

Numerical Investigation of Cold-formed steel composite column with steel fibre-reinforced concrete

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Abstract:

The Cold-formed steel tube (CFST) of rectangular cross-section is used in column with fibre-reinforced concrete (FRC). The column consists of the hollow cross section of the cold-formed steel tube and is filled with steel fibre reinforced concrete. In order to overcome buckling in the long columns and cold-formed steel tube has reduced the self weight of the column and is very economical in nature. The steel fibre reinforced concrete is used for the increase in the strength of the column to take more loads from upcoming floors. The column of cross-section 150mm*150mm and height of 480mm is tested experimentally and designed by using ANSYS software. Finally, analytically to discuss further to do research in cold-formed steel tubes plays a vital role in it. Strength capacity and analytical results are analyzed from the finite element analysis. The buckling values of the column are analyzed.

Key Word: Cold-formed steel tube, steel fibre-reinforced polymer, ANSYS Software

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I. Introduction

Both steel and concrete take advantages of concrete filled steel tube (CFST). It consists of rectangular shaped cold-formed steel tubes filled with fibre reinforced concrete. It is used in the apartments and multistorey structures and also used for small buildings (Beams & columns). In building construction usage of concrete filled steel tube has increased in recent years due to mainly as its simple construction sequence and superior structure performance.

Cold-formed steel thin sheets are used in the construction for structural and non-structural elements such as columns, beams, floor decking, and other components. The buckling problem in the thin walled steel tubes is reduced by means of the in-filled concrete cold-formed steel tube. The material separation in the cross-section plays a vital role for the structural performance. The cold-formed steel tube lies in the outer surface which always takes the tension and bending stresses in it. The cold-formed steel and fibre-reinforced concrete provides a higher modulus of elasticity and good values for moment of inertia under axial compression loads.

The fibre reinforced concrete is in-filled in the steel tube and provides efficient cross-sectional properties. The span of two rooms comes under single column. The size of the foundation can be reduced by reduction in size of columns. To take loads the cold-formed columns of large span play a vital role.

II. Numerical Investigation

2.1 General

The ANSYS workbench Software is used for finite element analysis and addition with CAD system Design model. It also imports CAD files and data, to build the geometry with the various "pre-processing".

The finite element model is required for computation is generated. After applying loads in it and carrying out the analysis, results obtained as numerical and graphical.

2.2 ANSYS MODEL DESCRIPTION

The study of the 3D finite element model is designed and developed a steel-encased Column in the compression load test. The normal conventional column and further fibre mixed column.

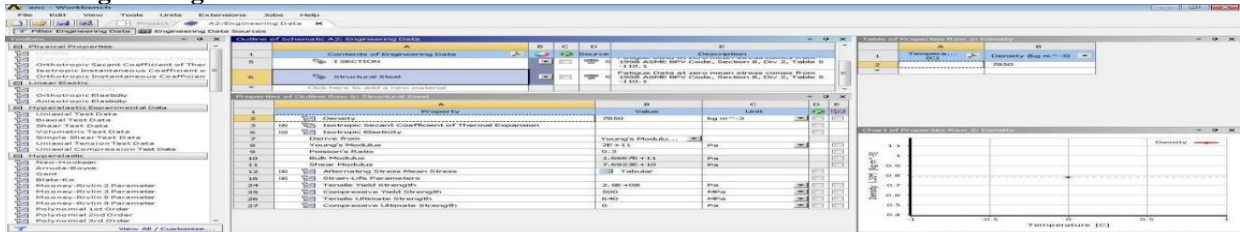
It integrates simulation technologies and parametric values of CAD systems with unique automation and performance. The power of ANSYS workbench to solve algorithms with many years of experience and to improve the product in the virtual environment.

2.3 ANSYS MODELLING PROCEDURE

The analysis mainly focuses on

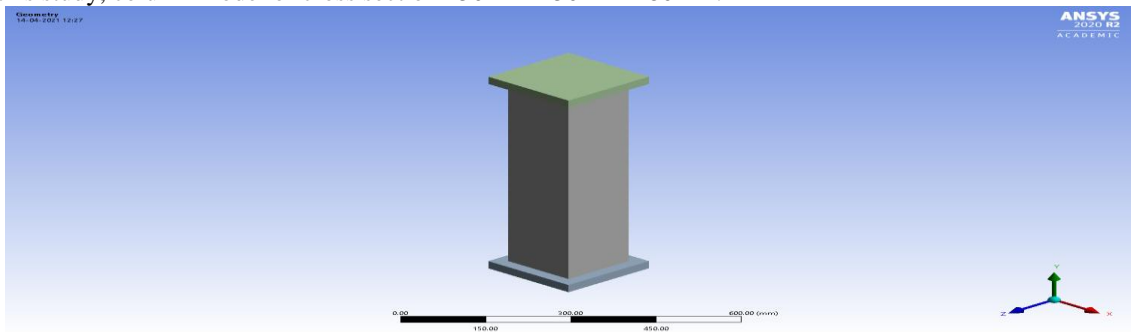
1. Engineering data
2. Geometry optimization
3. Attaching section properties
4. Finite element model
5. Solving
6. Results

2.3.1 Engineering data



2.3.2 Geometry Optimization

In this study, column model of cross section 150mm*150mm*480mm.

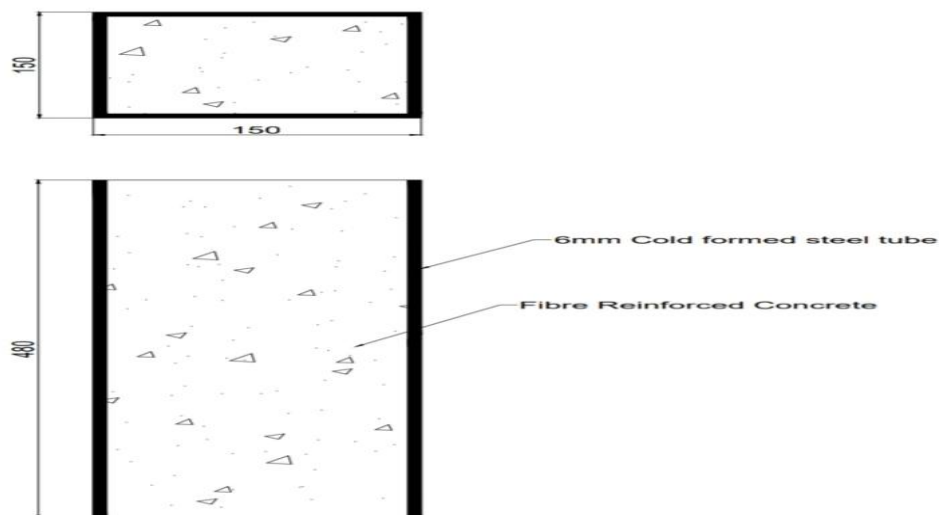


2.3.3 Assigning the Section Properties

The region of the part and assign the section to the particular region, to the toolset and create the homogeneous set to the particular region and assign the section to set the values. The section properties include various assigning values and section of steel and concrete.

2.3.3.1 CROSS-SECTIONAL OF COLD-FORMED STEEL TUBE

The cold-formed steel tube of thickness 6mm and cross section of 150mm x150mm having length of 480mm.



2.3.4 FINITE ELEMENT MODEL

After the geometry design, the modelling is to be done and assign material properties. The mesh is generated by using the finite element analysis and obtained correctly.

Table.No:5.1 Setting up the finite element model

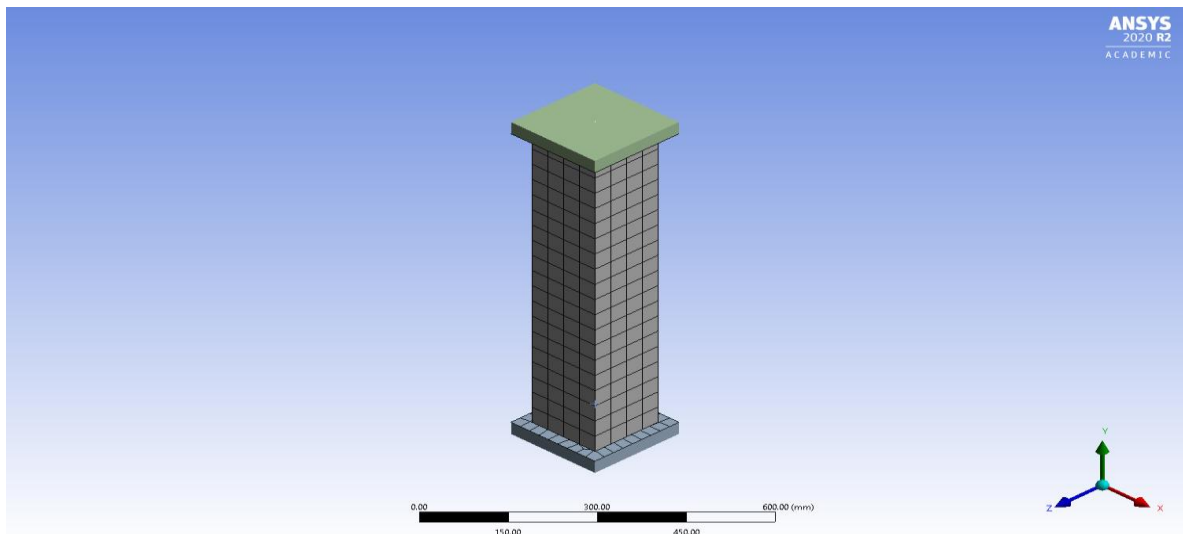
Materials	Density(Kg/m3)	Modulus of elasticity(Mpa)	Poisson Ratio
Concrete	2400	28	0.2
Steel	7850	2E5	0.3
SFRC	2500	32	0.28

2.3.4.1 MESH GENERATION

The Mesh generation is done to convert larger size particles into several nodes. Discretization is the process of generating the nodes. The load applies in each node and the load will be distributed throughout the structures.

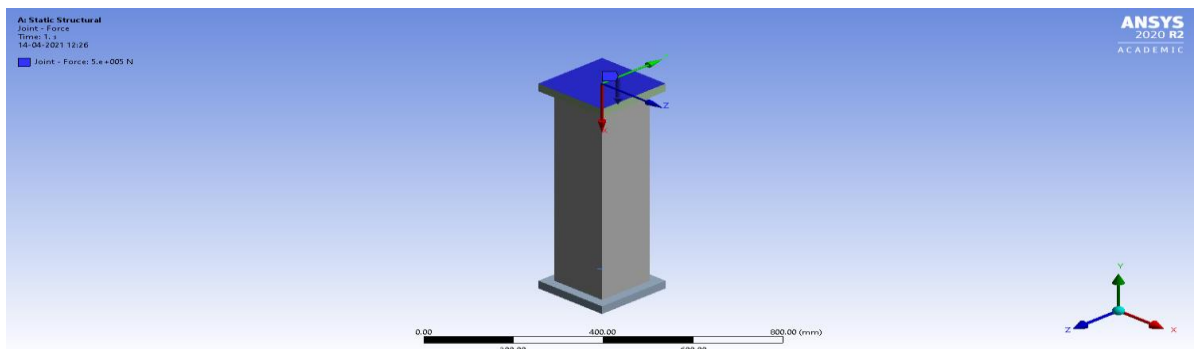
The cold-formed steel tube column mesh generation for the cross-sectional properties and values of the analytical model is performed and studied for the values of the deformation and the axial compression value.

Discretization is the meshing process by which the continuous body into finite element analysis. The accuracy depends upon the number of elements



2.3.4.2 LOADING PATTERN

The cold-formed steel encased the fibre concrete applied the point load and also to investigate the failure modes and the improvement in the strength values.



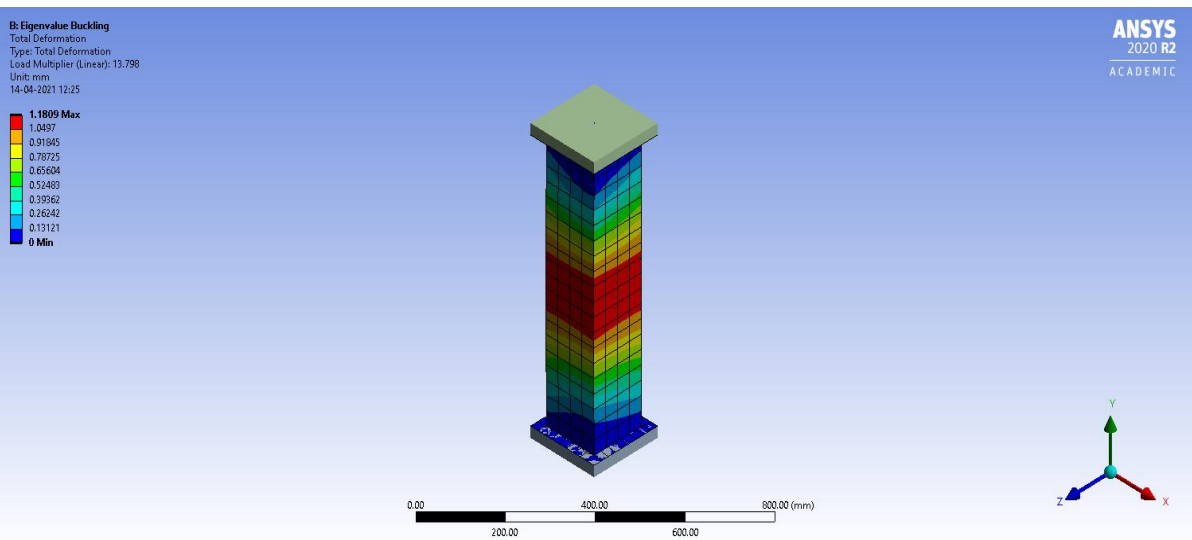
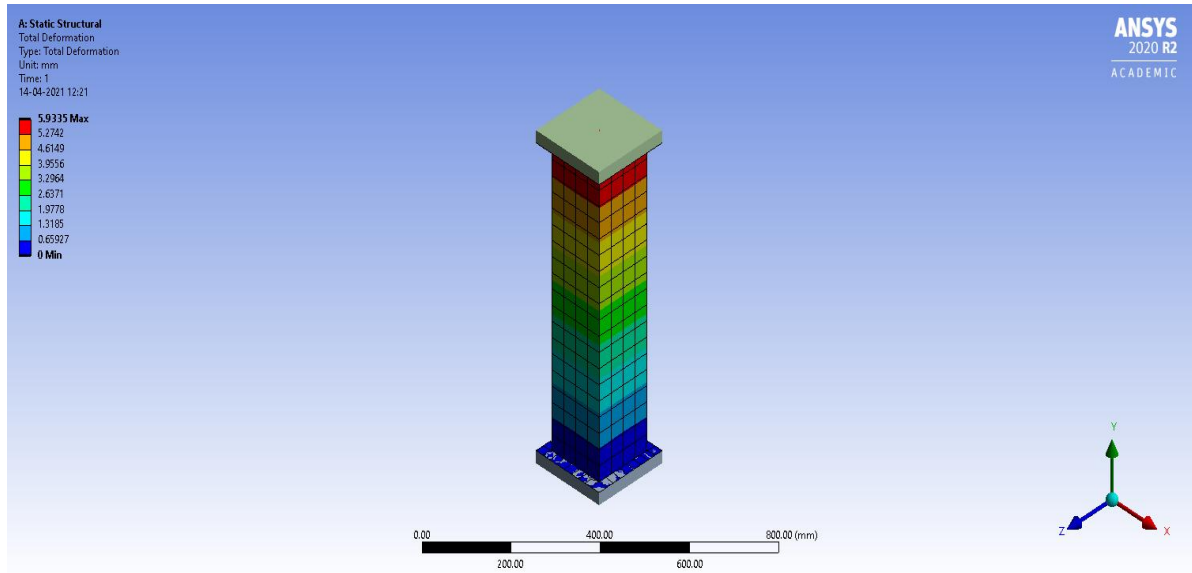
2.4 NUMERICAL RESULTS

The numerical results and analysis is done for the all the columns, stress contour for the both conventional and steel fibre concrete.

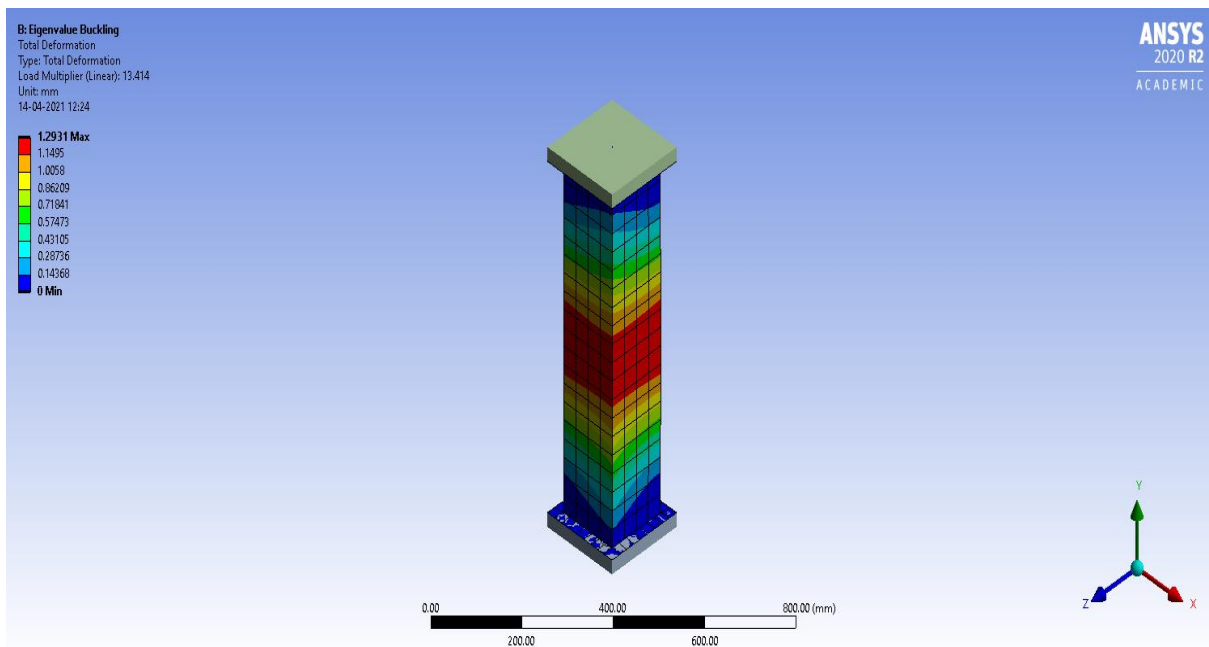
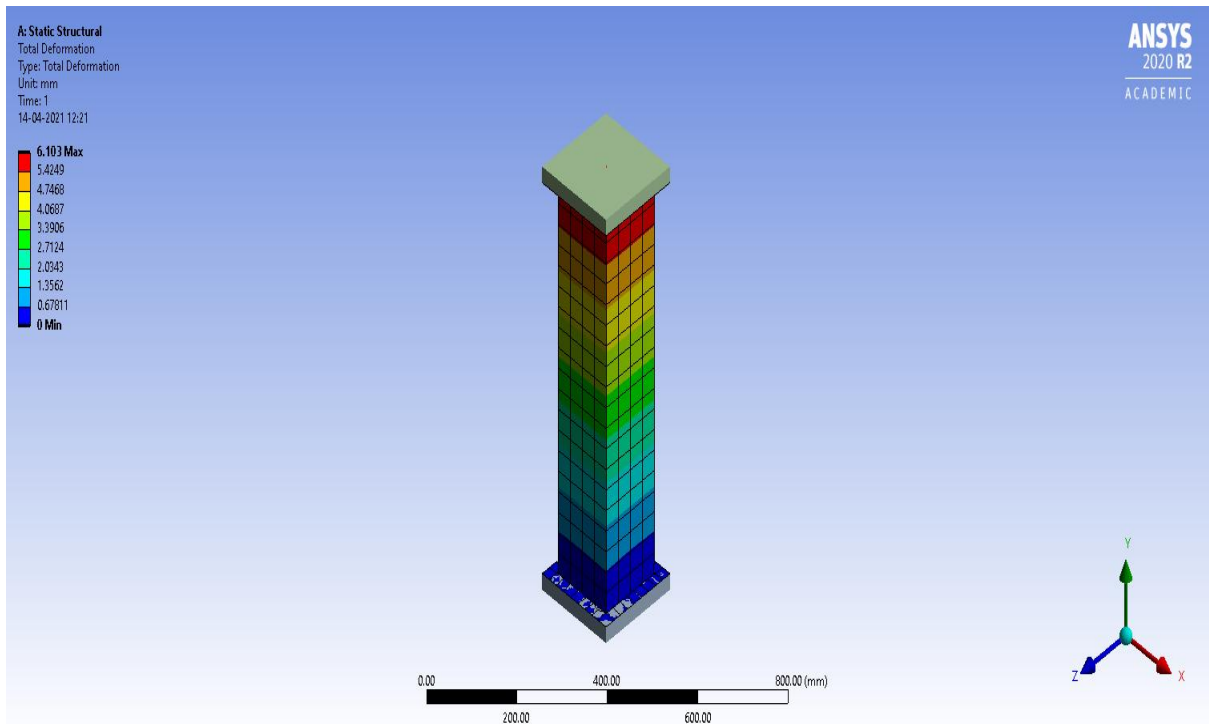
S.NO	LOAD	FRC COLUMN-1	FRC COLUMN-2	FRC COLUMN-3	FRC COLUMN-4
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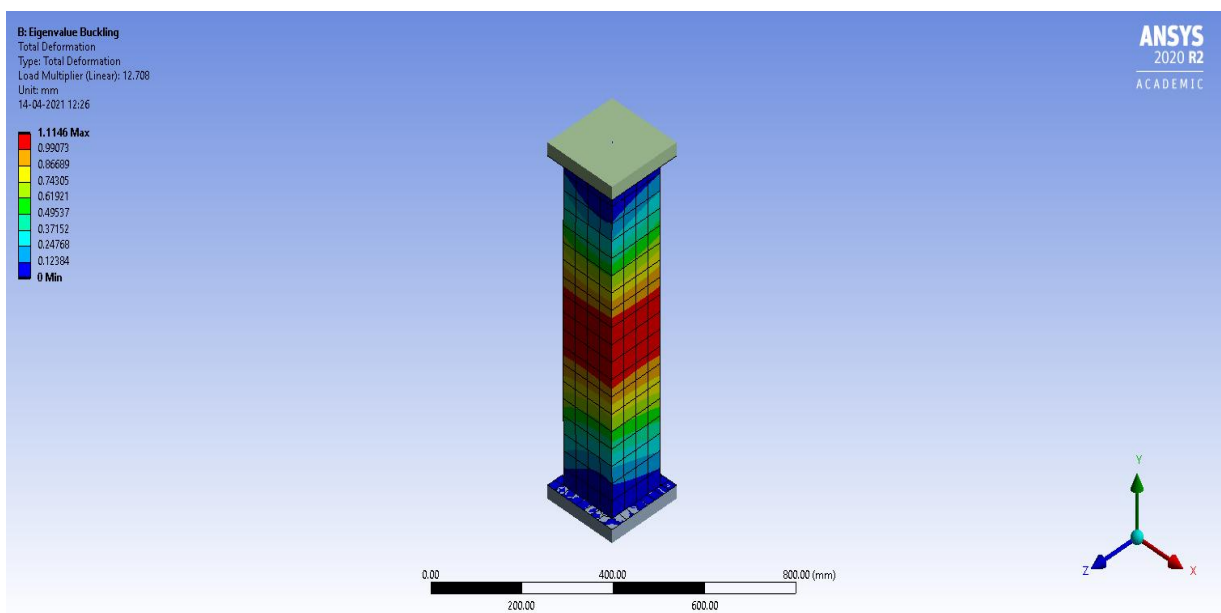
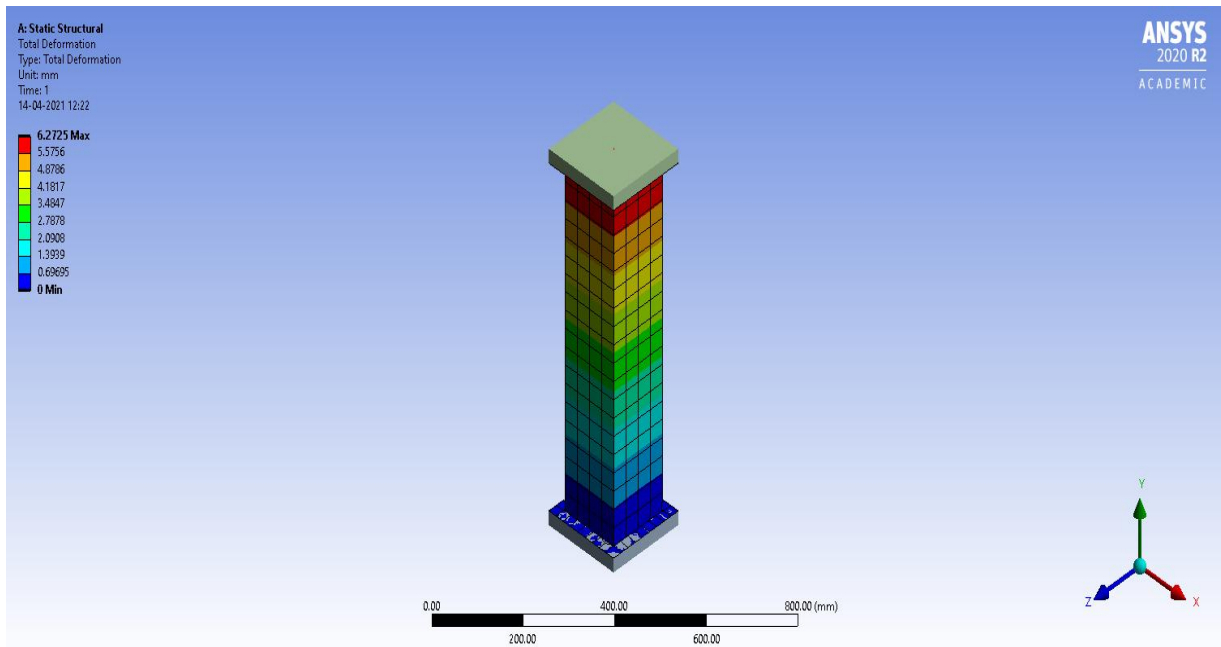
		Deformation	Deformation	Deformation	Deformation
1	300	4.82	4.94	4.98	5.02
2	350	5.26	5.32	5.45	5.24
3	400	5.64	5.84	5.92	5.94
4	450	5.92	6.12	6.24	6.28
5	500	6.25	6.24	6.38	6.40



FRC COLUMN-1



FRC COLUMN-2



FRC COLUMN-3

III. Conclusion

This paper did research on the cold-formed steel tube thoroughly its behaviour and design of cold-formed steel tube (CFST). Many research has been done related to the cold-formed steel of rectangular section and also in the design areas. It also provides excellent seismic behaviour.

- The cold-formed steel tube considerably reduces the local buckling, stiffness and further, the non-linear analysis is carried out.
- The composite column can be used in industrial structures and low-rise buildings.
- The confinement effect increases due to this cross-section and also reduces due to stress concentration at the corners.
- The tube of the cold-formed steel undergoes the confining effect and it can be investigated.
- The cold-formed steel tube considerably reduces the local buckling, stiffness and further, the non-linear analysis is carried out.
- Unlike Reinforced columns (RC), strain hardening does not occur in cold-formed steel tube column under axial loading.

References

- [1]. AbdelRahman, N. and K. S. Sivakumaran (1997). "Material properties models for analysis of cold-formed steel members." *Journal of Structural Engineering-Asce* 123(9): 1135-1143.
- [2]. AmericanStandard (2001). "North American Specification for the Design of Cold-formed Steel Structural Members.
- [3]. AS/NZS4600(2005 "Cold-FormedSteelStructures".
- [4]. ChineseStandard(GB50018) (2002). "Technical code of cold-formed thin-wall steel structures".
- [5]. EN1993-1-3 (2006). "Eurocode 3-Design of steel structures-Part 1-3: General rules-Supplementary rules for cold-formed members and sheeting ".
- [6]. Guo, Y. J., A. Z. Zhu, et al. (2007). "Experimental study on compressive strengths of thick-walled cold-formed sections." *Journal of Constructional Steel Research* 63(5): 718-723.
- [7]. Hu, S. D., B. Ye, et al. (2011). "Materials properties of thick-wall cold-rolled welded tube with a rectangular or square hollow section." *Construction and Building Materials* 25(5): 2683-2689.
- [8]. Karren, K. W. (1967). "Corner properties of cold-formed steel shapes." *Journal of the Structural Division* 93(ST1): 401-432.
- [9]. Wei, X. Luo, Z. Lai, A.H. Varma, Experimental behavior and design of highstrength circular concrete-filled steel tube short columns,

ANTONY RAJ T. "Numerical Investigation of Cold-formed steel composite column with steel fibre-reinforced concrete." *IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE)*, 18(5), 2021, pp. 43-49.