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 Regular Stone Prism Encased Composite Column

Shine Elsa Mathew[1], Midhila V.S[2]

[1]Shine Elsa Mathew, M.Tech Student, Dept. of Civil Engineering, Sree Buddha College of Engineering, Kerala, India
[2]Midhila V.S, Assistant Professor, Dept. of Civil Engineering Sree Buddha College of Engineering, Kerala, India

---***---

Abstract - *The core component of the concrete-filled steel tube (CFST) is replaced with a stone prism in this new type of CFST. This stone prism can be made either from newly mined and manufactured stone or from stone buildings that have been destroyed. Due to the high compressive strength of the stone and the efficient confinement offered by the steel tube, these columns should be able to support more weight than typical CFST columns. The high strength of the stone offers additional confinement from the inside of the concrete, therefore it is envisaged that the infilled stone prism will 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. As a result, it should be clear that if one column fails, the entire structure will crumble. Stub columns are referred to as columns that are not immediately attached to the footing. To transfer the load from the primary beam, it is built over a beam or a slab. Stub columns have a relatively small height. Figure 1 displays a stub column. Additionally, it is offered if the room is longer. To increase the rigidity of buildings, stub columns are also available. It aids in the transmission of load from one beam to another. Stub columns are utilised in this project. In order to take advantage of each material's advantageous qualities, composite columns are constructed using a variety of structural steel and concrete mixtures. The composite column is a rigid, economical, and hence structurally effective part in the construction of buildings and bridges due to the behaviour of concrete and steel elements. One kind of popular composite column is the CFST column. Concrete-Filled Double Skin Tubes (CFDST), Reinforced Concrete Filled Double Skin Tubes, Composite Column System, Concrete-Encased CFST column, and Stiffened CFST column are some of the different varieties of CFST columns. Compared to regular steel or reinforced concrete, a concrete-filled steel tube (CFST) column structure has various benefits.

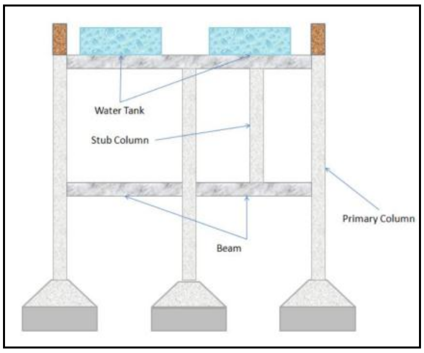


Fig.1 Stub Column

It was proposed that confining stone inside steel tubes would increase its ductility. Therefore, a new type of CFST member is suggested here, known as Stone Prism Encased Composite Columns, which swaps out the core section of the infilled concrete with a stone prism. A Stone Prism Encased Composite Column is examined in this thesis. Additionally, a composite column encased in a stone prism of a different shape is also studied. ANSYS 21 is a finite element programme used for modelling and analysis.

1.1 Stone Prism Encased Composite Column

Here a steel tube filled with stone prism and concrete is analyzed shown in Fig.2. The steel tube is of circular shape and different shape of stone prism such as circular, square, triangular, hexagon, rectangular and octagon are used here. Material used for the stone prism is granite. This stone prism can be either newly mined and fabricated or used from demolished stone structures. While considering the high compressive strength of stone blocks and the effective confinement offered by the steel tube, better load-carrying capacity could be expected in the stone prism encased concrete-filled steel tubular members than conventional CFST members.

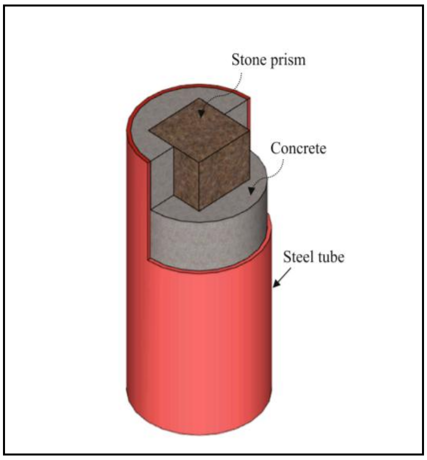


Fig.2 Stone Prism Encased Composite Column

The infilled stone prism is expected to improve the local bearing behavior of CFST, since the high-strength stone provides extra confinement from the inside of the concrete. The proposed system can also decrease negative environmental impacts by reducing concrete production and providing a reuse mechanism for demolished stone blocks.

1.2 Objective

To investigate the effect of circular steel tube filled with concrete and different shapes of stone prism like circular, square, triangular, pentagonal, hexagonal, rectangular and octagonal under axial loading.

2. ANALYSIS OF CIRCULAR STEEL TUBE FILLED WITH CONCRETE AND DIFFERENT SHAPES OF STONE PRISM

It deals with the dimensional details, modelling details and analysis and results of circular steel tubes filled with concrete and different shapes of stone prism like circular, square, triangular, pentagonal, hexagonal, octagonal and rectangular in ANSYS software.

2.1 Geometric Modelling

In order to determine the effective shape for the stone prism, six shapes of stone prism were selected for the analysis. The seven different shapes chosen for the comparison are circular, square, triangle, pentagon, hexagon, octagon and rectangular. 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 tubes filled with concrete and different shaped stone prism are given in Table 1 and Table 2.

Table -1: Dimensional details of circular steel tube

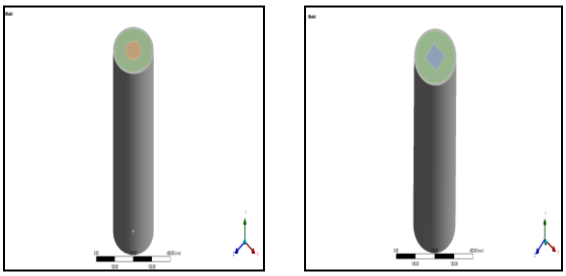
Total length of steel tube	600 mm
Outer diameter of steel tube	219 mm
Wall thickness of steel tube	8 mm

Table -2: Dimensional details of stone prisms

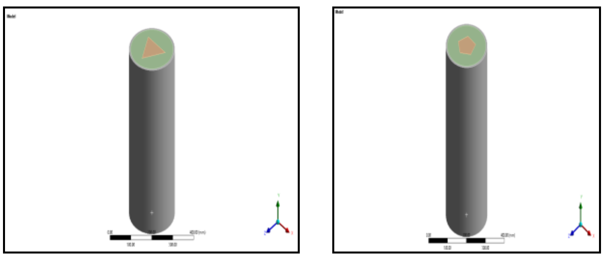
Circular	Diameter = 84.7 mm Height = 600 mm
Square	Width = 75 mm Height = 600 mm
Triangular	Width = 114 mm Height = 600 mm
Pentagon	Width = 57.2 mm Height = 600 mm
Hexagon	Width = 46.5 mm Height = 600 mm
Octagon	Width = 34.15 mm Height = 600 mm
Rectangle	Width = 113 mm Height = 600mm

2.3 Modelling

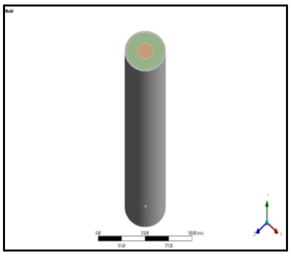
Modelling of circular steel tubes filled with concrete and square shaped stone prism is done by using element type SOLID186.Coefficient of friction 0.3 is given between steel tube and concrete to avoid the slip. Modelling of circular steel tube filled with concrete and square shaped stone prism is shown in Fig.3.



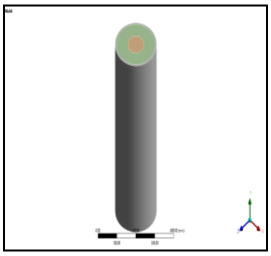
(a) (b)



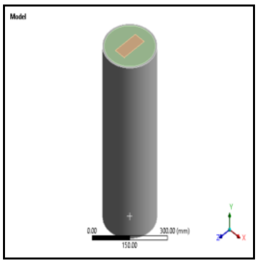
(c) (d)



(e)



(f)



(g)

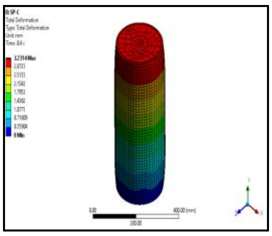
Fig-2.1: Solid model of circular steel tube filled with concrete and different shapes of stone prism (a) Circular stone prism (b) Square stone prism (c) Triangular stone prism (d) Pentagonal stone prism (e) Hexagonal stone prism (f) Octagonal stone prism (g) Rectangular stone prism

2.4 Meshing and Loading

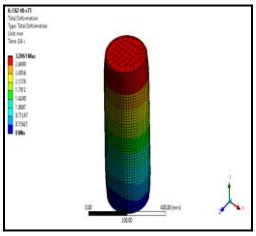
Here the element type used is SOLID186.Element shape is of hexahedron. Element size provided for steel tube is 10mm and a size of 30mm for concrete and stone prism. Loading is done based on displacement convergence criteria with a value of 8mm and the corresponding ultimate value is noted.

2.5 Analysis

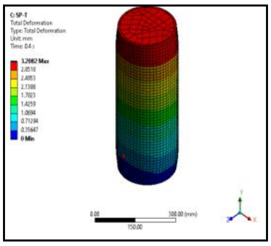
Non-linear static analysis is carried out in circular steel tube filled with concrete and different shapes of stone prism to find the maximum ultimate load corresponding to the deformation. The deformation of circular steel tube filled with concrete and different shapes of stone prism are shown in Fig. 4.



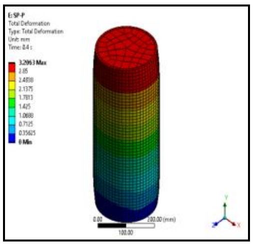
(a)



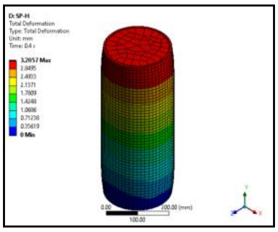
(b)



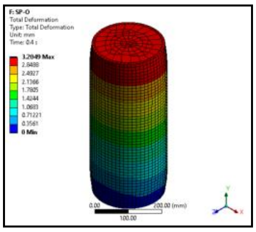
(c)



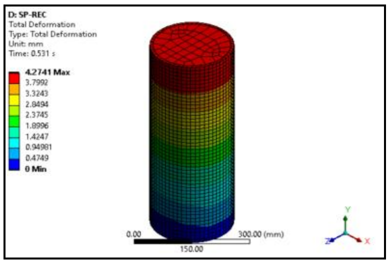
(d)



(e)



(f)



(g)

Fig-2.2: Deformation of circular steel tube filled with concrete and different shapes of stone prism (a) Circular stone prism (b) Square stone prism (c) Triangular stone prism (d) Pentagonal stone prism (e) Hexagonal stone prism (f) Octagonal stone prism (g) Rectangular stone prism

2.6 Results and Discussions

The load- deflection graph of Deformation of circular steel tube filled with concrete and different shapes of stone prism is shown in Fig.5.

Table -3: Comparison of results

Shapes of Stone prism	Deflection(mm)	Load(kN)
Square	3.2061	5464.2
Circular	3.2314	5561.6
Triangular	3.2082	5470.7
Pentagon	3.2063	5481.6
Hexagonal	3.2057	5517.1
Octagonal	3.2049	5507.9
Rectangular	3.2158	5429.7

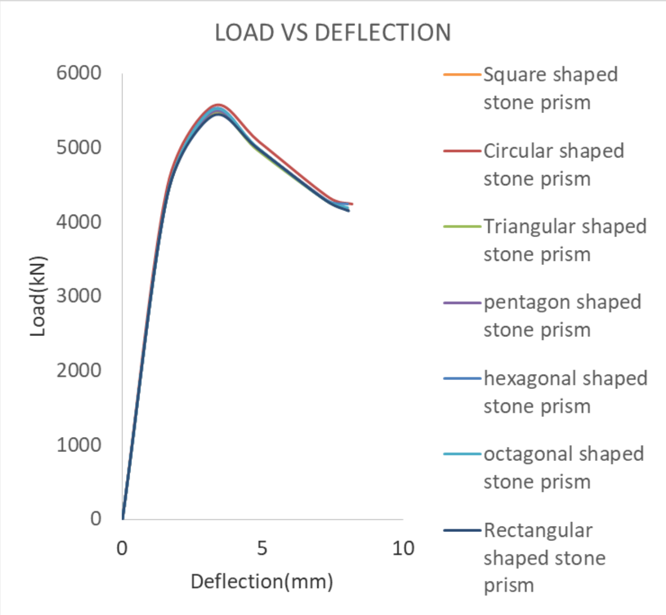


Chart -1: Comparison of load deflection graph

Here circular shaped stone prism has better ultimate load carrying capacity than the others. The percentage increase in load carrying capacity of circular shaped stone prism carries 1.782% more load than others.

3. CONCLUSIONS

This study examines the structural behaviour of a composite column encased in a Stone prism. Analysis of stone prisms is done to determine the best shape. The findings are as follows:

- Stone prisms with a round shape have a higher maximum load carrying capability than the others. The stone prism with a round shape has a 1.782 percent greater load carrying capability than the competition.
- There is symmetry in the circular column. While a rectangle only has two axes of symmetry and a square has four, respectively. In order to prevent buckling failure, the moment of inertia will be the same along all axes.
- The circular column has no weak places because it is shaped like a cylinder, unlike the rectangular or square column, which has four.
- The circular column is strong in compression when compared to the square column in the same cross-sectional area.

REFERENCES

[1] Yong Ye, Yang Liu, Stone prism encased concrete-filled steel tube columns subjected to axial compression, Structures 33, (2021) 1853–1867.

[2] Neetu Devi Singh, Anurag Wahane, Buckling analysis on CFST columns with different slenderness ratios & RCC columns using ANSYS,International Journal for Research in Applied Science & Engineering Technology,2020, ISSN: 2321-9653.

[3] Han LH, Xu CY, Tao Z,Performance of concrete filled stainless steel tubular (CFSST) columns and joints: Summary of recent research. J Constr Steel Res ;2019,152:117–31.

[4] Jing Liu, Zhe Li and Fa-Xing Ding,Experimental Investigation on the Axially Loaded Performance of Notched Hexagonal Concrete-Filled Steel Tube (CFST) Column, Volume 2019 ,Article ID 2612536.

[5] Chen J, Chan TM and Castro JM, Experimental assessment of the cyclic behaviour of concrete-filled steel tubular beam-columns with octagonal sections,Eng Struct 2019;180:544–60.

[6] Shen Q, Wang J, and Ding Z,Axial compressive performance of circular CFST columns partially wrapped by carbon FRP. J Constr Steel Res 2019;155:90–106.

[7] Wang Y, Yang L and Yang H,Behaviour of concrete-filled corrugated steel tubes under axial compression , Eng Struct 2019;183:475–95.

[8] Tao Zhang , Chengzhi Wang, Behavior of Concrete-Filled Steel Tube Columns Subjected to Axial Compression, Volume 2018 |Article ID 4059675.

[9] Qing-XinRena, KanZhoub, Dune sand concrete-filled steel tubular (CFST) stub columns under axial compression:Experiments,Thin-Walled Struct2018;124:291–302.

[10] M.H.Laia, J.C.M.Ho,An analysis-based model for axially loaded circular CFST columns, Thin-Walled Structures, 2017,Volume 119, Pages 770-781.

[11] Ghanbari Ghazijahani, Hui Jiao and Damien Holloway,Concrete-Filled Circular Steel Tubes with a Timber Infill under Axial Compression, Journal of Structural Engineering,2017,Volume 143 Issue 7.

[12] Zhang S, Huang L and Chan C ,Compressive behavior of hybrid double-skin tubular columns with a large rupture strain FRP tube. Compos Struct 2017;171:10–8.

[13] M.Pragna,Partheepan Ganesan, Analysis of Concrete Filled Steel Tubes using Ansys, International Journal of Latest Engineering Research and Applications (IJLERA),2016,ISSN: 2455-7137 Volume – 01, Issue – 09, PP – 71-78.

[14] Ye Y, Han LH, Sheehan T and Guo ZX,Concrete-filled bimetallic tubes under axial compression: Experimental investigation, Thin-Walled Structures 2016;108:321–32.

[15] Vishal V. Gore, Popat D. Kumbhar, Performance of Concrete Filled Steel Tube (CFST) Section: A Review, International Journal of Science and Research (IJSR),2015, ISSN (Online): 2319-7064.