INTERNATIONAL JOURNAL OF ADVANCE RESEARCH, IDEAS AND INNOVATIONS IN TECHNOLOGY

ISSN: 2454-132X
Impact Factor: 6.078
(Volume 7, Issue 4 - V7I4-1192)
Available online at: https://www.ijariit.com

Strengthening and compressive behavior of composite multilimbed lightweight CFS build up a column

C. N. Nazinin
nazinincn@gmail.com
Ilahia College of Engineering and Technology, Mulavoor, Kerala

Adila Abdulla Kunju
adilakunju14@gmail.com
Ilahia College of Engineering and Technology, Mulavoor, Kerala

ABSTRACT

In building construction there are basically two types of structural steel, hot-rolled steel shapes and cold-formed steel shapes. The manufacturing process cold formed steel involves forming the material by either press-braking or cold roll forming to achieve the desired shape. The built-up CFS columns has better performance than CFS columns of single channel section. In this study, structural performance of new types of composite columns: I-shape, C-shape and Z-shaped CFS columns of partially concrete filled and fully concrete filled is analysed. This axial performance is compared with hot rolled sections (ISMB) using ANSYS 19. A finite element analysis (FEA) model was developed to simulate structural performance of these special shaped CFS columns. Columns were analysed under axial loading conditions. Investigation in buckling improvement due to partially and fully filled in CFS has good scope in cost effective method of improving stiffness and strength. Global buckling was the major failure mode detected. From the comparison, it was observed that weight of CFS is half of ISMB and fully filled concrete CFS I-shaped section has 111% increase in load than ISMB section.

Keywords— *CFS column, Hot rolled ISMB column, Finite Element Analysis (FEA), Buckling, Axial loading, multi-limbed column, pinned support, Full filled concrete (FC), Partially filled concrete (PC).*

1. INTRODUCTION

New type of composite CFS columns in structural design provide excellent seismic behaviour, ultimate load bearing capacity, high strength and stiffness, fire resistivity and excellent ductility, particularly in zones of high seismic risk. decades. Large number of studies have already been carried out on the performance of CFS columns under different loading. It has been found that CFS columns have better structural performance than conventional hot rolled I section, in terms of load carrying capacity. Therefore, in this study economical design and analysis of a light weight columns to replace a hot rolled sections in building as primary section members is introduced. Study is limited to modelling and analysis of three limbed shaped CFS columns such as I- shaped, C-shaped, Z-shaped and comparing it with the conventional hot rolled ISMB section.

A finite element analysis (FEA) model was developed using ANSYS 19 to simulate the structural performance of these special shaped CFS columns. These CFS columns were analysed under axial loading conditions. From this, axial load capacity, ultimate displacement, failure type, weight ratio comparison, % of increase in load were found out. Global buckling was detected for sections as major failure. Damage occurred mainly in middle part of columns. In the literature, no previous work has described any multi-limbed CFS section of full concrete filled and partially concrete filled section.

2. FINITE ELEMENT MODELLING

2.1 General

To investigate the structural behaviour of CFS columns and ISMB, a finite element model was developed using the software ANSYS 19. In the model, Solid186 element was used to model the CFS. Element type used for screw is BEAM 188. SOLID186 is a higher order 3-D 20-node solid element that exhibits quadratic displacement behaviour. The element is defined by 20 nodes having six degrees of freedom per node: translations in the nodal x, y, and z directions and rotations in the x, y and z-directions. BEAM188 is suitable for analyzing slender to moderately stubby/thick beam structures.

2.2 Geometry

A multilimbed CFS column of I- shape, C-shape, Z-shape and hot rolled ISMB section are taken for analysis. Material properties and dimensions are taken same for above all. Length of column was taken as 1500mm and thickness of the section is 1mm. Length and depth of the flange is taken as 75mm and 45mm respectively. Width and depth of the web is taken as 45mm and 75mm respectively. Structural characteristics of steel including Young's modulus and Poisson's ratio are $2x10^5$ MPa and 0.3. Yield strength of steel is 559MPa. Light weight concrete is used to fill the sections of modulus of elasticity is 10790MPa and Poisson's ratio is .12. Compressive strength of concrete is 48.03MPa The geometry of T-shape, C-shape and Z-

shaped CFS column in finite Element Modelling is shown in fig1.

Column was analysed with pinned support at both ends whereas axial load is applied in one direction. CFS columns are analysed with both ends of the column was constrained in the three (X, Y, and Z) displacement directions; in addition, rotation about Y-axis was constrained and axial load is applied on the top of the column.

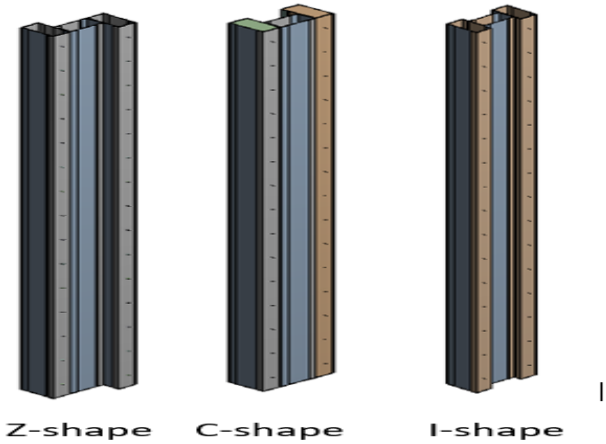


Fig. 1. Geometry of T, C, Z shaped columns

3. ANALYTICAL RESULTS AND DISCUSSION

Each of the column is axially loaded. During the initial stage of loading the specimen is in elastic state. After reaching the ultimate load the specimen gets failed. The global buckling was the major Failure mode. The damage occurred mainly in the middle part of the columns. For a fully filled concrete case, I-shaped CFS has better performance of 111.83% of increase in load capacity than ISMB as compared with C and Z shaped CFS columns. For a partially filled concrete case, 2 flanges filled Z-shaped CFS has better performance of 93.12% of increase in load capacity than ISMB as compared with C and I shaped CFS columns. For a full steel case, I-shaped CFS has better performance of 34.71% of increase in load capacity than ISMB as compared with C and Z shaped CFS columns.

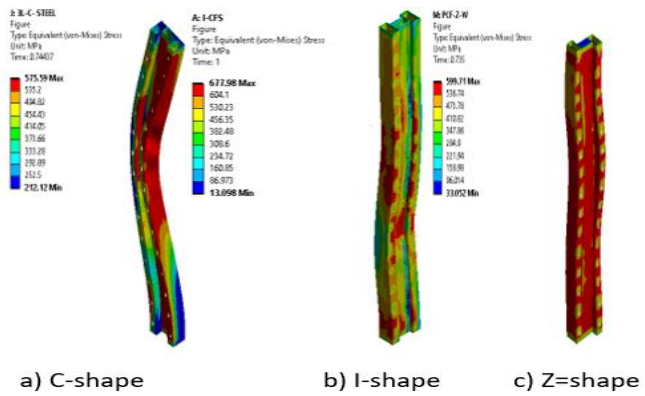


Fig. 2. Von-mises stress diagram of typical failures of specimen

Fig. 2 represents stress distribution across the entire specimen under axial loading. Fig.3 represents the deformation under axial loading. On partially concrete filled case, 2 flanges filled CFS takes more load than others. The weight of CFS is 12.78 Kg, half of the weight of ISMB 21.363Kg.CFS is analysed for the full concrete filled (FC-CFS), partially filled concrete (PC-CFS) and full steel CFS. Chart1 shows the load comparison chart of CFS with ISMB. Chart2 shows the deflection comparison chart of CFS with ISMB.

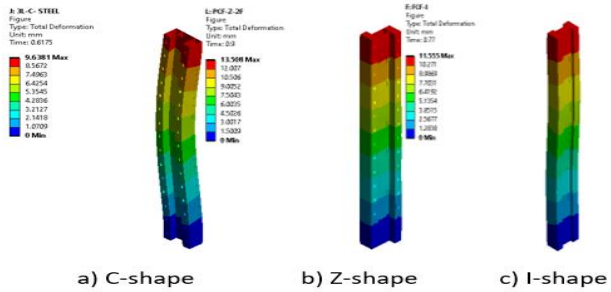
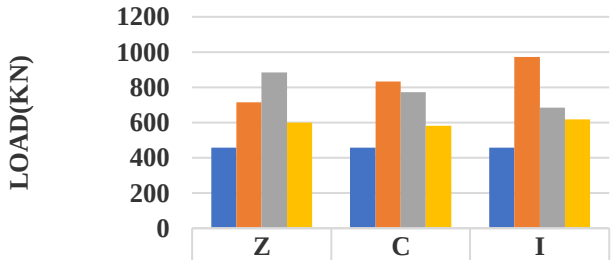
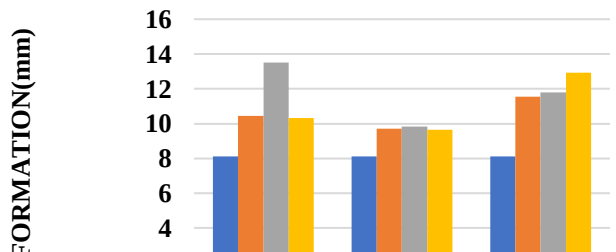


Fig. 3. Deformation of T, C, Z shaped columns



	Z	C	I
ISMB	458.43	458.43	458.43
FC-CFS	715.99	833.53	971.07
PC-2F-CFS	885.32	773.78	683.97
STEEL CFS	601	582.2	617.55

Chart. 1. Load comparison chart of CFS with ISMB



	Z	C	I
ISMB	8.125	8.125	8.125
FC-CFS	10.435	9.7022	11.555
PC-2F-CFS	13.508	9.8398	11.786
STEEL CFS	10.318	9.6381	12.917

Chart. 2. Deformation comparison chart of CFS with ISMB

Results obtained from finite element analysis for ISMB and different cases of I-shaped, Z-shaped, C-shaped are computed in the table1.Percentage increase in load for CFS in comparison with ISMB has noted. Fully filled concrete I shaped CFS column has taken the maximum load of 971.07KN with the deflection of 11.55mm. In partially filled case, one web filled and one flange filled has poor performance on comparing with two flanges filled column. In full steel case, CFS I- shaped section has good load carrying capacity than other shapes.

Table. 1. Analytical results of ISMB and CFS columns

	Model	Weight (KG)	Deflection (mm)	Load (KN)	% Of increase in load
Z Shape					
	ISMB	21.363	8.125	458.43	1
Full steel	Z-CFS	12.785	10.318	601	31.10
	PC-Z-2F	22.67	13.508	885.32	93.12

Partially filled	PC-Z-W	17.728	11.567	718.8	56.80
Full filled	FC-Z	27.613	10.435	715.99	56.18
C shape					
	ISMB	21.363	8.1253	458.43	1
Full steel	C-CFS	12.785	9.6381	582.2	27.00
Partially filled	PC-C--2F	22.67	9.8398	773.78	68.79
	PC-C-W	17.728	9.5445	654.29	42.72
Full filled	FC-C	27.613	9.7022	833.53	81.82
I shape					
	ISMB	21.363	8.1253	458.43	1
Full steel	I-CFS	12.785	12.917	617.55	34.71
Partially filled	PC-I--2F	22.67	11.786	683.97	49.20
	PC-I-W	17.728	9.5159	645.12	40.72
	PC-I--1F	17.728	15.071	478.61	4.40
	PC-IF+W	22.67	14.951	553.36	20.71
Full filled	FCF-I	27.613	11.555	971.07	111.83

4. CONCLUSIONS

In this paper, structural performance of CFS columns under axial loading conditions are analytically investigated. Based on the results of finite element simulation, the following conclusions can be drawn:

- I-shaped CFST column has better performance under axial loading conditions.
- In full steel case, I shaped CFS has got good 34.71% of increase in load than ISMB.
- In partially concrete filled case, two flanges filled has got better performance and two flange filled Z section has 93.12% of increase in load than ISMB
- In fully filled concrete case, I shaped CFS has 111.83% of increase in load than ISMB, with the increase in weight of 27.613 Kg. It has got high load carrying capacity than other shapes.
- The global buckling was the major failure mode. The damage occurred mainly in the middle part of the columns.
- Study shows that CFS columns have better structural performance than conventional hot rolled I section, in terms of load carrying capacity.
- The normal weight of CFS is half of ISMB, on filling the light weight, concrete the weight of CFS has increased approximately near to the weight of ISMB.

5. REFERENCES

[1]. Krishanu Roy, Tina Chui Huon Ting, Hieng Ho Lau, James B.P. Lim "Experimental and numerical investigations on the axial capacity of cold-formed steel built-up box sections": Journal of Constructional Steel Research 160 [2019] 411-427.

[2].K.Roy,C. Mohammadjani, J.B.P. Lim, "Experimental and numerical investigation into the behaviour of face-to-face built-up cold-formed steel channel sections under compression": Thin-Walled Struct. 134 (2019) 291–309.

[3]. K. Roy, T.C.H. Ting, H.H. Lau, J.B.P. Lim, "Nonlinear behaviour of back-to-back gapped built-up cold-formed steel channel sections under compression,": J. Constr. Steel Res. 147 (2018) 257–276.

[4]. M.A. Dar, D.R. Sahoo, S. Pulikkal, A.K. Jain, "Behaviour of laced built-up cold-formed steel columns: experimental investigation and numerical validation,": Thin-Walled Struct. 132 (2018) 398–409.

