Study on Composite Light Gauge Frames Subjected to Lateral Load

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Abstract

Cold form steel(CFS) sections are used in beams, columns and truss members of buildings. Generally hollow section fails due to torsional buckling, local buckling and distortional bucking. In order to avoid this failure CFS sections are in-filled. Frames are constructed using cold form steel. Cold form steel sections are filled with light weight concrete to resist the failures. Using this frame, experimental results of deflection and strength characteristics are obtained for the hollow cold form steel frame in-filled with concrete subjected to lateral load. It is compared with hollow cold formed steel without in filling of concrete (bare frame). These frames tested by applying lateral load by a hydraulic jack of 500KN capacity and loads are measured using load cell and deflections are measured by dial gauges . A non – linear finite element modeling is done to analyze cold form steel in-filled frame section under static loading using ANSYS16.2 WORKBENCH. Deflection characteristics stresses and strains are analyzed for the hollow section with and without in-filled concrete.

Keywords – Light gaugeframe, Composite frame,Foamed concrete, Lightweight concrete.

I. INTRODUCTION

In the field of structural engineering the design of cost efficient structures is highly important. This led to the development of cold-formed steel structures (CFS). Normally frames are constructed using RC frames and steel frames with panels. These types of frames are increasing the dead load of the structure and it is also more cost. Hence we using light gauge cold form steel frame filled with light weight concrete to reduce the dead load, cost and construction time.

Foamed light weight concrete is in the form of Bricks, blocks, poured in-situ is used for thermal insulation over flat roofs or for cold storage walls or as non-load bearing walls in RCC/Steel framed buildings or for load bearing walls for low-rise buildings. The 28 days strength and dry density of the material vary according to its composition, largely its air voids content, but usually they range from 1.0 to 25.00 N/mm2 and 200 to 1800 kg/m3.It is highly workable, self-compacting, self-leveling, resistance to freeze thaw exposure, adjustable unit weight and controlled low strength. It can be pumped successfully over significant height and distances

II. EXPERIMENTAL PROGRAM FOR LIGHT WEIGHT CONCRETE

The mix ratio studied in this project was 1:1.9. Foam concrete is prepared adding these materials given in table 1. Totally 9 mixes were done for light weight concrete by addition of foam in percentage of volume of concrete varying from 0% to 80%. For each mix, 6 cubes were cast and tested for 7 days and 28 days strength. The size of the cube is 100mm X 100mm. Curing days of the cubes are counted from the first day of cast.

Table 1: Materials and quantity

S.NO	Materials	Description	Quantity
1	Cement type	Ordinary Portland Cement OPC 53 grade	565 (kg/m^3)
2	Fine aggregate	Passes through 1.18mm sieve	1060 (kg/m^3)
3	Water	As per design	312 (kg/m^3)
4	Foam dosage	15ml/100ml of water produce 0.6L foam	0 to 80 %

A. Test Results and Discussions

The cubes are tested in a compressive testing machine of capacity 2000KN at STC. The test results of 7 days and 28 days compressive strength are shown in table 2 and figure 1 and 2.

Table 2: Test results of all mixes

Foam (%)	0	10	20	30	40	50	60	70	80
Compressive strength @ 7days (N/mm^2)	7.5	6.5	3.8	3.17	2.17	1.57	1.37	1.17	0.43
Compressive strength @ 28days (N/mm^2)	17.6	11.6	8.1	6.13	4.3	3.83	2.93	2.27	1.1

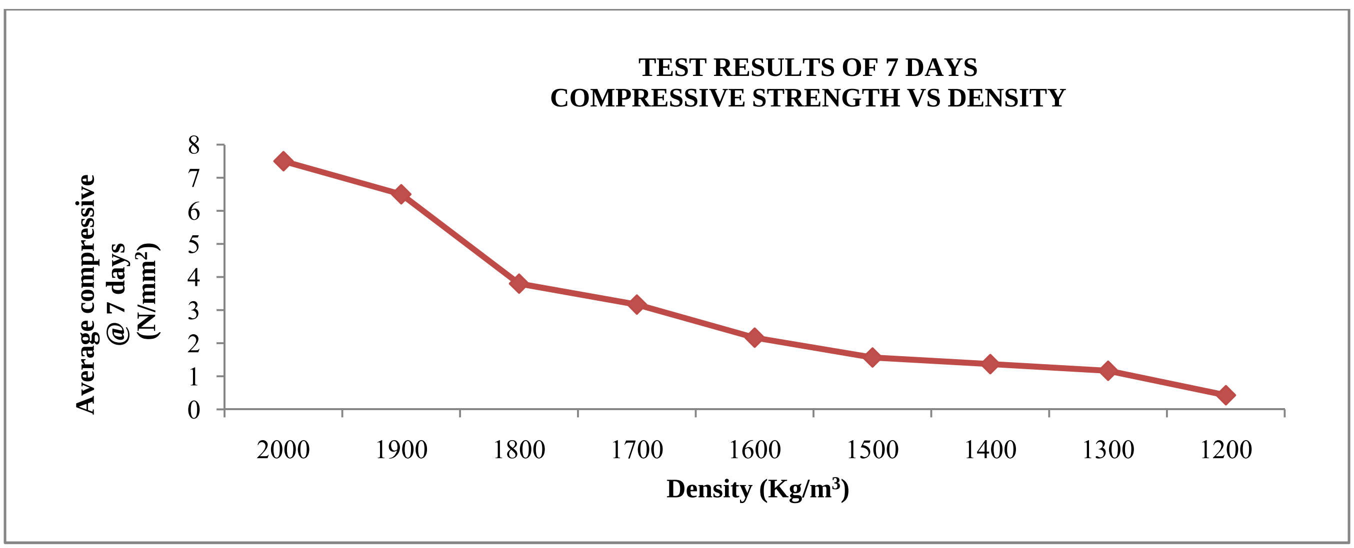

Figure 1: Average compressive strength @ 7 days

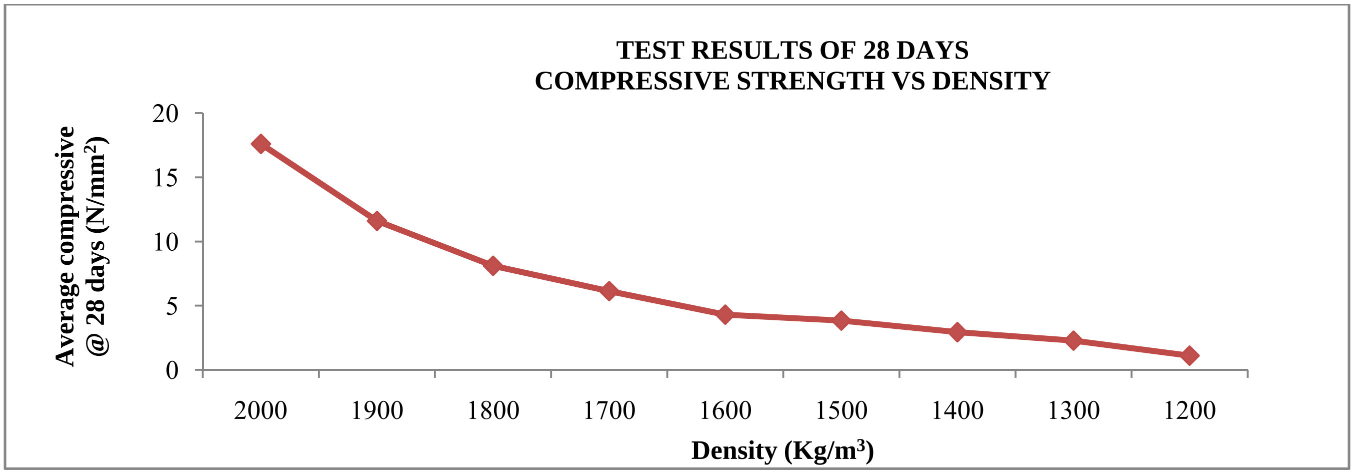

Figure 2: Average compressive strength @ 28 days

III. ANALYTICAL STUDY

A non –linear finite element modeling is done to analyze cold form steel in-filled and bare frame section under static loading using ANSYS16.2 WORKBENCH shown in figure 3. The test results are shown in figure 4.

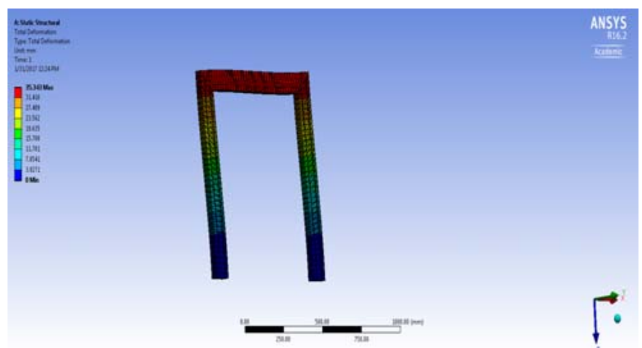

Figure 3: Ansys model of frame

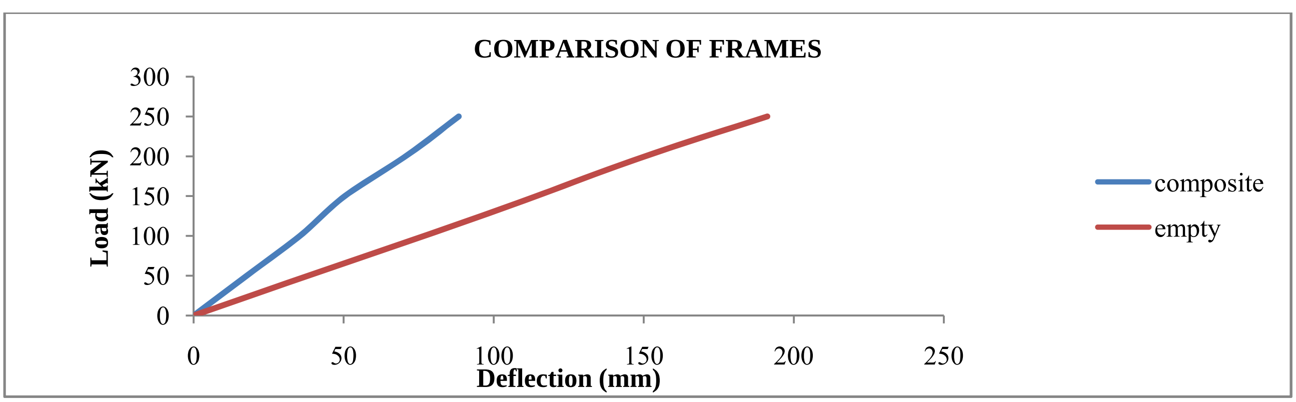

Figure 4: Load vs Deflection curve

Figure 5: Composite frame at before and after loading

IV. EXPERIMENTAL PROGRAM FOR FRAME

Tension test of steel should be done as per *IS 1608-2005*. Three specimens are tested. Two frames are constructed of 1m x 1m in dimension and cross section of the frame is 100mm x 50mm. one frame is filled with foam concrete of density 1800kg/m^3 and curing it for 28 days before testing and another frame is bare. These frames are tested by applying lateral load. 6 inch thickness of slab is provided at the base of frame for fixing it in loading frame. Loading test set up and failures of composite frame and bare frame are shown in figure5, 6, 7 and 8.

Figure 6: Failure of composite frame

A. Test results and discussions

The frames are tested in a loading frame of capacity 200 ton at Structural Technology Lab. Dial gauges are provided at top and center of frame to measure deflection. Load is applied gradually to the frame. In bare frame compression failure (bulging of frame) occurs at 65KN load and at 110 KN tension failure occurs at the welded joint near to the loading point. First yield load starts at 80KN and yields up to 85KN and the ultimate load for bare frame is 110KN. For composite frame yield load starts at 100KN and the ultimate load is 120 KN. Tension and compression failures occur in both the frames. Tension failure occurs at the loading side of frame and compression failure occurs at opposite to the side of loading. Test results are shown in table 3 and figure 9 and 10.

Figure 7. Bare frame at before and after loading

Figure 8. Failure of bare frame

Table 3: Load VS Deflection for both the frames

S NO	Load (KN)	Deflection (mm)		Deflection (mm)	
		Composite frame		Bare frame	
		L	L/2	L	L/2
1	0	0	0	0	0
2	5	0.38	0.14	0.58	0.29
3	10	0.85	0.37	1.15	0.57
4	15	1.66	0.79	1.75	0.84
5	20	2.08	0.99	2.34	1.13
6	25	2.58	1.21	3.06	1.43
7	30	3.1	1.44	3.72	1.71
8	35	3.67	1.72	4.42	2
9	40	4.3	2.01	5.23	2.32

10	45	4.98	2.32	6.15	2.65
11	50	5.62	2.65	6.94	2.95
12	55	6.29	3.03	7.84	3.3
13	60	7.1	3.52	8.77	3.67
14	65	7.68	3.84	9.7	4.05
15	70	8.44	4.25	10.74	4.5
16	75	9.16	4.65	11.83	4.91
17	80	9.94	5.09	13.28	5.43
18	85	10.85	5.54	15.92	5.54
19	90	11.62	5.96	16.2	6.23
20	95	12.55	6.46	16.56	6.24
21	100	13.52	7.1	17.7	6.25
22	105	14.5	7.55	19.6	6.56
23	110	15.46	8.17	26.12	6.7
24	115	16.61	8.66		
25	120	17.95	9.36		

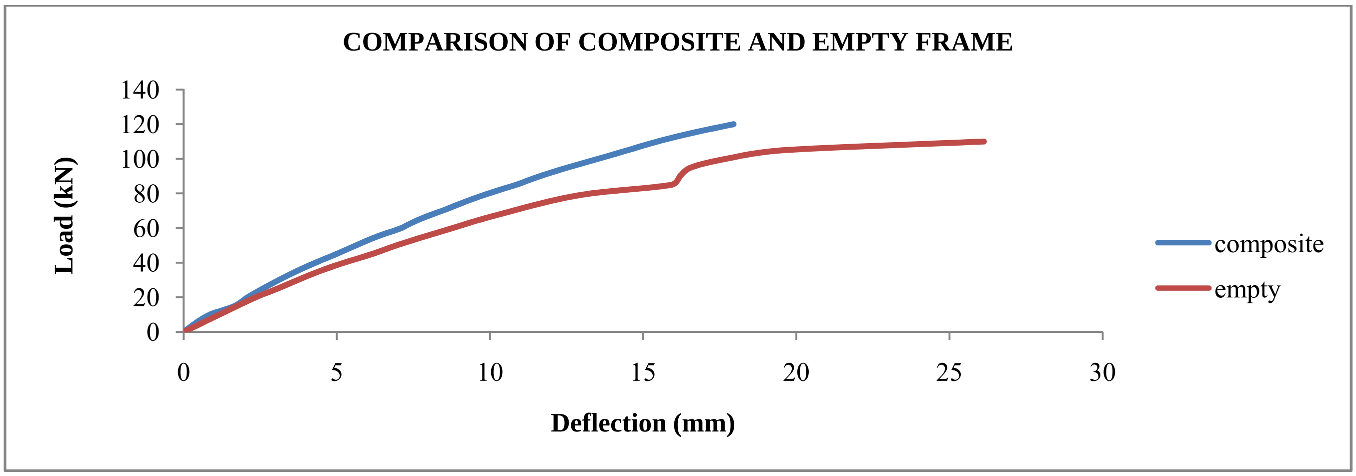

Figure 9: Load vs Deflection curve at L distance

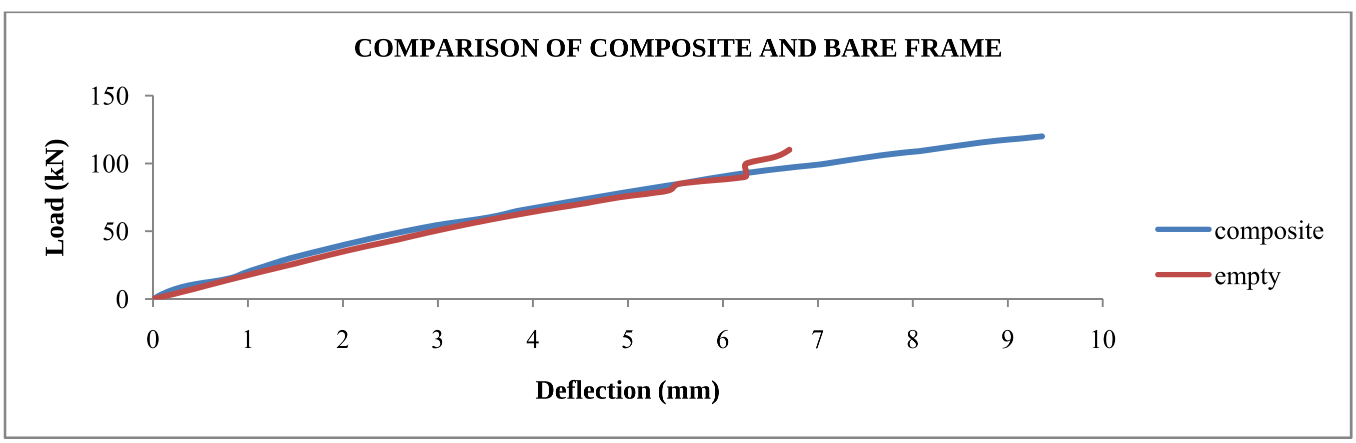

Figure 10: Load vs Deflection curve at L/2 distance

V. CONCLUSIONS

The yield load for bare frame is 80KN and the composite frame is 100KN. Hence the composite frame increases the ultimate loading capacity by 9 %. This shows that the composite frame shows better resistance towards deformation and increases the load carrying capacity. Instead of filling normal concrete, low strength concrete can be filling up to certain level. This also reduced the dead load of the structure. The analytical results (ANSYS 16.2 WORKBENCH) showcomparatively minimum deviation with experimental results. The failure pattern such as distortional buckling, local buckling and torsional buckling are reduced in composite frames. Large deformation of static loading reduced due to using infill material in the hollow sections.

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