Effect of Shapes on Concrete Filled Steel Tubes under Static Axial Load

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Abstract- *In this study, the mechanical properties of different CFST column shapes, including circular, rectangular, square, square with rounded corners, and triangular, are all analyzed and compared using the ANSYS R2 2021 software. Total deformation, equivalent stress in concrete and steel, equivalent elastic strain in concrete and steel, and mechanical characteristics of the various CFST column shapes are also compared. axial load as well as the highest load that CFST columns can support. Comparing the circular model to other models, it was discovered that it is more resilient to stress and strain and deforms less.13.648% total deformation and decreases in stress and strain of 41.66%, 25.93%, 42.06%, and 24.99% for concrete and steel, respectively.*

Key words: steel tubes with concrete filling, deformation, maximum load, stress-strain, and ANSYS software.

1.INTRODUCTION

Overview of the Concrete-Filled Steel Tube (CFST) Column A type of composite structural element used in construction and engineering is the concrete-filled steel tube, or CFST. It creates a column design that is very effective and adaptable by combining the positive aspects of steel and concrete. In order to construct CFST columns, a steel tube is first placed vertically, into which pressure-poured concrete is then poured.CFST columns, which blend steel and concrete, have several benefits over conventional reinforced concrete or steel columns.Steel tubular members made of concrete that combine the The greatest qualities of steel and concrete are renowned for their exceptional performance. As a result, these tubes are appearing in large and aerial buildings more frequently. For use in all architectural aesthetic applications, circular, rectangular, and square CFST can be made in a variety of shapes.

1.1 Steel Tube With Concrete Filling

In the construction of high-rise structures, bridges, subway platforms, and barriers, concrete filled steel tubes (CFST) columns are frequently employed. In many parts of the world, CFST columns are used as composite columns. The CFST column's fundamental design principle states that when a steel tube is used as a casing outside of the concrete filling Steel and concrete working together has an impact on characteristics. They are resistant to both static and seismic forces.

1.2 Advantages of CFST column

1. High load-bearing capacity with a small cross-section dimension;
2. Strong stiffness and ductility;
3. High seismic resistance
4.Is extremely useful for restoring CFST column-containing structures, including bridge piers and large skyscrapers, among others.
5. Extremely rigidity and ductility, and high earthquake

2. OBJECTIVES

1. To investigate the behavior of CFST columns with various forms

2. To investigate the impact of strain, deformation, and stress on various CFST column shapes.

3. To investigate the maximum stress and strain in steel and concrete using the ANSYS package

4. To examine the impact of stress, deformation, and strain on different CFST column shapes

3. METHODOLOGY

Static Structural Analysis:

1. Creating the geometric CFST model with the necessary dimensions using Design Modeller.

2. Defining the materials in engineering data, such as structural steel and concrete, with the appropriate qualities.

3. Giving the materials a name.

4. Establishing the model's preferred mesh size.

5. Identifying and determining the support or boundary conditions (fixed at the bottom and free at the top).

6. Specifying and allocating the desired pressure's magnitude.

7. Find the solution to the static structural analysis.

8. Calculate the overall deformation, the maximum elastic shear strain, and the maximum shear stress as results.

9. Total the findings.

4. MODELLING

The model description and the properties of materials are show in the table respectively.

Type of material	Concrete	Steel
Density	2300 kg/m^3	7850 kg/m^3
Grade	M25	Fe345
Young's modulus of elasticity	3e+10	2e+11
Poisson's ratio	0.18	0.3

Type of Geometry	Solid circular, Rectangle, Square, square with Round edge, Triangle
Type of Structural Element	Column
Concrete grade	M25
Steel grade	Fe345
Mesh size	Software generated
Analysis type	Static Structural

Table 4.1 *Details of model*

5.MODELLING PROCEDURE & ANALYSIS USING ANSYS

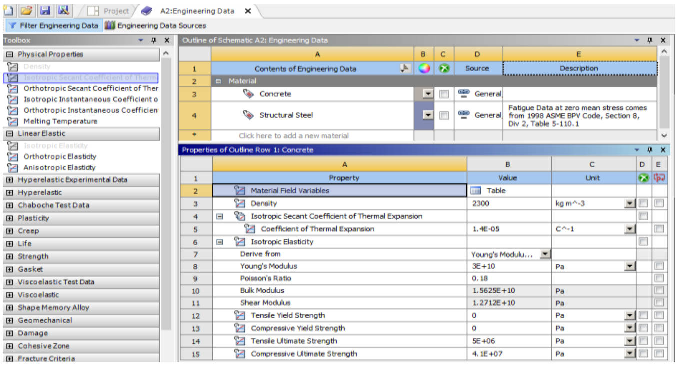

Fig:1 Ansys Engineering Data sources

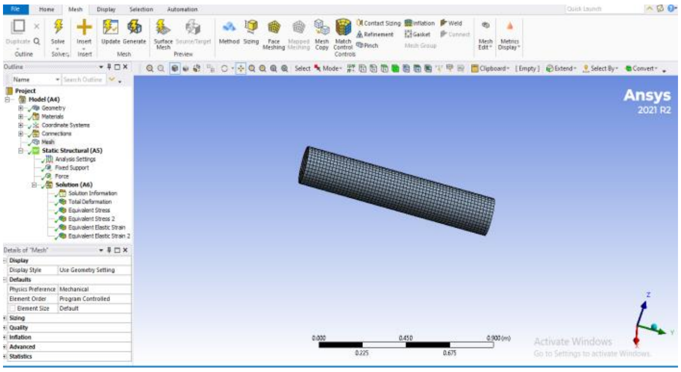

Fig:2 Meshed model

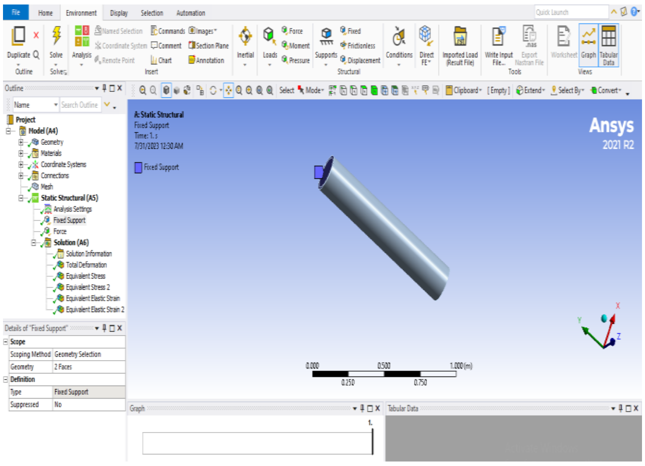

Fig:3 Applying Fixed Ends

SHAPE	TOTAL DEFORMATION(mm)
CIRCULAR	4.6654X10^-7
RECTANGULAR	5.0046X10^-7
SQUARE	4.97X10^-7
SQUARE WITH ROUND	5.0968X10^-7
TRIANGULAR	5.4028X10^-7

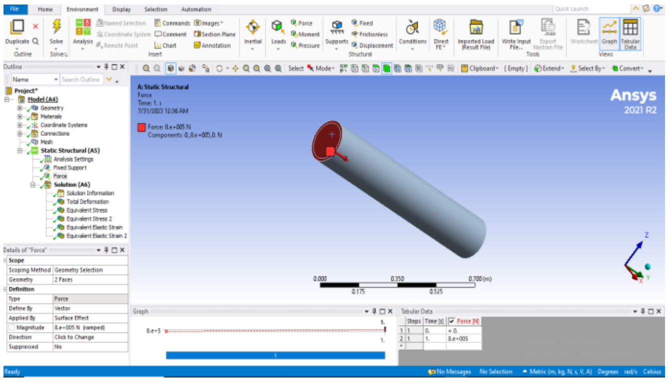

Fig :4 force applied

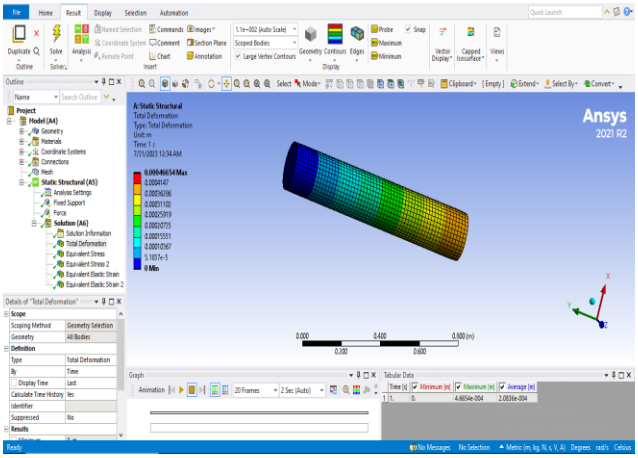

Fig:5 Total deformation of CFST

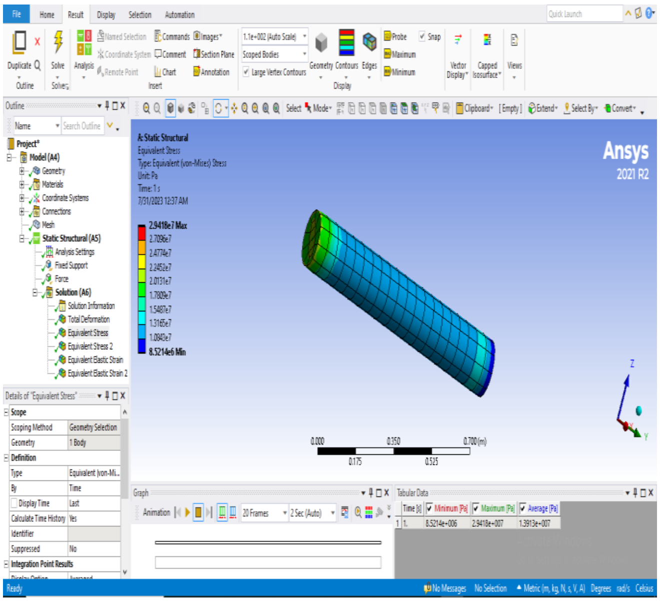

Fig:6 Equivalent stress at Concrete

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SHAPES	Steel	
	STRESS (N/mm^2)	STRAIN (mm/mm)
CIRCULAR	106.67	5.335X10^-4
RECTANGULAR	120.47	6.1343X10^-4
SQUARE	114.77	5.859X10^-4
SQUARE WITH ROUND EDGES	105.37	5.3621X10^-4
TRIANGULAR	142.26	7.1131X10^-4

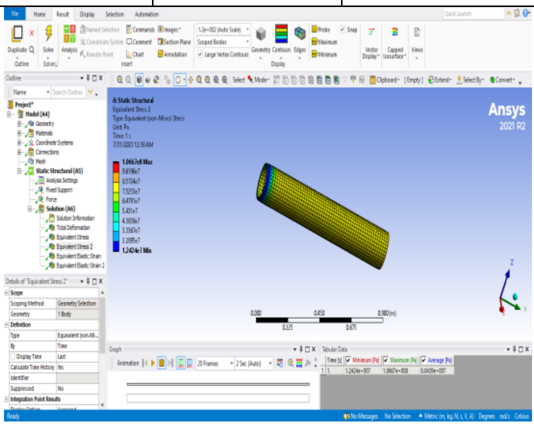


Fig 7 Equivalent stress at structural steel

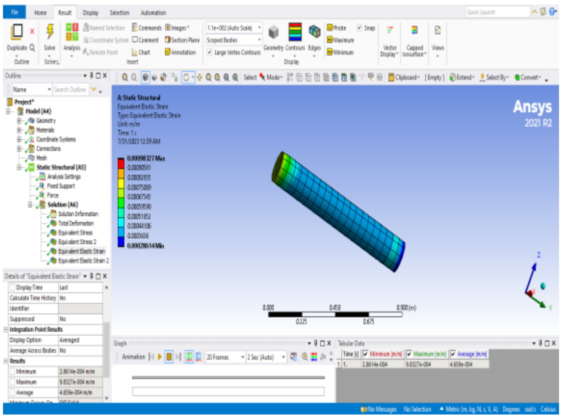


Fig:8 Equivalent Elastic strain at concrete

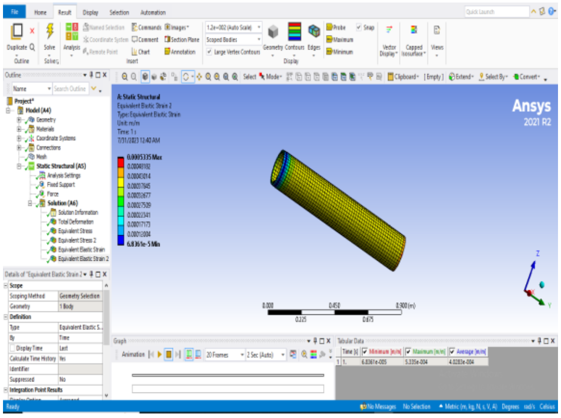


Fig 9: Equivalent Elastic strain at Structural steel

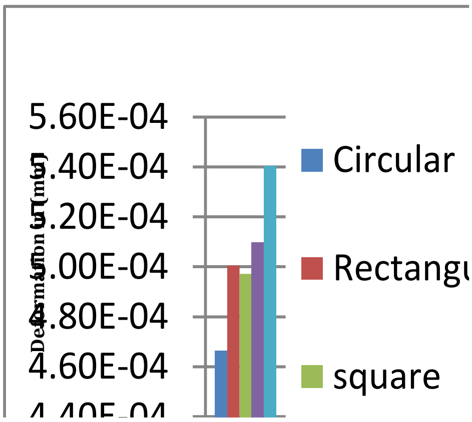
6. RESULT AND DISCUSSION

6.1 Deformation

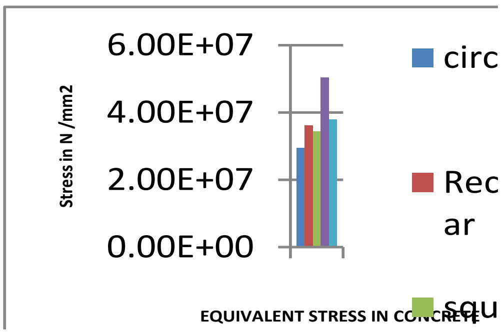
Deformation's maximum values vary depending on the model.

TABLE 6.1.1: Maximum Deformation of CFST

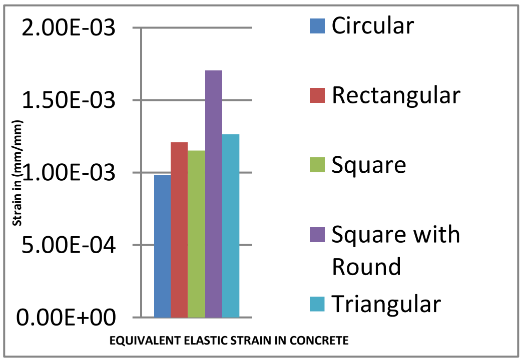
Table 6.1.2: Maximum stress & strain in Concrete



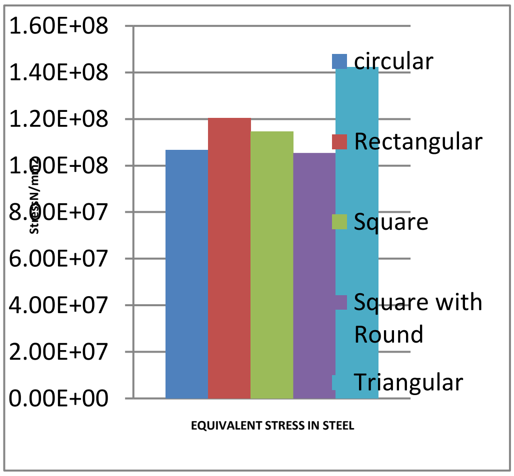
Graph 6.1.1: Graph for Total deformation



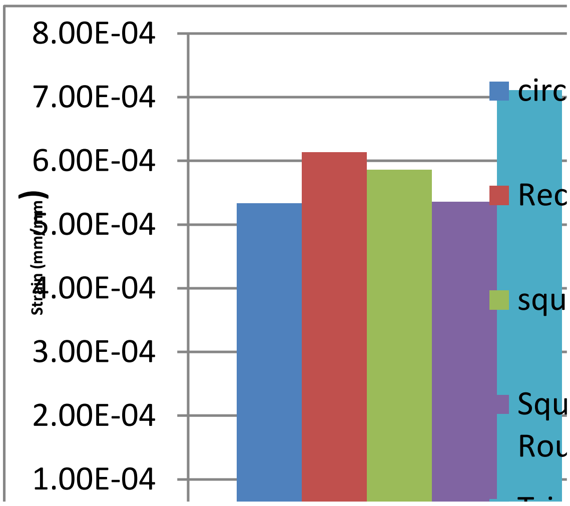
Graph 6.1.2 Max stress in concrete



Graph 6.1.2 Max strain in concrete



Graph 6.1.3 Max stress in steel



Graph 6.1.3 Max strain in steel

SHAPES	CONCRETE	
	STRESS (N/mm^2)	STRAIN (mm/mm)
CIRCULAR	29.418	9.8327X10^-4
RECTANGULAR	36.109	1.2103X10^-3
SQUARE	34.44	1.1516X10^-3
SQUARE WITH ROUND EDGES	50.43	1.7058X10^-3
TRIANGULAR	37.935	1.2654X10^-3

Table 6.1.3: Maximum stress & strain in steel

Discussion of Result

A.Deformation(Δ).

According to the deformation results, the model deformation in the triangular model is 5.4028x10-7 mm as opposed to 4.6654x10-7 mm in the circular model, and the overall deformation in the triangular model has increased by almost 13.648%.

B.stress in concrete.

According to the results of the stress test on concrete, the stress in a square with round edges is approximately 50.437 N/mm2, compared to 29.418 N/mm2 for a circular model, and the stress in a square with round edges has increased by around 41.66%.

C. Stress in steel

According to the results of the stress in steel analysis, the stress in steel in a triangle is approximately 142.26 N/mm2, compared to 105.37 N/mm2 in a square with round edges, and the stress in a triangle has increased by around 25.93%.

D.strain in Concrete

According to the results of the stress in steel analysis, the stress in steel in a triangle is approximately 142.26 N/mm2, compared to 105.37 N/mm2 in a square with round edges, and the stress in a triangle has increased by around 25.93%.

E.strain in steel

According to the results of the strain in steel analysis, the strain in steel in a triangle is approximately 7.113 x 10-4 mm/mm, compared to 5.335 x 10-4 mm/mm in a circle, and the strain in steel in a triangle has increased by around 24.99%.

7.Conclusions

1.Total maximum deformation for CFST decreases for circular model compared to triangular model.

2.Total maximum stress for CFST increases for square with round edges compared to circular model.

3.Total maximum stress for CFST increases for square with round edges compared to circular model.

4. Maximum strain for inner concrete tube in CFST circular model compared to square with round edges model.

8.REFERENCES

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BIOGRAPHIES

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