

EXPERIMENTAL INVESTIGATION ON COMPOSITE COLUMN SUBJECTED TO CYCLIC LOADING

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Abstract

This research paper focuses on experimental investigation on composite column subjected to cyclic loading was used for proper experimental work & analytical analysis of CFST columns were carried out. CFST column structure has high ductility, high load bearing capacity hence it has been widely used in civil engineering field. In this work experiment were carried for cfst column with infill of light weight concrete were used.. Experimental on circularly cyclic loaded composite steel tubes were also carried out for different length, width of varying thickness. Ultimate load values obtained were compared with analytical results. The experiment was a carried for different L/D ratio for different grade of concrete that is M20, M30 & M40

Keywords: Light Weight Concrete, Abaqus, CFST Column, Uniaxial Compression, L/D ratio

1. INTRODUCTION

CFST individuals use the benefits of combination of steel and concrete. They involve a steel empty area with circular or square shape loaded with plain concrete or RCC. They are generally utilized as a part of skyscraper and multistory structures as sections, and as supporting members in low-rise mechanical structures where a strong and effective basic framework is required.

There are various particular preferences identified with such auxiliary frameworks in both terms of basic execution and development succession. The intrinsic buckling issue identified with thin-walled steel tubes is either avoided or procrastinated because of the inner concrete section. Besides, the execution of the concrete in the interior is enhanced because of containment impact applied by the steel shell. The dispersion of materials in the cross segment additionally makes the framework exceptionally proficient in term of its auxiliary execution. The steel lies at the external border where it performs most viably in tension and buckling. It likewise gives the best strength as the material lies uttermost from the centroid. This, consolidated with the steel's much more noteworthy young's modulus, gives the best commitment to moment of inertia. The concrete center provides the more noteworthy commitment to applied axial force

2. MATERIALS

2.1 Light Weight Concrete

The conventional concrete will be usually having a higher density of 2400kg/m³ to obtain less dead load on structure

there is great requirement for lighter concrete, Hence once such concrete having a lighter weight is light weight concrete (LWC). LWC as density of least 300kg/m³ and a most extreme of 1850 kg/m³ when contrasted with ordinary concrete whose unit weight will be 2240 kg/m³ to 2400 kg/m³. For auxiliary applications the LWC strength ought to be more larger than 17MPa. LWC has strength equivalent with ordinary weight concrete, yet is regularly 25% to 35% lighter. In LWC basic components are same to that of ordinary concrete where sometimes an admixture is included, due to the entraining air

2.2 Cinder as Aggregate

- Cinder is the best aggregate to get light weight of the concrete in this present experiment cinder is utilized and it is a result of steel, iron producing organizations.
- The surface of this is typically harsh and very permeable because of mineral structure. The ash material outwardly delegated having 100% crushed front.
- This is utilized for constructing partition walls, for producing over level rooftops and for plastering purposes as a result of its light weight. Direct coefficient. In temperature increment is around 3.8* 10⁻⁶ °c.

2.3 Experimental Program

The following specimens are tested using cyclic loading compressive testing machine capacity in order to determine ultimate load and its corresponding deformation for a different section of specimens by varying the dimensions of it and also by varying the grade of concrete

Table 1: Specimens details

Grade of filling concrete material	Diameter of 33.7mm			Diameter of 42.4mm			Diameter of 48.4mm		
	L/D Ratio								
	8	10	14	8	10	14	8	10	14
Hollow steel tubes	3	3	3	3	3	3	3	3	3
M20	3	3	3	3	3	3	3	3	3
M30	3	3	3	3	3	3	3	3	3
M40	3	3	3	3	3	3	3	3	3

Table 2: Mix Design Prepared For Different Grades

Constituents	Grade Of Concrete		
	M20	M30	M40
Cement in Kg/m ³	320	411	455
Fine Aggregates in Kg/m ³	771	652	633
Coarse Aggregates Kg/m ³	611	587	532
Water in Kg/m ³	144	184.95	204.75
Water Cement ratio	0.45	0.45	0.45
Water:Cement:Fine Aggregates:Coarse Aggregates	0.45 : 1 : 2.4 : 1.9	0.45 : 1 : 1.58 : 1.43	0.45 : 1 : 1.39 : 1.17



Fig 1: Preparation steel tube specimens

3. MODELING USING ABAQUS SOFTWARE

In order to get better conclusion and clarification regarding the behavior and best combination of these specimens these are also analyzed using software called ABAQUS. The steps involved in preparation of these models are as follows,

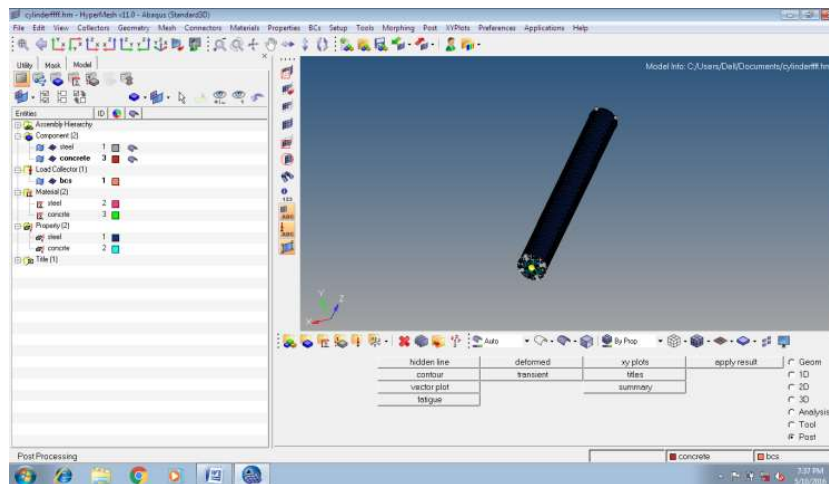


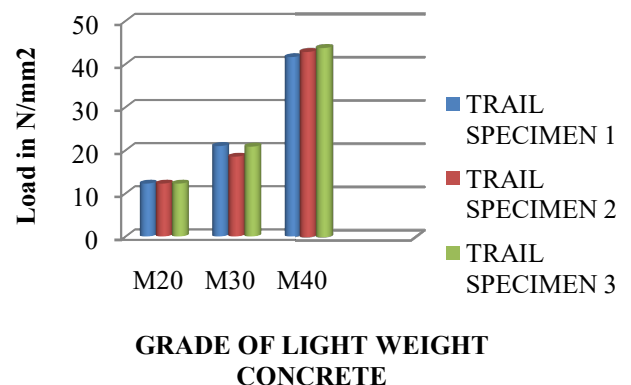
Fig 2: modeling in ABAQUS

4. EXPERIMENTAL RESULTS

Table 3: 7 days-Compressive strength of cube

Sl. No	Grade of concrete	Specimen code	Days	C/S Area in mm ²	Load in tons	Compressive strength in N/mm ²	Average strength in N/mm ²
1	M20	1	7	225	28	12.3	13.31
		2			30	13.43	
		3			32	14.19	
2	M30	1	7	225	45	21.00	19.85
		2			42	18.54	
		3			47	20.86	
3	M40	1	7	225	65	41.64	23
		2			70	42.85	
		3			73	43.76	

7-days compressive strength of cubes



4.1 Ultimate Load Carrying Capacity of LWC Filled Steel Tubes

Table 4: Hollow steel tube having diameter of 33.7mm, thickness 3.2mm and length of 337mm

Load in KN	Segment no	Area in mm ²	Original Length in mm	Decrease in Length in mm	Strain
1	0	891.96	337	0	0
76	0	891.96	337	0.02	2.97E-05
68	2	891.96	337	0.04	5.93E-05
66	3	891.96	337	0.05	8.9E-05
64	5	891.96	337	0.09	0.000119
71	6	891.96	337	0.19	0.000208
68	8	891.96	337	0.25	0.000593
68	8	891.96	337	0.33	0.001246
59	9	891.96	337	0.39	0.00184
59	9	891.96	337	0.66	0.002404
64	9	891.96	337	0.75	0.002789
71	9	891.96	337	1.05	0.003205
69	10	891.96	337	1.55	0.003412
58	10	891.96	337	2.20	0.00365
58	11	891.96	337	2.83	0.00549
59	11	891.96	337	3.20	0.006172
68	11	891.96	337	3.82	0.008783

Table 5: M20 grade CFST having diameter of 33.7mm, thickness 3.2mm and length of 337mm.

Load in KN	Segment no	Area in mm ²	Original Length in mm	Length in mm	Strain
6	0	891.96	337	0	0
64	1	891.96	337	0.03	8.9E-05
62	2	891.96	337	0.07	0.000208
61	3	891.96	337	0.08	0.000237
61	3	891.96	337	0.13	0.000386
64	3	891.96	337	0.20	0.000593
86	3	891.96	337	0.25	0.000742
83	3	891.96	337	0.32	0.00095
89	3	891.96	337	0.42	0.001246
82	4	891.96	337	0.65	0.001929
62	4	891.96	337	0.85	0.002522
62	5	891.96	337	1.00	0.002967
74	5	891.96	337	1.23	0.00365
90	5	891.96	337	1.75	0.005193
8	6	891.96	337	2.01	0.005964
74	6	891.96	337	2.52	0.007478
72	6	891.96	337	3.24	0.009614
71	6	891.96	337	3.56	0.010564
71	6	891.96	337	4.02	0.011929

Table 6: M30 grade CFST having diameter of 33.7mm, thickness 3.2mm and length of 337mm

Load in KN	Segment no	Area in mm ²	Original Length in mm	Decrease in Length in mm	Strain
2	0	891.96	337	0	0
47	1	891.96	337	0.03	8.9E-05
66	2	891.96	337	0.05	0.000148
61	2	891.96	337	0.08	0.000237
60	3	891.96	337	0.12	0.000356
64	3	891.96	337	0.21	0.000623
83	3	891.96	337	0.26	0.000772
89	3	891.96	337	0.35	0.001039
92	3	891.96	337	0.41	0.001217
90	3	891.96	337	0.53	0.001573
62	4	891.96	337	0.72	0.002136
61	5	891.96	337	1.02	0.003027
76	5	891.96	337	1.32	0.003917
92	5	891.96	337	1.65	0.004896
96	5	891.96	337	2.21	0.006558
83	5	891.96	337	2.53	0.007507
89	5	891.96	337	3.29	0.009763
67	5	891.96	337	3.82	0.010504

Table 7: 18 M40 grade CFST having diameter of 33.7mm, thickness 3.2mm and length of 337mm

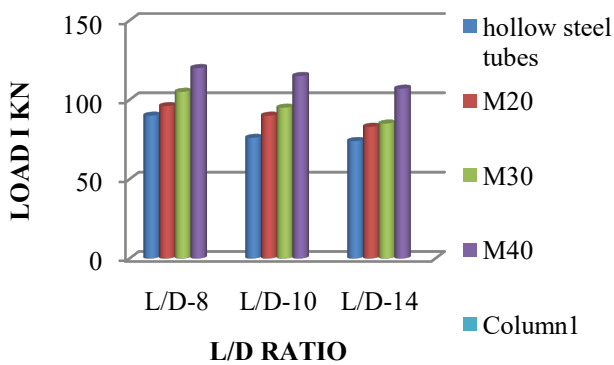
Load in KN	Segment no	Area in mm ²	Original Length in mm	Decrease in Length in mm	Strain
16	1	891.96	337	0	0
78	2	891.96	337	0.02	5.93E-05
63	2	891.96	337	0.05	0.000148
62	3	891.96	337	0.08	0.000237
61	3	891.96	337	0.1	0.000297
64	3	891.96	337	0.18	0.000534
78	3	891.96	337	0.23	0.000682
94	3	891.96	337	0.34	0.001009
108	3	891.96	337	0.42	0.001246
107	4	891.96	337	0.62	0.00184
115	5	891.96	337	0.85	0.002522
66	5	891.96	337	1.14	0.003383
62	5	891.96	337	1.74	0.005163
61	5	891.96	337	2.01	0.005964
77	5	891.96	337	2.32	0.006884
107	5	891.96	337	2.91	0.008635
113	5	891.96	337	3.24	0.009614
82	6	891.96	337	3.45	0.010237
16	7	891.96	337	3.96	0.011751

Table 8: comparison of experimental results with abacus value

Type	Case	Length (mm)	Thickness (mm)	Diameter (mm)	L/D	Exp Load (KN)	ABAQUS Load			
1	HOLLOW STEEL TUBES	269.6	3.2	33.7	8	90	98			
					10	76	83			
					14	74	86			
				42.4	8	123	132			
					10	120	135			
					14	117	127			
		48.3	8	138	148					
			10	132	144					
			14	125	136					
			2	M20 GRADE LWC INFILL	269.6	3.2	33.7	8	96	109
								10	90	106
								14	83	98
42.4	8	130					147			
	10	129					134			
	14	120					139			
48.3	8	140			154					
	10	135			159					
	14	128			138					
	3	M30 GRADE LWC INFILL			269.6	3.2	33.7	8	105	116
								10	95	109
								14	85	99
42.4			8	162			175			
			10	140			156			
			14	130			139			
48.3			8	172	191					
			10	145	157					
			14	136	149					
			4	M40 GRADE LWC INFILL	269.6	3.2	33.7	8	120	134
								10	115	129
								14	107	119
42.4	8	175					188			
	10	153					164			
	14	148					159			
48.3	8	205			221					
	10	185			199					
	14	173			186					

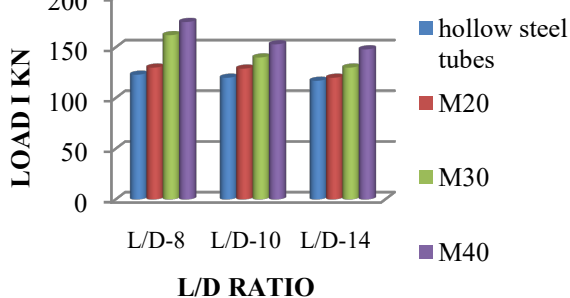
4.2 Graphs

ULTIMATE LOAD OF CFST WITH DIA-33.7mm



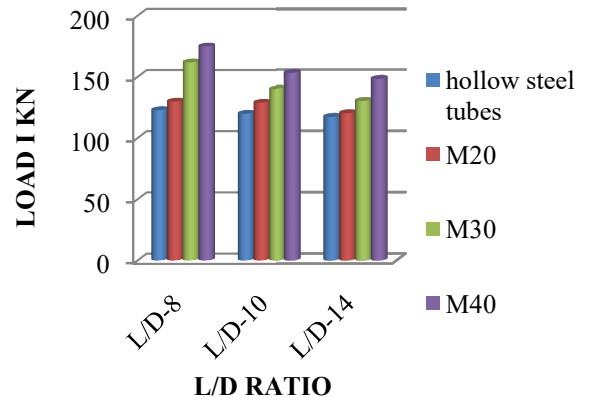
Graph 1: ultimate load for 33.7mm

ULTIMATE LOAD OF CFST WITH DIA-42.4mm



Graph 2: ultimate load for 42.4mm

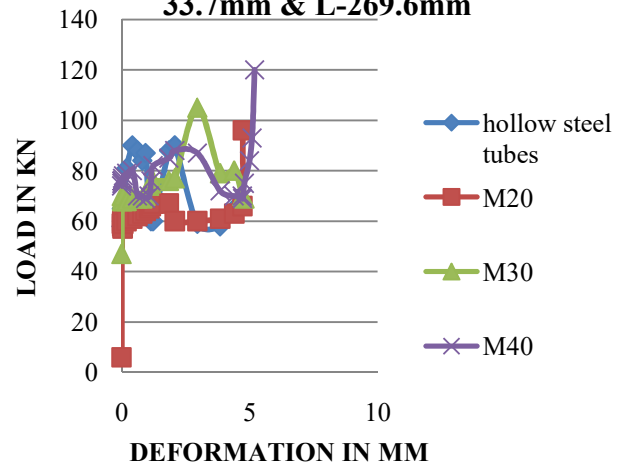
ULTIMATE LOAD OF CFST WITH DIA-48.4mm



Graph 3: ultimate load for 48.4mm

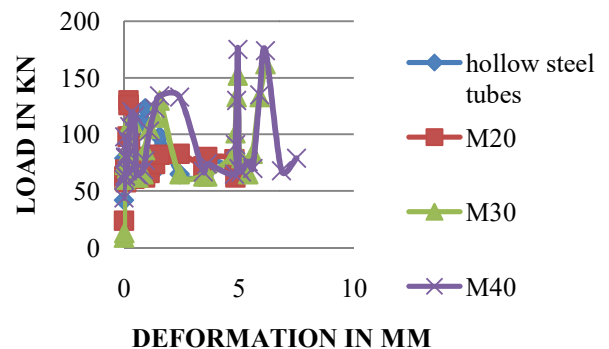
4.3 Load v/s Deformation Comparison between Different Types of Specimen

LOAD V/S DEFLECTION FOR D-33.7mm & L-269.6mm



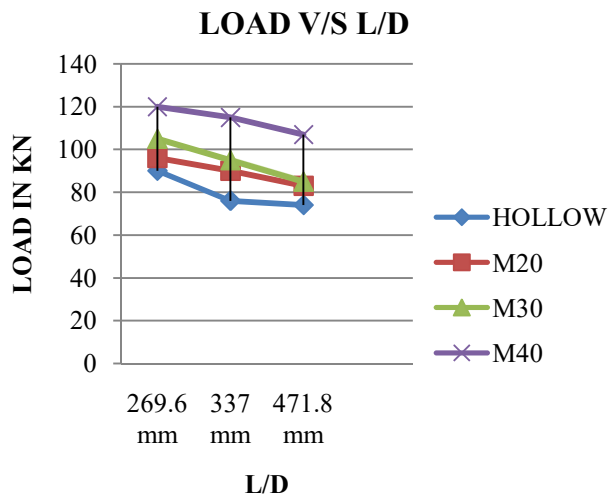
Graph 4: load v/s deformation for diameter of 33.7mm & length 269.6mm for all grade concrete.

LOAD V/S DEFLECTION FOR D-42.4mm & L-339.2mm

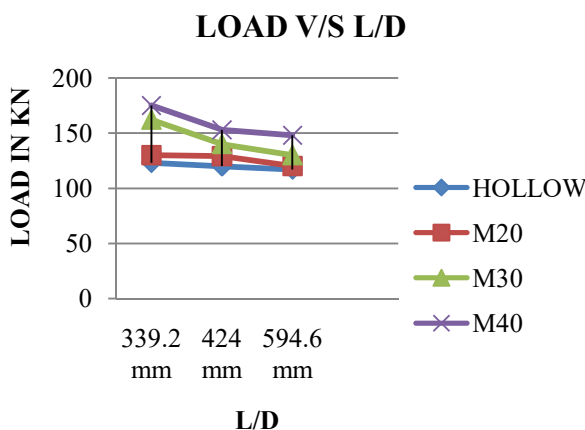


Graph 5: 6 load v/s deformation for diameter of 42.4mm & length 339.2mm for all grade concrete.

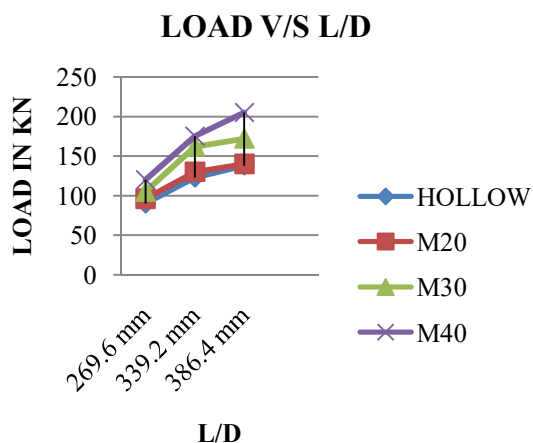
5. LOAD COMPARISON BETWEEN DIFFERENT TYPES OF SPECIMEN



Graph 6: Comparison of L/D ratio (displayed in terms of length above) v/s Ultimate load for dia 33.7mm



Graph 7: Comparison of L/D ratio (displayed in terms of length above) v/s Ultimate load for dia 42.4mm



Graph 8: Comparison of L/D ratio (displayed in terms of length above) v/s Ultimate load for dia 48.3mm

6. CONCLUSION

- Ultimate load carrying capacity of specimen is inversely proportional to length of the specimen
- With increase in concrete grade the strength of CFST also increases.
- For L/D ratio of 8 for length 269.6mm specimen of M20 grade CFST takes 6.25% more load than hollow steel tube and that for M30 grade CFST incremental of percentage comparison with hollow is 14.28% and that for M40 grade CFST incremental of percentage comparison with hollow is 25%
- For L/D ratio of 10 for length 337mm specimen of M20 grade CFST takes 15.5% more load than hollow steel tube and that for M30 grade CFST incremental of percentage comparison with hollow is 20% and that for M40 grade CFST incremental of percentage comparison with hollow is 33.9%
- For L/D ratio of 14 for length 471.8mm specimen of M20 grade CFST takes 10.8% more load than hollow steel tube and that for M30 grade CFST incremental of percentage comparison with hollow is 13% and that for M40 grade CFST incremental of percentage comparison with hollow is 30.8%

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