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Analytical Study on Structural Stability Behaviour of Multi Limbed Built-Up Box Columns

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Abstract *-Cold-formed steel built-up sections are applied as structural members in the construction industry for more structurally efficient cross-section shapes when higher capacity is required. Two or more single CFS members are connected for a built-up section in order to carry higher loads as well as to cross a larger span. Built-up sections have advantages of lightness, fast production, transportation and erection. In this paper analytical study is conducted to evaluate the structural stability behaviour of cold form made multi limbed built-up columns with three different modes of arrangements of the limbs such as T shape, I shape and composite rectangular shape and they are subjected to axial loading conditions so as to find out the most efficient multi limbed section that can be implemented for structural applications as primary as well as secondary structural members.*

Key words: **Finite Element Analysis, ANSYS, Cold-formed steel built-up sections, Multi limbed built-up columns**

1. INTRODUCTION

Cold-formed steel built-up sections are applied as structural members in the construction industry for more structurally efficient cross-section shapes when higher capacity is required. Two or more single CFS members are connected for a built-up section in order to carry higher loads as well as to cross a larger span. Built-up sections have advantages of lightness, fast production, transportation and erection. They have high strength-to-weight ratio, high structural efficiency and so on over hot-rolled members. The main design standards and specifications do not present methods for designing this type of cold-formed steel built-up sections. Even though cold-formed steel sections find its applications in transmission poles, transmission towers, grain bins, storage racks, car bodies, railway coaches and various types of equipment, but in building construction it has limited advancement. The use of hot rolled steel sections become uneconomical for the steel structures subjected to light and moderate loads. Since, the thin walled sections may undergo local, distortional, overall or mixed modes of buckling, the accurate prediction of the member strength becomes more complex.

1.1 Scope and Objective of the study

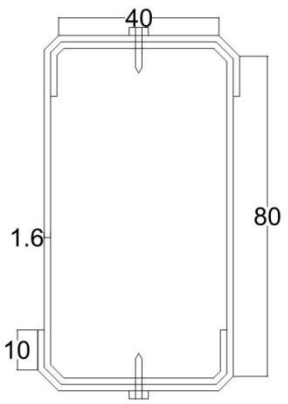
In this paper analytical study is conducted to evaluate the structural stability behaviour of cold form made multi limbed built-up columns with three different modes of arrangements of the limbs such as T shape, I shape and composite rectangular shape and they are subjected to axial, eccentric and lateral or shear loading conditions so as to find out the most efficient multi limbed section that can be implemented for structural applications as primary as well as secondary structural members. The structural stability performance of various shapes can be evaluated on the basis of output parameters such as deflection, moment capacity and shear capacity.

2. ANALYTICAL STUDY

Here ANSYS 16.1 workbenchis used for the analysis. Short and slender columns of three different geometrical shapes such as I shape, Composite rectangular shape and T shape are modeled and analyzed by applying axial loads.

2.1 Analytical Modelling of multi limbed built-up box columns

The columns have an overall length of 1500mm with cross sections in three different shapes such as T shape, I shape and composite rectangular shape. The multi limbed box columns are made using cold formed lipped channel sections of size 80×40×10×1.6mm taken from IS 811:1987. The lipped channels are connected face to face to form a single limb, which are then connected in different patterns in order to form columns of three different shapes.



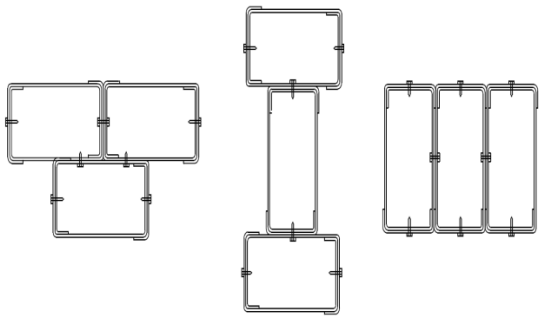


Fig-1: T shaped, I shaped and composite rectangular shaped multilimbed built-up box columns

Member properties

Young's modulus = 207Gpa

Poisson's ratio = 0.3

Yield strength =205.94 MPa

Modelling, meshing and analysis of multi limbed built-up box columns of three different geometrical shapes are shown in fig 2 to fig 10.

(i) T shaped multi limbed built-up box column

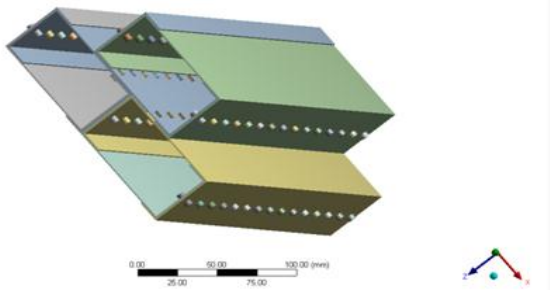


Fig-2: Model of T shaped multi limbed built-up box column

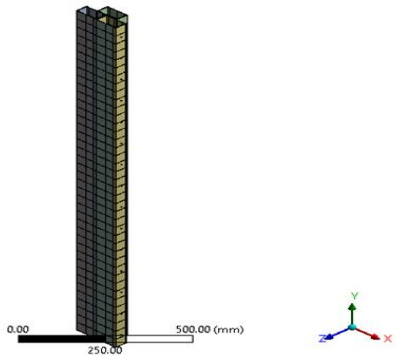


Fig-3: Mesh model of T shaped multi limbed built-up box column

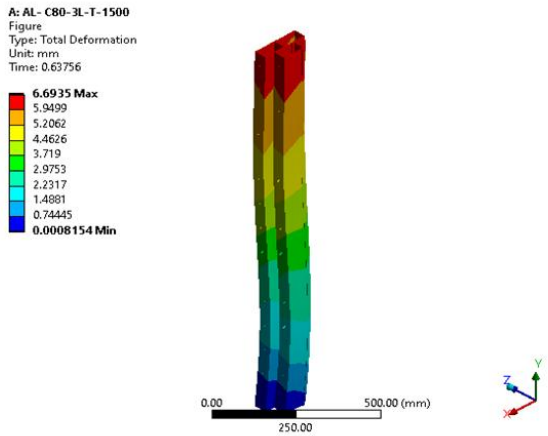


Fig-4 Total deformation of T shaped multi limbed built-up box column

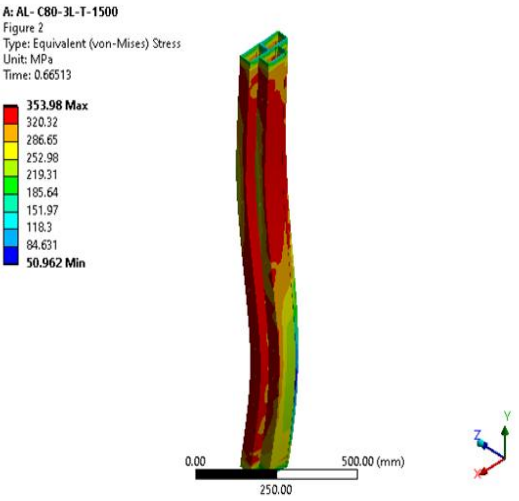


Fig-5 Equivalent (Von-Mises stress) of T shaped multi limbed built-up box column

(ii) I shaped multi limbed built-up box column

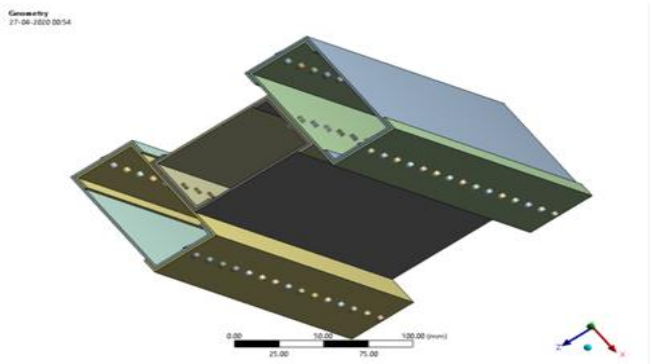


Fig-6: Model of I shaped multi limbed built-up box column

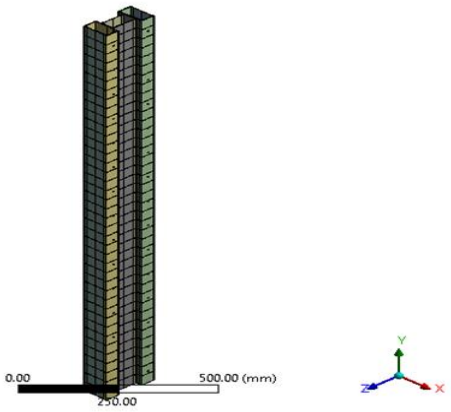


Fig-7: Mesh model of I shaped multi limbed built-up box column

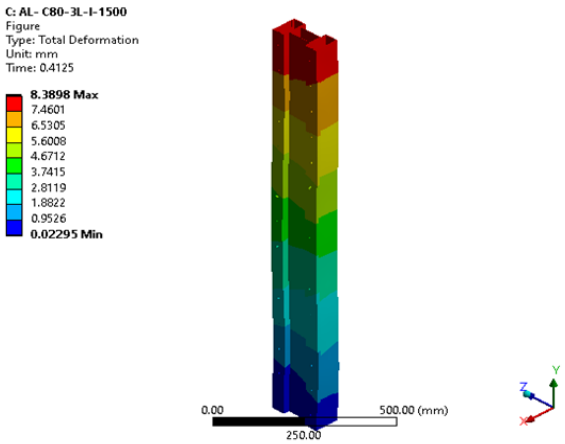


Fig-8 Total deformation of I shaped multi limbed built-up box column

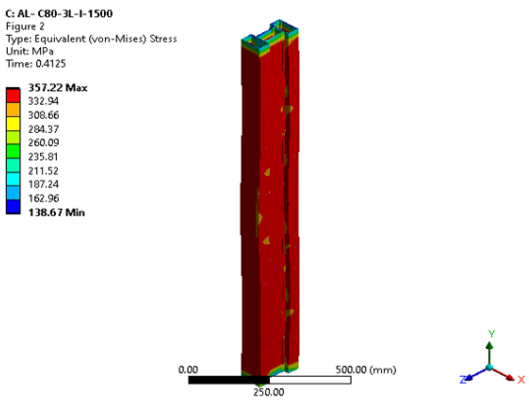


Fig-9 Equivalent (Von-Mises stress) of I shaped multi limbed built-up box column

(iii) Composite rectangular shaped multi limbed built-up box column

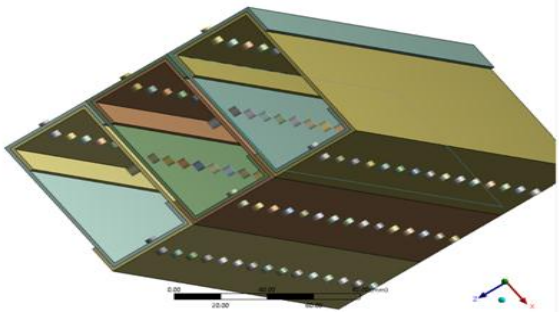


Fig-10: Model of composite rectangular shaped multi limbed built-up box column

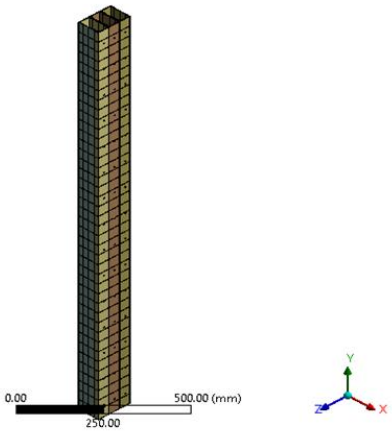


Fig-11: Mesh model of composite rectangular shaped multi limbed built-up box column

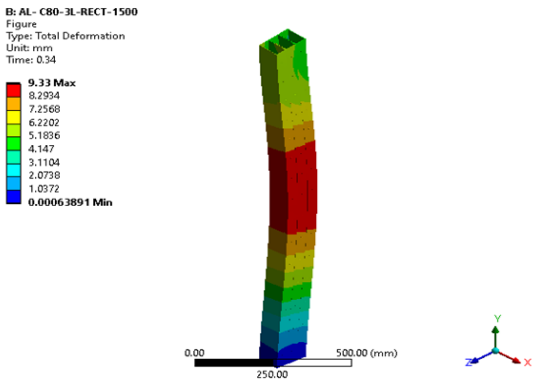


Fig-12: Total deformation of composite rectangular shaped multi limbed built-up box column

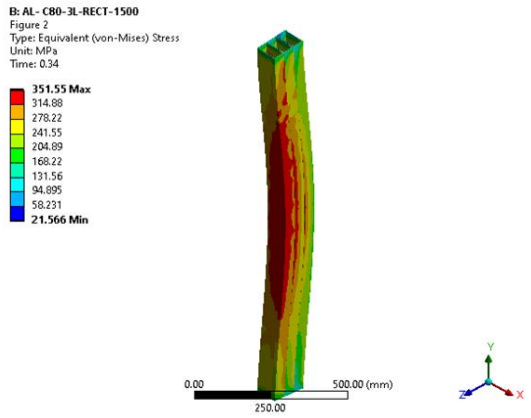


Fig-13: Equivalent (Von-Mises stress) of composite rectangular shaped multi limbed built-up box column

3. RESULTS AND DISCUSSION

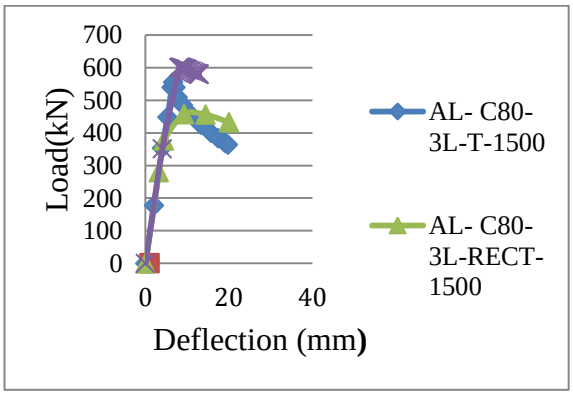


Chart-1: Load – deflection graph of multi limbed built-up box columns of three different geometries

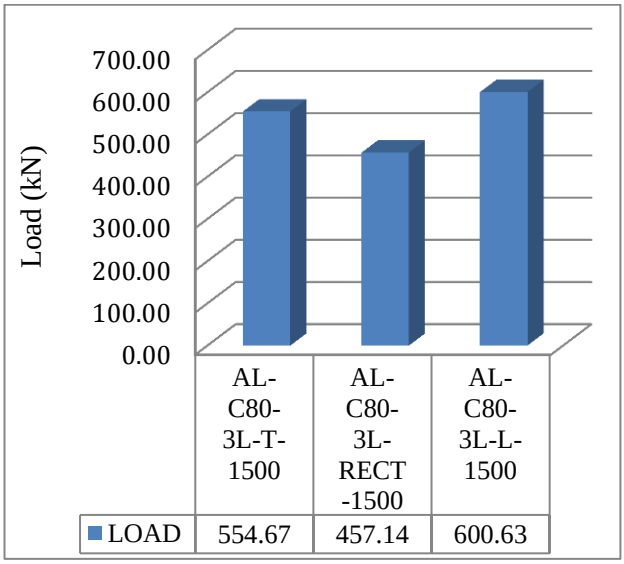


Chart-2: Load comparison chart

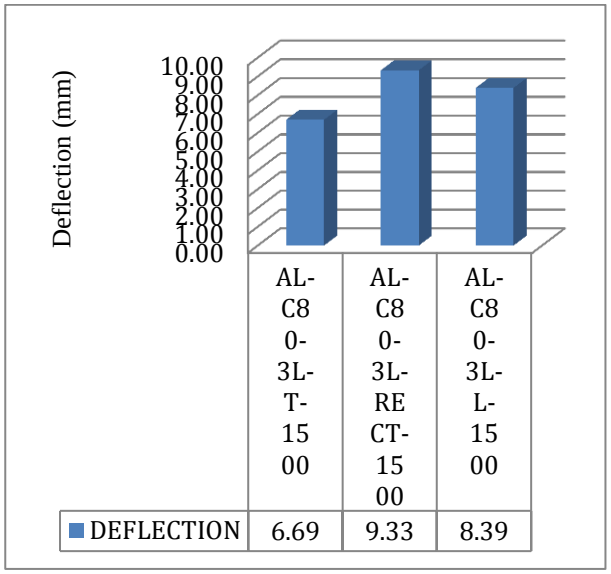


Chart-3: Deformation chart

When multi limbed built-up columns of three different geometries were subjected to axial loading condition, I shaped column had a strength of 600.63kN where as the T shaped and composite rectangular shaped sections had a strength of 554.67kN and 457.14kN respectively which shows that I shaped multi limbed built-up box columns are more adoptable to withstand under higher axial loads.

4. CONCLUSION

Cold form made multi limbed box column sections of different shapes such as I shape and composite rectangular shape and T shape are used in this paper. All the sections are modeled using ANSYS software and are subjected to axial, eccentric and lateral or shear loadings in order to study the structural stability behaviour of the sections under different loading conditions. From the results obtained, it can be concluded that among the columns in the three considered geometries, I shaped multi limbed columns can carry more axial loads and lateral loads where as T shaped multi limbed columns has more stability in eccentric loads.

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