

Finite Element Analysis of Steel Tubular Section Filled with Concrete

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ABSTRACT:The behaviour of steel tubular section filled with concrete CFST is analysed using finite element software ANSYS. The present study is an attempt to understand the failure load of steel tubular section filled with concrete column under axial loading for different shapes such as circular and rectangular. In this project modelling of various cross section of column is been simulated nonlinearly by finite element method. Models are to be loaded in a concentric axial compression, and the failure loads are to be extracted. All models to be simulated have length to diameter ratio (L/D) not exceeding the value of 4.5 to act as short column and therefore no slenderness would be taken in to account. Failure loads calculated by ANSYS are compared with the results obtained using AISC code of practices and EURO CODE 4.

KEYWORDS:finite element, steel tubular section, ANSYS.

I. INTRODUCTION

The Concrete Filled Steel Tube (CFST) Structural System is a system based on filling steel tubes with high-strength concrete. It is one of the modifications to composite steel-concrete structures. CFST structure is a type of the composite steel concrete structures used presently in civil engineering and consists of steel tube and concrete core inside it. Combining the advantages of both hollow structural steel (HSS) and concrete, rectangular concrete filled steel tubes (RCFST) are being used widely in real civil engineering projects due to their excellent static and earthquake resistant properties, such as high strength, high ductility and large energy absorption capacity. Concrete filled steel tubes (CFST) are also used extensively in other modern civil engineering applications. When they are used as structural columns, especially in high-rise buildings, the composite members may be subjected to high shearing force as well as moments under wind or seismic actions. In the past few decades, behaviour of CFST columns in axial compression and flexure has been studied but yet the knowledge gap is not fully filled up. It may be noted here that mechanical and economic benefits can be achieved if CFST columns are constructed taking advantages of high-strength materials. For example, high-strength concrete infill contributes greater damping and stiffness to CFST columns compare to normal strength concrete. Moreover, high-strength CFST columns require a smaller cross-section to withstand the load, which is appreciated by architects and building engineers.

II. ANALYTICAL STUDY AND MATERIALS

Analytical study: An analytical study was conducted to understand the behavior of Short Concrete Filled Steel Tubular Columns (CSFT) under axial compression to failure. The theoretical study was also done to compare with the analytical results. A total of 24 specimens having different cross-sections were tested to investigate the load carrying capacity in particular and behavior as a whole. The steel pipes are made up of high yield steel of grade 350 and concrete grade 35. Thickness of tube wall varied from 4 mm to 10 mm. Tests were carried out on the said steel tubes under axial compression. The objective of this study was to evaluate the accuracy of codal design approach for prediction of load carrying capacity under axial compression.

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Materials used: (i) **Structural steel:** All structural steels used shall, before fabrication conform to IS: 1977-1975, IS: 2062 1992, and IS: 8500-1977 as appropriate. Some of the structural steel grade commonly used in construction as per IS: 961-1975 and IS: 1977-1975 (ii) **Concrete:** Concrete strengths are specified in terms of the characteristic cube strengths, (fck)cu, measured at 28 days

III.FINITE ELEMENT ANALYSIS

Numerical modelling will be carried out using FEA software ANSYS to obtain the best result from ANSYS, or for that matter any finite element program it is important to understand were initially developed for structural problems but they have been extended to numerous field the basic concepts of finite element method. The finite element method is a technique for approximating the governing different equation for a continuous system with a set of algebraic equations relating a finite number of variables. These method are popular because they can be easily programmed the FE techniques problems.

Finite element analysis of circular CFST column

Input data

Structural Steel = 350 N/mm²
Diameter of steel tube = 219.1 mm
Wall thickness = 4.8 mm
Length = 700 mm
Young's modulus $E_s = 2 \times 10^5$ N/mm²
Poisson's ratio $\gamma_s = 0.3$
Grade of Concrete = M35
Young's Modulus $E_c = 2500$ Mpa
Poisson's ratio $\gamma_c = 0.16-0.3$
Density = 2400 kg/m³

Output data

Squash load of specimen = 2085.34 kN

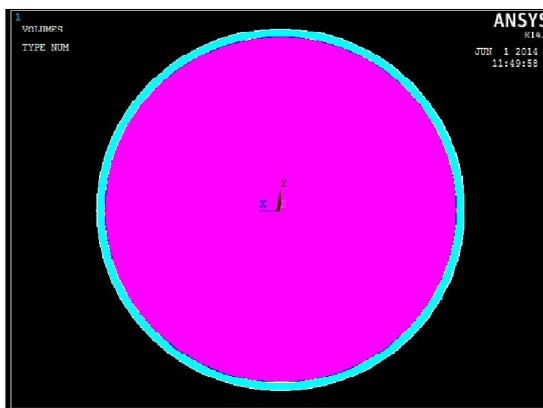


Fig.1: Modelling of circular steel tube with concrete

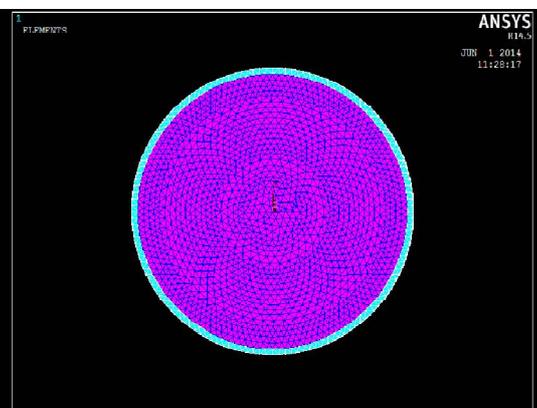


Fig.2: Meshing of circular CFST element

Finite element analysis of rectangular CFST column

Input data

Structural Steel = 350 N/mm²
 Breadth of steel tube = 100 mm
 Depth of steel tube = 200 mm
 Wall thickness = 4 mm
 Length = 700 mm
 Young's modulus $E_s = 2 \times 10^5$ N/mm²
 Poisson's ratio $\gamma_s = 0.3$
 Grade of Concrete = M35
 Young's Modulus $E_c = 2500$ Mpa
 Poisson's ratio $\gamma_c = 0.16-0.3$
 Density = 2400 kg/m³

Output data

Squash load of rectangular CFST element = 1150.54 kN

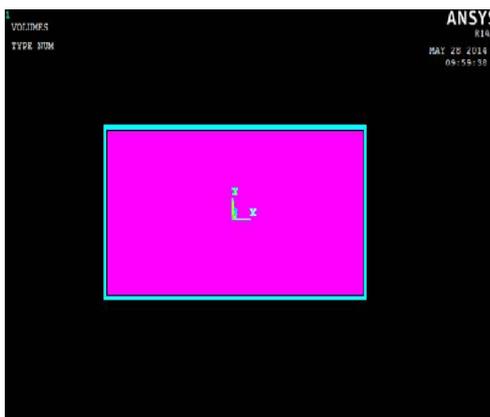


Fig.3:Modelling of rectangular steel tube with concrete

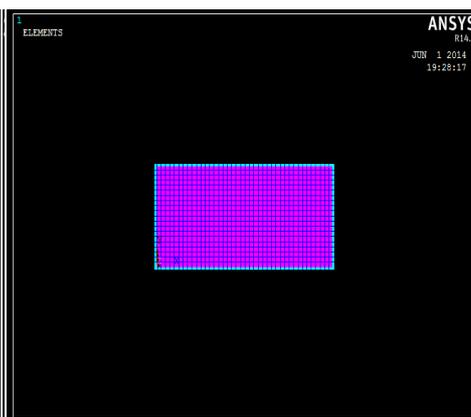


Fig.4: Meshing of rectangular CFST element

IV. RESULTS AND DISCUSSION

The study presents a finite element analysis steel tubular section filled with concrete investigation on the behaviour of axially loaded composite concrete filled steel columns strengthened with steel tube as external confinement. The geometric linearity and material linearity leads to do the static linear analysis. Table 1 shows Results of rectangular specimens. Table 2 shows Results of circular specimens. The parametric study shows that with varying length, diameter and thickness has greater influence to load carrying capacity of CFST column.

V. SUMMARY AND CONCLUSIONS

The behaviour of steel tubular section filled with concrete (CFST) is analysed using finite element software ANSYS. The present study is an attempt to understand the failure load of steel tubular section filled with concrete column under axial loading for different shapes such as circular and rectangular. In this project modelling of various cross section of column is simulated nonlinearly by finite element method. In this study, 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 core of concrete-filled steel tubes under axial compression. Both material and geometric linearity are considered in the analysis. The numerical results obtained from ANSYS indicate good agreement with the

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theoretical resultcalculated by using AISC code of practice and Euro code 4. The results obtainedfrom FEA values are found very close with theoretical result calculated by usingAISC code of practise and Euro code 4

TABLE 1: SQUASH LOAD OF RECTANGULAR SPECIMENS

SPECIMENMARKE D	F _y (N/MM ²)	F _{ck} (N/MM ²)	SQUASH LOAD kN(EC4)	SQUASH LOAD kN(AISC)	SQUASH LOAD kN(ANSYS)
C1	350	35	2029.99	2261.21	2085.32
C2	350	35	2125.12	2243.54	2115.32
C3	350	35	2254.13	2437.48	2269.23
C4	350	35	2448.88	2612.31	2435.24
C5	350	35	2214.72	2417.54	2284.14
C6	350	35	2372.32	2594.19	2354.92
C7	350	35	2441.23	2654.94	2484.86
C8	350	35	2695.54	2842.37	2654.52
C9	350	35	2443.12	2641.28	2484.56
C10	350	35	2553.74	2737.49	2556.41
C11	350	35	2674.47	2845.32	2645.77
C12	30	35	2894.85	3042.32	2847.46

TABLE 4.2 SQUASH OF CIRCULAR SPECIMENS

SPECIMENMARKE D	F _y (N/MM ²)	F _{ck} (N/MM ²)	SQUASH LOAD kN(EC4)	SQUASH LOAD kN(AISC)	SQUASH LOAD kN(ANSYS)
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C10	350	35	2553.74	2737.49	2556.41
C11	350	35	2674.47	2845.32	2645.77
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