AN EXPERIMENTAL STUDY ON CFDST COLUMN UNDER AXIAL LOADING

Ranjith Gowda G[1], Abdul Rehaman[2]

[1]Post Graduate Student, Dept. of Civil Engineering, Ghousia college of Engineering, Ramanagara-562159
[2]Assistant Professor, Dept. of Civil Engineering, Ghousia college of Engineering, Ramanagara-562159

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Abstract -

The research focuses on analysing the characteristics of these columns under axial compression circumstances. The behaviour and properties of CFDST columns with CHS (circular hollow section) inner and exterior tubes are investigated through experimental research.

This research study centers on a meticulous evaluation of Circular-Filled Double-Skin Tubular (CFDST) columns when compression in the axial direction conditions. By employing a systematic approach of experimental analysis, we aim to investigate into the intrinsic properties of these columns. Specifically, our focus lies on CFDST columns that exhibit a unique composition, with both interior and exterior tubes constructed using Circular Hollow Sections (CHS).

Understanding the behaviour and characteristics column CFDST data is at the core of our work. Through rigorous experimental analysis, we subject these columns to the axial compression – a simulation of real-world loading conditions. This approach provides a direct window into their load-carrying capacity, deformation patterns, and underlying response mechanisms. By shedding light on the behavior of the CFDST columns featuring CHS outer and interior tubes, we aim to contribute vital insights that can potentially transform the way the columns in these incorporated into structural designs.

Key Words: CFDST, CHS, capacity.

1.Introduction

In the modern age, the uses of space, which is includes the spaces needed by a vertical member (smaller are always better), is given the utmost priority in the current period. The most crucial component of a structure for transferring compressive and tensile loads is the vertical elements. A column's lateral dimensions are surprisingly tiny when contrasted to its height. A Column can be horizontal or vertical elements. Struts are members that experience compression in the vertical, diagonal, or horizontal directions.

1.1 Concrete Filled Double Skin Steel Tubes (CFDST)

A concrete filled double skin steel tube (CFDST) is a type of composite structure that is commonly used in modern construction. It is made up of an inner and outer steel tube, which are separated by a space or void that is filled with concrete. The inner and outer steel tubes provide the primary load-bearing structure of the CFDST, while the concrete filling provides additional strength and stiffness. The concrete filling also helps to protect the steel tubes from fire and corrosion. CFDST structures are often used in tall buildings and bridges because they are able to withstand high levels of compression, tension, and bending. They are also relatively lightweight compared to traditional reinforced concrete structures, which will help to reduce the overall weight of the building or bridge. CFDST structures can be designed in a variety of shapes and sizes, depending on the specific needs of the project. They can also be prefabricated off-site and assembled on-site, which can help to reduce construction time and costs. Overall, CFDST structures are a durable and efficient construction option that can provide a range of benefits for building and bridge projects.

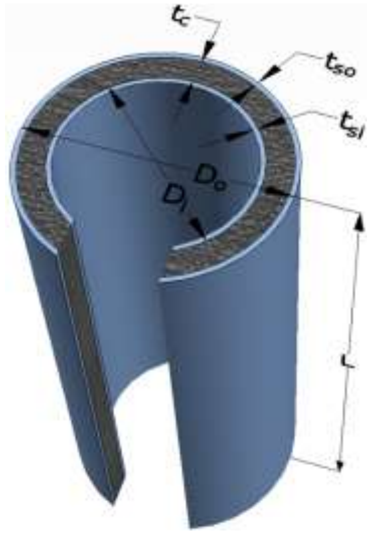

Fig 1.1: A concrete-filled double-skin steel tubular (CFDST) member with CHS exterior and interior steel tubes is shown schematically, and the geometric notations used here are described.

2. Literature Review

The Ultimate Axial Load Carrying Capacity of a Column can be accurately estimated, according to the Time Series Plot. From this research, parametric optimisation and factors impacting the reaction, such as concrete thickness, length, and grade, may be accurately anticipated. When results from ANSYS software were compared to experimental data, they ranged from 5% to 10%. When outcomes from the EC4 code of practise were compared to experimental data, they ranged from 2% to 15%. When results from the ACI code of practise were compared to experimental data, the differences ranged from 6% to 25%. When results from the BS400 code of practise were compared to experimental results, they ranged from 5% to 15%. When compared to experimental results, the results from the AISC 360-10 code of practise ranged from 5% to 15%. For M30 grade of concrete (constant diameter, constant thickness), load carrying capacity decreased by 4% to 8%. For M40 grade of concrete (constant diameter, constant thickness), load carrying capacity decreased by 5% to 10%. For Hollow CFST (constant diameter, constant thickness), the load capacity decreased by 5% to 10%.

2.1 Scope of the Work

1. Examine the mechanical characteristics of the steel with the concrete utilised to construct the CFDST columns.

2. A mix design is carried out for concrete of grade M50.

3. Examine the CFDST columns' deformation properties, load-deflection behaviour, and failure mechanisms.

4. A practical examination was done to ascertain the CFDST columns' ability to support an axial load.

5. To estimate the load-carrying capability of CFDST columns under axial for validation, static structural analysis is performed.

2.2 Objective of the Research Work

1.Testing experimentally CFDST column specimens with axial loads in a UTM machine.

2.Recognising Concrete and Tube Behaviour in CFDST Columns.

3.Determining CFDST Column Deformation Characteristics under Axial Load.

4.Use the models to examine stress distribution, load-carrying capability, and deformation behaviour, and validate the simulation findings against the data.

3. Methodology

The method employed for casting the specimens and subsequently conducting tests. The casting process involves carefully assembling interior and exterior steel tubes with precise spacing, followed by controlled pouring of concrete. The evaluation stage encompasses subjecting these specimens to various loading conditions using a Universal Testing Machine (UTM), evaluating their mechanical properties and performance. This comprehensive approach underscores the integration of fabrication and evaluation methodologies, offering a holistic understanding of Concrete-Filled Double-Skinned Steel Tube (CFDST) behaviour.

3.1 About UTM:

An essential piece of machinery used in engineering, manufacturing, and research to assess the mechanical properties and behaviours of various materials and components is a universal testing machine (UTM), also known as a material testing machine or a mechanical testing machine. By applying controlled mechanical forces to specimens, the UTM is able to measure tensile strength, compressive strength, bending characteristics, shear resistance, and other parameters. It is essential to comprehend how materials behave under various loading scenarios in order to inform the development of innovative materials and products as well as quality control practises and design decisions.

4. Validation

There are various ways to analyse the columns, including limit state analysis and elastic analysis. Approximate or accurate procedures were employed in limit or elastic state methods. Using a FEM software (ANSYS), I have examined the axial loads placed on the columns and compared the results to the Practical analysis (experimental conduction) in the current thesis.

4.1 Finite Element Method

Finite Element Analysis (FEA) is a powerful computational technique used in engineering and physics to simulate the behavior of complex structures and systems. It's based on the concept of dividing a complex geometry into smaller, simpler elements, each represented by a set of equations that describe its behavior. By solving these equations collectively, FEA enables engineers and researchers to analyze the response of a structure or system to various loading and boundary conditions.

4.2 About ANSYS

ANSYS (version 21) is a popular software suite used for engineering simulation and analysis. It provides a comprehensive set of tools for simulating a wide range of physical phenomena, including structural, thermal, electromagnetic, and fluid dynamics problems. ANSYS is widely used in industries such as aerospace, automotive, energy, electronics, and biomedical engineering.

The software package comes with a number of modules, including ANSYS Mechanical, ANSYS Fluent, ANSYS Electronics, ANSYS Maxwell, ANSYS CFX, and ANSYS HFSS, among others. Each module is designed to address a particular set of simulation needs, and they are employable together for multi-physics simulations.

5. Materials Used

5.1 Steel

Steel is an alloy, which means the material composed of two or more chemical elements, with iron being the main component. Other elements commonly found in steel include carbon, manganese, silicon, and sulfur, among others. The specific composition of steel can vary depending on its intended use, with different alloys being used for different applications.

Due to its strength, longevity, and versatility, steel is one of the most frequently used materials in the world. It can be used for a wide range of things, including building and infrastructure, transportation, and industrial. Consumer products including electronics, furniture, and appliances are frequently made from steel.

5.2 Concrete

Concrete is a versatile and frequently utilised building supplies produced by mixing cement, water, and aggregates (such as sand, gravel, or crushed stone). The resulting mixture can be poured into moulds or forms to create structures, such as buildings, bridges, roads, and dams. Concrete is known for its strength, durability, and versatility, making it a popular choice for a variety of construction applications.

Table 5.1. Properties of CFDST

Particular	Interior tube	Exterior tube
Outer diameter	62.50mm	175mm
Thickness	3.60mm	2.60mm
Inner diameter	55.30mm	169.80mm
Grade of Concrete	M50	
Youngs modulus of concrete	41833.00 MPa	
Youngs modulus of Steel	200000 MPa	

6. Results

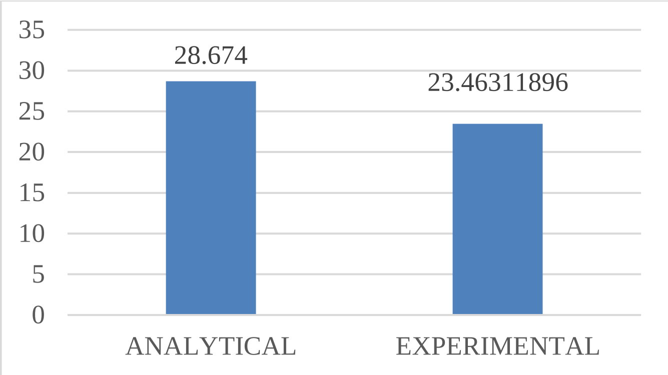

Chart 1: Max. stress allowed in models and specimen without stiffener.

In the assessment of maximum stress within configurations lacking stiffeners, a notable discrepancy emerged between the analytical and experimental approaches. Specifically, the analytical method projected a greater maximum stress value than that gleaned from experimental results. This divergence indicated a significant variation of 22% between two methodologies. This disparity underscores the challenges inherent in precisely modeling the intricate behaviors of Concrete-Filled Double-Skinned Steel Tube (CFDST) structures through theoretical computations alone. The observed discrepancy highlights the necessity of harmonizing theoretical predictions with empirical findings to achieve a more comprehensive and accurate understanding of CFDST behavior.

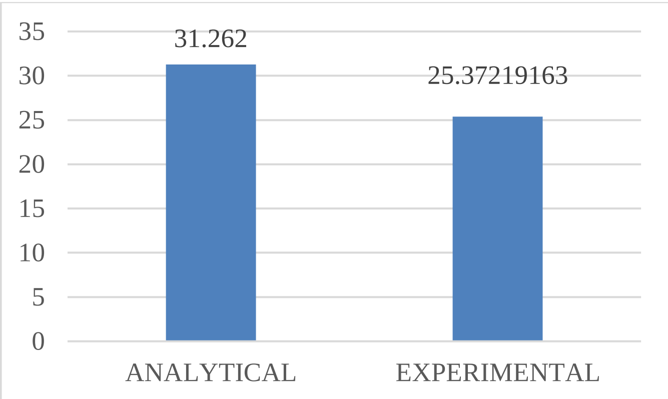

Chart 2: Max. stress allowed in models and specimen with stiffener.

Upon scrutiny of maximum stress levels within configurations featuring stiffeners, a distinct contrast surfaced between the analytical and experimental methodologies. Specifically, the analytical predictions yielded a greater maximum stress when value compared to the empirical results. This divergence signaled a significant discrepancy of 23% between experimental and the analytical approaches. This observation underscores the intricate nature of replicating Concrete-Filled Double-Skinned Steel Tube (CFDST) behaviors through analytical calculations alone. The discernible variance accentuates the significance of integrating theoretical understanding with empirical validation, culminating is more holistic comprehension of CFDST structural responses.

7. CONCLUSIONS

1. ANSYS software analysis resulted in a reasonable variation of 20% to 25% compared to experimental outcomes.

2. This variation indicates alignment between computational predictions and real-world data.

3. It provides a solid foundation for refining computational models and their application in engineering scenarios.

4. Evaluation of CFDST column performance revealed an improvement in elastic energy absorption capacity with higher concrete strength.

5. Choosing the right concrete strength strategically can lead to superior energy-absorbing properties.

6. This has promising implications for structural resilience and durability.

8. Future Scope

The domain of research within the realm of Concrete-Filled Double-Skin Tubular (CFDST) columns presents an array of promising prospects for future investigation and advancement. The following directions provide a robust framework for expanding the existing comprehension of these intricate structural elements:

1. Investigating various column shapes under different loading conditions offers valuable insights.

2. It deepens our understanding of how geometries affect the structural behavior of CFDST columns.

3. Diverse loading scenarios reveal relationships between design parameters and performance characteristics.

4. This research enriches the knowledge base in structural engineering.

5. Studying different concrete and steel grades provides in-depth material analysis.

6. Systematically varying these parameters uncovers how combinations affect strength, durability, and behavior of CFDST columns.

7. Optimized material selections for specific applications may result from this exploration.

8. Contributes to the development of more efficient and resilient structures.

9. Evaluating different column dimensions provides data on their influence on critical parameters.

10. Factors like buckling behavior, load distribution, and overall stability are considered.

11. Helps refine design guidelines for optimal column sizing in practical applications.

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BIOGRAPHIES

Ranjith Gowda G
Post Graduate Student, Dept. of Civil Engineering, Ghousia college of Engineering, Ramanagara-562159

Abdul Rehaman
Assistant Professor, Dept. of Civil Engineering, Ghousia college of Engineering, Ramanagara-562159