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Structural Performance of Cold Formed Steel Quadruple Built-up Box Column

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Abstract - *To better understand the mechanical behaviour of cold-formed steel (CFS) quadruple built-up box-section columns associated with flexural buckling, axial compression tests and screw spacing are conducted. When the screw spacing was reduced from 600 to 150 mm, the load-bearing capacity increased by about 14.6%–17.5%. A finite-element model was developed and calibrated against the test results. A series of parametric analyses was carried out to analysis the effects of the screw spacing and shear stiffness on the elastic buckling load and ultimate load-carrying strength. The structural performances of the cold formed steel built-up columns under axial compression test was studied through the ANSYS software.*

Key Words: **Cold-formed steel (CFS), Built-up section, Flexural buckling, Column**

1.INTRODUCTION

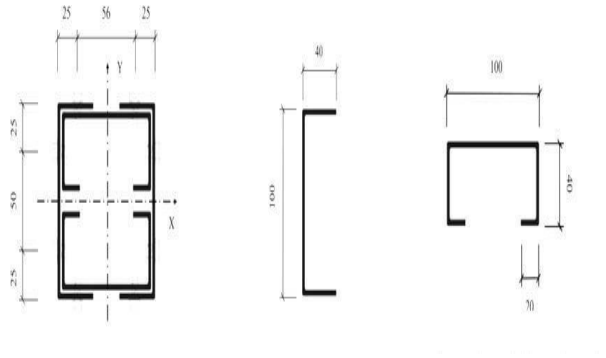
Cold-Formed Steel (CFS) members are made from structural quality steel sheet that are formed into C-sections and other shapes by roll forming the steel through series of rollers which doesn't required heat to form the shapes unlike hot-rolled steel, thus the cold formed steel. CFS members Fig.1.1 used in bridges, railway coaches, highway products, transmission towers etc and these types of cold- formed from steel sheet, strip, plate etc in roll forming machines by bending operations, pressing, stamping, which is in the form of thin gauge sheets commonly used in construction industry for structural or non- structural items such as column, beam, studs, built-up sections and other components. The difference between hot and cold formed steel is how they are processed. Hot rolled steel has been rolled at high temperature while cold rolled steel is essentially hot rolled steel is further processed in cold reduction materials. Cold rolling produces steel with closer dimensional tolerances and a wider range of surfaces finishes than hot rolling and upto 20% stronger than hot rolled through the use of strength hardening. When making more precise shapes, the process involves : (a) breakdown (b) semi-finishing (c) sizing (d) semi-roughing (e) roughing (d) furnishing. Cold rolled steel results in a productwith a better more finished surface with closer tolerance, also yield smoother surfaces which are oily to touch. It can be used harder and stronger than hot rolled steel and aesthetically pleasing finish with wider range of surfaces.

Fig.1.1 Cold-formed steel section

In this thesis, a structural performances of cold formed steel quadruple column is studied. Also, built-up column with different shape of section is also analysed. The modelling and analysis is done using finite element software ANSYS 21.

1.1 Cold formed steel quadruple column

A cold formed steel with channel section C shape and sigma shape is analyzed shown in Fig.1.2.and 1.3. The sections like C shape (C-face to Face and C-Back to Back), Sigma shape (Sigma–Face to Face and Sigma- Back to Back) are used here. Material is used Q355 steel sheet .Quadruple is defined as a structure consisting of four parts or elements, four sections of CFS can be over-lap the column by using screws. The use of CFS built-up column to resist axial forces in CFS multistory buildings has gained high strength and lightweight structure.



(a) (b) (c)

Fig.1.2: (a) built-up section (b) channel section (c) lipped channel section

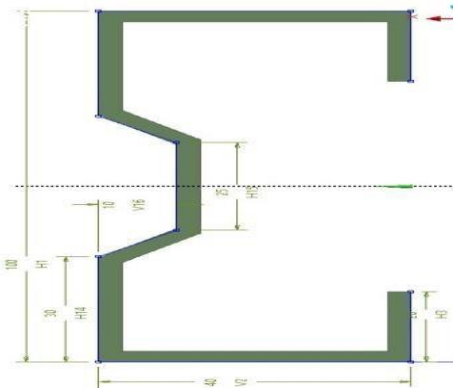


Fig.1.3: Sigma section

The dimensions of C and Sigma sections are shown in Fig.1.2 and 1.3, along with these dimension it provide a thickness as 3 mm. The proposed system can improve the strength of built-up column.

1.2 Objective

To investigate the effect of cold formed steel column with two shapes like channel section C and Sigma (S) segment or shapes under axial loading.

2. ANALYSIS OF COLD FORMED STEEL COLUMN BY VARYING QUADRUPLE MEMBERS

It deals with the dimensional details, modelling details and analysis and results of cold formed steel column with C and sigma shape and their combination in ANSYS software.

2.1 Geometric Modelling

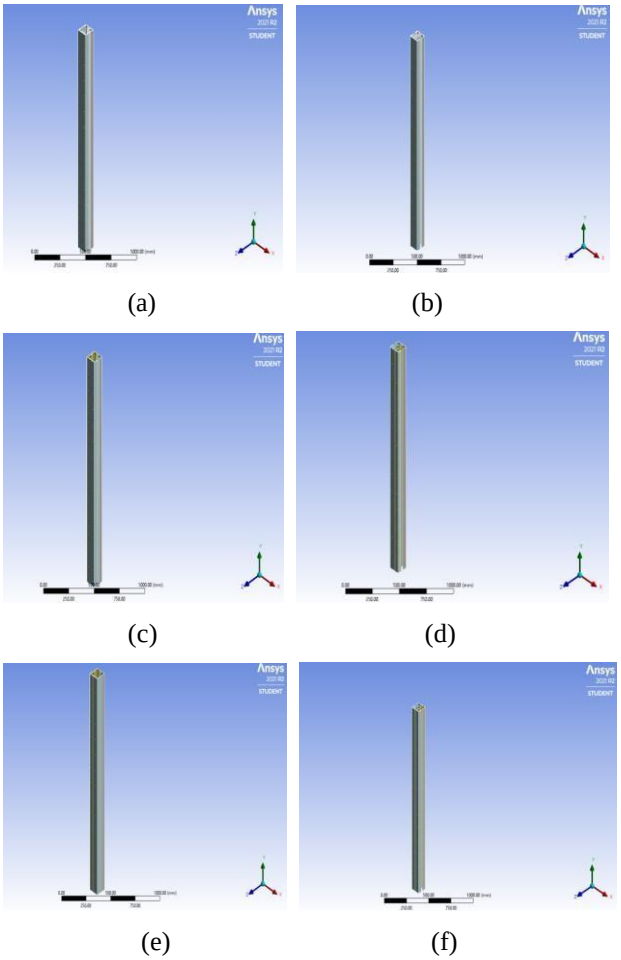
In order to determine the effective shape for cold formed steel column. The end supporting condition was provided as both ends are hinged end condition. The material properties are shown in Table 1.

Table -1: Material properties

Density	7800 kg/m^3
Poisson's ratio	0.3
Young's modulus	2X10^5 N/mm^2
Yield strength	345 MPa

2.3 Modelling

The modelling of the two different shapes of C section as well as Sigma section is done by using CFS SOLID 186 / SCREWS BEAM 188 element type to determine the effective shape. The models of different shapes is shown in Fig.2.1.



(a) (b) (c) (d) (e) (f)

Fig-2.1: Solid model of CFS built-up column (a) C-Face to Face (b) C-Back to Back (c) Sigma- Face to Face (d) Sigma-Back to Back (e) combining C and Sigma-Face to Face (f) combining C and Sigma-Back to Back

2.4 Meshing and Loading

Here the element type used is CFS SOLID186.Element shape is of hexahedron. Element size provided for is 25mm Loading is done based on displacement convergence criteria with a value of 10mm and the corresponding ultimate value is noted.

2.5 Analysis

Non-linear static analysis is carried out in cold formed steel column and different shapes of segments to find the maximum ultimate load corresponding to the deformation. The deformation of CFS built-up box column and different shapes of sections are shown in Fig. 2.2.

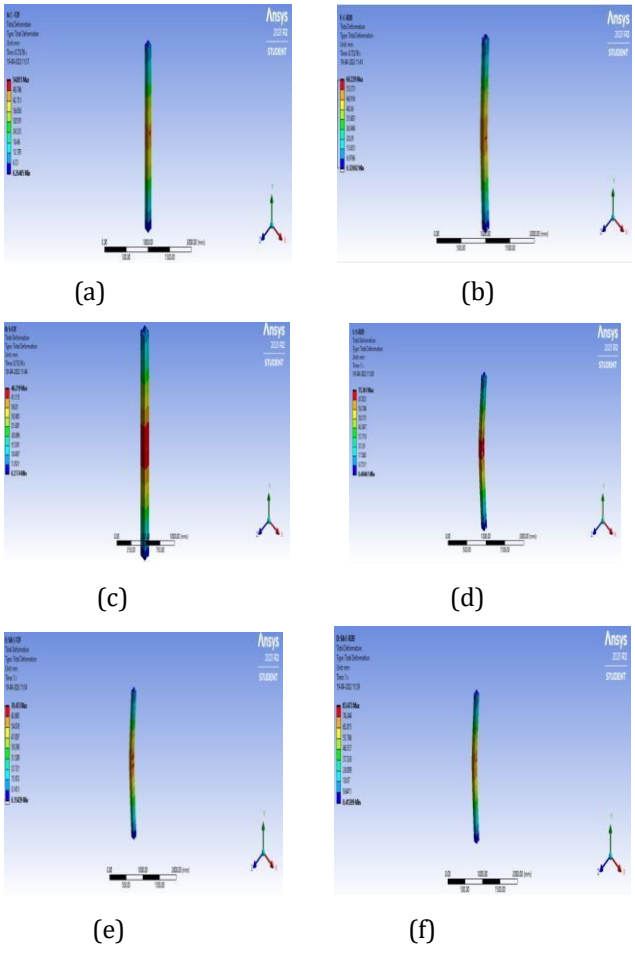


Fig-2.2: Deformation of CFS built-up column (a) C-Face to Face (b) C-Back to Back (c) Sigma- Face to Face (d) Sigma-Back to Back (e) combining C and Sigma-Face to Face (f) combining C and Sigma-Back to Back

2.6 Results and Discussions

The load- deflection graph of deformation of cold formed steel column and different shapes of segment is shown in Chart-1.

Table -2: Comparison of results

Types of column	Deflection (mm)	Load (kN)
C-Face to Face	9.6537	687.27
C-Back to back	14.708	621.09
S-Face to Face	10.278	694.21
S-Back to Back	14.499	637.21
Sigma & C- Face to Face	10.323	684.42
Sigma & C- Back to Back	13.922	646.51

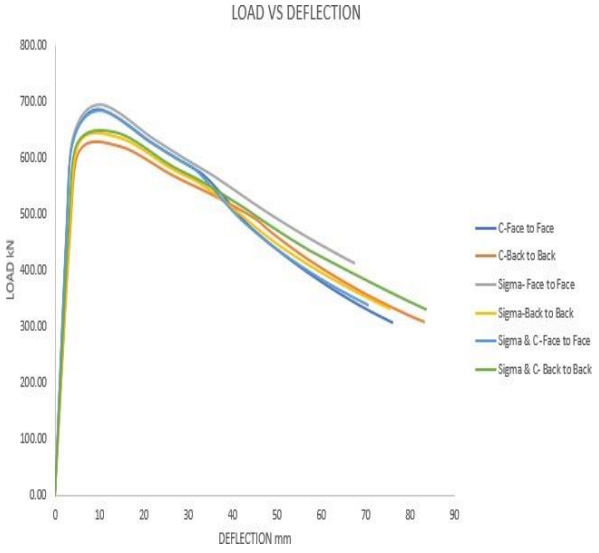


Chart-1: Comparison of load deflection graph

Here sigma-face to face has better ultimate load carrying capacity than the others. The percentage increase in load carrying capacity of sigma face to face column carries 8.21% more load than others.

3. CONCLUSIONS

In this study, structural behavior of cold formed steel column is studied. To find the better shape of section is analyzed. The conclusions obtained are:

Sigma-face to face has better ultimate load carrying capacity than the others. The percentage increase in load carrying capacity of sigma face to face column carries 8.21% more load than others.

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