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Behaviour of composite circular steel column infilled with fibre reinforced concrete subjected to monotonic loading

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D.O. E approach (Taguchi's approach),
Hollow steel tube (HST).

ABSTRACT

Many in-fill materials are used to improve ductility of Concrete Filled Steel Tube (CFST). Among the various in-fill materials, fibre is gaining attention in the CFST column. Here an attempt is made to study the effects of the diameter, thickness of steel tube, grade of concrete & volume fractions of glass fibre to Concrete on the behaviour of CFST under Axial Compression. In this research, Taguchi's methodology with DOE (Design of Experiments) is adopted before conducting experiments for selection of combinations. Therefore, 27 experiments have been conducted for M20 grade, 9 experiments for M25 grade & 9 experiment for Hollow Steel Tube. The results indicate that glass fibre reinforced concrete filled steel tube columns appears to have a significant increasing trend in ductility, & have slight increasing trend in load capacity with increase in volume fraction of glass fibre for 0.5% & 1% whereas decreasing beyond 2%. Obtained Experimental results have been verified with three different codes- Euro code 4, American code (AISC 2005, ACI 2008X, AS), and British code (BS-5400-1979). Variation was found to be in the range of 5%-10% for Euro code & 5%-20% for AISC, ACI, AS & BS-5400 may be due to quality of steel & micro defects.

Introduction

The in-fill material inside steel tubes is required to be of the quality as to increase the ductility, but not the strength of composite columns, many kind of in-fill materials were used to improve ductility of composite columns. Among the various in-fill materials, fibre is gaining attention in the composite columns, due to high flexural strength, tensile strength, lower shrinkage, & better fire resistance. The use of fibre reinforced concrete as filling material has an improvement in the ductility of fibre reinforced concrete filled steel tube, delays the bulge deformation and results in an enhanced energy absorption capacity of fibre reinforced concrete filled steel tube.

In this paper, the effects of the diameter, thickness of steel tube, grade of concrete & volume fractions of glass fibre to concrete on the behaviour of short glass fibre reinforced concrete filled steel tube columns under axial compression are presented. According to the past study on the concentric compression behaviour of the CFT columns, the ultimate axial strength of CFT column is considerably affected by the wall thickness of the steel tube, strength of in-filled concrete and the length of the CFT. The present work is intended to study the parameters affecting the ultimate axial load carrying capacity and corresponding axial shortening of the CFT using Design of Experiments (DOE) approach.

Advantage of Using Cft Over Encased Columns

Composite column combines the advantages of both structural steel & concrete, namely the speed of construction, strength, & light weight steel, & the inherent mass, stiffness, damping, & economy of concrete. The steel frame serves as the erection frame to complete the construction of the rest of the structure. Thus improving ductility. Furlong concludes that the concrete infill delays the local buckling of the steel tube. However, no increase in concrete strength due to confinement by steel tube was observed.

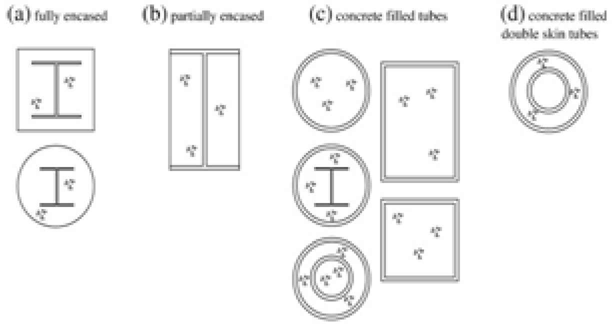

Fig 1. Types of Composite Column

Material Properties

Concrete:-Design mixes are prepared using locally available Portland Pozzolana Cement (PPC), crushed granite jelly (12.0mm down) and river sand. Mix designs of these two grades (M20, M25) of concrete are made based on the guidelines of IS 10262-1982. The mix proportions adopted for the two grades of concrete are shown in table below

Steel (Circular Hollow Steel Tubes-Chs):-The steel columns used were hot-rolled CHS sections of diameters (33.7, 42.4, and 48.3). The allowable D/t ratios of the steel hollow sections are less than the limits specified in EC-1994 and thus the premature buckling failure of CFT specimens is avoided.

Glass Fiber: - In this section the glass fibre-reinforced concrete is examined. It is a cement-based material reinforced with short glass fibres. When glass fibre is added to a concrete mix, they

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are randomly distributed and act as crack stemmers. Debonding and pulling out of fibres require more energy, giving a considerable increase in resistance and toughness under static or dynamic, monotonic or cyclic loading

Properties

- High tensile strength, 1020 to 4080 N/mm^2
- Lengths of 25mm are used
- Improvement in impact strengths, to the tune of 1500%
- Increased flexural strength, ductility and resistance to thermal shock

Test Setup:-The column specimens are tested at 28 days of age. The tests are conducted in a 200Ton capacity Monotonic loading machine. The specimen is tightly fixed and then axial load is applied slowly by careful manipulation of the loading-values. The readings of the applied load, Axial shortening are recorded at appropriate load increments.

Current Design Provisions

- The AISC (AISC 2005), The ACI - American Concrete Institute (ACI 2008X), The AASHTO Specifications (AASHTO 2009)
- The EUROCODE 4 -1994
- The British code BS-5400-1979

Provide design rules for CFT construction

Introduction to DOE

DOE (Design of Experiments) is a formal structured technique for studying any situation that involves a response that varies as a function of one or more independent variables.

Types of DOE

- Factorial Design
- Mixture Design
- Response surface Method
- Taguchis Method

Comparison of Taguchi's Design

For 3 Factors with 3 levels in General Design =3^3X3 (L^F X 3 Levels) = 81

For 3 Factors with 3 levels in Taguchi's Design=9 Combinations X 3 Levels = 27

Save =66.66 %

For 4 Factors with 3 levels in General Design =3^4X3 (L^F) X 3 Levels =243

For 3 Factors with 3 levels in Taguchi's Design=9 Combinations X 3 Levels = 27

Save =88.89%

Experimental Programme

Concrete is filled in the steel tube in approximately four layers and each layer is well compacted. Top of the concrete is trimmed off using a trowel and steel tube is kept undisturbed until it is taken out from the stand after 24hr to keep in water for curing. After curing the in filled tubes for 28days CFST in filled tubes with fibre reinforced concrete of different percentages as per Taguchi level-3 design with 4 - factors are placed upright for compression loading with proper end conditions and are tested for ultimate axial load and axial shortening under a 200 Ton Cyclic and Sustained Loading. The specimen is tightly fixed and then axial load is applied slowly by careful manipulation of the loading-values. The readings of the applied load, Axial shortening are recorded at appropriate load increments

27 Experiment for CFST of M20 grade, 9 Experiments for M25 & 9 Experiments for Hollow steel tubes are conducted.

Theoritical formulae & calculation

The design values/capacity of CFST column was calculated using the codes: EC4, ACI (1999), AIJ (1997) & BS5400.

Euro code 4 (EC4) method, $N_{EC4} = (A_S*f_y) + (A_C*f_c)$

ACI, AIJ & Australian Standards (AS) method, $N_{ACI,AIJ,AS} = (A_S*f_y)+0.85\ (A_C*f_c)$

BS5400 method, $N_{BS5400} = (A_S*f_y)+0.675\ (A_C*f_c)$

Where, Ac = Area of concrete infill, As = Area of steel tube

f_y= Yield strength of steel tube, f_c= Compressive strength of concrete infill

Fig. 2. Casting, Curing & Testing of Cube for finding 28 days Compressive Strength

Fig 3. Cutting & preparation of Specimen to required Length

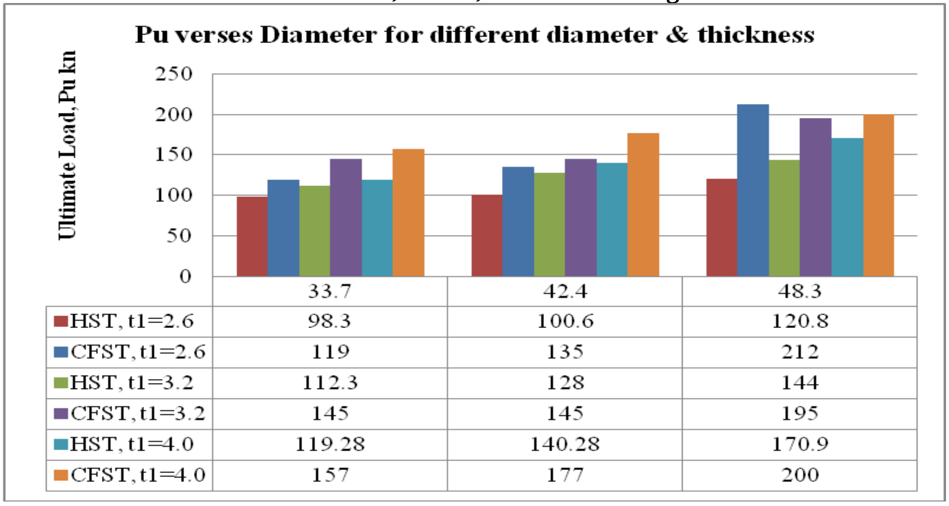
Fig 4. Glass Fibre

Fig 5. Loading Apparatus

Fig 6:- Experiment Procedure

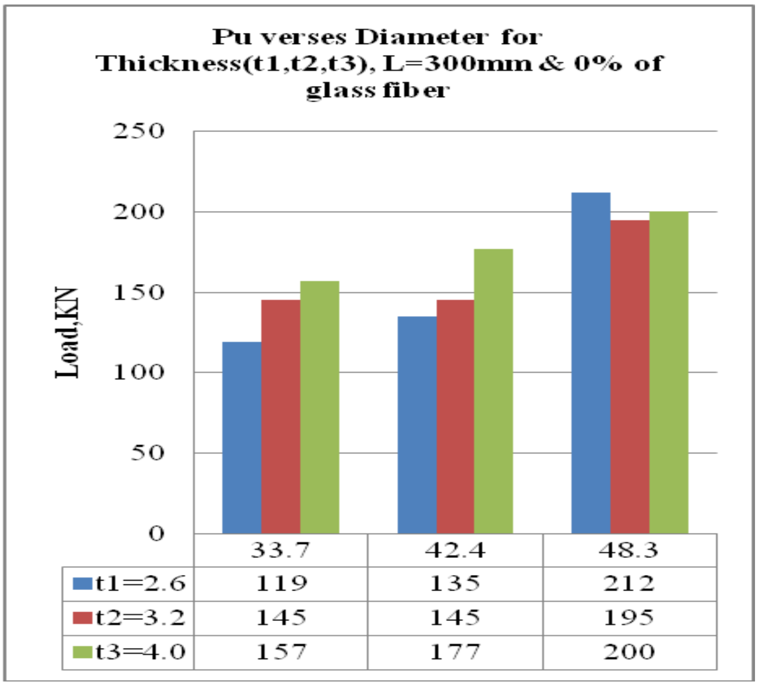
Graphical Representation Of Experimental Results

Comparison of CFST and hollow steel tube P_u for three different diameter d1=33.7, d2=42.4, d3=48.3 & for three different thickness t1=2.6, t2=3.2, t3=4.0 for M20 grade.



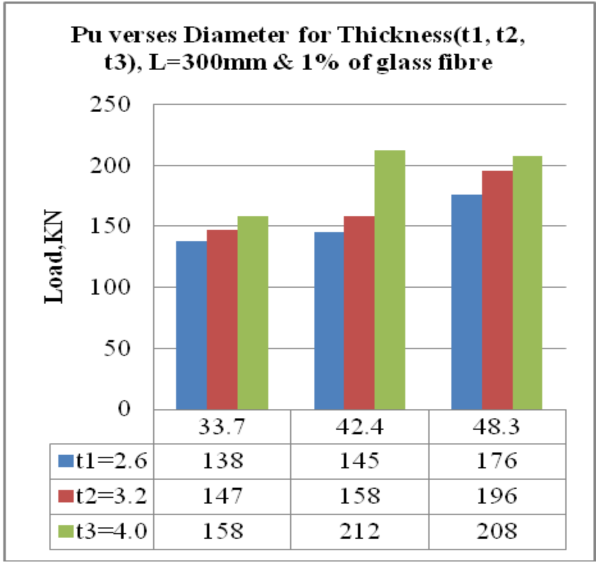
	33.7	42.4	48.3
HST, t1=2.6	98.3	100.6	120.8
CFST, t1=2.6	119	135	212
HST, t1=3.2	112.3	128	144
CFST, t1=3.2	145	145	195
HST, t1=4.0	119.28	140.28	170.9
CFST, t1=4.0	157	177	200

Comparision of load verses diameter for three different thickness t1=2.6, t2=3.2, t3=4.0, length L=300mm & 0% of glass fibre.



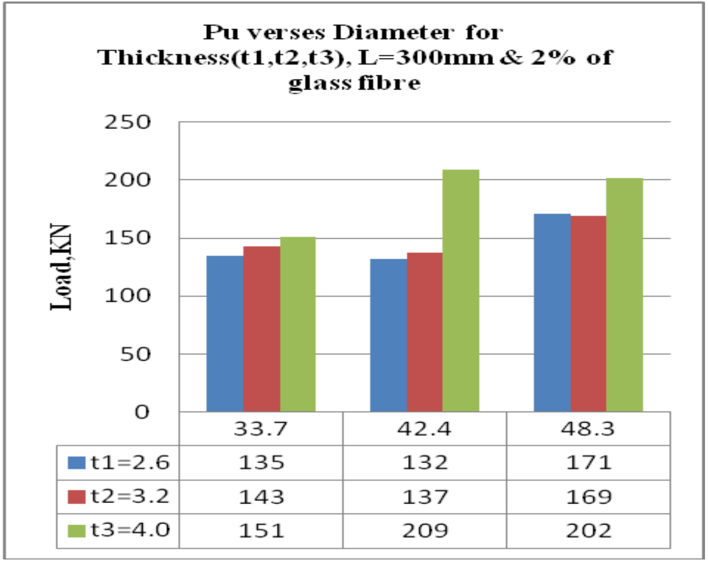
	33.7	42.4	48.3
t1=2.6	119	135	212
t2=3.2	145	145	195
t3=4.0	157	177	200

Comparison of load verses diameter for three different thickness t1=2.6, t2=3.2, t3=4.0 for 1% of glass fibre.

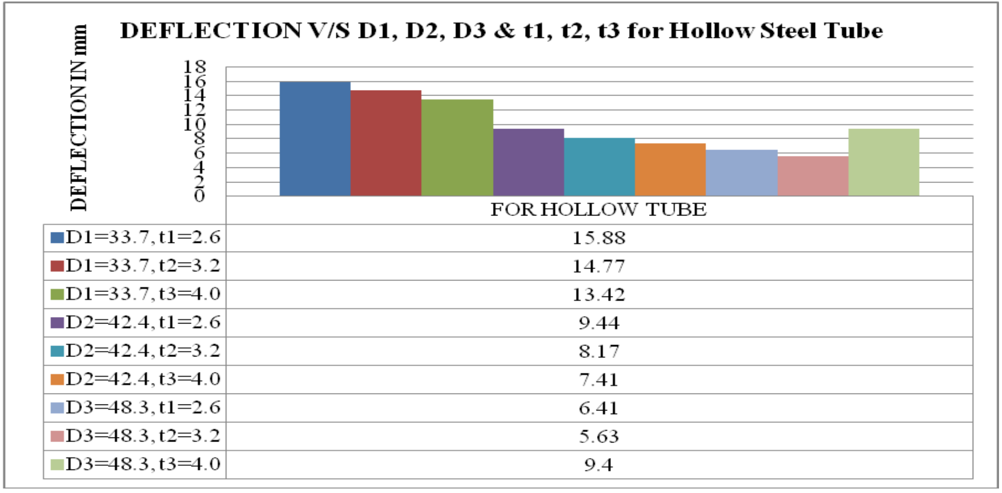


	33.7	42.4	48.3
t1=2.6	138	145	176
t2=3.2	147	158	196
t3=4.0	158	212	208

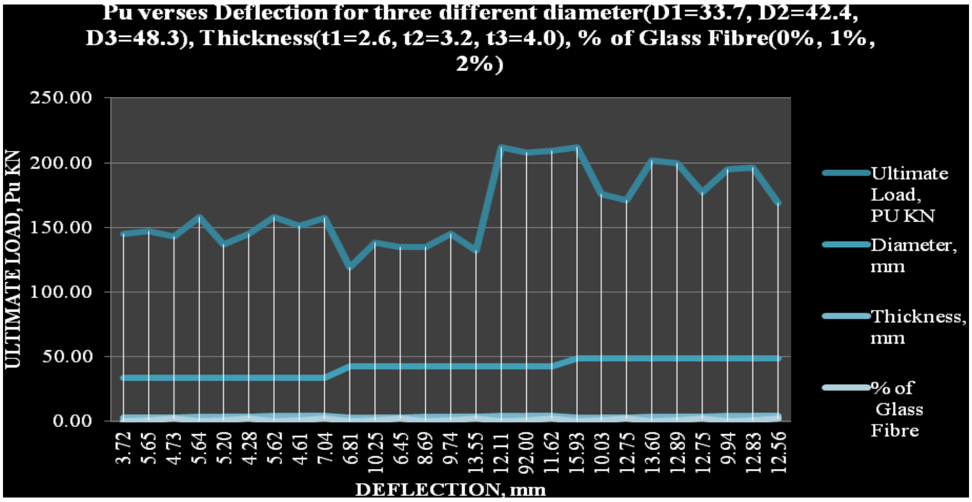
Comparison of load verses diameter for three different thickness t1=2.6, t2=3.2, t3=4.0 for 2% of glass fibre



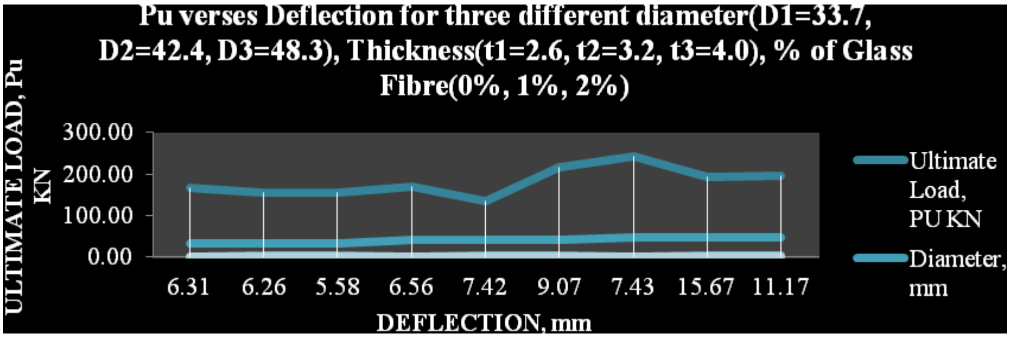
Deflection verses D1, D2, D3 & t1, t2, t3 for Hollow Steel Tube



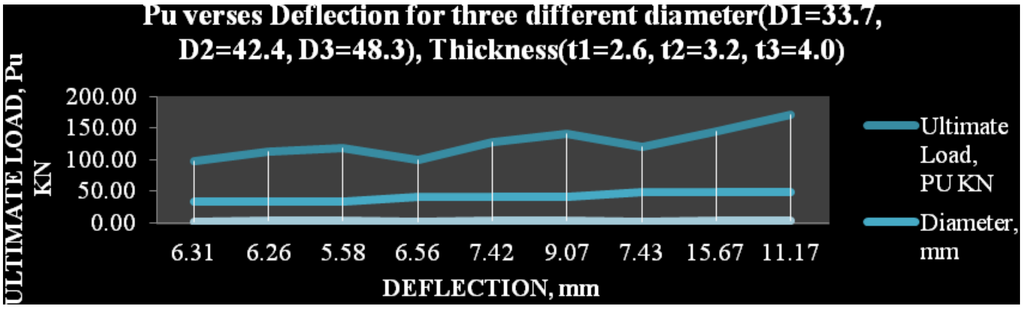
Load v/s Deflection Graph for M20 Grade



Load v/s Deflection for M25 Grade

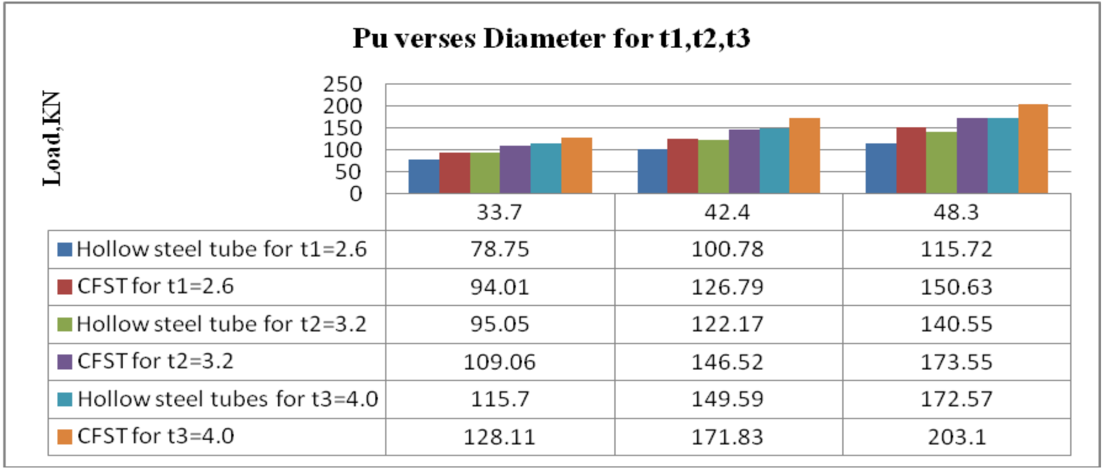


Load verses Deflection graph for Hollow Steel Tube



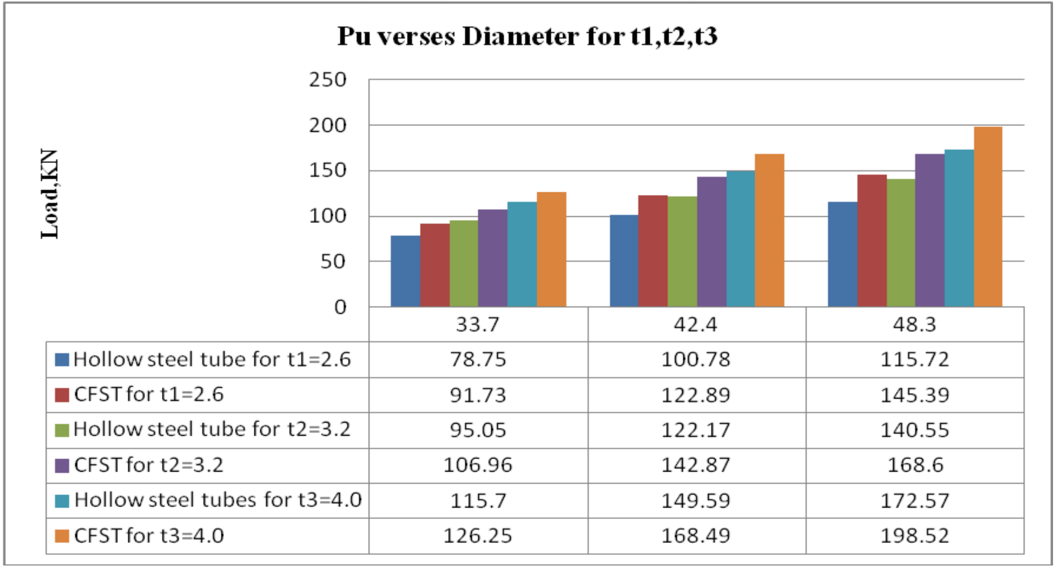
Graphical representation of theoretical calculations

Comparison of CFST and hollow steel tube P_u for three different diameter d1=33.7, d2=42.4, d3=48.3 & for three different thickness t1=2.6, t2=3.2, t3=4.0 based on Euro code 4



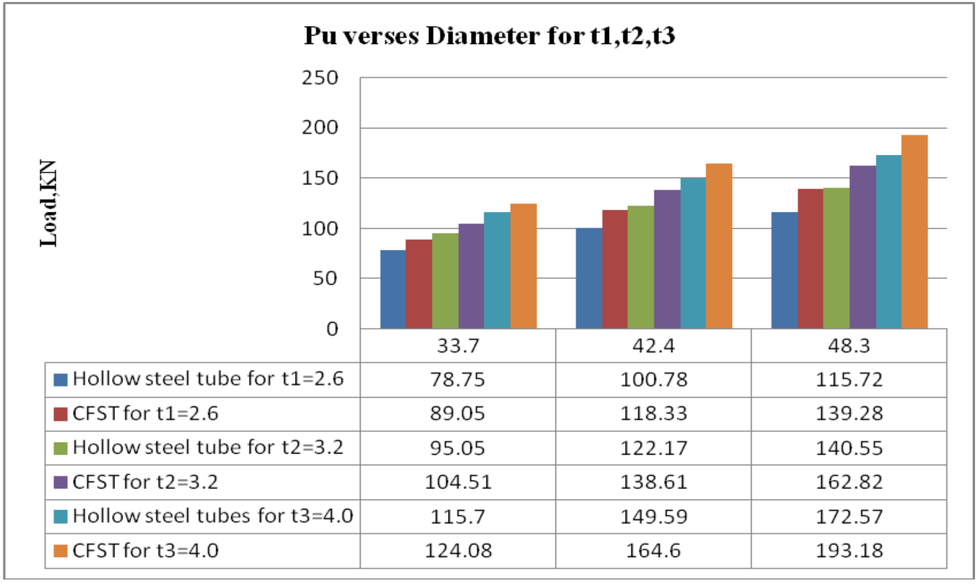
	33.7	42.4	48.3
🟦 Hollow steel tube for t1=2.6	78.75	100.78	115.72
🟥 CFST for t1=2.6	94.01	126.79	150.63
🟩 Hollow steel tube for t2=3.2	95.05	122.17	140.55
🟪 CFST for t2=3.2	109.06	146.52	173.55
🟦 Hollow steel tubes for t3=4.0	115.7	149.59	172.57
🟧 CFST for t3=4.0	128.11	171.83	203.1

Comparison of CFST and hollow steel tube P_u for three different diameter d1=33.7, d2=42.4, d3=48.3 & for three different thickness t1=2.6, t2=3.2, t3=4.0 based on ACI, AIJ & AS code



	33.7	42.4	48.3
🟦 Hollow steel tube for t1=2.6	78.75	100.78	115.72
🟥 CFST for t1=2.6	91.73	122.89	145.39
🟩 Hollow steel tube for t2=3.2	95.05	122.17	140.55
🟪 CFST for t2=3.2	106.96	142.87	168.6
🟦 Hollow steel tubes for t3=4.0	115.7	149.59	172.57
🟧 CFST for t3=4.0	126.25	168.49	198.52

Comparison of CFST and hollow steel tube P_u for three different diameter d1=33.7, d2=42.4, d3=48.3 & for three different thickness t1=2.6, t2=3.2, t3=4.0 based on BS5400 code



	33.7	42.4	48.3
🟦 Hollow steel tube for t1=2.6	78.75	100.78	115.72
🟥 CFST for t1=2.6	89.05	118.33	139.28
🟩 Hollow steel tube for t2=3.2	95.05	122.17	140.55
🟪 CFST for t2=3.2	104.51	138.61	162.82
🟦 Hollow steel tubes for t3=4.0	115.7	149.59	172.57
🟧 CFST for t3=4.0	124.08	164.6	193.18

Table 1. Mix Proportions

SL NO.	Mix designation	% of Fibre	Binder(B)(Kg/m^3) CEMENT	Proportions B:FA:CA	W/B ratio	28 days compressive strength (f_{cu} N/mm^2)
1	M_{20}	0%	336.42	1:1.6:3.3	0.5	23.33
2		1%				28.06
3		2%				29.01
4	M_{25}	0%	320.00	1:2.35:4.24	0.43	27.95
5		1%				30.54
6		2%				31.28

YST 310 GRADE

TO PREVENT LOCAL BUCKLING, λ<(125/(Fy/250))=(125/(310/250))=100.8

NOMINAL BORE, mm	OUTSIDE DIAMETER, mm	THICKNESS mm	$\lambda=\frac{(2(sqrt(3))*L)}{D}$	Slenderness value for L=300MM	D/t	L/D for L=300MM
25	33.70	2.60	0.103L	30.84	12.96	8.90
		3.20			10.53	
		4.00			8.43	
32	42.40	2.60	0.082L	24.51	16.31	7.08
		3.20			13.25	
		4.00			10.60	
40	48.30	2.90	0.072L	21.52	16.66	6.21
		3.20			15.09	
		4.00			12.08	

Taguchi l9 Orthogonal array

EXPERIMENT NOS	A	B	C
1	A1	B1	C1
2	A1	B2	C2
3	A1	B3	C3
4	A2	B1	C2
5	A2	B2	C3
6	A2	B3	C1
7	A3	B1	C3
8	A3	B2	C1
9	A3	B3	C2

(OR)

EX NOS	D	t	% OF GF
1	D1	t1	0%GF
2	D1	t2	1%GF
3	D1	t3	2%GF
4	D2	t1	1%GF
5	D2	t2	2%GF
6	D2	t3	0%GF
7	D3	t1	2%GF
8	D3	t2	0%GF
9	D3	t3	1%GF

Experimental Data & Result

Exp no.	Diameter, mm	Thickness, mm	% of Glass Fibre	Grade	Length, mm	Area, mm^2	fck, from cube testing	fy	(EXP)Ultimate Load, P_U KN	TYPE
1	33.70	2.60	0.00	M20	300.00	891.52	23.93	310	119.00	CONCRETE FILLED STEEL TUBES(CFST)
2	33.70	2.60	1.00	M20	300.00	891.52	28.06	310	138.00	
3	33.70	2.60	2.00	M20	300.00	891.52	29.01	310	135.00	
4	33.70	3.20	0.00	M20	300.00	891.52	23.93	310	145.00	
5	33.70	3.20	1.00	M20	300.00	891.52	28.06	310	147.00	
6	33.70	3.20	2.00	M20	300.00	891.52	29.01	310	143.00	
7	33.70	4.00	0.00	M20	300.00	891.52	23.93	310	157.00	
8	33.70	4.00	1.00	M20	300.00	891.52	28.06	310	158.00	
9	33.70	4.00	2.00	M20	300.00	891.52	29.01	310	151.00	
10	42.40	2.60	0.00	M20	300.00	1411.24	23.93	310	135.00	
11	42.40	2.60	1.00	M20	300.00	1411.24	28.06	310	145.00	
12	42.40	2.60	2.00	M20	300.00	1411.24	29.01	310	132.00	
13	42.40	3.20	0.00	M20	300.00	1411.24	23.93	310	145.00	
14	42.40	3.20	1.00	M20	300.00	1411.24	28.06	310	158.00	
15	42.40	3.20	2.00	M20	300.00	1411.24	29.01	310	137.00	
16	42.40	4.00	0.00	M20	300.00	1411.24	23.93	310	177.00	
17	42.40	4.00	1.00	M20	300.00	1411.24	28.06	310	212.00	
18	42.40	4.00	2.00	M20	300.00	1411.24	29.01	310	209.00	
19	48.30	2.60	0.00	M20	300.00	1831.32	23.93	310	212.00	
20	48.30	2.60	1.00	M20	300.00	1831.32	28.06	310	176.00	
21	48.30	2.60	2.00	M20	300.00	1831.32	29.01	310	171.00	
22	48.30	3.20	0.00	M20	300.00	1831.32	23.93	310	195.00	
23	48.30	3.20	1.00	M20	300.00	1831.32	28.06	310	196.00	
24	48.30	3.20	2.00	M20	300.00	1831.32	29.01	310	169.00	
25	48.30	4.00	0.00	M20	300.00	1831.32	23.93	310	200.00	
26	48.30	4.00	1.00	M20	300.00	1831.32	28.06	310	208.00	
27	48.30	4.00	2.00	M20	300.00	1831.32	29.01	310	202.00	
28	33.70	2.60	0.00	M25	300.00	891.52	27.95	310	168.00	
29	33.70	3.20	1.00	M25	300.00	891.52	30.54	310	157.00	
30	33.70	4.00	2.00	M25	300.00	891.52	31.28	310	155.00	
31	42.40	2.60	0.00	M25	300.00	1411.24	27.95	310	169.00	
32	42.40	3.20	1.00	M25	300.00	1411.24	30.54	310	136.00	
33	42.40	4.00	2.00	M25	300.00	1411.24	31.28	310	218.00	
34	48.30	2.60	0.00	M25	300.00	1831.32	27.95	310	243.00	
35	48.30	3.20	1.00	M25	300.00	1831.32	30.54	310	194.00	
36	48.30	4.00	2.00	M25	300.00	1831.32	31.28	310	197.00	
37	33.70	2.60	-	-	300.00	891.52	0	310	98.20	HOLLOW
38	33.70	3.20	-	-	300.00	891.52	0	310	112.30	
39	33.70	4.00	-	-	300.00	891.52	0	310	119.28	
40	42.40	2.60	-	-	300.00	1411.24	0	310	100.60	
41	42.40	3.20	-	-	300.00	1411.24	0	310	128.00	
42	42.40	4.00	-	-	300.00	1411.24	0	310	140.28	
43	48.30	2.60	-	-	300.00	1831.32	0	310	120.80	
44	48.30	3.20	-	-	300.00	1831.32	0	310	144.00	
45	48.30	4.00	-	-	300.00	1831.32	0	310	170.90	

Load, Deflection, Stress & Strain Values Obtained From Experiment

Exp no	Diameter, mm	Thickness, mm	% of Glass Fiber	Grade	Length, mm	Area, mm^2	Ultimate Load, P_U KN	Measured length, mm	Change in length, mm	Strain	Stress, KN/mm^2	Young's Modulus, KN/mm^2
1	33.7	2.6	0.0	M20	300.0	891.52	119.0	293.19	6.81	0.023	0.133	5.880
2	33.7	2.6	1.0	M20	300.0	891.52	138.0	289.75	10.25	0.034	0.155	4.531
3	33.7	2.6	2.0	M20	300.0	891.52	135.0	293.55	6.45	0.022	0.151	7.043
4	33.7	3.2	0.0	M20	300.0	891.52	145.0	295.72	4.28	0.014	0.163	11.400
5	33.7	3.2	1.0	M20	300.0	891.52	147.0	294.35	5.65	0.019	0.165	8.755
6	33.7	3.2	2.0	M20	300.0	891.52	143.0	295.27	4.73	0.016	0.160	10.173
7	33.7	4.0	0.0	M20	300.0	891.52	157.0	292.96	7.04	0.023	0.176	7.504
8	33.7	4.0	1.0	M20	300.0	891.52	158.0	294.38	5.62	0.019	0.177	9.460
9	33.7	4.0	2.0	M20	300.0	891.52	151.0	295.39	4.61	0.015	0.169	11.022
10	42.4	2.6	0.0	M20	300.0	1411.24	135.0	291.31	8.69	0.029	0.096	3.302
11	42.4	2.6	1.0	M20	300.0	1411.24	145.0	290.26	9.74	0.032	0.103	3.165
12	42.4	2.6	2.0	M20	300.0	1411.24	132.0	286.45	13.55	0.045	0.094	2.071
13	42.4	3.2	0.0	M20	300.0	1411.24	145.0	296.28	3.72	0.012	0.103	8.286
14	42.4	3.2	1.0	M20	300.0	1411.24	158.0	294.36	5.64	0.019	0.112	5.955
15	42.4	3.2	2.0	M20	300.0	1411.24	137.0	294.80	5.20	0.017	0.097	5.601
16	42.4	4.0	0.0	M20	300.0	1411.24	177.0	287.25	12.75	0.043	0.125	2.951
17	42.4	4.0	1.0	M20	300.0	1411.24	212.0	287.89	12.11	0.040	0.150	3.721
18	42.4	4.0	2.0	M20	300.0	1411.24	209.0	288.38	11.62	0.039	0.148	3.823
19	48.3	2.6	0.0	M20	300.0	1831.32	212.0	284.07	15.93	0.053	0.116	2.180
20	48.3	2.6	1.0	M20	300.0	1831.32	176.0	289.97	10.03	0.033	0.096	2.875
21	48.3	2.6	2.0	M20	300.0	1831.32	171.0	287.25	12.75	0.043	0.093	2.197
22	48.3	3.2	0.0	M20	300.0	1831.32	195.0	290.06	9.94	0.033	0.106	3.214
23	48.3	3.2	1.0	M20	300.0	1831.32	196.0	287.17	12.83	0.043	0.107	2.503
24	48.3	3.2	2.0	M20	300.0	1831.32	169.0	287.44	12.56	0.042	0.092	2.204
25	48.3	4.0	0.0	M20	300.0	1831.32	200.0	287.11	12.89	0.043	0.109	2.542
26	48.3	4.0	1.0	M20	300.0	1831.32	208.0	208.00	92.00	0.307	0.114	0.370
27	48.3	4.0	2.0	M20	300.0	1831.32	202.0	286.40	13.60	0.045	0.110	2.433

Theoritical Calculation												
Exp no	**Diameter, mm**	**Thickness, mm**	**% of Glass Fibre**	**Grade**	**Length, mm**	**Area, mm^2**	**fck, from cube testing**	**fy**	**EUROCODE 4 $N_{EC4}=A_S*fy+A_C*fc$**	**ACI, AIJ & AS method, $N_{ACI,AIJ,AS}=A_S*fy+0.85*A_C*fc$**	**BS5400 method, $N_{BS5400}=A_S*fy+0.675*A_C*fc$**	**TYPE**
1	33.70	2.60	0	M20	300	891.52	23.93	310	94.01	91.73	89.05	**CFST**
2	33.70	2.60	1	M20	300	891.52	28.06	310	96.65	93.96	90.83	
3	33.70	2.60	2	M20	300	891.52	29.01	310	97.26	94.48	91.24	
4	33.70	3.20	0	M20	300	891.52	23.93	310	109.06	106.96	104.51	
5	33.70	3.20	1	M20	300	891.52	28.06	310	111.48	109.01	106.14	
6	33.70	3.20	2	M20	300	891.52	29.01	310	112.03	109.49	106.51	
7	33.70	4.00	0	M20	300	891.52	23.93	310	128.11	126.25	124.08	
8	33.70	4.00	1	M20	300	891.52	28.06	310	130.25	128.07	125.52	
9	33.70	4.00	2	M20	300	891.52	29.01	310	130.75	128.49	125.86	
10	42.40	2.60	0	M20	300	1411.24	23.93	310	126.79	122.89	118.33	
11	42.40	2.60	1	M20	300	1411.24	28.06	310	131.28	126.70	121.36	
12	42.40	2.60	2	M20	300	1411.24	29.01	310	132.31	127.58	122.06	
13	42.40	3.20	0	M20	300	1411.24	23.93	310	146.52	142.87	138.61	
14	42.40	3.20	1	M20	300	1411.24	28.06	310	150.73	146.44	141.44	
15	42.40	3.20	2	M20	300	1411.24	29.01	310	151.69	147.26	142.10	
16	42.40	4.00	0	M20	300	1411.24	23.93	310	171.83	168.49	164.60	
17	42.40	4.00	1	M20	300	1411.24	28.06	310	175.67	171.76	167.19	
18	42.40	4.00	2	M20	300	1411.24	29.01	310	176.55	172.51	167.79	
19	48.30	2.60	0	M20	300	1831.32	23.93	310	150.63	145.39	139.28	
20	48.30	2.60	1	M20	300	1831.32	28.06	310	156.66	150.52	143.35	
21	48.30	2.60	2	M20	300	1831.32	29.01	310	158.04	151.69	144.29	
22	48.30	3.20	0	M20	300	1831.32	23.93	310	173.55	168.60	162.82	
23	48.30	3.20	1	M20	300	1831.32	28.06	310	179.24	173.44	166.67	
24	48.30	3.20	2	M20	300	1831.32	29.01	310	180.55	174.55	167.55	
25	48.30	4.00	0	M20	300	1831.32	23.93	310	203.10	198.52	193.18	
26	48.30	4.00	1	M20	300	1831.32	28.06	310	208.37	203.00	196.73	
27	48.30	4.00	2	M20	300	1831.32	29.01	310	209.58	204.03	197.55	
28	33.70	2.60	0	M25	300	891.52	27.95	310	96.58	93.90	90.78	
29	33.70	3.20	1	M25	300	891.52	30.54	310	112.93	110.25	107.12	
30	33.70	4.00	2	M25	300	891.52	31.28	310	131.93	129.49	126.65	
31	42.40	2.60	0	M25	300	1411.24	27.95	310	131.16	126.60	121.28	
32	42.40	3.20	1	M25	300	1411.24	30.54	310	153.25	148.59	143.15	**CFST**
33	42.40	4.00	2	M25	300	1411.24	31.28	310	178.66	174.30	169.21	
34	48.30	2.60	0	M25	300	1831.32	27.95	310	156.50	150.38	143.24	
35	48.30	3.20	1	M25	300	1831.32	30.54	310	182.66	176.35	168.98	
36	48.30	4.00	2	M25	300	1831.32	31.28	310	212.47	206.49	199.51	
37	33.70	2.60	-	-	300	891.52	0	310	78.75	78.75	78.75	**HOLLOW**
38	33.70	3.20	-	-	300	891.52	0	310	95.05	95.05	95.05	
39	33.70	4.00	-	-	300	891.52	0	310	115.70	115.70	115.70	
40	42.40	2.60	-	-	300	1411.24	0	310	100.78	100.78	100.78	
41	42.40	3.20	-	-	300	1411.24	0	310	122.17	122.17	122.17	
42	42.40	4.00	-	-	300	1411.24	0	310	149.59	149.59	149.59	
43	48.30	2.60	-	-	300	1831.32	0	310	115.72	115.72	115.72	
44	48.30	3.20	-	-	300	1831.32	0	310	140.55	140.55	140.55	
45	48.30	4.00	-	-	300	1831.32	0	310	172.57	172.57	172.57	

Conclusion

From the above experiment it has been seen that the important parameters affecting the load-deformation behaviour,

- Geometric parameters like shape of the cross section, member size, thickness of steel tube, slenderness, D/t ratio of the tube, Grades of concrete and steel, Percentage of fibre added to the concrete. Further degree of concrete confinement also affects the load-deformation behaviour.
- Cross-section area of the steel tube has the most significant effect on both the ultimate axial load capacity and corresponding axial shortening of CFST.
- Strength of the in-fill concrete, % of glass fibre & the wall thickness have respectively lesser effects compared to cross-section area of the steel tube.
- Next to cross-section area wall thickness has most influenced on ultimate axial load carrying capacity of CFST's.
- Increase in wall thickness, helps to postpone the local buckling failure. Increase in strength of in-filled concrete has more effect than the wall thickness when axial shortening of the CFST are concerned.
- Further it has been concluded that glass fiber reinforced concrete filled steel tube columns appears to have a significant increasing trend in ductility, & have slight increasing trend in load capacity with volume fraction of glass fiber to concrete increasingly.
- The failure mode of the composite columns is similar with that of CFST. Results obtained from theoretical calculation matched well with experimental values (with a deviation of not more than 20%)

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