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ANALYTICAL PREDICTION OF CRUSHING LOAD FOR HIGH STRENGTH STEEL TUBULAR COLUMN WITH AND WITHOUT INFILLED MATERIAL USING ANSYS

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ABSTRACT

This paper investigates the behaviour of high strength steel tubular section filled with concrete is analysed by using finite element software ANSYS. The present study is an attempt to understand the failure load of high strength steel tubular section filled with concrete column under axial loading for different shapes such as circular and square.

This project deals with the behaviour of concentrically axially loaded circular and square shaped high strength steel (FE310) of columns filled different grades (M20,M30,M40) of concrete .The effects of grade of concrete and composite action between the steel tube and the concrete core on axial load capacity of concrete filled steel tubular columns(CFST) are studied and also studied graphs of axial load capacity (axial shortening curves). Models are to be loaded in a concentric axial compression and the failure loads are to be extracted and all models need to be simulated with have length to diameter ratio(L/D) not exceeding the value of 4.0 to act as a short column and therefore no slenderness ratio should be taken into account. Failure loads calculated by ANSYS are compared with the results obtained by using AISC code of practice, BS code and experimentally.

Keywords: Finite element, ANSYS, CFST columns, steel tubular section.

1. INTRODUCTION:

Due to rapid increase of technology in civil engineering construction field. This is one of the modern technology and many engineers are using in construction are columns filled with concrete. These are mainly using in modern building and deep foundation of power transmission lines.

The steel tubes on the outer side of column provides formwork to the concrete structure. The high tensile strength and ductility are the main advantages of steel members. However the concrete members can increase the compressive strength and stiffness to assist the resistant of service loads.

Classifications of infilled tubular steel columns are

1) concrete filled circular columns

2) concrete filled square columns

They have been popular for use as individual column elements. The confined concrete fill increases the axial load resistance but has little effect on the flexural resistance. For that reason, it is unlikely that these columns would be a good choice for a moment resisting frame. Filling the tube with concrete will increase the ultimate strength of the member without significant increase in cost. The main effect of concrete is that it delays the local buckling of the tube wall and the concrete itself, in the restrained state, is able to sustain higher stresses and strains than when in the unrestrained state.

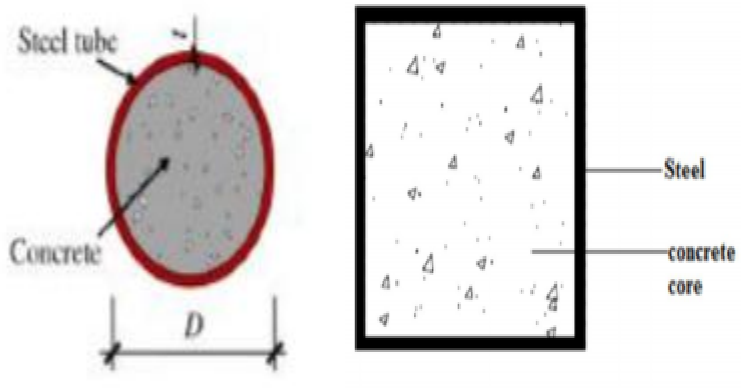


Figure : Concrete filled circular, square column

1.1 Advantages of using concrete filled tubular columns

The use of concrete filled tubular columns provides large saving in cost by increasing the floor area by a reduction in the required cross-section size. This is very important in the design of tall buildings in cities where the cost of letting spaces are extremely high. Concrete filled tubular columns can provide an excellent monotonic and seismic resistance in two orthogonal directions. Using multiples bays of composite concrete filled tubular column framing in each primary direction of a low-to medium-rise building provides seismic redundancy while taking full advantage of the two-way framing capabilities of concrete filled tubular columns. As a typical composite structural system, due to the composite effects, the advantages of the two materials can be utilized and their disadvantages can be avoided, thus forming a more rational system. The steel tubes can be used as the formwork for casting concrete and the shoring system in construction, thus concrete filled tubular column structures have much better constructability than concrete structures.

2. MATERIALS AND SPECIFICATIONS

Concrete is a composite mixture which consists of Cement, Sand and Aggregate. Concrete mix design is the procedure for finding the right quantities of these materials to achieve the desired strength.

Grades of concrete:M20,M30,M40 .

fck (Characteristic compressive strength) for M20 grade is25 N/mm^2

M30 grade is 34.4 N/mm^2 and for M40 grade is 44.4 N/mm^2

High strength steel:

High strength steels are most notable for their corrosion resistance, which increases with increasing chromium content. Additions of molybdenum increase corrosion resistance in reducing acids and against pitting attack in chloride solutions. Thus, there are numerous grades of stainless steel with varying chromium and molybdenum contents to suit the environment the alloy must endure. Stainless steel's resistance to corrosion and staining, low maintenance, and familiar luster make it an ideal material for many applications where both the strength of steel and corrosion resistance are required. Stainless steels are available in sheets, plates, bars, wire, and tubing.

Grade of steel fy 310 N/mm^2 are used.

2.1 Specifications of the component:

Finite element analysis of filled steel tube data:

Circular	Square
Structural steel of fy =310 N/mm^2	Structural steel of fy =310 N/mm^2
Diameter of steel tube=88.9mm	Breadth of steel tube =80mm
	Depth of steel tube =80mm
Wall thickness = 4.8mm	Wall thickness =4.8mm
Length =300mm	Length =300mm
Es= 2x10^5 N/mm^2	Es= 2x10^5 N/mm^2
Grade of concrete =M20,M30,M40	Grade of concrete =M20,M30,M40
Density =2400kg/m^3	Density =2400kg/m^3
Friction value =0.23	Friction value =0.23

3. EXPERIMENTAL PROGRAM :

The following experimental program was carried out by using an finite element software ANSYS.

INTRODUCTION OF FEA:

The finite element analysis (FEA) is computing technique that is used to obtain approximately Solution to boundary valve problems. It uses a numerical method called finite element method(fem).In FEA involves the computer model of a design that is loaded and analysed for specific results, much as stress, deformation, deflection, natural frequencies, mode shapes, temperatures distribution and soon.

The concept of FEA can be explained through a basic measurement of dimensions. In FEA simulation the loading condition of design and determination the design responses in those conditions. It can be used in new product design as well as in exiting product refinement. A model is divided into a finite number of regions/ divisions call elements. These elements can be of predefinition shapes, such as triangular, quadrilateral, hexahedron, tetrahedron and soon. This predefined shapes(elements) helps to find the sum of responses of all elements in model gives the total responses of complete model.

Project Overview

A. Start a new project and
B. Create the model.
C. Choose materials
D. Generate the mesh.
E. Set the boundary and loading conditions.
F. Solve the model.
G. Duplicate the existing analysis system.
H. Interpret the results.
F. Save the project.

3.1 CREATING MODEL AND ASSIGNING THE MESH

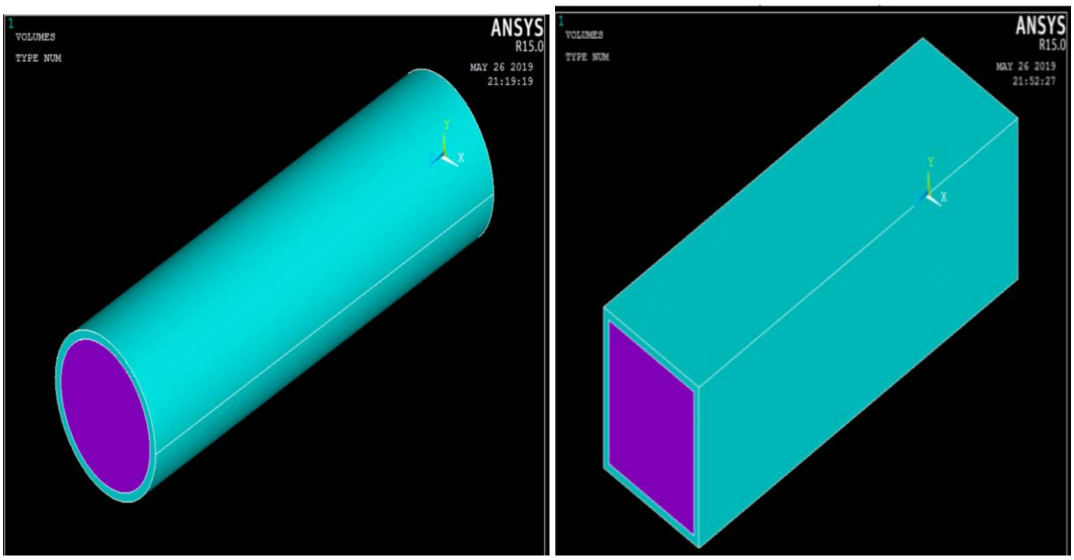
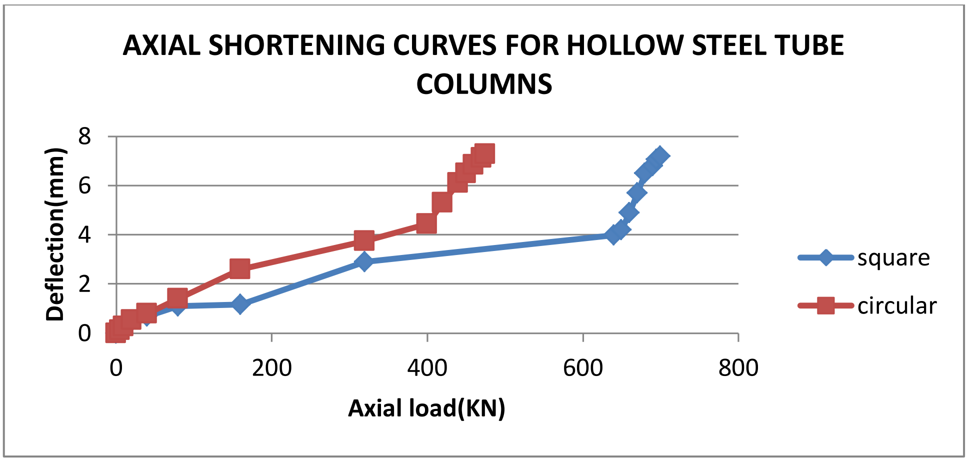


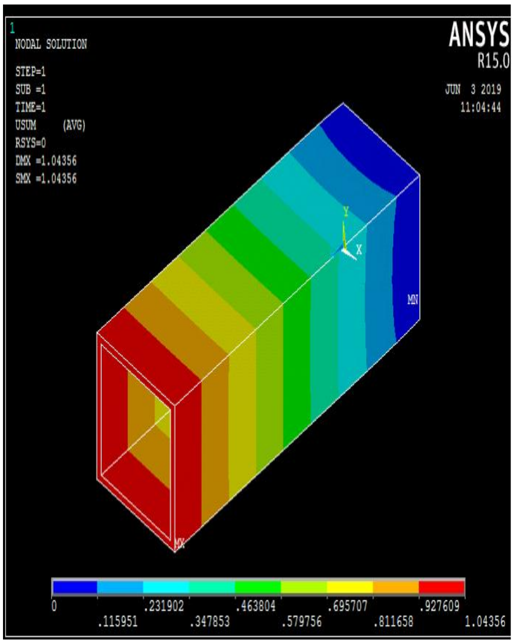
Figure :CFST of circular and square columns

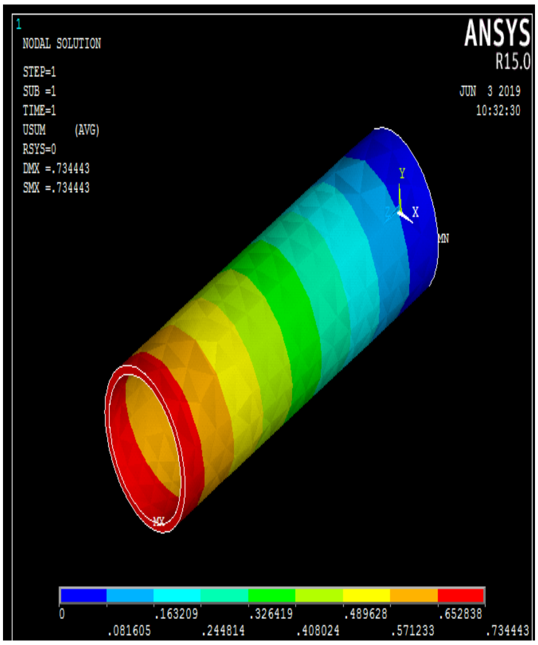
4. RESULTS AND DISCUSSIONS

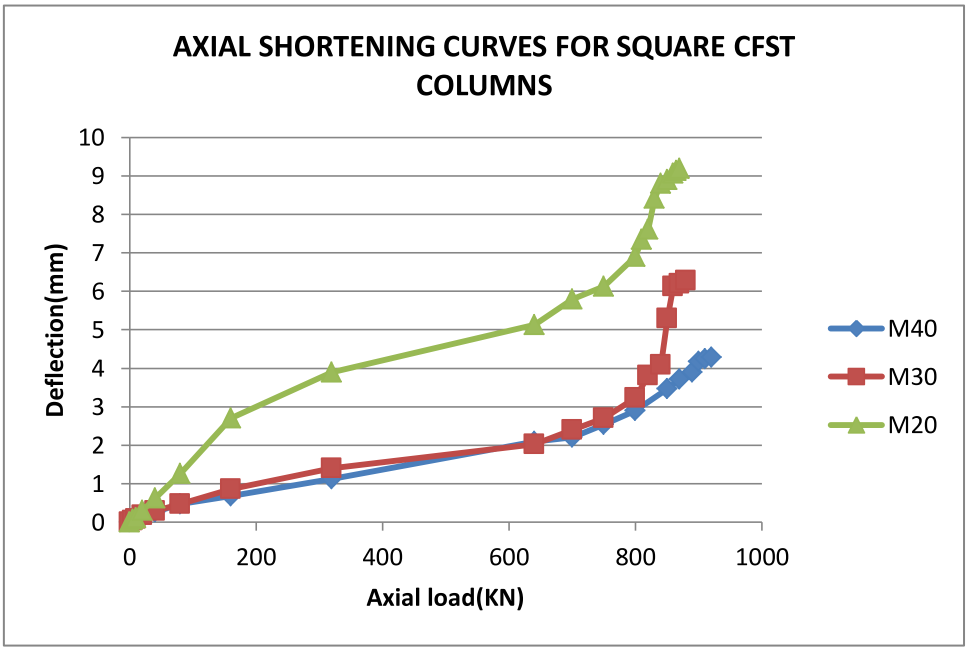
This paper discuss the finite element analysis of concrete filled steel tubular section. On this investigation the behaviour of axially loaded composite CFST columns are strengthened with steel tube as external confinement.

Axial shortening curves (for axial compression load Vs vertical deflection) as shown in figures below.

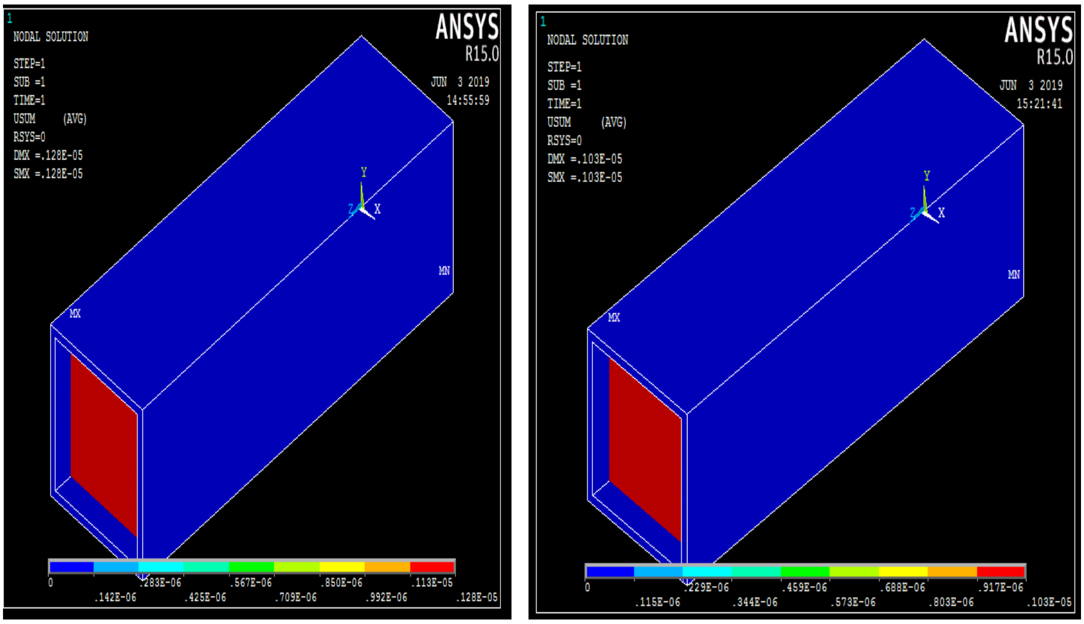




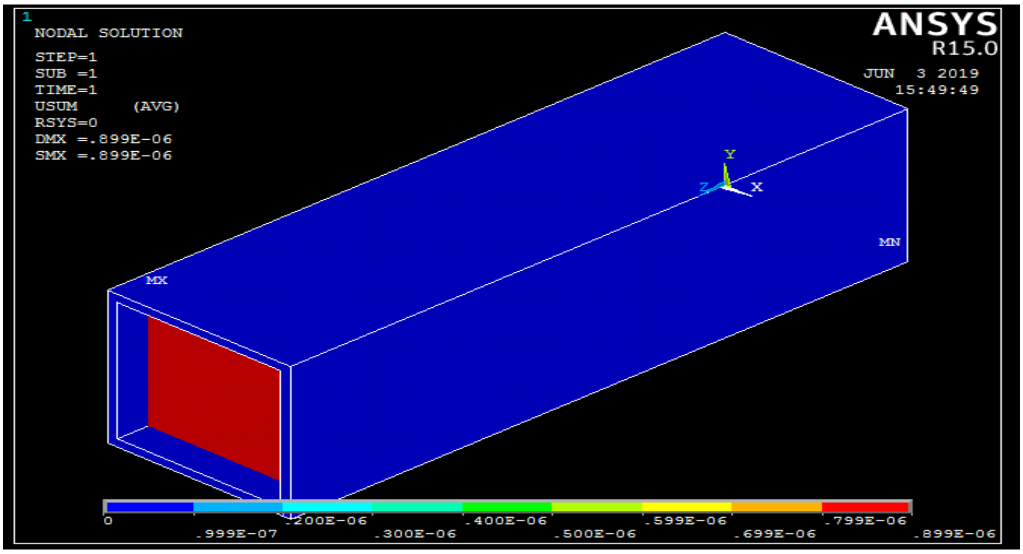


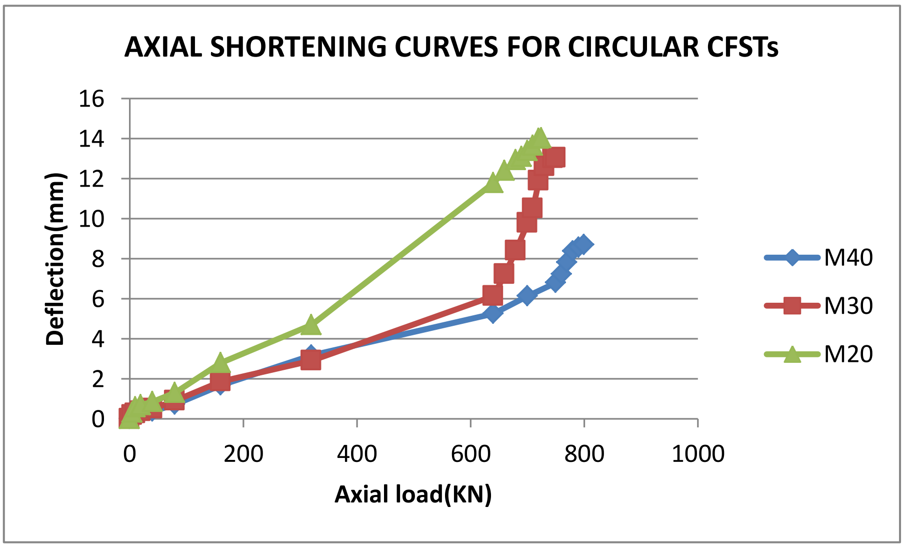


FOR SQUARE CFSTS WITH M20 AND M30 CONCRETE

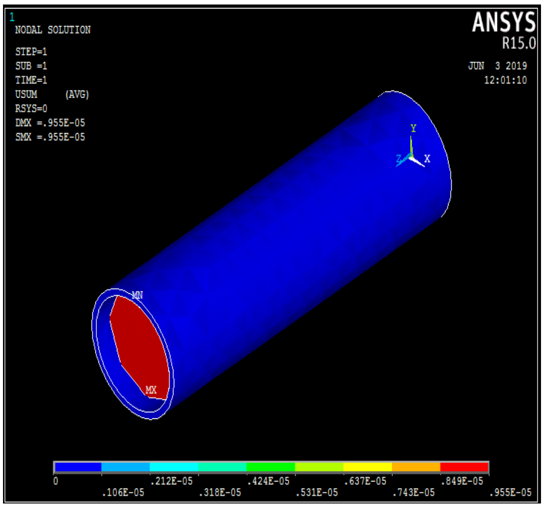


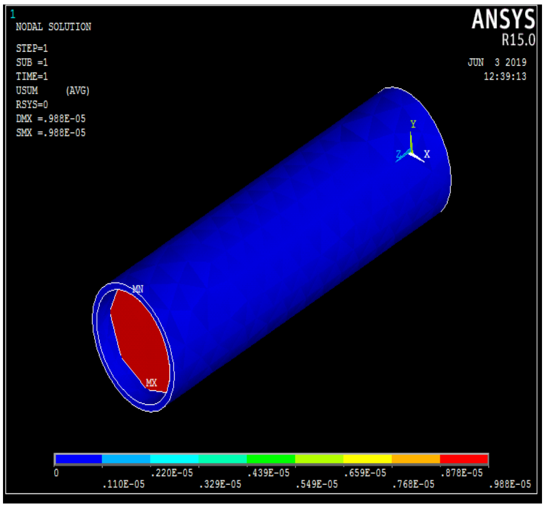
FOR SQUARE CFSTS WITH M40 CONCRETE



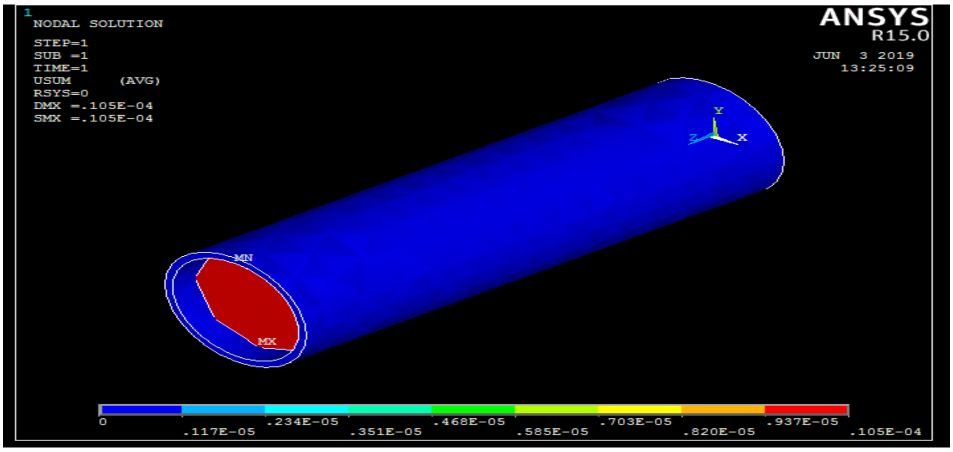


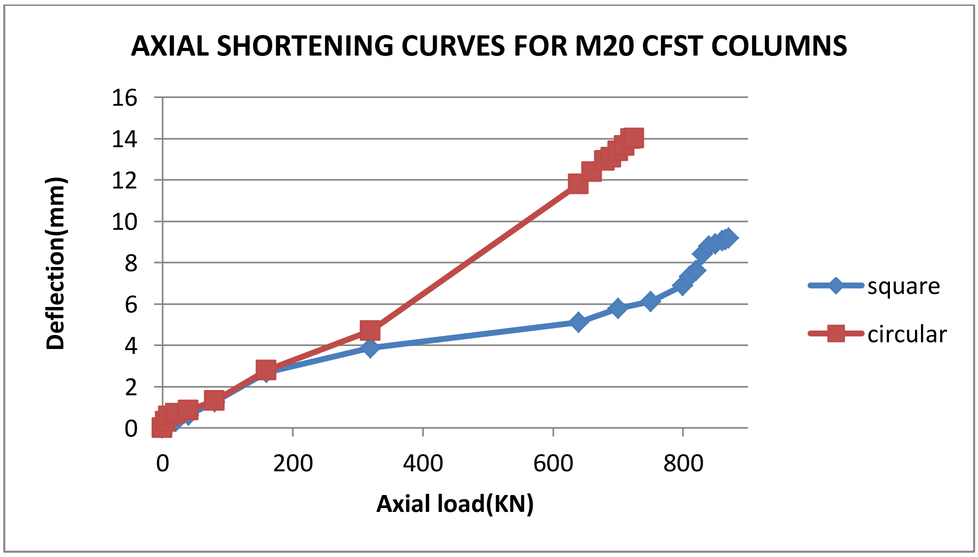
FOR CIRCULAR CFSTS WITH M20 AND M30 CONCRETE

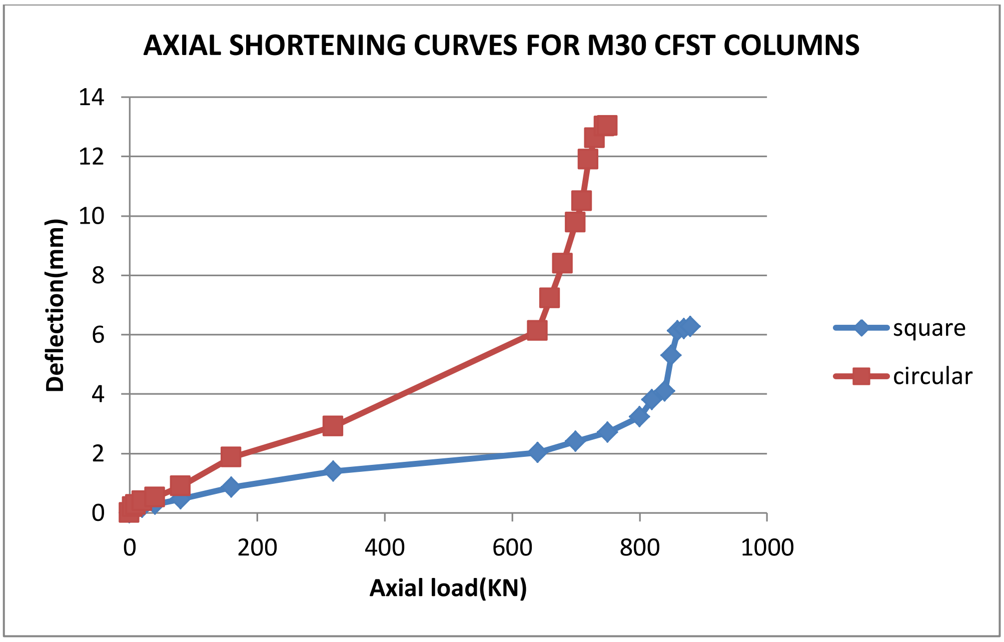


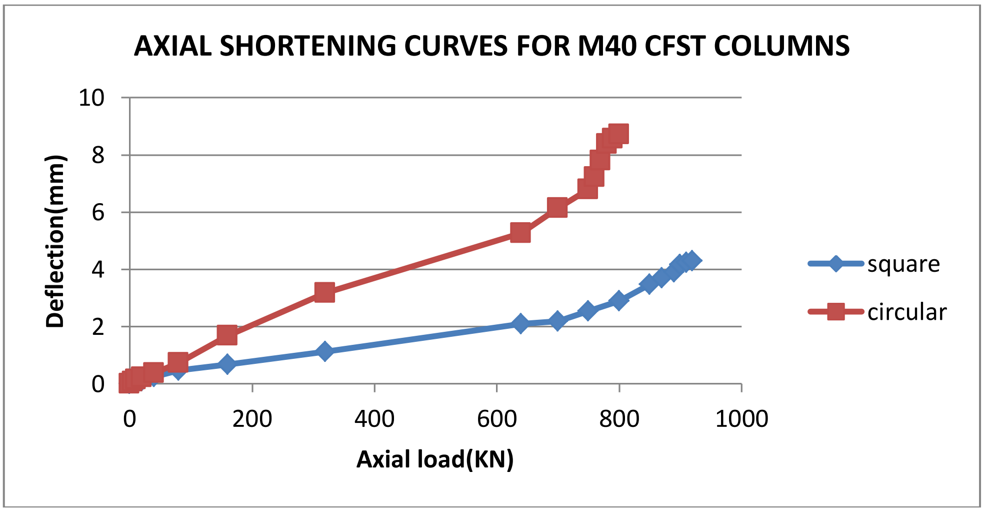


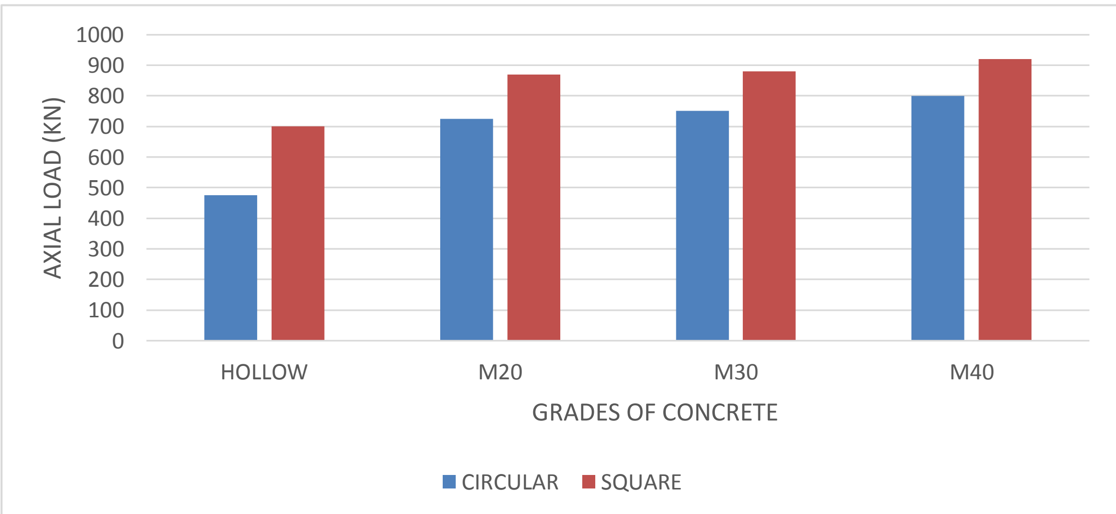
CIRCULAR CFSTS WITH M40 CONCRETE











From the above graph the square infilled columns carry more axial loading capacity when compare to the circular infilled columns.

And from the above graphs we can conclude that the deflection values are also less for the square columns when compare with circular columns .

4.1 CODE COMPARISION

The ultimate load of a high strength steel tubular column infilled with concrete is predicted numerically using British code and American code. Then the predicted numerical value is compared with the values obtained experimentally and analytically.

BS 5400 (British code)

Pu = 0.45fcu*Ac + 0.91fy*As

Whereas fcu represents the compressive strength of concrete,

Ac is the Area of concrete,

fy indicates yield strength of steel and

As specifies Area of steel.

AISC LRFD 2010

(American Institute of Steel construction Load and Resistance Factor Design)

Pu = (0.85fcu*Ac + fyss*Ass)

Whereas fcu indicates compressive strength of concrete,

Ac represents the Area of concrete,

fyss specifies yield strength of steel,

Ass is the Area of steel.

4.2 COMPARISON OF ULTIMATE LOAD (KN) OF HOLLOW AND INFILLED COLUMNS (4.8MM THICKNESS)

		ANSYS VALUES	EPERMENTAL	BS5400 CODE	AISC2010 CODE
Circular	Hollow	475	450	357.758	393.141
	M20	725	700	413.385	498.040
	M30	750	720	434.175	527.483
	M40	800	776	456.389	579.443
Square	Hollow	700	680	407.307	447.570
	M20	870	840	463.064	552.908
	M30	880	860	484.028	592.508
	M40	920	894	506.307	634.635

5. CONCLUSIONS

The behaviour of concrete filled steel tubular columns (CFST) is analysed by using FEM software is ANSYS.

This paper compares the ultimate load carrying capacity of both HST and CFST of two different sections such as example circular and square sections.

The obtained ANSYS values and experimental values are almost similar and the predicted ultimate load carrying capacity of CFST columns for both analytically and experimentally was found by varying a factor of 1 to 1.5%.

The present paper shows the failure load of steel tubular section filled with concrete columns under axial loading for different shapes example circular and square.

In this paper the three dimensional finite element models have been developed to investigate the load transfer by natural bond and the interaction between the steel tube and the concrete are studied under axial compression loading.

And it also suggest that which type of infilled columns are best for construction.

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