.66	16.8125
	42.1	1.6	10	26.312
538 mm	15.88	1.6	33.87	9.925
	26.9	1.6	20	16.8125
	42.1	1.6	12.77	26.312

Fig.3.1.Before testing Steel tube

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fig.3.2.After testing Steel tube (Buckling observed at middle of Steel tube)

Fig.3.3.before testing of stiffened steel tube

fig.3.4.after testing of stiffened steel tube (Observed buckling at middle of steel tubes but stiffer is unaffected)

Fig.3.5.bofore testing of steel tube

fig3.6.after testing of steel tube (Observed bulging at top of the steel tube)

Fig.3.7.Steel column specimens after testing

Table 2. Tabulation of Result Specimen

Sl No	Case	Length (mm)	Thick-ness (mm)	Diam-eter (mm)	L/D	D/t	Load (KN)	EC4 Code(KN)
1	Hollow	238.2	1.6	15.88	15	9.925	30	-
		238.2	1.6	26.9	8.855	16.8125	38	28.6
		238.2	1.6	42.1	5.65	26.312	52	43.64
	Hollow	421	1.6	15.88	26.51	9.925	26	-
		421	1.6	26.9	15.66	16.8125	34	31.59
		421	1.6	42.1	10	26.312	50	47.813

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	Hollow	538	1.6	15.88	33.87	9.925	24	-
		538	1.6	26.9	20	16.8125	30	-
		538	1.6	42.1	12.77	26.312	47	52.75
2	Filled	238.2	1.6	15.88	15	9.925	45	-
	(M30 Grade SCC Filled)	238.2	1.6	26.9	8.855	16.8125	62	51.77
		238.2	1.6	42.1	5.65	26.312	98	108.58
		421	1.6	15.88	26.51	9.925	68	-
		421	1.6	26.9	15.66	16.8125	75	72.47
		421	1.6	42.1	10	26.312	82	78.8
		538	1.6	15.88	33.87	9.925	62	-
		538	1.6	26.9	20	16.8125	68	-
		538	1.6	42.1	12.77	26.312	76	-
3	Hollow stiff-ened	238.2	1.6	26.9	8.855	16.8125	45	28.6
		421	1.6	26.9	15.66	16.8125	40	31.59
		538	1.6	26.9	20	16.8125	34	-
4	Filled stiff-ened	238.2	1.6	26.9	8.855	16.8125	68	51.77
	(M30 Grade SCC Filled)	421	1.6	26.9	15.66	16.8125	76	76.47
		538	1.6	26.9	20	16.8125	74	-

L/D ratio	Length	diam-eter	Thickness	Hollow	Filled	Hollow Stiffened	Filled Stiffened
15	238.2	15.88	1.6	30	45		
8.855	238.2	26.9	1.6	38	62	45	68
5.65	238.2	42.1	1.6	52	98		
26.51	421	15.88	1.6	26	68		
15.66	421	26.9	1.6	34	75	40	76
10	421	26.9	1.6	50	82		
33.87	538	15.88	1.6	24	62		
20	538	26.9	1.6	30	68	34	74
12.77	538	42.1	1.6	47	76		

3.1.Grapical representation

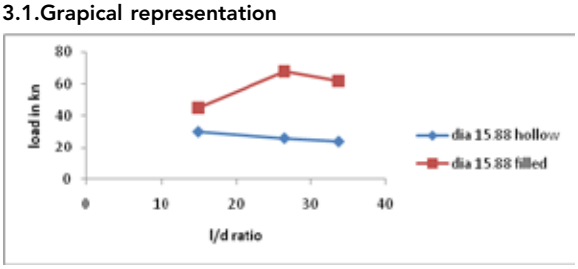

Fig.3.1.comparision of l/d v/s load for 15.88 diamter of both hollow and scc filled steel tubes for different length.

- Scc filled steel tube is strong than hollow steel tube.

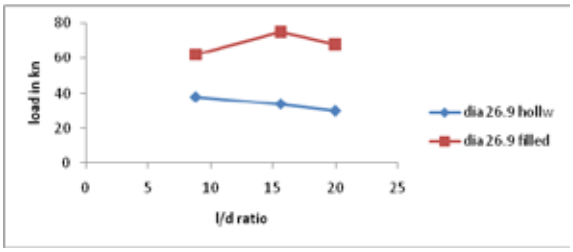

Fig.3.2.comparision of l/d v/s load for 26.9 diamter of both hollow and scc filled steel tubes for different length.

- Scc filled steel tube is strong than hollow steel tube.

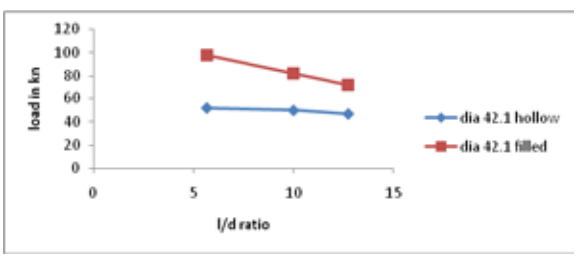

Fig.3.3.comparision of l/d v/s load for 42.1 diamter of both hollow and scc filled steel tubes for different length.

Scc filled steel tube is strong than hollow steel tube.

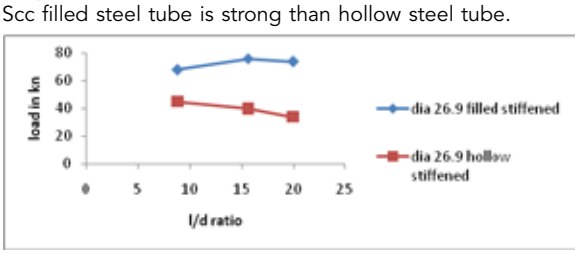

Fig.3.4.comparision of l/d v/s load for 26.9 diamter of both hollow stiffened and scc filled stiffened steel tubes for different length.

- Scc filled steel tube is strong than hollow steel tube.

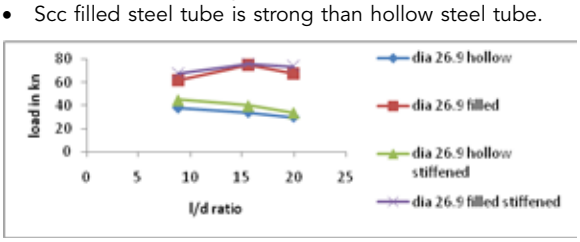

Fig.3.5.comparision of l/d v/s load for 26.9 diamter of both hollow and scc filled stiffened and unstiffened steel tubes for different length.

- Scc filled steel tube is strong than hollow steel tube.

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4.CONCULSION

From the experimental result it can be concluded that

1. As length increased, load carrying capacity decrease.
2. As diameter increases load carrying capacity increased
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4. when compared to the Unstiffened Steel Tube Stiffened Steel Tube is stronger ,and load carrying capacity of stiffened steel tube is also higher.

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