AXIAL COMPRESSIVE BEHAVIOUR OF CRISS CROSSED SHAPED CONCRETE COLUMNS FENCED WITH STEEL

Mary Paul V, Nisha Vargheese

Abstract

This paper concerns with the axial load behaviour of criss-cross shaped columns. The criss-cross shaped columns were consist of five CFST mono columns and connected by Lacing bar, single steel plate with stiffeners and double vertical steel plate. The column was analyzed by the finite element method. FEM modelling by using the software ansys16.2. The variables were the height and the width of the vertical steel plates. Based on the finite-element model, the loading carrying capacity of these type columns depends on height and dimensions of criss-cross shape. Load carrying capacity decreasing with increasing height of criss-cross shaped columns. There for we need to increase the dimensions of criss-cross shape. In this paper also find width of steel plate corresponding to height of criss-cross shaped columns connected by double vertical steel plate.

Key words: Criss-Cross shaped columns; CFST column; Steel plates, lacing bars

1 Introduction

Concrete-filled steel tubular (CFT) columns were used as structural components. So many investigations have been conceded out to find the axial behaviour of circular, square and rectangular CFT columns and several researches carried on the special-shaped CFT columns, such as the T-shaped, L-shaped and elliptic CFT columns while the studies on other kinds of special-shaped CFT columns were rare, for example criss-crossed. Criss-cross shaped columns were used at four walls were intersecting together and thus help to avoid column projections. Studies have revealed that the constraining effect of special-shaped CFST columns is mainly concentrated at their corners and this outcome decreases quickly outside the corner. Because the constraining effect of the steel plate in the middle section of the column on the core concrete is small, the material strengths of the steel and concrete are not used to their full benefit in the column. To deal with this issue, many scholars have attempted to optimize various special-shaped CFST columns. Here criss-crossed shaped column consist of five mono columns. These mono columns were CFT.CFT was connected by three methods.

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First method is connected by lacing bars. Second method is connected by single vertical steel plate. Third method is connected steel tubes and concrete was filled between the gaps. The load carrying capacity was more than concrete column. Also find the height of column corresponding to 32mm and 64mm width of steel plate. This study investigates axial compressive behaviour of columns by finite element analysis. FEM modelling by Ansys 16.2 Software. In this paper we consider different sizes of columns corresponding to different heights of columns.

2 Brief Description of Software Used

The FEA is numerical method for solving problem of engineering.FEA ANSYS software for structural analysis allows you to solve most complex structural engineering project and make superior design decision more quickly. The ANSYS workbench environment for performing structural, thermal, and electromagnetic analysis. It is free software and easiest to learn is ANSYS Workbench software.

3 Material modelling

Bilinear properties for steel tube and multi-linear property of concrete are used.

Concrete property: Density – 2400 kg/m^3, Poisson's ratio - 0.2, Elastic modulus - 28460 N/mm^2 Compressive Cube strength – 35 N/mm^2.

Structural double vertical steel plate property: Density – 7850 kg/m^3, Poisson's ratio - 0.3, Elastic modulus – 1.76x10^{5}N/mm^2 Yield strength – 450 N/mm^2.

Structural steel tube property: Density – 7850 kg/m^3, Poisson's ratio - 0.3, Elastic modulus – 2x10^{5}N/mm^2 Yield strength – 450 N/mm^2.

Structural Lacing bar property: Density – 7850 kg/m^3, Poisson's ratio - 0.3, Elastic modulus – 2x10^{5}N/mm^2 Yield strength – 410 N/mm^2.

Structural single steel plate property: Density – 7850 kg/m^3, Poisson's ratio - 0.3, Elastic modulus – 2x10^{5}N/mm^2 Yield strength – 410 N/mm^2.

Connection between concrete and steel is frictional and other connections are bonding. Solid 65 for concrete and solid 145 for steel. Elastic–plastic model is used to describe the constitutive behaviour of steel. The modulus of elasticity of concrete is taken as 5000√fck according to IS 456:2000, where fck is characteristic strength of concrete.

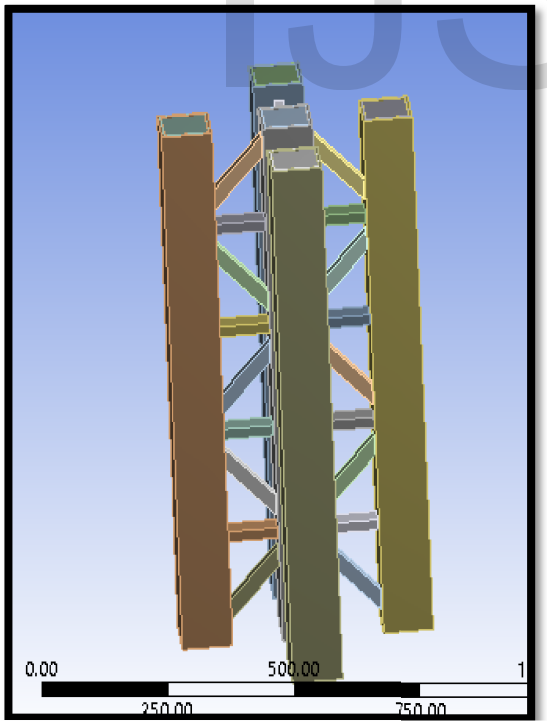

Fig. 1: Columns connected by lacing bar

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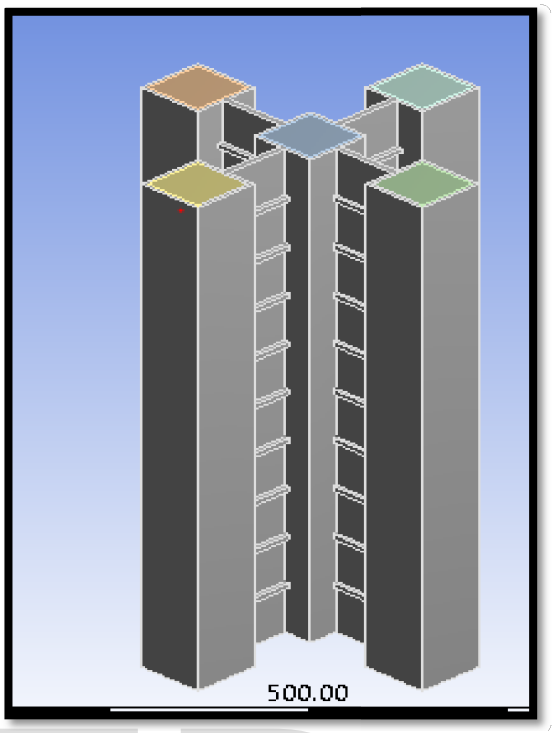

Fig. 2: Column connected by single steel plate

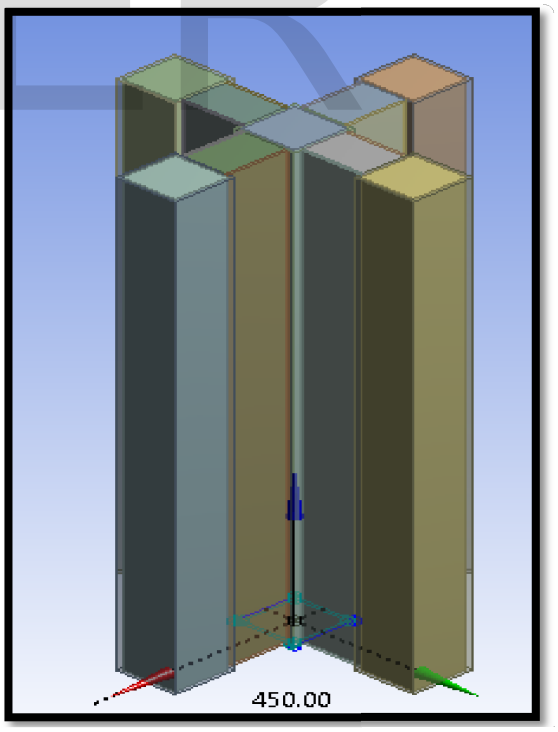

Fig. 3 : Column connected by double steel plate

3.1. Boundary Conditions

Coupling points were particular at the centroid of the top of the column to form rigid surfaces. The top of the column was constrained in the X and Z displacement directions. Rotation about the X-axis, Y-axis and Z-axis was constrained. The bottom of the column is fixed.

4. Details of specimens

In comparison study, dimension of CFT is 100mm x 100mm and thickness of steel tube is 5mm. Steel plate is 100mm width. Horizontal Lacing bar is 100mm X 40mm at 45^0. Single vertical steel plate is 100mm X 5mm.Double vertical steel plate is 100mm X 5mm and width of concrete is 68mm. The height of column is 1000mm. Second model has 32mm x 32mm dimension of mono column and Width of steel plate is 32mm and 64mm.The height of specimen changing from 1000mm to 6000mm.

5. Results and Discussions

5.1. Comparison study

The mono columns are connected by lacing bar, single vertical steel plate and double vertical steel plate. There is Load value difference is obtain between the models .The columns connected by double vertical steel plate carrying more load because amount of confinement concrete is more
In the case of single vertical steel plate, the ultimate load is 7634kN this is due the stiffeners effect. Mono columns are connected by lacing bar has less load carrying capacity (6385.4kN).When we use stiffeners the load carrying capacity is increases and buckling of steel plate is reduces. But in these three models, the double vertical steel plate cans carrying more loads because more concretes come into compression zone and this specimen is more stiffened when compare to others.

TYPE	LOAD (kN)
Connected by lacing bar	6385.4
Connected by single plate	7634
Connected by Double plate	8651.7

Table 1 : Load values

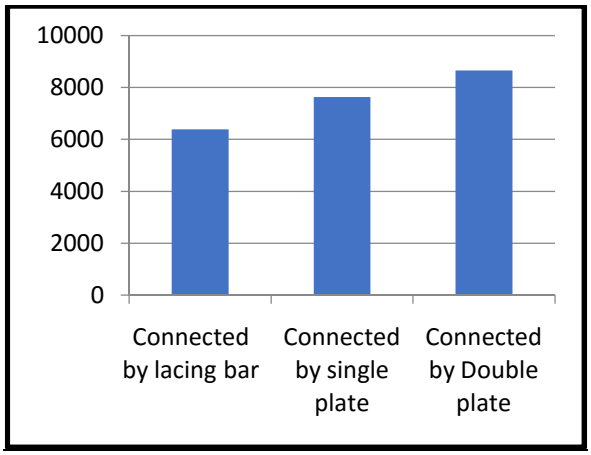

Fig. 4 : Load variation

5.2. 32mm width of steel plate

Here total dimension of criss-crossed shaped column is 160mm x160mm.The area of cross section is small when compared to others. As a result the load carrying capacity is small and the maximum height of column is 1725mm. When height is increases then load carrying capacity is decreases (Fig.2.). Also we can find that deformation of column is inversely propositional to height of the column.

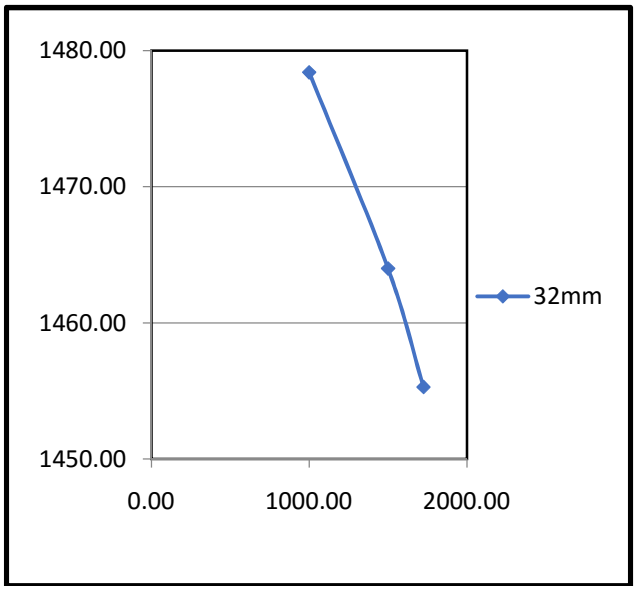

Fig. 5 : Load – Height curve

HEIGHT (mm)	LOAD (kN)	DEFORMATION (mm)
1000	1478.40	75.40
1500	1464.00	79.82
1725	1455.30	83.79

Table 2 : Load – Deformation

HEIGHT (mm)	LOAD (kN)
2000	1580.9
4000	1405.7
6000	1346

Table 3 : Load – Deformation

5.3. 64mm width of steel plate

Total dimension of criss –crossed shaped column is 224mm X 224mm. Each mono column is 32mm x 32mm. Here width is increases the load carrying capacity are also increases. This is because confinement effect. As the width of the vertical steel plate increased, the axial stiffness of a specimen and the ultimate load value increased significantly; this behaviour can be attributed to expansion of the vertical steel plate and the internal concrete in the compressive zone. The local buckling is occurred on short columns and global buckling occurred on long columns. As the slenderness ratio increased, the axial stiffness and peak load of the columns decreased. This occurred because the additional bending moment due to the initial imperfection of the specimens increased with the slenderness ratio. The bearing capacity decreased because of the second-order effect. Moreover, the displacement at the peak load increased because of the shift from strength failure to stability failure.

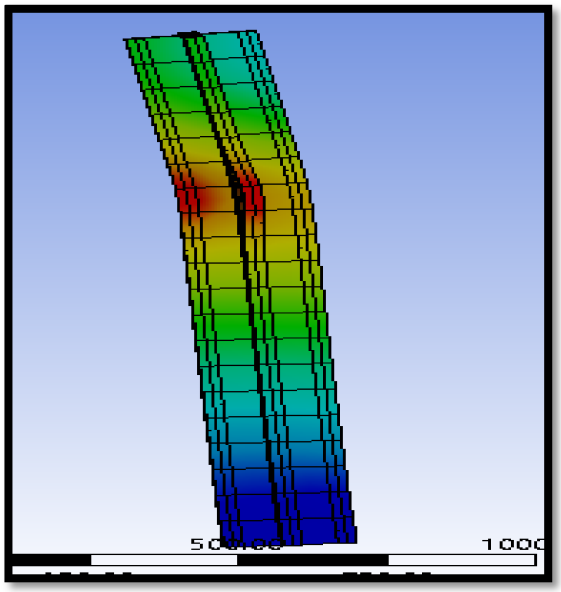

Fig. 6 : Deformation of 4000mm height column

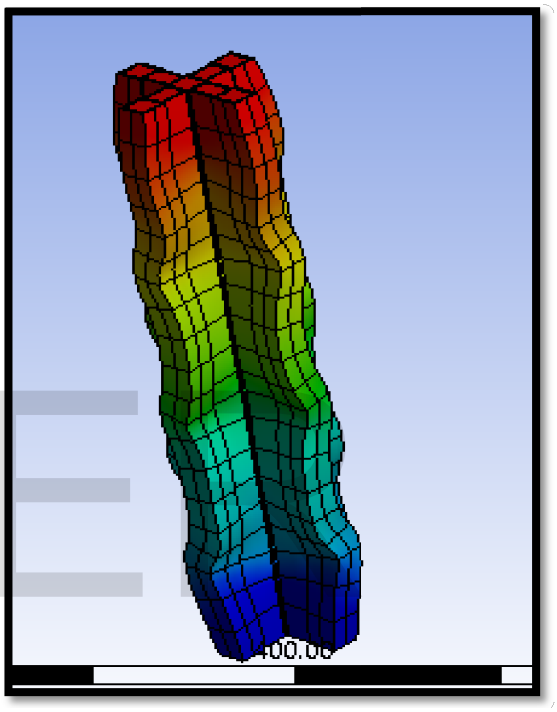

Fig. 7 : Deformation of 1000mm height column

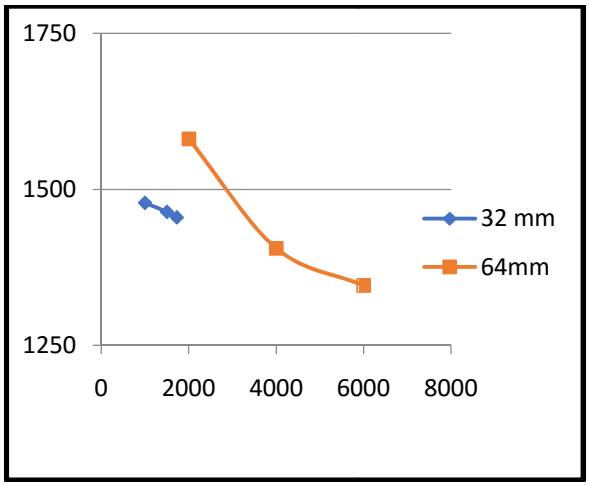

Fig. 8 : Load – Height curve of 32mm and 64mm

Here we can conclude that 64mm width steel plate has more efficient than 32mm width steel plate. 32mm width steel plate columns can used at car parking areas. This is reduces the floor height. 64mm width steel plate columns can used at rooms etc.

6. Conclusion

In this paper, Criss – crossed shaped columns connected by lacing bar, Single vertical steel plate with stiffeners, Double vertical steel plate, Effect of height, Effect of width and axial compressive behaviour were analysed. The marks of finite element analysis on the applied boundary conditions and material properties are brief as follows.

- Mono columns connected by double vertical steel plate have more load carrying capacity.
- Mono columns connected by lacing bar have less load carrying capacity.
- Mono columns connected by single vertical steel plate with stiffeners have more load carrying capacity than lacing bars.
- Load carrying capacity inversely propositional to height of the columns.
- Load carrying capacity depends upon the width of steel plate.
- The amount of confinement concrete is increases the load carrying capacity.

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