

A Comparative and Parametric Investigation of Circular and Square CFST Columns Using Finite Element Analysis

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ABSTRACT

This thesis presents a comparative and parametric investigation into the structural behavior of circular and square Concrete-Filled Steel Tube (CFST) columns using finite element analysis. CFST columns, a composite system where a hollow steel tube is filled with concrete, offer significant advantages over traditional reinforced concrete, including enhanced strength, stiffness, and ductility due to the synergistic interaction between the steel and concrete. The primary objectives of this research were to develop and validate nonlinear finite element models using ANSYS software, evaluate the axial compression and deformation properties of circular and square CFST columns, determine their ultimate load-bearing capacities, and analysis the influence of key design parameters such as steel tube thickness, cross-section depth, and concrete grade.

The methodology involved creating detailed three-dimensional models in ANSYS, simulating axial loading conditions, and comparing the results with design calculations based on Eurocode 4. The study's findings demonstrate that circular CFST columns exhibit superior performance, experiencing up to 70% less deformation compared to their square counterparts due to more effective concrete confinement. Results consistently show that CFST columns are more robust than plain concrete columns of identical dimensions. Furthermore, the ultimate load-carrying capacity is inversely proportional to the diameter/breadth-to-thickness (D/t or B/t) ratio and directly proportional to the compressive strength of the concrete core. The conclusions affirm that a lower D/t or B/t ratio, combined with higher-grade concrete, substantially enhances column strength and efficiency.

Keywords-CFST columns, finite element analysis, ANSYS

I. INTRODUCTION

1.1 GENERAL

Concrete-Filled Steel Tube (CFST) members represent a composite structural system that offers significant advantages compared to traditional steel or reinforced concrete elements alone. These members are constructed by filling a hollow steel tube with concrete, enabling the two materials to act compositely in resisting applied loads. The steel tube, positioned at the exterior of the cross-section, provides high resistance to tension and bending moments. Furthermore, due to steel's high modulus of elasticity, it substantially increases the overall stiffness of the member.

A critical function of the infilled concrete core is to brace the steel tube internally, which effectively delays the onset of inward local buckling and enhances the overall structural behaviour. Concurrently, the steel tube provides excellent confinement to the concrete core, which significantly increases the concrete's compressive strength and ductility. Owing to these benefits, CFST systems are widely utilized as columns and beam-columns in high-rise buildings and as robust beams in industrial structures where strength and efficiency are paramount.

Several international standards govern the design of CFST columns, including Eurocode 4 (EC 4), the American Institute of Steel Construction (AISC) LRFD, the Brazilian Code NBR 8800, and GB50396-2014. Notably, the AISC specifications, primarily developed for steel columns, limit their applicability to composite members with steel yield strengths up to 415 MPa and concrete cylinder strengths not exceeding 55 MPa. In contrast, codes such as EC4 and NBR 8800 calculate the section's resistance by summing the capacities of the individual steel and concrete components. In contemporary structural engineering, the Finite Element Method (FEM) is a cornerstone of analysis, supported by a wide range of design and simulation software. The widespread adoption of CFST in

buildings and bridges is also due to their excellent structural behavior and simple erection process. A key advantage is that the hollow steel sections can often be installed to carry construction loads for three or four levels before the concrete is poured, speeding up the construction timeline. This investigation focuses on modelling and analysing CFST columns of various cross-sections using the finite element software ANSYS, considering a range of design parameters and concrete grades.

1.2 THE STUDY'S OBJECTIVES

The primary objectives of this research are:

1. To create and validate analytical models capable of reproducing the nonlinear behaviour of CFST columns.
2. To evaluate the square and circular CFST columns' axial compression and deformation properties.
3. To determine the investigation columns' maximum load-bearing capability.
4. To investigate how steel tube thickness and cross-section depth affect CFST column performance.
5. To contrast the outcomes of the ANSYS finite element analysis with the Eurocode 4 design expectations.
6. To investigate the differences in load-carrying capacity and deformation characteristics of CFST columns versus standard concrete columns.

II. LITERATURE REVIEW

Extensive research has been conducted on the behaviour of CFST structures, exploring the use of both plain and reinforced concrete of various grades and different steel section sizes. Many studies have utilized Finite Element Method (FEM) models, developed in software such as ANSYS and ABAQUS, to simulate structural performance. These numerical investigations are often validated against experimental work and manual design calculations based on established codes. The following is a review of pertinent literature:

C. Ibanez, D. Hernandez-Figueirido, & A. Piquer (2021) did an experimental based study on CFST structures, specifically investigating the influence of steel tube thickness on column behaviour. Their work involved testing 18 specimens of square, rectangular, and circular shapes using C30 and C90 grade concrete and comparing the results with analytical methods from Eurocode 4 (EC4), American standards (AISC), Chinese code (DBJ), and Australian standards (AS).

Dibyendu Adak *et al.* compared the structural performance of CFST columns against conventional RCC columns. They used experimental testing with concrete grades M20, M25, and M30, and corroborated these findings with Finite Element Modeling (FEM) in ABAQUS. The numerical simulations included a variety of models for both circular and square sections, exploring different grades, geometries, and thicknesses

In 2018, **Pengfei Li, Tao Zhang, and Chengzhi Wang** explored the compressive ability of the performance of CFST (concrete-filled steel tube) columns through a series of compression, bending, and tensile tests conducted on square, rectangular, and circular sections. Their analysis considered several design standards, including AISC-LRFD, Eurocode 4, the Brazilian code NBR 8800, and GB50396. An important aspect of the study was the comparison between CFST columns with foundations and those without, which revealed that the presence of steel tubes greatly enhances the columns' ductility and load-bearing capacity.

Qing-Xin Ren *et al.* (2014) examined the compressive behaviour of axially loaded CFST stub columns with various special cross-sections (triangular, fan-shaped, D-shaped, etc.) while maintaining the same outer perimeter. By testing 44 specimens, they focused on the effects of steel thickness and infill concrete, noting that failure was typically initiated by outward buckling in the middle of the cross-sections.

Shilpa Sara Kurian, Dinu Paulose, and Sreepriya Mohan (2016) examined the compressive performance of hollow steel tubes in comparison with circular and rectangular CFST columns through ANSYS simulations. By comparing the finite element results with theoretical buckling load predictions, they observed that CFST columns exhibited significantly higher buckling load capacity. Their FEM analysis further indicated that parameters such as steel thickness, diameter, slenderness ratio, and concrete grade influence behavior, with higher concrete grades leading to a 10–15% reduction in column deformation.

Han, L. H. *et al.* (2007) Examined the performance of CFST beam-columns when subjected to combined axial loads and bending moments. The authors created and verified a three-dimensional nonlinear FE model, from which they derived simplified equations to estimate the ultimate capacity and load-deformation behaviour. Their work is crucial for accurately modelling the axial load-moment (P-M) interaction in software like ANSYS.

Evirgen, B. et al. (2014) Performed a parametric investigation using FEA software (ABAQUS/ANSYS) to analyze eccentrically loaded circular CFST columns. Their study explored how performance is affected by the diameter-to-thickness (D/t) ratio, concrete strength, and load eccentricity. The finite element model successfully predicted the failure mechanisms and verified that a lower D/t ratio is a highly effective way to enhance both the strength and ductility of the column.

Lu, H. et al. (2019): Developed a sophisticated FE model to study the eccentric behaviour of loaded slender CFST columns. The model considered geometric imperfections and material nonlinearities. Their work provides crucial insights into the second-order effects (P-delta) and how to accurately simulate the buckling behavior of long CFST columns in ANSYS.

Wang, Y. H. et al. (2017): Focused on the behavior of rectangular CFST beam-columns. Their numerical model, validated against experimental data, was used to analyse the influence of the aspect ratio and width-to-thickness ratio on ultimate capacity. The paper offers practical design formulas derived from the FEA results.

Tao, Z. et al. (2008): Presented an FE model to analyze the post-buckling and ultimate behavior of eccentrically loaded CFST columns. They paid special attention to the confinement effect of the steel tube on the concrete core and how it evolves under combined loading, a critical aspect to model correctly at the material interface in ANSYS.

III. METHODOLOGY

3.1 GENERAL

This study presents a comparative investigation between conventional cement concrete columns and concrete-filled steel tube (CFST) columns. Both square and circular cross-sections with varying design parameters are examined. Finite element models of the CFST columns are developed using ANSYS APDL, and the numerical outcomes are validated against manual calculations based on relevant design provisions. While columns are primarily designed to carry axial compressive loads, in practice, they are also subjected to combined compression and bending due to eccentric loading conditions.

3.2 REVIEW OF DESIGN CODE

Composite columns are governed by several international design standards, which may treat them either as steel columns reinforced with concrete or as concrete columns reinforced with structural steel. For the present study, the design of CFST columns was carried out in reference to established codes, including the Brazilian Code NBR 8800, Eurocode 4 (EC4), the American Institute of Steel Construction (AISC) LRFD, and the Chinese standard GB50396-2014. These codes provided the basis for evaluating the performance of the CFST models.

3.3 MATERIAL SPECIFICATION

Different parameters for concrete and steel were used to generate the numerical models. Material characteristics like concrete's compressive strength and steel's yield strength, as well as geometrical factors like the cross-sectional shape and the diameter-to-thickness ratio, have a significant impact on a CFST column's ultimate load capacity. Table 3.1 provides specifics on the material characteristics utilised for the concrete classes in this investigation. The table below displays the characteristics of the material used in the model.

Table 3.1: Material Specifications

Properties	Grade of concrete				
	M25	M30	M55	M60	M80
Modulus of elasticity (MPa)	25000	27385	37079.9	38730.8	447214.6
Density (kg/m ³)	2400	2400	2400	2400	2400
Poisson's ratio	0.16	0.16	0.16	0.16	0.161
Compressive Strength (MPa)	25	30	55	60	80

3.4 ANALYSIS USING THE SOFTWARE

3.4.1 GENERAL

Many engineering analysis problems are difficult to solve because of the complexity associated with boundary conditions, material properties, and structural configurations. ANSYS, a finite element analysis (FEA) software, addresses these challenges by discretizing structures into smaller elements and providing reliable analytical results. It offers a wide range of capabilities, including linear and nonlinear analyses, static evaluations, and

advanced transient dynamic simulations.

In this study, the behaviour of CFST columns subjected to axial loading and incorporating normal-grade concrete was examined using a three-dimensional nonlinear finite element model developed in ANSYS Mechanical APDL. The SOLID65 element was employed to model the concrete, as it is specifically designed to simulate brittle materials in a nonlinear manner. This element incorporates a plasticity algorithm to capture concrete crushing in compression zones, while smeared crack analogies are used to represent cracking under tensile stresses.

3.5 MODELLING IN ANSYS

In the modelling process, the **SOLID65 element** is adopted for three-dimensional representation of concrete, regardless of whether reinforcing rebars are included. For the steel tube in CFST columns, **SHELL181 elements** are employed, which are suitable for analysing thin to moderately thick shell structures. Two types of boundary conditions are applied at the column ends. The bottom end is assumed to be fully fixed, where both translational and rotational degrees of freedom (U1, U2, and U3) are restrained to zero in all directions. At the top end, representing the free end, displacement degrees of freedom (U1, U2, and U3) are also constrained to ensure stability during analysis.

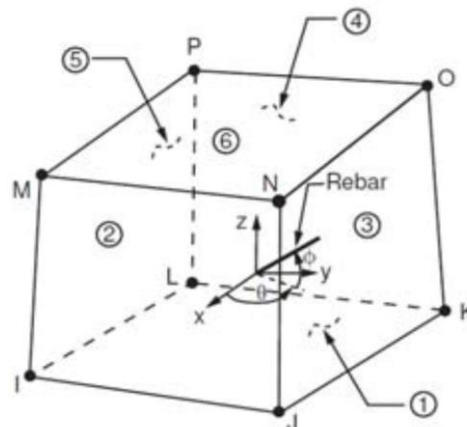
The primary objectives of this study are as follows:

- To produce different FE model behaviours, starting with the concrete's first cracking and continuing through the steel's yielding until the concrete column falls.
- The suitability of ANSYS software for column analysis and column deformation detection
- The software's benefits include reducing the expense and time associated with experimental testing.

3.6 CONCRETE CORE MODELLING

The concrete core of the CFST column is modelled using the **SOLID65 element** (3D Reinforced Concrete Solid). This element consists of eight nodes, each with three translational degrees of freedom in the global xxx, yyy, and zzz directions. SOLID65 is capable of simulating nonlinear material behaviour, including plastic deformation, crushing under compressive stresses, and cracking under tensile stresses, making it particularly suitable for representing the behaviour of concrete in finite element analysis. The graphic illustrates SOLID 65's geometry.

Fig 3.1: Geometry of SOLID65 element



3.7 MODELLING OF STEEL TUBE

Translations with a degree of freedom will be the most efficient method to encourage this behaviour since the concrete-filled steel tube column under compression deforms more by translation than by rotation. Steel tubes are simulated using the solid shell 181 element, which consists of four nodes with three translational and three rotational degrees of freedom each.

3.8 THE STEPS INVOLVED IN ANALYSIS

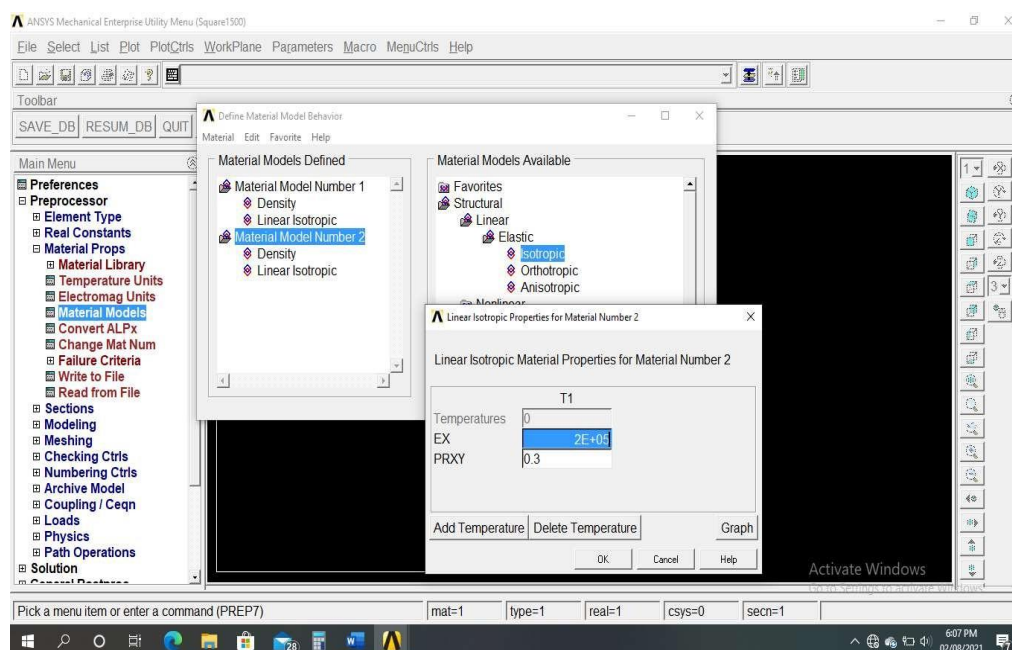


Fig 3.2: Assigning Material Properties

Assigning the attributes of the defined materials is the first stage in the modelling process. In this case, concrete is represented by material model 1, and table (3.1) lists the characteristics of concrete materials. Additionally, model 2 is regarded as steel having the following characteristics: passion's ratio of 0.3, Young's modulus of 2×10^5 , and steel grade Fe250.

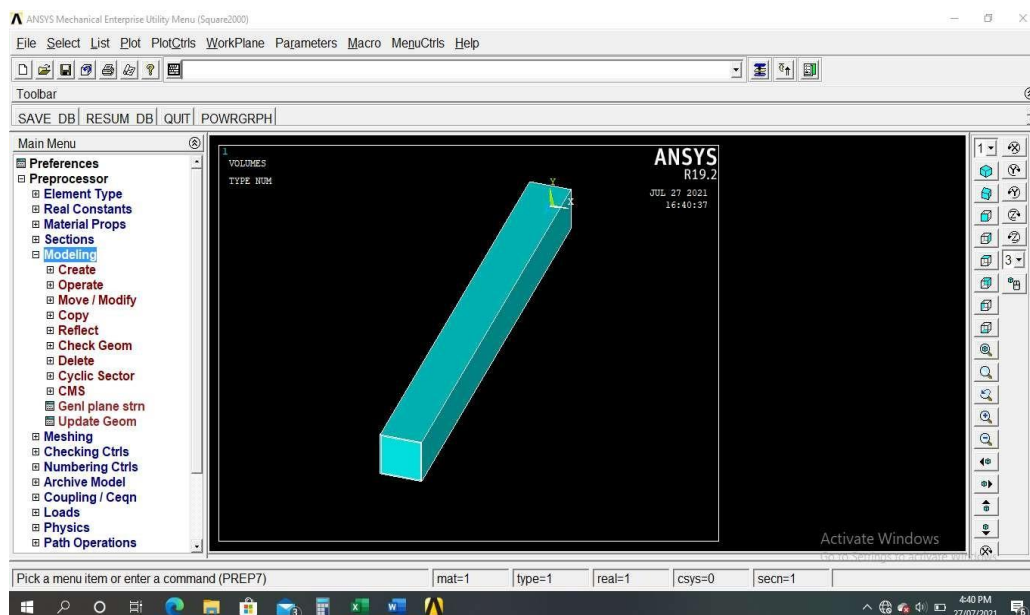


Fig. 3.3: Modelling of the CFST Column

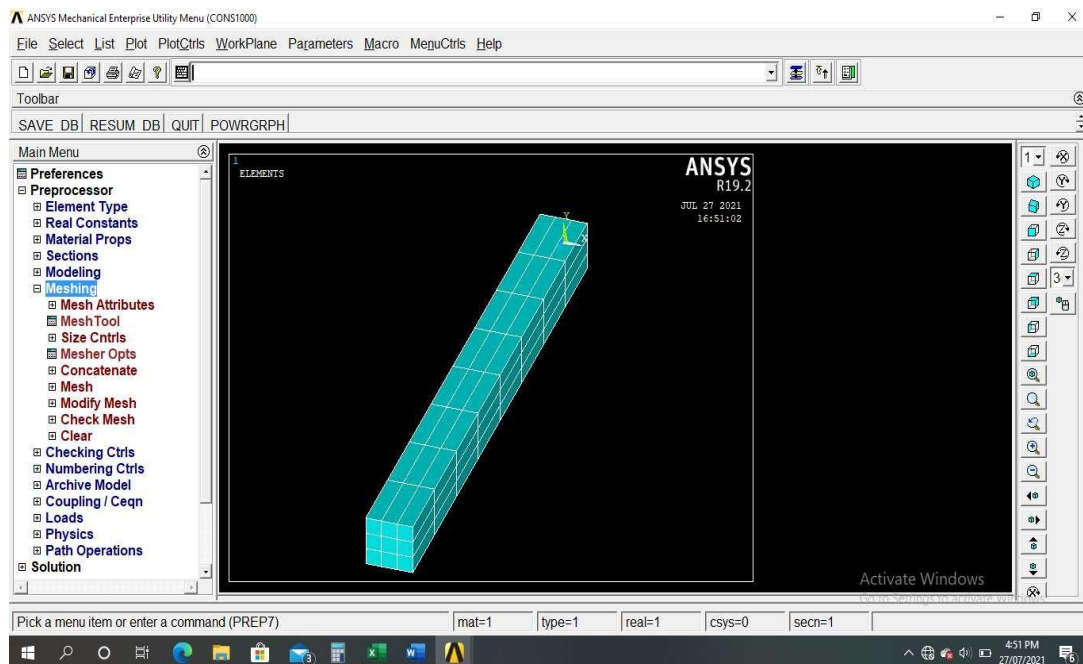


Fig. 3.4: Meshing of Column

After assigning the material properties, the next step involves modelling the column with the specified dimensions using the **Create** tool in ANSYS. Once the geometry is defined, the model is discretized through meshing. The steel tube is meshed using **SHELL181 elements**, which are suitable for thin to moderately thick shell structures, while the concrete core is meshed with **SOLID65 elements**, enabling accurate simulation of nonlinear concrete behaviour.

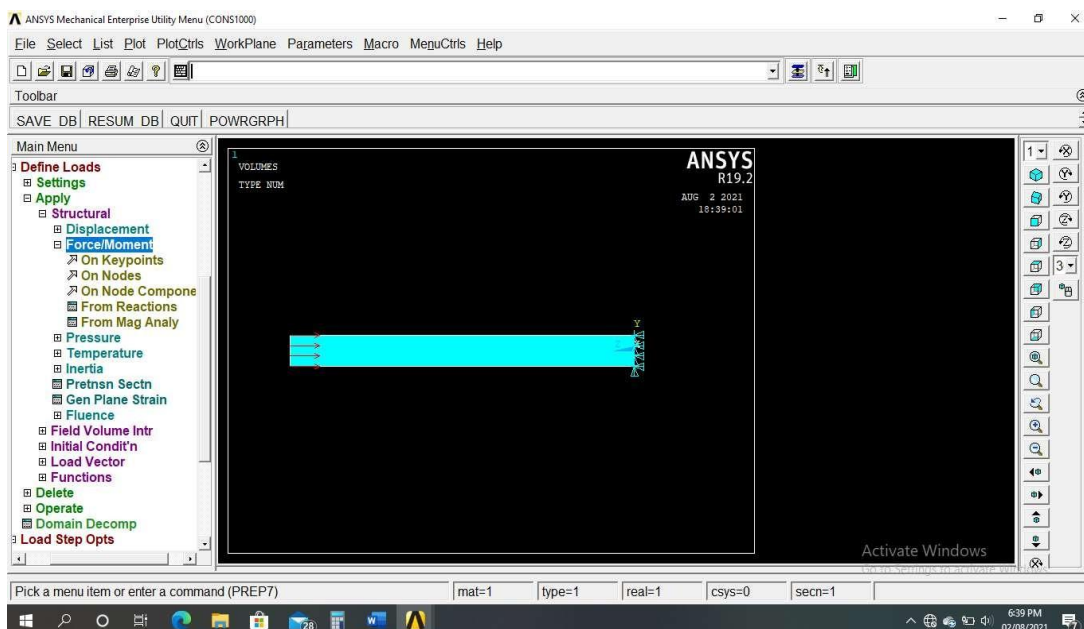


Fig. 3.5: Load Application

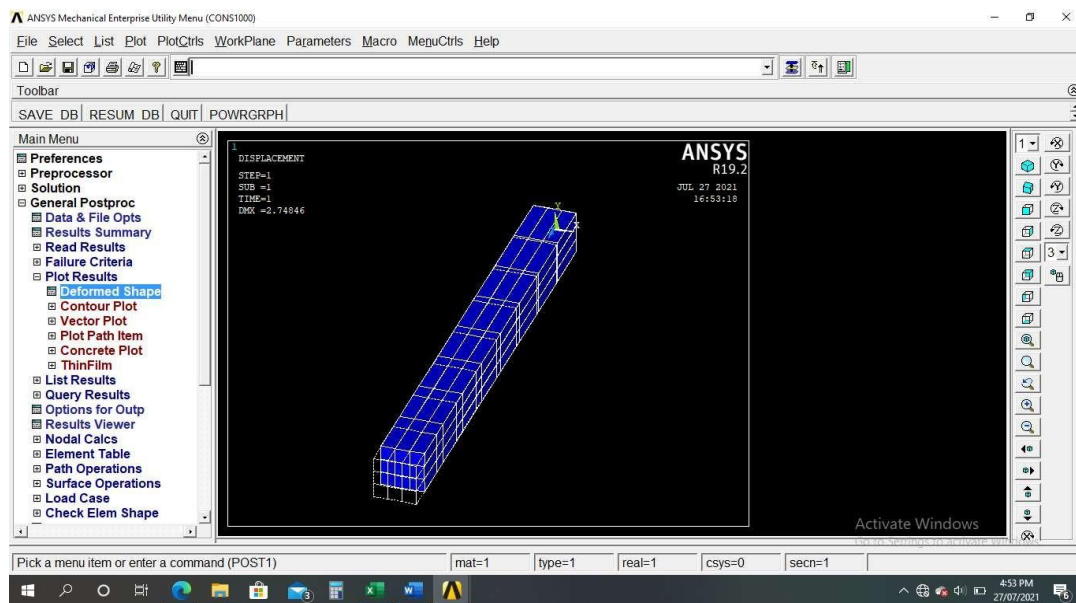


Fig. 3.6: Deformation Shape of Column

Following meshing, load application is the following stage, during which force moments and displacements are applied. The CFST column's deformation shape following the application of load is seen in Fig. 3.6.

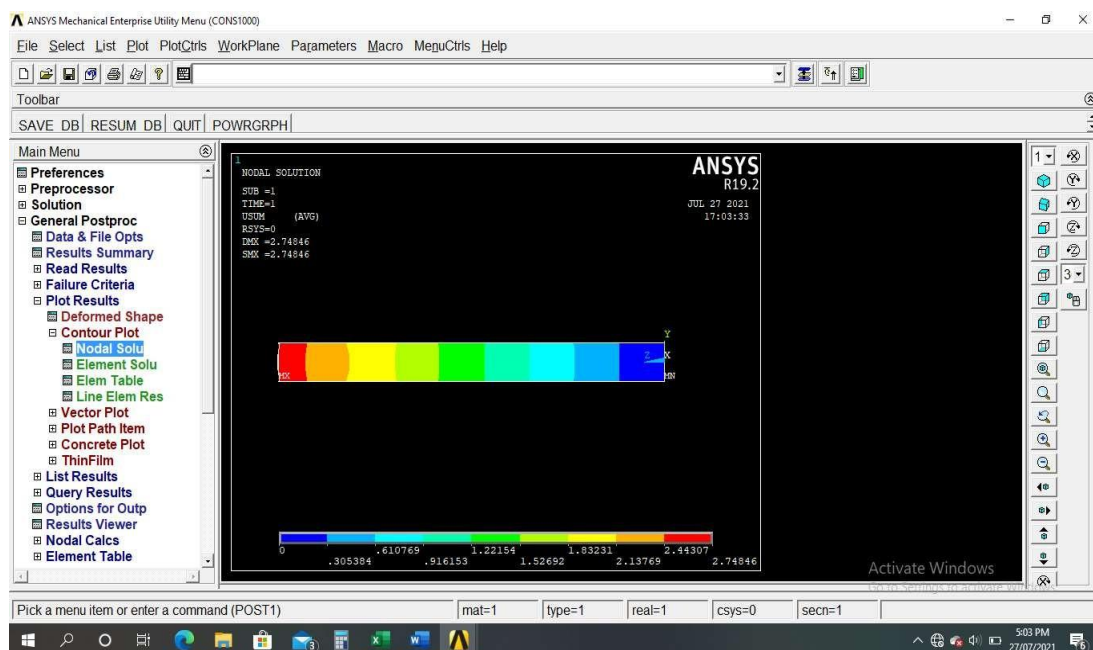


Fig. 3.7: Deformation Values of Column

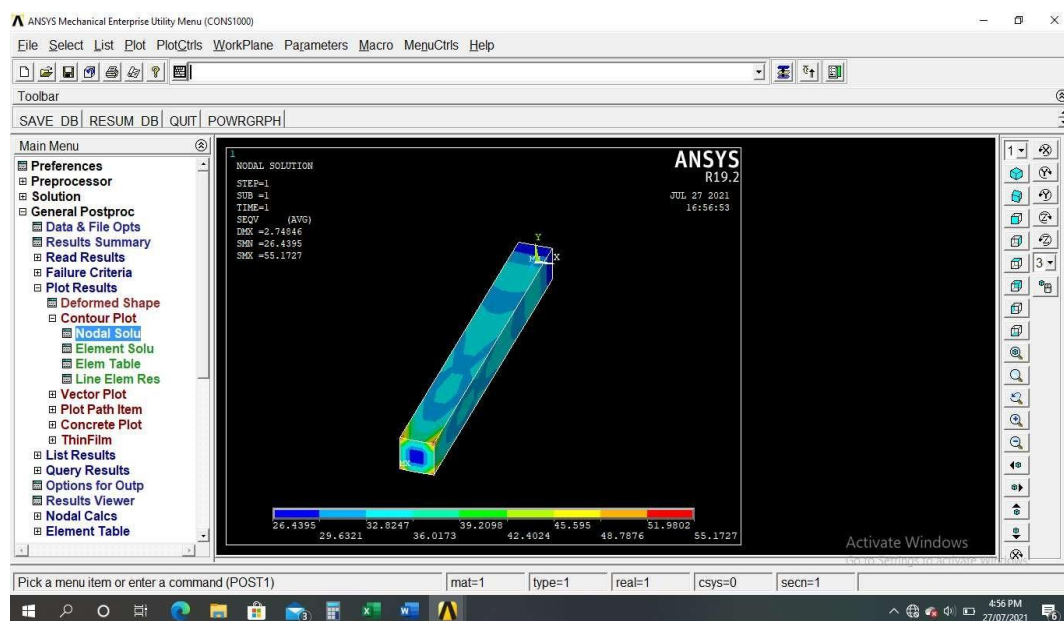


Fig. 3.8: Stress Value of Column

IV. RESULTS AND DISCUSSIONS

The circular CFST column's load bearing capability when the steel tube's thickness is increased to Fe 250

Table 4.1: Different Grades of Concrete and Their Load Capacity

D (mm)	t (mm)	D/t (mm)	Grades of concrete with load capacity			
			M25	M30	M55	M60
210	5	42	1228	1318	1727	1783
212	5.6	37.857	1338	1423	1876	1899
214	7	30.571	1554	1643	2068	2129
215	7.5	28.667	1637	1726	2150	2211
218	9	24.222	1889	1977	2399	2460

Five concrete-filled steel tubes in all, varying in thickness from 5 mm to 5.6 mm to 7 mm to 7.5 mm to 9 mm, are used to represent the section. The following table illustrates how the CFST's load bearing capacity dramatically rises when the D ratio decreases. Additionally, the load bearing capacity increases with the grade of concrete used; for example, it has been shown that the M 60 grade concrete has a 30% higher load carrying capacity than the M25 grade have identical features. The CFST circular column's load-bearing capability as the depth of the Fe 250 steel tube decreases.

Table 4.2: Different Grades of Concrete and Their Load Capacity

D (mm)	t (mm)	D/t (mm)	Grades of concrete with Load capacity			
			M25	M30	M55	M60
210	5	42	1228	1318	1727	1783
209	4.5	45.44	1148	1238	1641	1697
207	3.5	59.22	989	1080	1469	1524
205	3	69.3	901	984	1368	1421
203	2.8	71.9	855	938	1312	1363
201	2.4	84.75	784	864	1222	1270

Five concrete-filled steel tubes in all, varying in thickness from 5 mm to 5.6 mm to 7 mm to 7.5 mm to 9 mm, are used to represent the section. The following table illustrates how the CFST's load bearing capacity dramatically rises when the D ratio decreases. Similarly, the capacity increases with the usage of high-grade concrete. The above table shows that, under the identical load conditions, the M60 grade concrete's capacity is 33% greater than that of the M25 type of concrete grade. Squared type CFST column load bearing capability as steel tube depth of

Fe 250 increases

Table 4.3: Different Grades of Concrete and Their Load Capacities

B(mm)	t (mm)	B/t (mm)	Grades of concrete with Load capacity			
			M25	M30	M55	M60
185	7.5	24.6	1675	1764	2184	2245
184	8	23	1736	1823	2233	2292
183	8.5	21.5	1795	1880	2281	2338
182	9	20.22	1853	1936	2327	2383
181	9.5	19.05	1910	1991	2372	2427
180	10	18	1965	2044	2416	2470

The analysis involved six concrete-filled steel tube specimens with wall thicknesses of 7.5 mm, 8 mm, 8.5 mm, 9 mm, 9.5 mm, and 10 mm. The data reveals that the column's load-bearing capacity significantly increases as the breadth-to-thickness (B/t) ratio decreases. Additionally, a higher concrete grade enhances the overall capacity. Specifically, the specimen with M60 grade concrete demonstrated a **24% greater capacity** than the one using M25 grade concrete. The square CFST column's load-bearing capability as the breadth of the Fe 250 steel tube increases

Table 4.4: Capacity Load of Concrete Grades

B (mm)	t (mm)	B/t (mm)	Concrete grades-Load Capacity			
			M25	M30	M55	M60
185	7.5	24.67	1675	1764	2184	2245
186	7	26.57	1613	1704	2135	2197
188	6	31.34	1486	1581	2032	2097
189	5.5	34.36	1420	1581	1979	2045
190	5	38	1354	1453	1925	1992

The investigation covered five CFST specimens with a range of steel tube thicknesses: 7.5 mm, 7 mm, 6 mm, 5.5 mm, and 5 mm. The results indicate an inverse relationship between the breadth-to-thickness (B/t) ratio and the column's ultimate strength. Performance was also heavily dependent on the concrete grade, with the M60 specimen showing a 28% higher load-bearing capacity than the M25 specimen. Deformation Characteristics of CFST Members.

Table 4.5: CFST Column- Behavior of Deformation

Total Load	Circular Shape	Square Shape
1000	0.65	2.47
1500	0.981	3.7
2000	1.3	4.98
3000	1.96	7.5
4000	2.61	9.89

The table above compares the deformation characteristics of five square and five circular CFST columns under incremental loading. Despite all specimens sharing identical material properties, the square columns consistently exhibited greater deformation than their circular counterparts. For all columns, a direct relationship was observed where deformation increased with the applied load. Notably, the square columns experienced 70% increased amount of deformation than the circular columns under equivalent conditions. CFST columns' stress behaviour under various load conditions

Table 4.6: CFST Behavior of Stress

Load	Circular	Square
1000	23.05	47
1500	34.6	71
2000	46.118	95
3000	70.1	130
4000	92.23	189

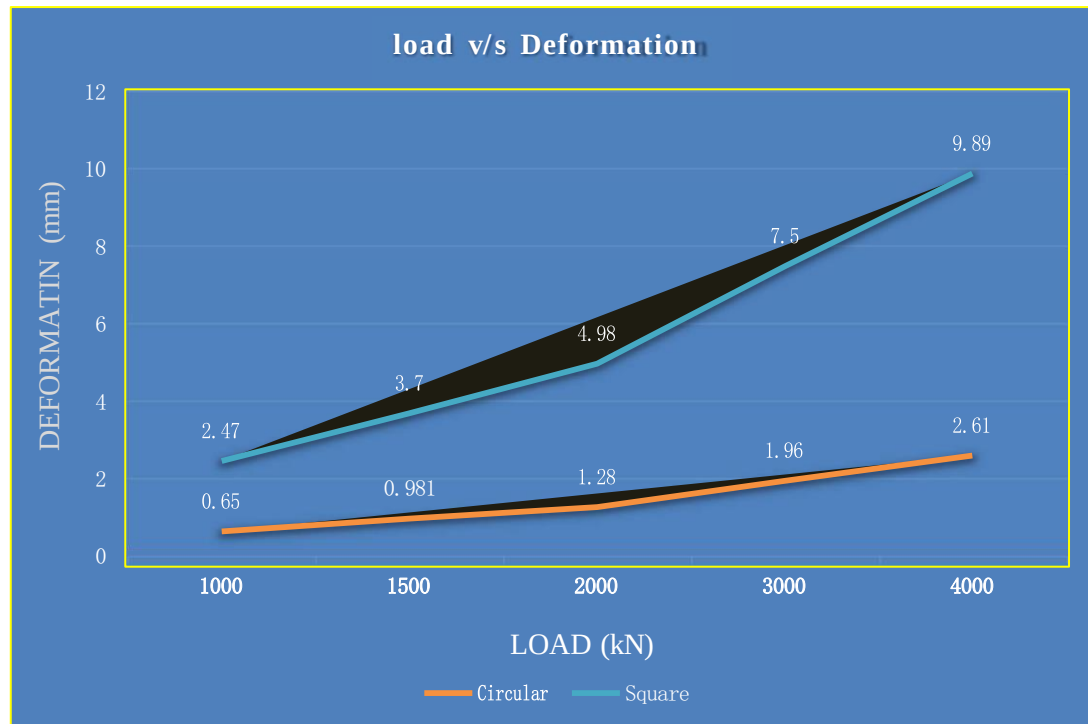


Fig. 4 .1: Deformation behavior of CFST column

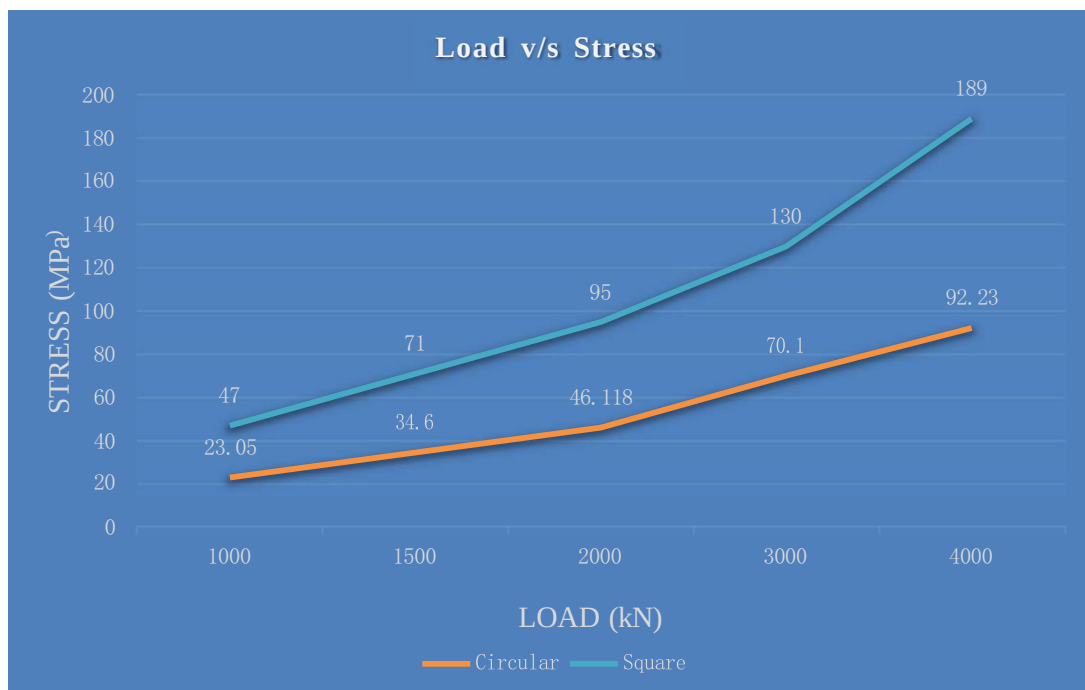


Fig 4.2: Stress Behavior of CFST column

The graph clearly illustrates a proportional relationship between load and stress for both column configurations. It is evident that the square columns consistently exhibited higher stress values compared to the circular counterparts. For specimens with identical material and geometric properties, the stress sustained by the square sections was approximately 50% greater than that of the circular sections. PCC (Plain cement

concrete) columns deformation behaviour.

Table 4.7: *Deformation of PCC (plain cement concrete)*

Load (kN)	Circular (mm)	Square (mm)
1000	0.719	2.75
1500	1.23	4.14
2000	1.35	5.51
3000	2.05	8.2
4000	2.74	10.1



Fig 4.3: *Cement Column Deformation Behavior*

The table shows deformation data for identically specified square and circular cement columns, with the square shape deforming more. The primary takeaway is that CFST columns are more robust; under the same stress, a conventional concrete column deforms more than a CFST column. Specifically, at 4000 kN, deformation is 10.1 mm for concrete versus 9.89 mm for CFST, making the CFST column 4% more effective. Plain cement concrete's stress behaviour under various load scenarios

Table 4.8: *Plain Concrete Stress Behavior*

Load (kN)	Circular (mm)	Square (mm)
1000	15.24	55.2
1500	22.88	82.71
2000	33.14	110.31
3000	49.29	165.53
4000	66.4	220.1

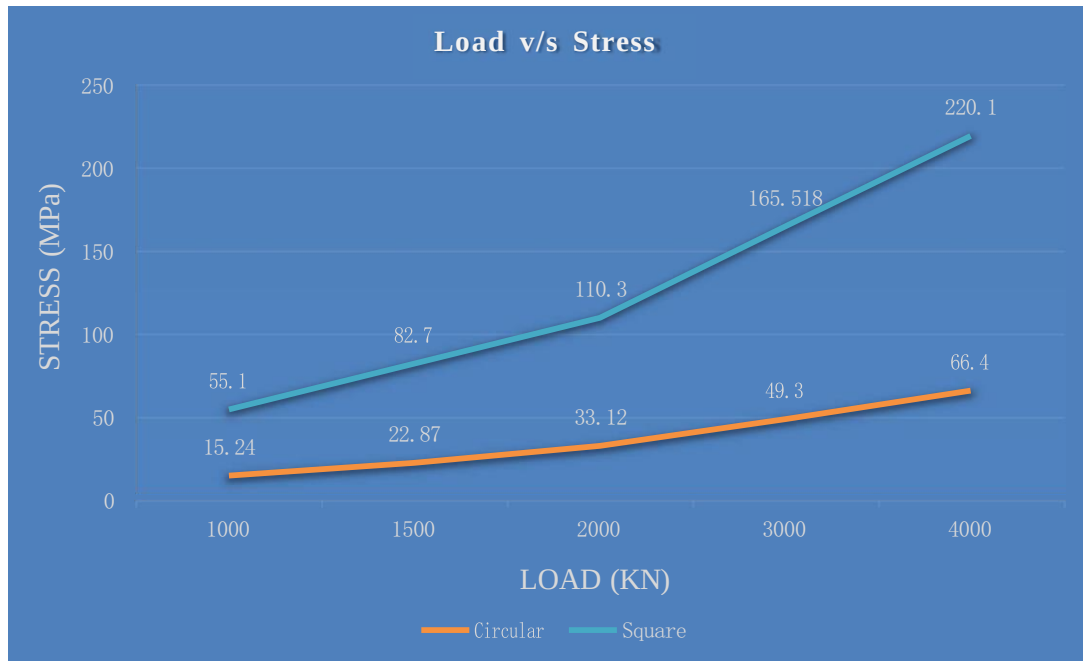


Fig. 4.4: Cement Column-Stress Behavior

The graph clearly shows that square columns experience significantly more stress than circular columns—specifically 70% more. It was also observed that CFST columns are more efficient, exhibiting lower stress levels than conventional concrete columns under the same loading conditions. CFST deformation behaviour with varying concrete grades

Table 4.9: Concrete Grade Deformation

F_{ck} (N/mm ²)	Deformation (mm)	
	Circular	Square
25	1.38	4.98
30	1.21	4.5
55	0.88	3.3
60	0.83	2.83



Fig 4.5: Grade X Deformation Graph of Concrete

The deformation characteristics of square and circular CFST columns with varying concrete grades are presented in the accompanying table. Two important observations emerge from the data: (i) square columns display approximately 70% higher deformation compared to circular columns under identical loading and material conditions, and (ii) an inverse correlation exists between concrete grade and deformation, wherein higher-strength concrete results in reduced column deformation. The circulated CFST column's load-bearing capability when the column's Diameter/thickness ratio decreases

Table 4.10: A lower diameter-to-thickness (D/t) ratio enhances the load capacity of Concrete-Filled Steel Tube (CFST) columns.

D (mm)	t (mm)	D/t (mm)	Grades of Concrete-Load Capacity			
			M25	M30	M55	M60
210	5	42	1228	1318	1727	1783
212	5.6	37.857	1338	1423	1876	1899
214	7	30.571	1554	1643	2068	2129
215	7.5	28.667	1637	1726	2150	2211
218	9	24.222	1889	1977	2399	2460

The table summarizes the load-bearing amount of circular CFST columns as a function of concrete grade and the diameter-to-thickness (D/t) ratio. The data reveals that the column's ultimate capacity is enhanced by both a decrease in the D/t ratio and an increase in the concrete's compressive strength. Circular column of CFST load bearing capability as the D/t ratio increases.

Table 4.11: Amount of Increasing D/t ratio with Load Capacity

D (mm)	t (mm)	D/t (mm)	Concrete Grade Load Capacity			
			M25	M30	M55	M60
210	5	42	1228	1318	1727	1783
209	4.5	46.43	1148	1238	1641	1697
207	3.5	59.14	989	1080	1469	1524
205	3	68.32	901	984	1368	1421
203	2.81	72.45	857	938	1312	1363
201	2.4	83.76	783	863	1222	1270

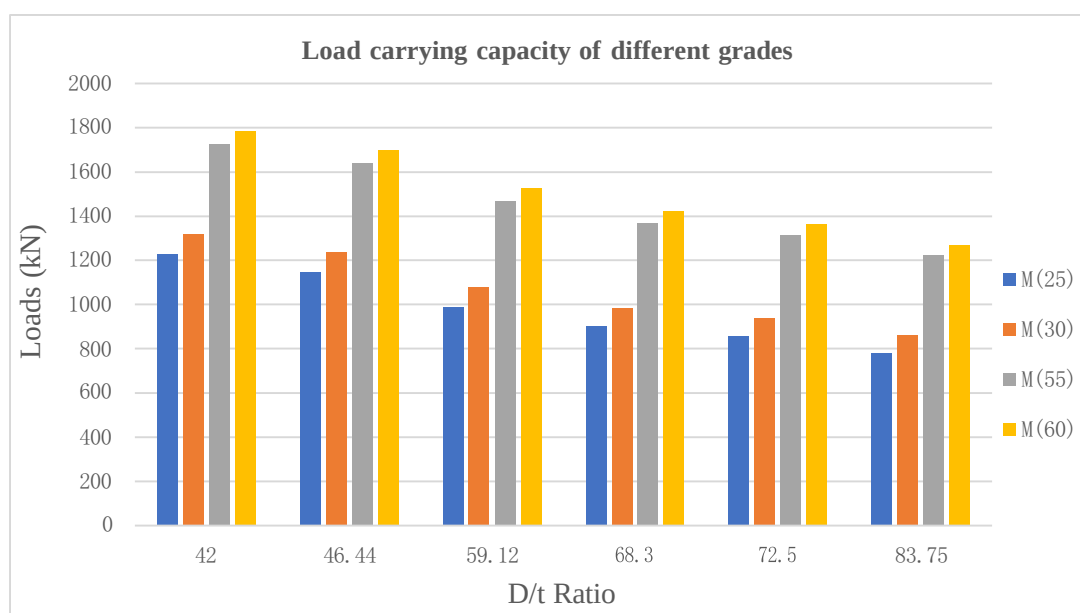


Fig 4.6: Increasing D/t ratio with Load capacity

We may infer from the preceding table that the CFST column's load bearing capability reduces with increasing D/t ratio and increases with increasing concrete grade. The CFST square column's load-bearing capability as b/t ratio goes up.

Table 4.12: Enhancing B/t ratio with Load capacity

B (mm)	t (mm)	B/t (mm)	Concrete Grades with Load Capacity			
			M25	M30	M55	M60
185	7.5	24.67	1675	1764	2184	2245
186	7	26.57	1613	1704	2135	2197
188	6	31.34	1486	1581	2032	2097
189	5.5	34.36	1420	1581	1979	2045
190	5	38	1354	1453	1925	1992

The tabulated data shows the ultimate load capacity of square CFST columns at varying B/t ratios. It is evident that as the B/t ratio becomes larger, the load-bearing capacity of the column reduces. CFST based Squared type column with decreasing the b/t ratio's carrying of load capacity

Table 4.13: Reducing B/t ratio with Load Capacity

B (mm)	t (mm)	B/t (mm)	Concrete Grades with Load Capacity			
			M25	M30	M55	M60
185	7.5	24.6	1675	1764	2184	2245
184	8	23	1736	1823	2233	2292
183	8.5	21.52	1795	1880	2281	2338
182	9	20.23	1853	1936	2327	2383
181	9.5	19.06	1910	1991	2372	2427
180	10	18	1965	2044	2416	2470

The summarized tables show the ultimate load capacity of CFST columns at various B/t ratios. The findings confirm that columns with lower B/t ratios sustain higher loads compared to those with larger ratios.

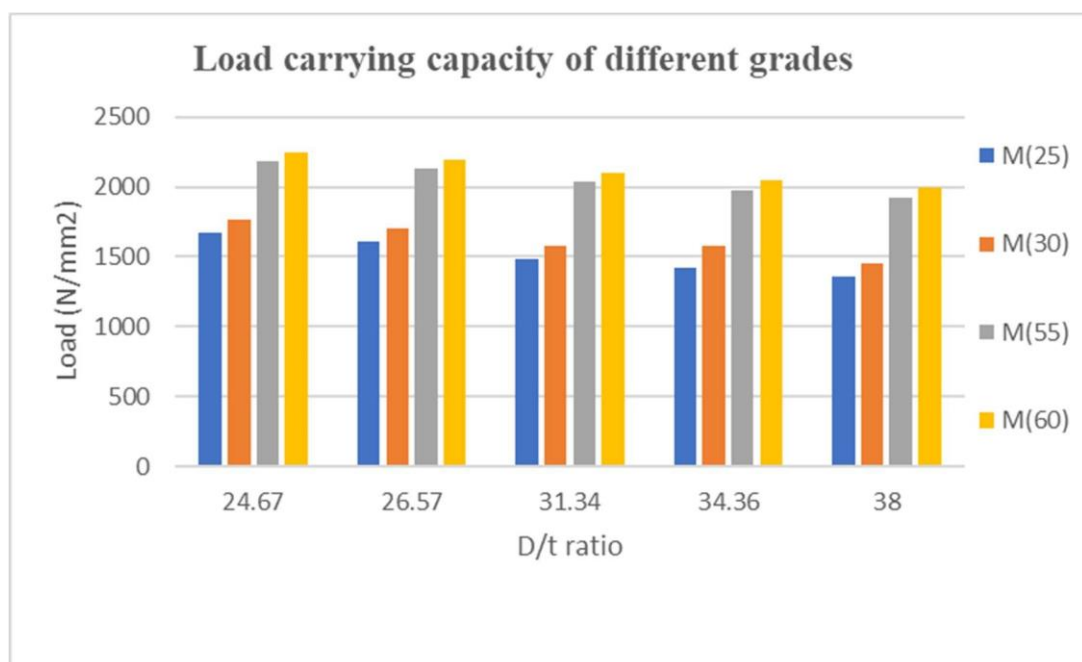


Fig 4.7 Load capacity with increasing B/t ratio

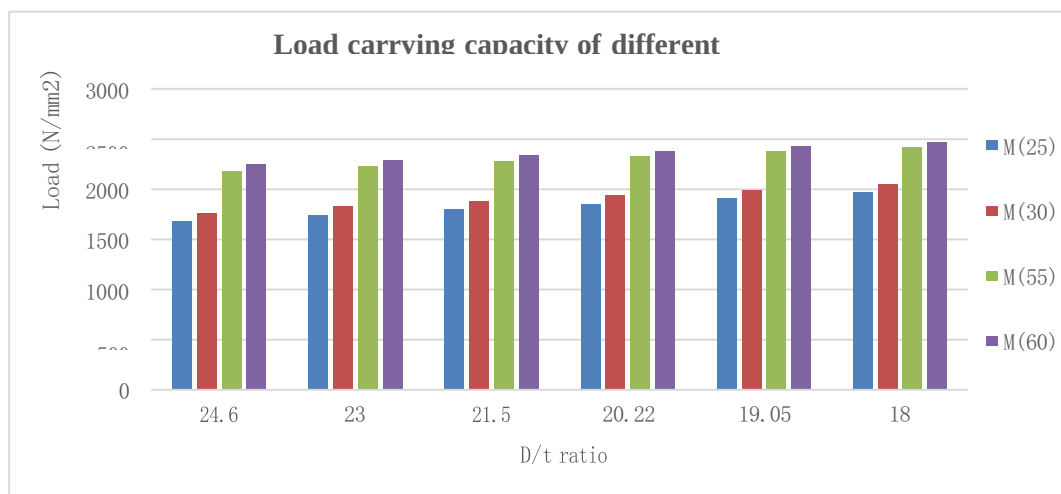


Fig 4.8: Load capacity with decreasing B/t ratio

V. CONCLUSIONS

5.1 SUMMARY OF FINDINGS

Three-dimensional finite element models were effectively created in this work to examine how CFST columns would respond to axial loading. The following are the main findings from the analysis:

1. **Effect of Cross-Sectional Shape:** Circular CFST columns consistently outperform their square counterparts. The circular geometry provides a more uniform and effective confining pressure on the concrete core, which leads to **significantly less deformation** under load.
2. **Comparison with Plain Concrete:** For identical sizes and loads, CFST columns undergo less deformation than traditional concrete columns. This improved behavior is primarily due to the composite action of the encasing steel tube and the confined concrete core.
3. **Influence of D/t and B/t Ratio:** There is an **inverse relationship** between the column's strength and its D/t (or B/t) ratio. A smaller ratio, which corresponds to a relatively thicker steel tube, results in a substantial enhancement of the column's **ultimate load-carrying capacity**.
4. **Influence of Material Strength:** The strength of a CFST column depends directly on the material properties of the steel tube and the concrete core. Specifically, the concrete's compressive strength and the steel's yield strength largely determine performance, and using higher-grade concrete results in greater load resistance.

5.2 FUTURE SCOPE

Findings of this research work says that, the following areas are recommended for future investigation:

- An analysis of other cross-sectional shapes for CFST columns that may be utilized in construction.
- A direct comparative study on the performance, cost, and construction efficiency of the columns of CFST versus hollow steel sections under various loading scenarios.

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