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STUDY ON THE BEHAVIOUR OF CONCRETE FILLED STEEL TABULAR SHORT AND MEDIUM COLUMN UNDER GRAVITY LOADING.

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Abstract - *Concrete-Filled Steel Tubes (CFST) represent a hybrid structural system that effectively combines the compressive strength of concrete with the tensile strength and ductility of steel. This composite action results in enhanced structural performance, making CFST columns increasingly popular in modern construction applications, such as bridges, high-rise buildings, and infrastructure in seismic zones. This paper reviews the extensive research conducted on CFST sections, focusing on their mechanical properties, design methodologies, and applications. Experimental studies on CFST columns, considering parameters like length-to-diameter (L/D) ratio, diameter-to-thickness (D/t) ratio, and steel tube thickness, are discussed to evaluate their axial load-carrying capacity under gravity and lateral loading. The experimental results demonstrate the superior performance of CFST columns compared to conventional steel tubes, highlighting their increased strength, ductility, and stiffness. Advanced numerical modeling techniques and code compliance with standards such as Eurocode 4, ACI, AISC, and Australian standards are explored. The paper concludes by discussing the future potential of CFST in sustainable and resilient construction practices, considering advancements in materials science and construction technologies.*

Key Words: *CFST, Concrete, Column, Testing, Curing, HST, compound, UTM.*

1.INTRODUCTION

CFST stands for "Concrete-Filled Steel Tube." It's a type of composite structure where a steel tube is filled with concrete. This combination takes advantage of the high compressive strength of concrete and the high tensile and flexural strength of steel. CFST structures are widely used in civil engineering for various applications such as bridges, columns, and piles. The introduction of CFST technology revolutionized structural engineering by offering several advantages over traditional construction materials and techniques. However, it wasn't until the mid-20th century that CFST gained widespread recognition and acceptance in the field of structural engineering

1.1 Need of study/ Significance

improved structural performance. Understanding how CFSTs behave under different loads allows designers to optimize their designs for greater strength, stability, and durability. Seismic resistance CFST are a popular alternative for earthquake-prone areas due to their outstanding seismic performance. Studying their behavior under seismic loads leads to safer designs. Fire resistance CFST's fire resistance is crucial for building safety. Researching their behaviour under fire circumstances aids in the development of better fire-resistant structures. Sustainability CFST provides reduced material usage and increased structural efficiency, making it a sustainable solution. The study of their environmental impact aids in the development of more environmentally friendly designs. Innovative applications. The adaptability of CFST enables novel applications in offshore structures, bridges, and high-rise buildings. Researching their behavior in these circumstances broadens their possibilities.

1.2 Applications

Concrete-Filled Steel Tube (CFST) technology has numerous uses in civil engineering and construction. Some of the important applications are:

Bridge building: CFST elements are frequently utilized in the building of bridge piers, abutments, and other structural components. CFST bridge piers provide increased strength, longevity, and seismic resistance, making them suited for highway and railway bridges. High-rise structures use CFST columns and structural elements because they have a higher load-carrying capacity, are more fire resistant, and perform better seismically. CFST technology enables taller, more slender building designs while maintaining structural integrity and safety. maritime Structures: CFST piles are commonly used to construct maritime structures such as wharves, jetties, and offshore platforms. CFST piles have good corrosion resistance and load-bearing capacity, making them ideal for maritime situations. Retaining walls and excavation support systems are constructed with CFST sheet piles in civil engineering projects.

2. Experiment

Table -1: Details of column specimens

SR.NO	SPECIMEN	LENGTH(MM)	NO OF SPECIMEN	CONCRETE GRADE
1	HST 100mm²	500	3	-
2	HST 100mm²	750	3	-
3	HST 50 mm²	500	3	
4	HST 50mm²	750	3	
5	HST circular D-100mm	500	3	-
6	HST circular D=100MM	750	3	-
7	CFST-Square	500	3	M30
8	CFST-Square	750	3	M30
9	CFST1-Circular	500	3	M30
10	CSFT2-Circular	750	3	M30

To calculate the axial load-carrying capacity of the CFST column, we can use the following analytical formula: Eurocode 4 (EN 1994-1-1:2004)

N Rd = (A_s x f_yd) + (A_c x f_cd)

Where:

- N Rd = Axial load-carrying capacity

- A_s = Cross-sectional area of the steel tube

- f_yd = Design yield strength of steel (assuming 310 MPa)

- A_c = Cross-sectional area of the concrete core

- f_cd = Design compressive strength of concrete (assuming 30MPa)

Given:

- Diameter (D): 100 mm

- Thickness (t): 3.75 mm

Calculate:

- A_s = π/4 × (100^2-92.8^2) = 1090.25 mm^2 as per steel table 1250 mm2

- A_c = π/4 × (92.8) ^2 = 6763.72 mm^2

Now, substitute the values into the formula:

N Rd = (1250x 269.56) + (6763.72 x 20)

= 336950+ 135274.4

= 472224.4 N

Therefore, the axial load-carrying capacity of the CFST column is approximately 472224.4 N OR 472.23 KN.

Note: The values used are:

- f_yd =310 MPa (yield strength of steel) 310/1.15=269.56 mpa

- f_cd = 30 MPa (compressive strength of concrete) 30/1.5=20 mpa

To calculate the axial load-carrying capacity of the CFST column, we can use the following analytical formula: Eurocode 4 (EN 1994-1-1:2004)

N Rd = (A_s x f_yd) + (A_c x f_cd)

Where:

- N Rd = Axial load-carrying capacity

- A_s = Cross-sectional area of the steel tube

- f_yd = Design yield strength of steel (assuming 345MPa)

- A_c = Cross-sectional area of the concrete core

- f_cd = Design compressive strength of concrete (assuming 30 MPa)

Given:

- Square column: 100 mm x 100 mm

- Thickness (t): 3.75 mm

Calculate:

- A_s = (100 x 100) - (92) ^2) = 1536 mm^2 as per steel table 1495 mm2.

- A_c = (92 x 92) = 8464 mm^2

Now, substitute the values into the formula:

N Rd = (1495 x 269.56) + (8464 x 20)

= 402992.2 + 169280

= 572272.2N

Therefore, the axial load-carrying capacity of the CFST column is approximately 572272.2N or 572.28KN.

Note: The values used are:

- f_{yd} = 310 MPa (yield strength of steel) 310/1.15=269.56 mpa

- f_{cd} = 30 MPa (compressive strength of concrete) 30/1.5=20 mpa

The analytical axial load carrying capacity of a Concrete-Filled Tube (CFT) column can be calculated using the following formula: (AISC) design guidelines

$P_0 = 0.85 [0.78(1-A_1/A_2) + 0.22(f_{xl}/f_{xo})] f_{xo} A_2$

Where:

- P_0 = Axial load carrying capacity

- A_1 = Cross-sectional area of the steel tube

- A_2 = Cross-sectional area of the concrete core

- f_{xl} = Yield strength of the steel tube

- f_{xo} = Compressive strength of the concrete core

This formula is based on the American Institute of Steel Construction (AISC) design guidelines for CFT columns and takes into account the composite action between the steel tube and the concrete core.

Note: This is a simplified formula and additional factors such as slenderness ratio, eccentricity, and local buckling should be considered for a more accurate calculation.

Also, it's important to note that this formula is for a concentrically loaded CFT column, if the load is eccentric, additional calculations are needed to account for the bending moment.

It's always recommended to consult the relevant design codes and guidelines, such as AISC, ACI, or Eurocode, and to perform a detailed analysis with the help of a structural engineering software or consult with a structural engineer for a more accurate and safe design.

Table no -2 Results

Sr no	Size	Analytical value Eurocode 4 (EN 1994-1-1:2004)(KN)	Analytical value AISC formula (KN)	Experimental value (KN)
1	100x100x3.75 mm square	572.28	631.809	473.79
2	100mm dia 3.75mm thk circular	472.231	496.221	585.66

Fig -1: Test set up on UTM

Fig 2- Behaviour of CFST column

Table no -3 CFST column

Sr. No	Type of Column	Shape	Length(mm)	Dimension
1	CFST Short Column	Square	500	100 mm x 100mm x 3.75mm
		Circular	500	100 mm Dia. x 3.75 mm thk
2	CFST Medium Column	Square	750	100mmx100mm x3.75mm
		Circular	750	100 mm Dia. x 3.75 mm thk
		Square	500	50 mm x 50mm x 3.75mm
3	CFST long Column	Square	750	50 mm x 50mm x 3.75mm

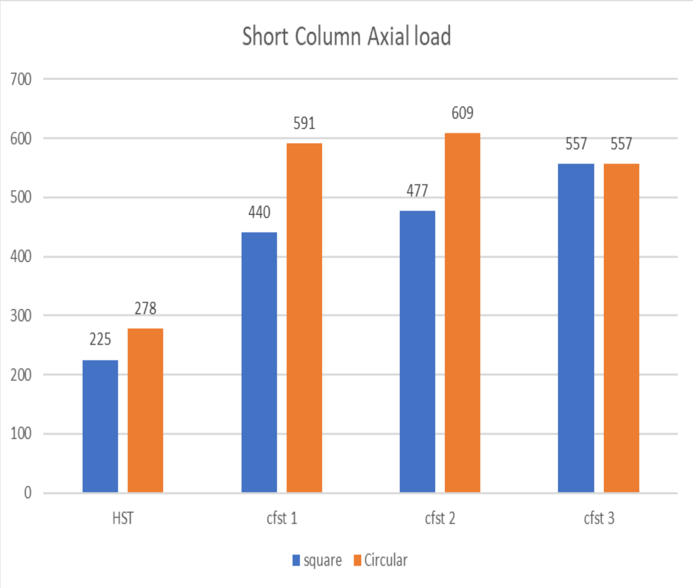

Fig no -3 Short column Axial load

Fig no -3 shows Square and circular axial load carrying capacity by short column.

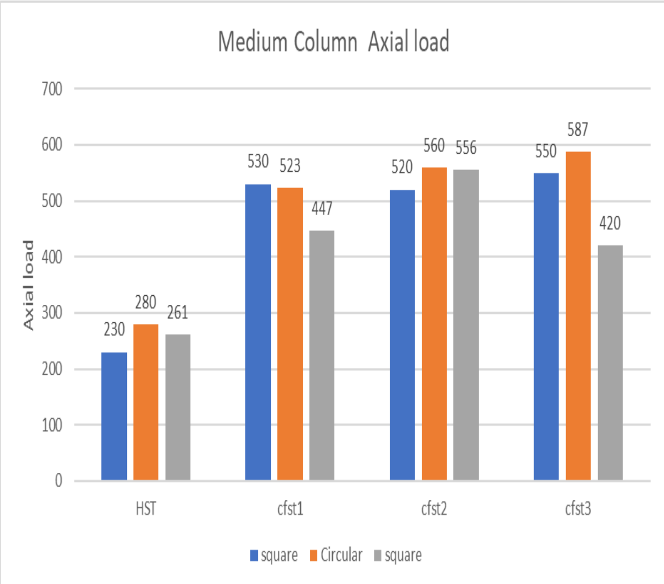

Fig no -4 Medium column Axial load

Fig no-4 shows Square and circular column Axial load carrying capacity by medium column.

3. CONCLUSIONS

A conclusion is a final section of a study, paper, or report that summarizes the key findings, implications, and recommendations derived from the research. It provides a concise overview of the primary results and their significance, often highlighting the practical applications, contributions to the field, and potential areas for future research. The conclusion aims to bring closure to the research by reinforcing the main points and offering insights or guidance based on the evidence presented.

1) The axial load carrying capacity of square column experimental value is 473.79 KN and calculated by Analytical method by use AISC formula is 631.80 KN and use Eurocode 4 (EN 1994-1-1:2004) value is 5725.28 KN .M30 grade of concrete respectively.
2) Square column CFST increased axial load carrying capacity is 46.4% compared by HST column.
3) The axial load carrying capacity of circular column experimental value is 585.66 KN and calculated by Analytical method by AISC formula is 496.22 KN and use Eurocode 4 (EN 1994-1-1:2004) value is 472.23 KN. M30 grade of concrete respectively.
4) Circular column CFST increased axial load carrying capacity is 58.56% compared by HST column.
5) The failure of the CFST columns was basically due to the local buckling near the mid height compares to the failure of Hollow Steel Tubular columns which failed due to local buckling near the ends.

FUTURE RECOMMANDATION

1) Researchers and engineers have substantially expanded the scope of CFT with the rapid expansion of study and application of CFT structures all over the world.
2) One of the characteristics of CFT is the ability to improve structural qualities through the composite action of steel tube and filled concrete.
3) CFST can be used as an alternative to the steel or RC system.
4) Studies on the CFT system's adaptability should be thoroughly studied in order to broaden its uses in the future.
5) Innovative applications: The adaptability of CFST makes it suitable for usage in offshore structures, bridges, and high-rise buildings. Researching their behavior in these circumstances broadens their possibilities.
6) Advances in construction technology: CFST research promotes innovation in construction materials and procedures, propelling the industry forward.

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