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"Behaviour Of Stub Stainless Steel Square Hollow Sections Subjected To Monotonic Loading"

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Abstract:
In this experimental research, investigation of the behaviour of epoxy resin concrete in filled square steel column subjected to monotonic loading is studied in detail.
Taguchi's method is adopted to select typical 27 combinations for 3 different rates of concrete. 2%, 4% epoxy resin used as infill with M_{20}, M_{25}, & M_{30} is studied .3 different lengths of specimens that is 300mm, 320mm, & 340mm with the same thickness 1.5mm are selected. In order to know the effect of stub columns (i.e., L/B ratio 3) under monotonic loading, 27 experiments have been conducted.
Following are the conclusions :
As length increased, load carrying capacity decreased.
As grade of concrete increased, load carrying capacity increased for a particular length of the column by 5 to 8%.
Stub columns are better in resisting compressive loads.

***Key words**: Square Steel tube, concrete, EC 4 code, epoxy resin*

1.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 & cost. An example of a widely used composite section in construction is composite slabs, this form of construction has become very popular in recent years, Where steel beams & concrete slabs 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 structural applications including columns, supporting platforms of offshore structures, roofs of storage tanks, bridge piers, piles, and columns in seismic zones. Concrete filled steel box columns offer excellent structural performance, such as high strength, high ductility and large energy absorption capacity. Application of the CFST concept can lead to overall savings 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 distributed reinforcement. Test results have shown that the concrete core delays local buckling and forces the steel tube to buckle outwards rather than inwards, resulting in a higher flexural strength therefore, tubes with thinner walls could reach yield strength before local buckling occurs. conducted experiments on concrete filled steel tubes from this study following inferences are obtained due to filling of steel hollow tube with concrete an increase in flexural strength are obtained. The composite action and bond in CFST were also studied by Hunatiti (1997) from this study following interesting findings are observed under axial compression, the steel tube confines the concrete which improves both the axial load resistance and ductility of the CFST members. The test conducted by Angeline Prabhavathy et al (2006) in filled frames, showed that concrete infilled beams give additional stiffness, which delays the failure of the columns. The main objective of this test program is to obtain experimental data and to study the hysteretic behavior of CFST column with different infill materials.

2.Stub Columns
Stub column is nothing its a simple reduntant compression/ tension member which even can be horizontal depending on the type of load....sometimes it has footing and sometimes it doesn't depending on the length of the column. Therefore L/B ratio is 3.

3.Taguchi Level -3 Design With 3 Factors

1	1	1
1	2	2
1	3	3
2	1	2
2	2	3
2	3	1
3	1	3
3	2	1
3	3	2

Table 1: Level 3x3 Design

EX NOS	L	SIZE	% OF EP	Grade
1	300	40X40	0%EP	M20
2	320	40X40	2%EP	M25
3	340	40X40	4%EP	M30
4	300	50X50	0%EP	M25
5	320	50X50	2%EP	M30
6	340	50X50	4%EP	M20
7	300	60X60	0%EP	M30
8	320	60X60	2%EP	M20
9	340	60X60	4%EP	M25

Table 2:Taguchi Level 3x3 Design.

4.Material Properties

Totally twenty seven specimens consisting of nine Square normal mix concrete specimens, nine 2% epoxy resin concrete specimens and nine 4% epoxy resin concrete specimens were used. The sizes of SHS section were selected as 40x40, 50x50 &60x60 mm at the same thickness 1.5mm. The Grade of Steel is Yst202 in accordance with IS 4923:1997 "INDIAN STANDARD HOLLOW STEEL SECTIONS FOR STRUCTURAL USE –SPECIFICATIONS".

The SHS columns are 202Mpa (yield stress, fy).There designed as simply supported as is common practice. Three different lengths of the specimens were 300mm, 320mm, 340mm used. In the columns current research, SHS (square hollow sections) tubes were supplied by TATA Steel Industries (p) Ltd., India. The nominal dimensions for the SHS sections used in this research are shown in Table 1. The M20, M25, M30 concrete used had respective water cement ratio of 40%, 45%, 50% (by weight). The filler material consisted of normal mix concrete and epoxy resin concrete with different compression strengths and densities. The mechanical properties of the concrete were then determined from the average compression test results on three cubes (150mm x 150mmx150mm) in each series. Concrete cubes were cured for 28 days to determine the compression strength. The concrete cube tests were carried out on the same day as the column tests.

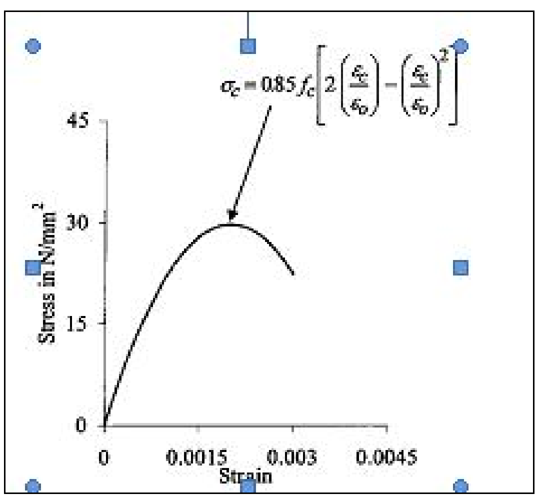

Figure 1: Stress-Strain Relation

Figure 2:Concrete Cubes

Figure 3: Infilled Steel Tube

Figure 4: Epoxy Resin With Catalyst

Figure 5: Mixing Of Epoxy To The Cement Concrete

Figure 6 : It Was Observed Splitting Occurred
At 1/3rd From The Top
&
Figure 7: Outward Convex Tear-Off Of The Material
1/3rd Portion From The Top Can Be Observed.

SL no	Size in mm	Grade	L in mm	Area in mm^2	% of epoxy resin	f_{ck} in N/mm^2	P_u (exp) in KN	Pu (the) in KN	Δ in mm	Stess In N/mm^2	Strain
1	40x40	M20	300	1600	0	23.67	156	282.05	290.75	0.0712	1.031814
2	40x40	M25	300	1600	2	26.08	171	282.56	298.5	0.0776	1.005025
3	40x40	M30	300	1600	4	29.04	148	283.24	249	0.0712	1.204819
4	50x50	M25	300	2500	0	24.25	151	453.27	298.79	0.088	1.00405
5	50x50	M30	300	2500	2	27.22	158	454.14	296.72	0.08	1.011054
6	50x50	M20	300	2500	4	30.91	133	455.21	294.34	0.088	1.019229
7	60x60	M30	300	3600	0	29.28	139	666.57	296.72	0.0936	1.011054
8	60x60	M20	300	3600	2	33.71	141	668.13	297.21	0.0728	1.009387
9	60x60	M25	300	3600	4	37.90	130	669.60	295.71	0.0824	1.014507
10	40x40	M20	320	1600	0	23.67	177	282.05	323.65	0.0808	1.004171
11	40x40	M25	320	1600	2	26.08	168	282.56	323.84	0.0776	1.003582
12	40x40	M30	320	1600	4	29.04	170	283.24	323.07	0.076	1.005974
13	50x50	M25	320	2500	0	24.25	159	453.27	323.96	0.088	1.00321
14	50x50	M30	320	2500	2	27.22	174	454.14	322.18	0.0904	1.008753
15	50x50	M20	320	2500	4	30.91	183	455.21	321.29	0.08	1.011547
16	60x60	M30	320	3600	0	29.28	169	666.57	321.16	0.0872	1.011957
17	60x60	M20	320	3600	2	33.71	152	668.13	322.89	0.0824	1.006535
18	60x60	M25	320	3600	4	37.90	180	669.60	322.63	0.0936	1.007346
19	40x40	M20	340	1600	0	23.67	181	282.05	349	0.08	1.002865
20	40x40	M25	340	1600	2	26.08	164	282.56	347.93	0.096	1.005949
21	40x40	M30	340	1600	4	29.04	172	283.24	348.06	0.0776	1.005574
22	50x50	M25	340	2500	0	24.25	189	453.27	346.29	0.088	1.010714
23	50x50	M30	340	2500	2	27.22	184	454.14	346.5	0.0904	1.010101
24	50x50	M20	340	2500	4	30.91	198	455.21	347.13	0.1	1.008268
25	60x60	M30	340	3600	0	29.28	179	666.57	345.3	0.0944	1.013611
26	60x60	M20	340	3600	2	33.71	166	668.13	346.96	0.0816	1.008762
27	60x60	M25	340	3600	4	37.90	177	669.60	346.57	0.0992	1.009897

Table 3: Tabulation Of Results Of Specimens

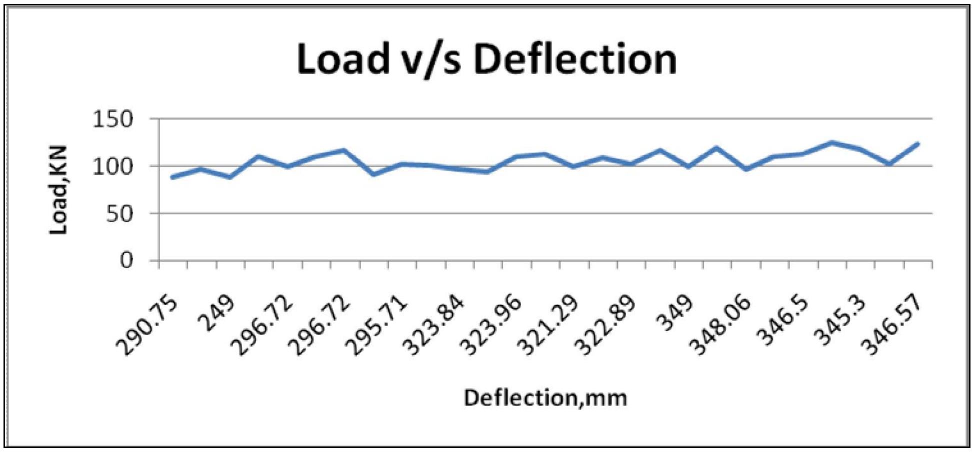

Figure 8: Load V\S Deflection

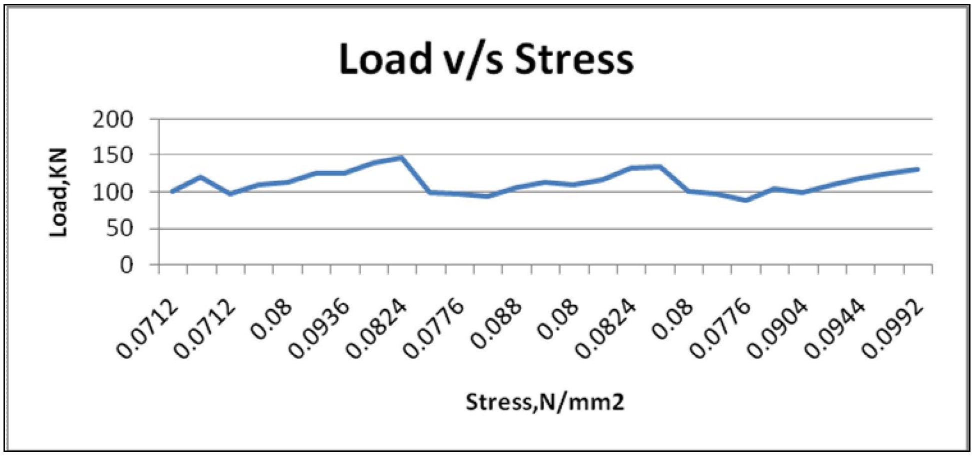

Figure 9 : Load V\S Stress

5.Conclusion

From the experiment results it can be concluded that

- As grade of concrete increased, load carrying capacity increased for a particular length of the column
- As length increased, load carrying capacity decreased.
- As grade of concrete increased, load carrying capacity increased for a particular length of the column by 5 to 8%.
- Stub columns are better in resisting compressive loads.

6.References

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