International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 09 Issue: 06 | Jun 2022 www.irjet.net p-ISSN: 2395-0072

Structural Performance of Equally and Unequally of Stone Prism Encased Composite Column

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Abstract - *The centre piece of the infilled concrete is planned to be replaced with a stone prism, creating a new form of concrete-filled steel tube (CFST) structural element. This stone prism can either be newly mined and made, or it can be recycled from old stone buildings. The stone prism enclosed composite column should have a higher load-carrying capacity than traditional CFST columns because of the high compressive strength of stone blocks and the efficient confinement provided by the steel tube. Furthermore, because the high-strength stone offers additional confinement from the inside of the concrete, the infilled stone prism is anticipated to improve the local bearing behaviour of CFST. Using ANSYS software, the structural performance of the composite columns encased in stone prisms under axial compression was investigated.*

Key Words: **Axial Compression, CFST, Composite, Confinement, Infilled, Stone prism, Ansys**

1. INTRODUCTION

A vertical structural component intended to convey a compressive load is known as a column. The foundation receives the load from the beam and slab supporting the ceiling or roof, including its weight, through a column. Therefore, it should be clear that the collapse of the entire structure is caused by the failure of a column. A stub column is a sort of column that is built above a beam or slab to shift load off the main beam but is not directly attached to the footing. Stub columns have a relatively small height. Figure 1 displays a stub column. When there are extra rooms, a stub column is offered. To make buildings more rigid, stub columns are occasionally added. The load is moved from one beam to another beam using a stub column. Stub columns are utilised in this project. In order to make use of each material's advantageous qualities, composite columns are built employing a variety of structural steel and concrete mixtures. The composite column is an extremely rigid, economical, and hence structurally effective member in building and bridge structures due to the interaction of concrete and structural steel elements. One kind of popular composite column is the CFST column. Concrete-Filled Double Skin Tubes (CFDST), Reinforced Concrete Filled Double Skin Tubes, Concrete-Encased CFST column, and Stiffened CFST column are some of the different varieties of CFST columns. Compared to regular steel or reinforced concrete structures, a concrete-filled steel tube (CFST) column system has various benefits. The system performs exceptionally well structurally thanks to the distribution of materials in the cross-section. The steel is located at the outside edge, where it excels in tension and bending. Due to the material's distance from the centroid, it also provides the highest stiffness. The greatest contribution to the moment of inertia is made by this along with the steel's enormous modulus of elasticity. The fundamental disadvantage of CFST is that the steel tube dilates more from its real position than does the concrete when the column is subjected to maximum loading. As a result, the column loses strength and stiffness due to a lack of confining pressure [1]. Different types of CFST members have acquired favourable mechanical behaviour as a result of the composite activities between the various components. This is because the outside steel tube provides confinement and increases the strength and deformation capacity of the infilled concrete, while the infilled concrete suspends local buckling of the outer steel tube.

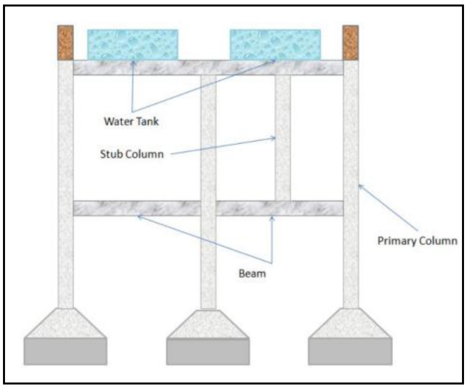


Fig.1 Stub Column

It was proposed that confining stone inside steel tubes would increase its ductility. The core component of the infilled concrete is therefore replaced with a stone prism using the Stone Prism Encased Composite Columns, a novel type of CFST member that is proposed here. A composite column encased in stone is examined in this thesis. Also Stone Prism Encased Composite Column splitted with different length of stone is analyzed . ANSYS 21 is a finite element programme used for modelling and analysis.

1.1 Stone Prism Encased Composite Column

Here, a steel tube containing concrete and stone prisms is being examined. Here, the height of the column is employed to divide the steel tube equally and unequally. Granite is the primary component of the stone prism. This stone prism can either be newly mined and made, or it can be recycled from old stone buildings. The concrete-filled steel tubular members enclosed in stone prisms should have a higher load-carrying capacity than traditional CFST members due to the high compressive strength of stone blocks and the effective confinement provided by the steel tube.

Since the high-strength stone offers additional confinement from the inside of the concrete, the infilled stone prism is projected to improve the local bearing behaviour of CFST. By lowering the manufacture of concrete and supplying a mechanism for the reuse of stone blocks that have been destroyed, the proposed technology can also reduce its detrimental environmental effects.

1.2 Objective

To investigate the effect when the stone is equally divided and unequally divided by the height of column under axial loading.

2. ANALYSIS OF EFFECT WHEN THE STONE IS EQUALLY AND UNEQUALLY DIVIDED BY THE HEIGHT OF THE COLUMN

It deals with the dimensional details, modelling details and analysis and results of stone prism encased composite column when the stone prism is equally and unequally divided by the height of the column in ANSYS software.

2.1 Geometric Modelling

. The end supporting condition was provided as bottom end fixed and the load was applied on the other end. The dimensional details of circular steel tube and length of stone when it is equally and unequally divided by the height of column are given in Table 1 and Table 2.

Table -1: Dimensional details of circular steel tube

Total length of steel tube	600 mm
Outer diameter of steel tube	219 mm
Wall thickness of steel tube	8 mm

Table -2: Length of stone prisms

Parameter	Value
Length of stone prism when it is equally divided by the height of column	200 mm ,200mm, 200 mm 300 mm, 300 mm
Length of stone prism when it is unequally divided by the height of column	200 mm,400 mm 450 mm,150 mm

2.3 Modelling

Modelling of stone prism when it is equally and unequally divided by the height of column is done by using element type SOLID186.Coefficient of friction 0.3 is given between steel tube and concrete to avoid the slip. Modelling of stone prism encased composite column when the stone prism is equally and unequally divided by the height of column is shown in Fig.3.

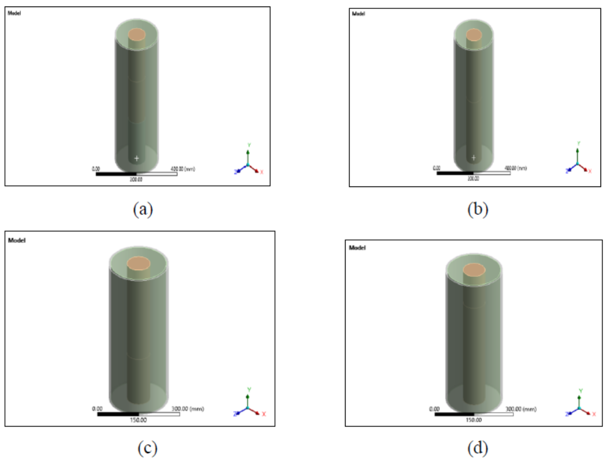


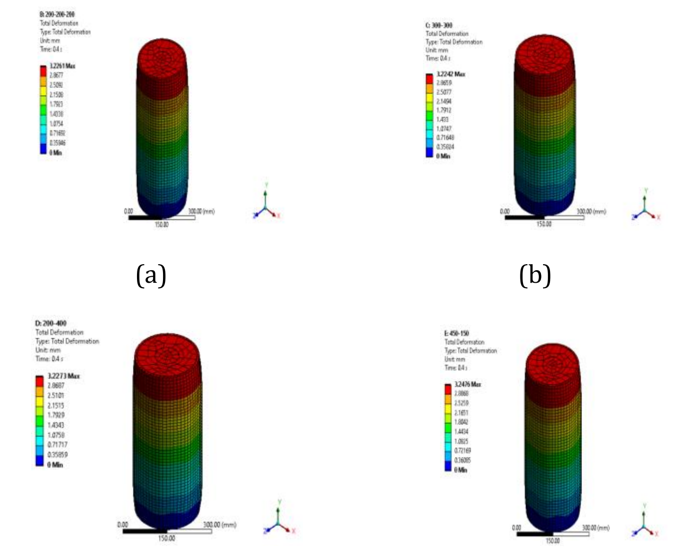
Fig-2.1: Solid model when stone prism is equally and unequally divided by the height of the column (a) 200 mm-200 mm - 200 mm (b) 300 mm - 300 mm (c) 200 mm -400 mm (d) 450 mm - 150 mm

2.4 Meshing and Loading

Here the element type used is SOLID186.Element shape is of hexahedron. Element size provided for steel tube is 10mm and a size of 30mm for concrete and stone prism. Loading is done based on displacement convergence criteria with a value of 8mm and the corresponding ultimate value is noted.

2.5 Analysis

Non-linear static analysis is carried out to find out the effect when the stone is equally and unequally divided by the height of the column.Deformation and load carrying capacity is studied.The deformation diagram obtained for the models are shown in in Fig. 4.



(a) (b) (c) (d)

Fig-2.2: Deformation of stone prism encased composite column when stone prism is equally and unequally divided by the height of the column (a) 200 mm-200 mm - 200 mm (b) 300 mm - 300 mm (c) 200 mm -400 mm (d) 450 mm - 150 mm

2.6 Results and Discussions

The load-deflection graph of Deformation of stone prism encased composite column when stone prism is equally and unequally divided by the height of the column is shown in Fig.5.

Table -3: Comparison of results

Length of stone prism	Deflection (mm)	Load (kN)
200-200-200	3.2261	5531.1
300-300	3.2242	5563
200-400	3.2273	5565.3
450-150	3.2476	5549.6

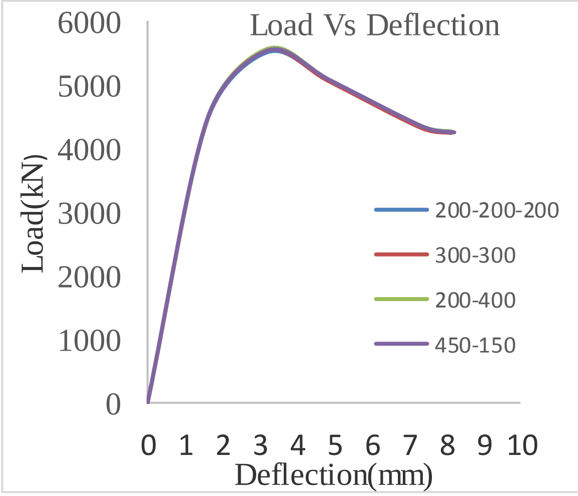


Chart -1: Comparison of load deflection graph

Here 200 mm – 400 mm length of stone prism has better load carrying capacity than the others.

3. CONCLUSIONS

In this study, structural behavior of Stone prism encased composite column is studied. The conclusions obtained are:

- 200 mm – 400 mm length of stone prism has better load carrying capacity than the others.

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