COMPRESSION & BENDING PERFORMANCE OF NON-PRISMATIC CIRCULAR TUBED STEEL REINFORCED CONCRETE COLUMNS

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Abstract -
CTSRC column is the circular tubed steel reinforced concrete columns. Steel and concrete is a good combination because of the excellent composite behavior. In this analysis compression and bending performance of non-prismatic CTSRC column is studied. Non-prismatic column means cross-section varying along longitudinal direction. Different type tapered conditions are used in this analysis like single side tapered, double side tapered and partial tapered This study also helps to understand deformation, ultimate load, buckling behavior of straight and non- prismatic or tapered CTSRC columns. The models with following parameters were tested by using ANSYS workbench16.1.

***Key Words*: CTSRC, Non-prismatic, Steel, concrete, ANSYS ,Tapered , Composite**

1.INTRODUCTION

The composite columns are constructed using various combinations of concrete and structural steel. This combination will improve properties of each material. The behaviour of concrete and steel section makes the composite column very stiff, cost effective & more ductile. In conventional composite columns construction, column cross-sections are uniform throughout the length.

In order to meet the architectural requirements of some spatial constructions in recent years, tapered (non-prismatic) composite columns with cross-sections varied along the longitudinal direction have gain attention from researches and designers. Since some case the become more economical solution compared with the conventional prismatic ones. The applications of tapered non prismatic circular tubed steel reinforced concrete columns are station platforms, bridges, exhibition hall etc.

The behaviour of non-prismatic CTSRC column may be different ,when compared with prismatic CTSRC columns. Taper ratio may affect the strength difference in columns. Tapered circular tubed steel reinforced concrete column is a good choice of high-rise construction.

1.2 OBJECTIVE

To study the compression and bending behaviour of prismatic and non-prismatic circular tubed steel reinforced concrete columns subjected to axial loading. The performance evaluated by using varying parameters and short column effect. The various parameters are slenderness ratio, taper ratio and short column effect.

1.3 SCOPE

Scope of the work is limited to conduct performance evaluation of straight and non-prismatic circular tubed steel reinforced concrete columns (CTSRC) using the parameters includes slenderness ratio, taper ratio and axial loading to compare their performance, using nonlinear finite element approach.

2.MODELING AND ANALYSIS

2.1 Geometry and material properties

Models have been made by using ANSYS software with the properties like yield strength, poisson's ratio, etc of CTSRC columns and steel sections. In total there were 10 models, 7 models of prismatic (straight) and non- prismatic of long CTSRC columns with two taper ratio (1.125,1.28) and 3 models of short non-prismatic CTSRC columns with one taper ratio (1.125). Long straight column have diameter is 180mm. One type of Non-prismatic long column having bottom diameter is 180 mm and 160 mm on top side. Another type of non-prismatic have bottom diameter is 180 mm and top diameter is 140 mm. Short non-prismatic column have bottom diameter is 180mm and top diameter is 160 mm. The height of long column is 3000mm and short column is 1000mm. H section is used as steel section in column.

Table-1: Material properties of concrete

Properties	Description
Density (kg/m3)	2512 kg/m^3
Young's modulus (MPa)	4.18×10^{11}Pa
Poisson's ratio	0.12

Table-2: Material properties of steel section

Properties	Description
Density (kg/m3)	7850 kg/m^3
Young's modulus (MPa)	1.80 × 10^{11}Pa
Poisson's ratio	0.291

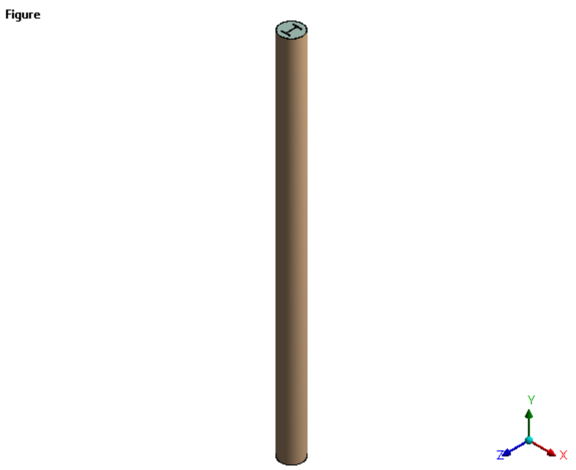

Fig -1: Straight long column

Fig-2: Long column–double side tapered condition (TR=1.125)

Fig-3: Long column–partial tapered condition (TR=1.125)

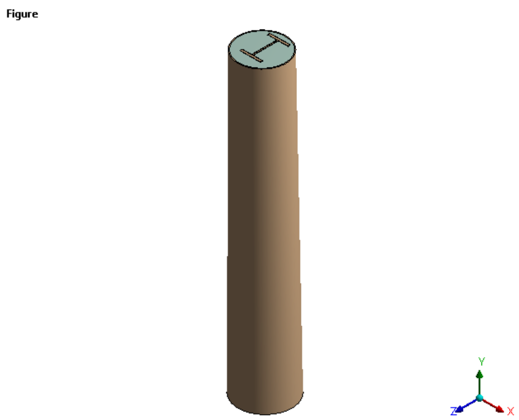

Fig -4: Short column– single side tapered condition (TR=1.125)

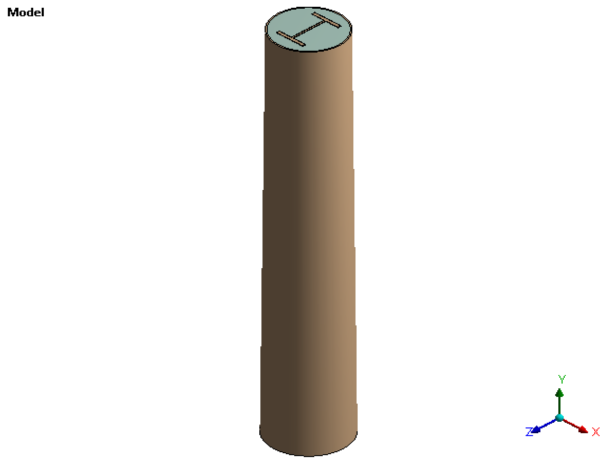

Fig -5: Short column–double side tapered condition (TR=1.125)

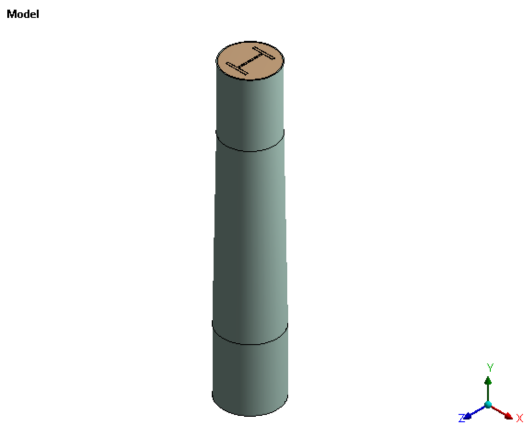

Fig -6: Short column–partial tapered condition TR=1.125

Meshing

Loading and Boundary conditions

To simulate real conditions, columns were one end is fixed and one end is pinned. The load is applied in one direction. Performance of column under axial and lateral loading was studied by ANSYS. A 3D finite element model was formed for each column and comparison was made for straight and non-prismatic columns.

3. RESULTS AND DISCUSSIONS

3.1 Axial Loading

column models are subjected to load at the centroid of column cross section. From the load deflection graph, maximum load carrying capacity and total deflection of model was obtained and compared between them.

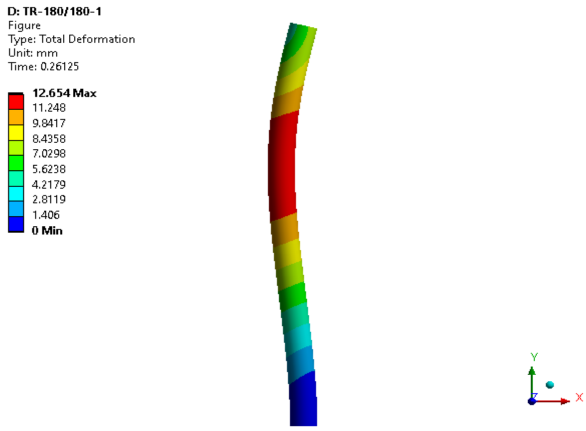

Fig-7: Total deformation of long straight column

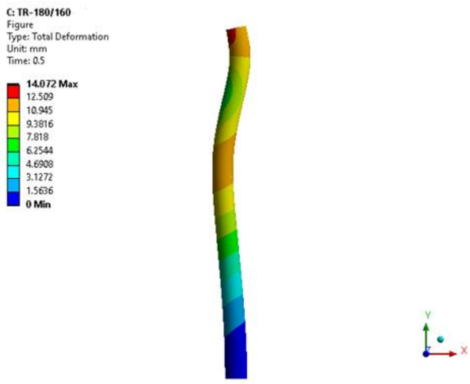

Fig-8: Total deformation of Long column -double side tapered condition (TR=1.125)

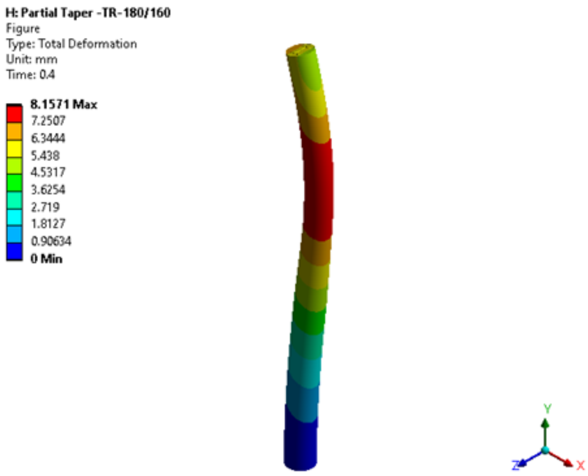

Fig-9: Total deformation of Long column -Partial tapered condition (TR=1.125)

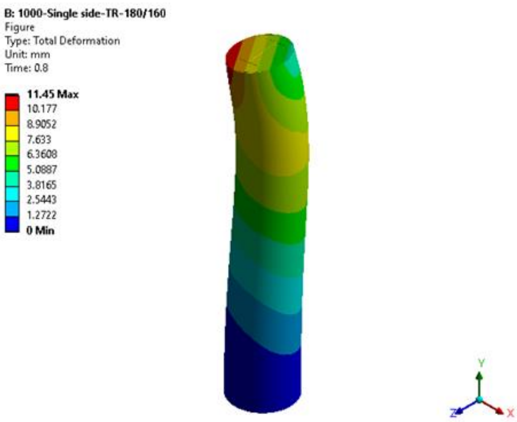

Fig-10: Total deformation of short column -single side tapered condition (TR=1.125)

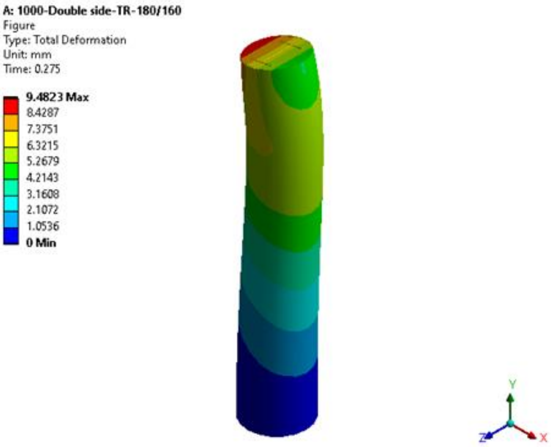

Fig-11: Total deformation of Long column -double side tapered condition (TR=1.125)

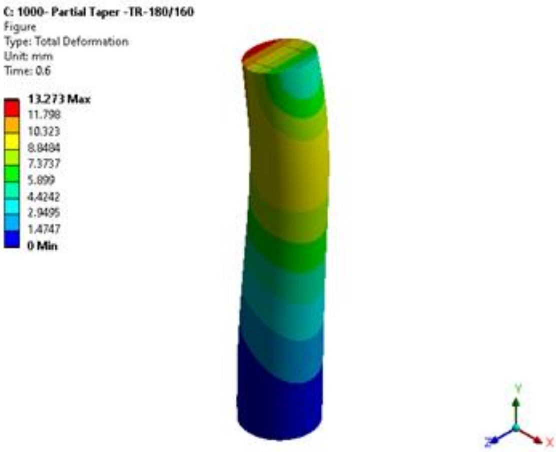

Fig-12: Total deformation of short column -partial tapered condition (TR=1.125)

Table -3: Ultimate load and Total deformation of Double side tapered and straight long column

Model	Stiffness (KN/mm)	U-def (mm)	Pu-load (KN)	Type of failure
Double side TR-1.125	191.85	14.07	2,699.3	Inward +lateral buckling
Straight	201.96	12.65	2,554.8	Lateral buckling

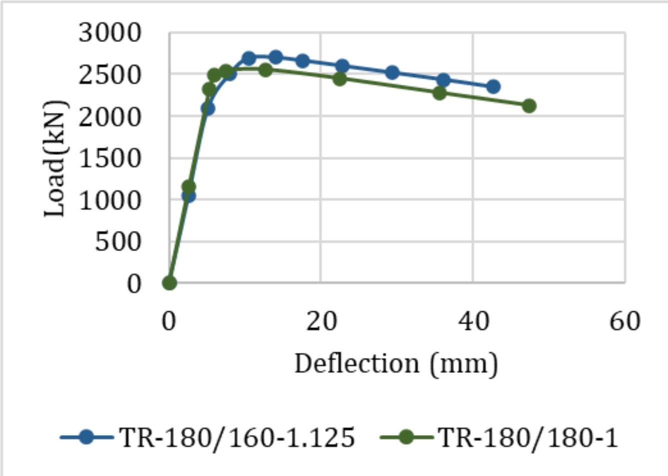

Chart-1: Load deflection graph of Double side tapered long columns and straight long column

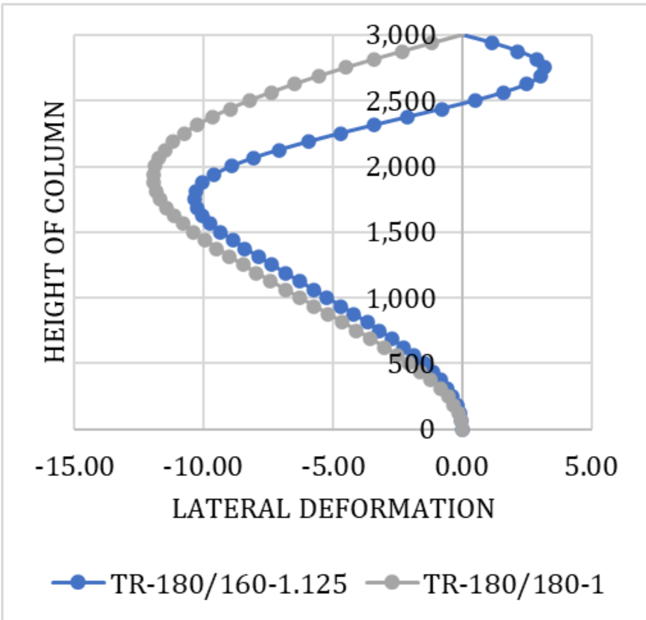

Chart-2: Buckling lateral deformation of double side tapered & straight long column

From the data obtained it is clear that non-prismatic double side tapered column TR-180/160=1.125) are having more load carrying capacity than prismatic long straight column model, precisely double side tapered TR-180/160=1.125) column shows 5.4 % higher strength than straight column.

Table -4: Ultimate load and Total deformation of partial tapered and straight long column

Model	Stiffness (KN/mm)	U-def (mm)	Pu-load (KN)	Type of failure
Partial taper-TR-1.125	288.82	8.16	2356.80	lateral buckling
Straight	201.96	12.65	2554.80	lateral buckling

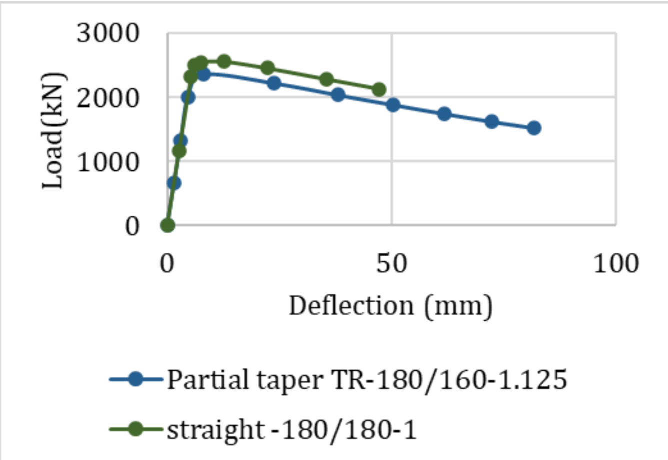

Chart-3: Load deflection graph of partial tapered long columns and straight long column

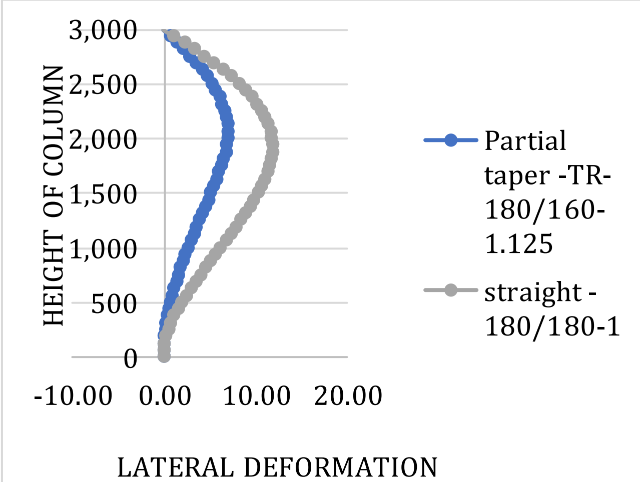

Chart-4: Buckling lateral deformation of Partial tapered & straight long column

Table -5: Ultimate load and Total deformation of single, double and partial taperd short column

Model	Stiffness (KN/mm)	U-def (mm)	Pu-load (KN)	Type of failure
1000-double side	305.63	9.48	2,897.4	Lateral buckling
1000-single side	252.62	11.45	2,892.5	Lateral buckling
1000-partial taper	230.38	13.27	3,057.2	Lateral buckling

From the data obtained it is clear that prismatic straight column TR-180/180=1) are having more load carrying capacity than partial tapered column model, precisely straight column shows 8.4 % higher strength compare to partial tapered (TR-180/160=1.125)

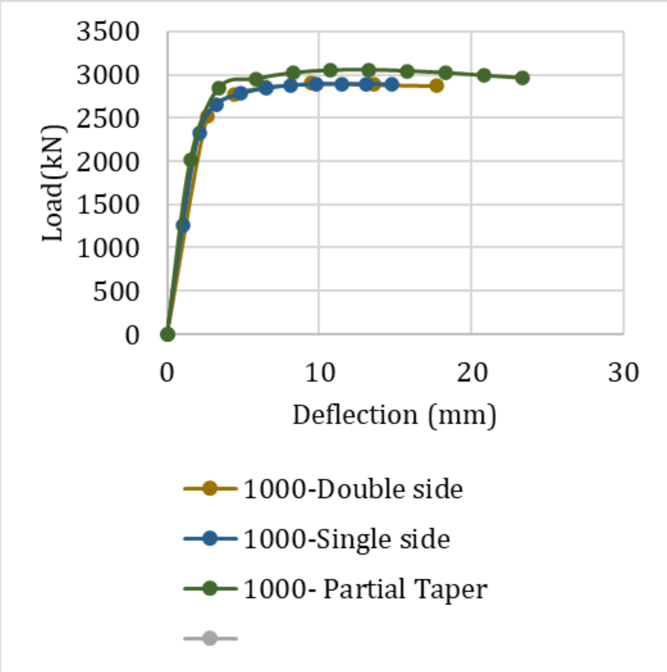

Chart-5: Load deflection graph of single , double and partial tapered short column

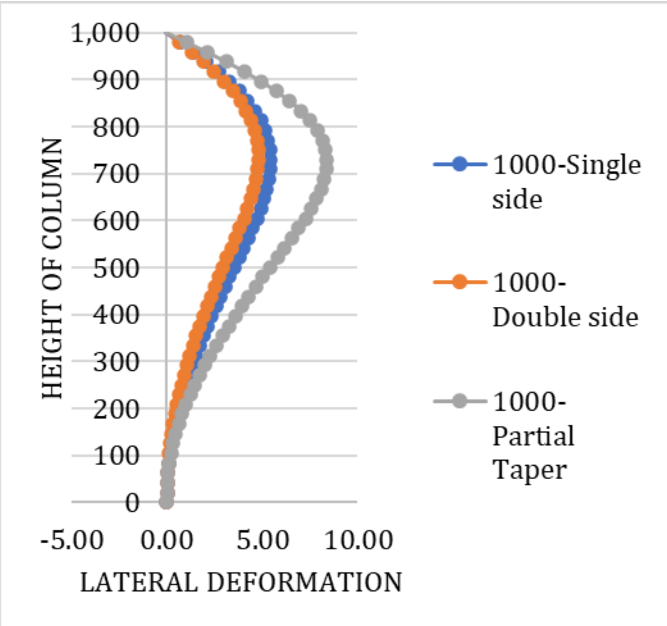

Chart-6: Buckling lateral deformation of single, double and partial tapered short column

From the data obtained it is clear that non-prismatic partial tapered column TR-180/160=1.125) are having more load carrying capacity than single side and double side tapered column model, precisely partial tapered column shows 5.5 % & 5.6% higher strength than double side tapered (TR-180/160=1.125) and single side tapered (TR-180/160=1.125) respectively.Double side and single side tapered shows less buckling lateral deformation compared to partial tapered column.

CONCLUSIONS

- Long straight column shows 8.4% higher strength compare to partial tapered (TR-1.125) long column.
- While in the case of partial tapered (TR-1.125) shows less buckling lateral deformation compared to straight long column.
- In double side tapered column shows 5.35 % higher strength compared to long straight prismatic column.
- In double side both tapered column (TR-1.125) shows less lateral buckling than straight prismatic long column.
- Partial taper (TR-1.125) shows 5.23 % and 5.38% higher than double side and single side tapered short column respectively.

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