Experimental Investigation on Behaviour of Lightweight CFST under Axial compression

[1]Amrutha R, [2]Abhishek K R, [3]Naveen Kumar S, [4]Pradeep Kumar K M, [5]Prof. Abhilasha G T

[1,2,3,4] UG Scholar, [5]Head of the department
Department of Civil Engineering,
Mysore College of Engineering & Management, Mysore. India

***Abstract*: Test on steel column of rectangular and circular sections filled with lightweight concrete were performed to investigate the behaviour of such columns under axial loadings to resist earthquake in buildings. With the rapid growth in building construction and urbanisation, buildings are getting taller and bigger than ever. Everywhere majority of structures are constructed with the help of concrete resulting into very heavy structures. Heavy loads are one of the limitations for construction of tall buildings. If somehow structures are made lighter, cost of the foundation can also be lowered down. Conventional concrete is one of the main reason in increasing the weight of the buildings. Light weight concrete can be very much effective in reducing the overall weight of the building. In conventional concrete, larger volume comprises of coarse aggregates. In this experiment, attempt has been made to replace conventional coarse aggregates with cinders, which is lightweight due to its low specific gravity and thermal conductivity. The hollow tubes are designed in such a way that they are capable of supporting the floor load up to three or four floors. The hollow steel tubes are either fabricated or rolled to be erected first to support the construction load of the upper floors. Such structural system has the additional advantage of both steel and reinforced concrete frame. As the cinder is fully replaced to coarse aggregate to design the coarse aggregate to design the concrete mix ACI 211.2-98 Code is used.**

***Keywords*: Cement, Cinders, (LWCFST) Lightweight concrete filled steel tubes.**

I. INTRODUCTION

Concrete filled steel tubes are being more widely used in construction of high-rise buildings, bridges, subway platforms and barriers. Their usage provides excellent static and earthquake resisting properties such as high strength, high durability, high stiffness, and large energy absorption capacity. By using cinders as coarse aggregate in concrete it makes light weight concrete. Density of this concrete is considerably low 300 kg/m3 to 1850 kg/m3 when compared to normal concrete. Normal concrete as 2400 kg /m3. The lightweight concrete reduced mass and improved thermal and sound insulation properties, while maintaining adequate strength. The reduced self-weight of LWC will reduce the gravity load as well as seismic inertial mass which leads to decreased member sizes as well as forces on foundation can be reduced. Lightweight concrete filled steel tubes are used in construction industry where it is use to reduce the density of the concrete. Lightweight concrete is made by replacing cinders in place of coarse aggregate which helps to reduce the dead weight, better insulation against heat and sound. The LWCFST usage provides excellent static and earthquake resisting properties with high durability and stiffness.

II. Lightweight concrete filled steel tubes (LWCFST)

Column occupy a vital place in the structural system weakness or failure of a column destabilizes the entire structure. Strength & ductility of steel columns need to be ensured through adequate strengthen repair & rehabilitation techniques to maintain techniques to maintain adequate structural performance. Recently, LWCFST are finding a lot of usage for seismic resistance. In order to prevent shear failure of RC column resulting in storey collapse of building, it is essential to make “Ductility” of column layers. Recently most of the buildings utilize this concrete filled tube concept as primary for lateral load resisting frames. The concrete used for encasing the structural steel section not only enhance its strength and stiffness but also protects it from fire damages.

III. MATERIALS AND PROPERTIES

In experimental program the process of methodology is carried by using different types of materials with its basic test to get the materials state to this attempt and mix proportion for concrete with proper casting and curing.

1. Cement (OPC 53 grade) Ordinary Portland Cement is the most common type of cement in general use around the world because it is a basic ingredient of concrete, mortar & stucco. Ordinary Portland cement of 53 grade JSW Cement conforming to IS: 12269-1987 has been used and properties are presented in Table 1.

Table 1: Properties of Cement

Properties	Results	IS 12269:1987
Setting time *Initial *Final	146 min 286 min	≥30 min ≤600 min
Standard Consistency	29.5%	≤ 40%
Specific Gravity	3.15	2.8 - 3.3
Fineness of Cement	3.40%	≤ 10%

2. Fine Aggregate In this investigation fine aggregate used is 4.75 mm down, manufactured sand has been used, obtained from the local market in Mysore is tested as per IS: 2386, presented in Table 2.

Table 2: Properties of Fine Aggregate

Properties	Values
Specific gravity	2.61
Bulk density	1520
Fineness modulus	2.80
Water Absorption	0.60
Classification zone	Zone-2

3. Cinders: It is a pyroclastic material. Cinder are extensive Igneous rock. It is similar to pumice, which has so many cavities. It is in black colour. The size of cinders used is 12.5mm presented in Table 3.

Table 3: Properties of Coarse Aggregates

Properties	Values
Water absorption	1.7%
Specific gravity	1.01
Fineness Modulus	7.19
Bulk density	974 kg/m^3
Crushing value	26%
Impact value	20%

4. Steel: Steel is very strong metal which is made mainly from iron. The company steel we used are HI- TECH, with different length of 150, 250, 350mm of two cross section rectangular 60X40mm and circular 60, 40mm diameter with thickness of 2.5mm.

(a) (b) (c)

(a) Empty columns before casting
(b) Filled steel columns after curing
(c) Steel column testing in UTM

IV. METHODOLOGY

Experimental investigation is carried out to study the properties of concrete by fully replacing coarse aggregate with Cinders, for mix design for M-30 grade (ACI 211.2-98) Code.

Experimental Procedure

1. Collection of literature
2. Selection of lightweight aggregate
3. Selection of steel section
4. Mix design for M30
5. Estimation of material quantity
6. Casting and curing of steel tubes
7. Test and Analysis
8. Conclusion of Project

V. RESULTS

Here, an attempt is made to study strength and energy absorption capacity (i.e, Modulus of resilience and Modulus of toughness) of totally specimen of the following four model each modal is of four sets and modal are mission cut for different length of 150, 250, 350mm theses section will be tested under the following conditions.

1. Empty steel column
2. Steel column filled with sand
3. Steel column filled with cement mortar(1:3) ratio
4. Steel column filled with lightweight concrete (M30)

Patricia importance of this study is in the application of this system in column supporting platform offshore structures, bridge pier, piles & column in seismic zones.

For thickness of 2.5mm steel tube

Table 6: Empty steel column

Length (mm)	Circular 60mm diameter	Circular 40mm diameter	Rectangular 60X40mm
150	181.04	84.30	117.82
250	175.98	81.62	114.28
350	170.88	80.30	111.70

Table 7: Steel column filled with sand

Length (mm)	Circular 60mm diameter	Circular 40mm diameter	Rectangular 60X40mm
150	186.92	89.72	123.25
250	182.10	86.38	119.98
350	176.18	84.92	114.85

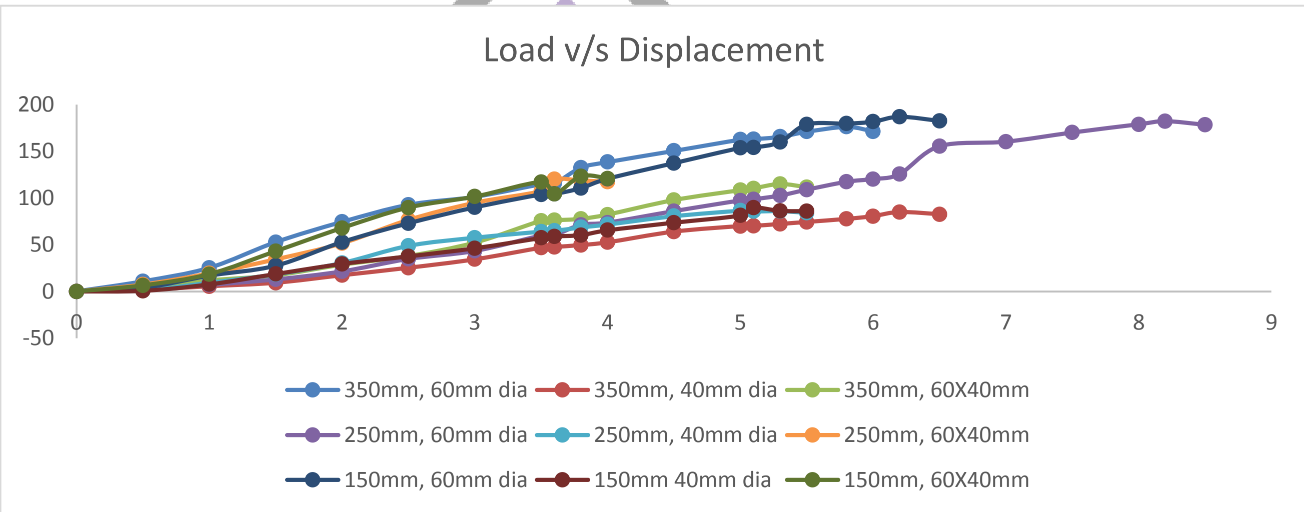
Table 8: Steel column filled with cement mortar (1: 3) ratio

Length (mm)	Circular 60mm diameter	Circular 40mm diameter	Rectangular 60X40mm
150	230.28	98.04	141.00
250	224.94	95.33	137.08
350	219.38	92.98	134.76

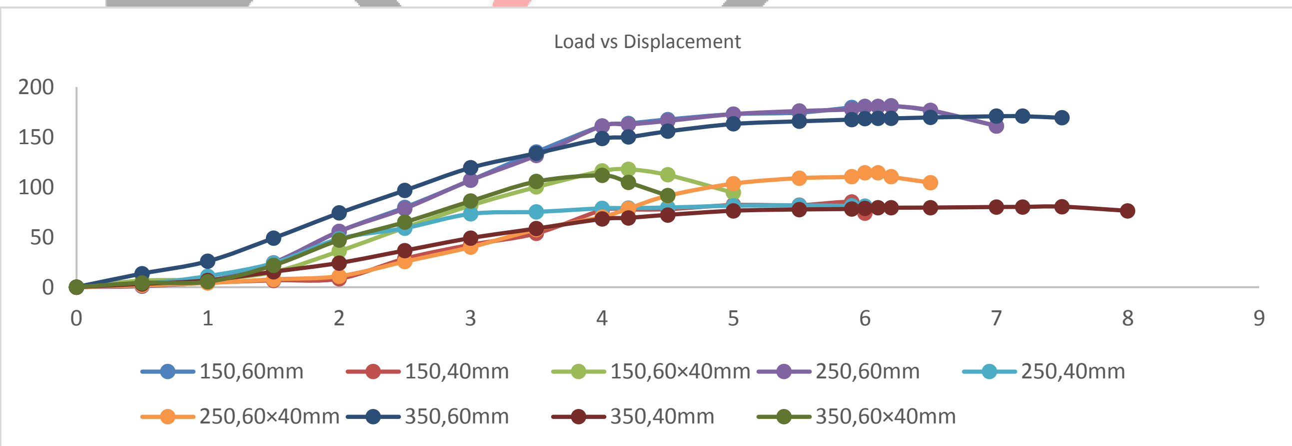
Table 9: Steel column filled with lightweight concrete M30

Length (mm)	Circular 60mm diameter	Circular 40mm diameter	Rectangular 60X40mm
150	343.25	145.64	194.41
250	303.24	137.82	186.34
350	274.07	129.480	175.02

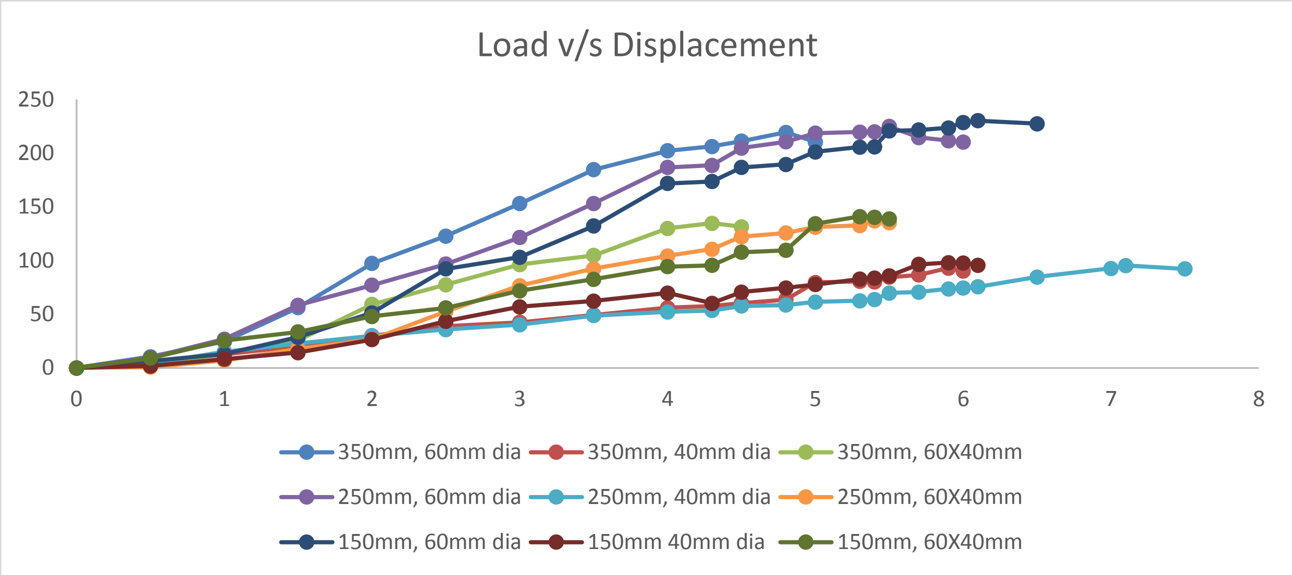
Graph 1: Empty steel column



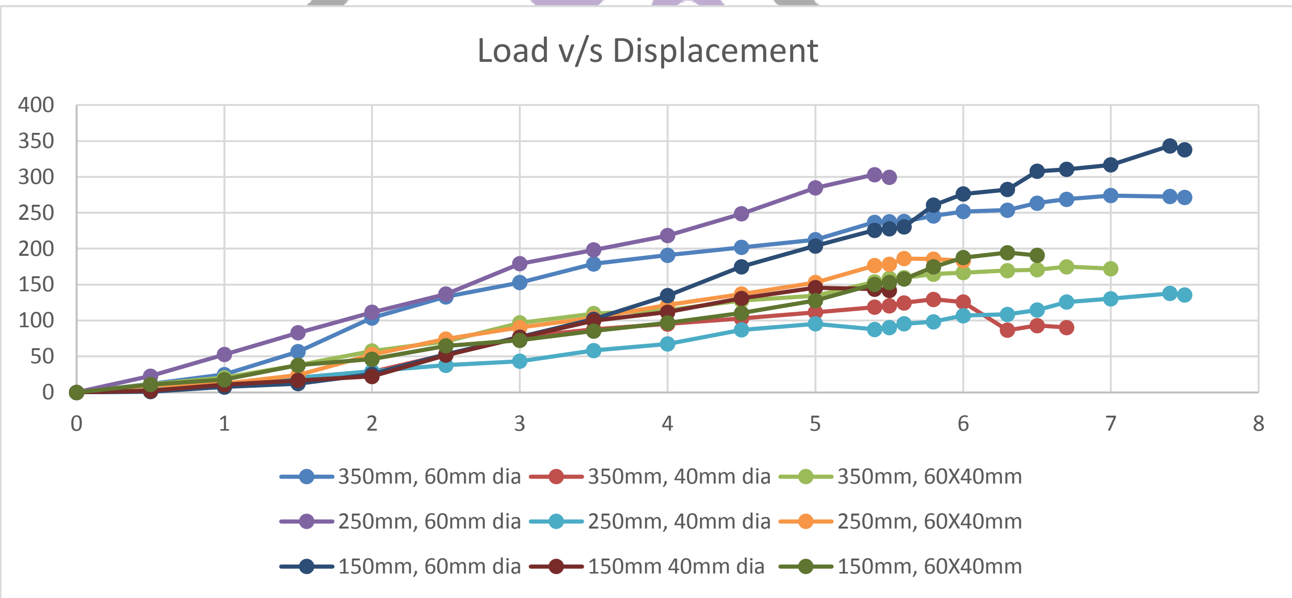
Graph 2: Steel column filled with sand



Graph 3: Steel column filled with cement mortar 1:3 ratio



Graph 4: Steel column filled with lightweight concrete M30



VI. CONCLUSIONS

1. Load carrying capacity of sand filled column was found to be increase by about 2.5% to 6%, in comparison with empty column of same length, same diameter, and same thickness.
2. Load carrying capacity of mortar filled column was found to be increase by about 11% to 29%, in compared with empty column of same length, same diameter, and same thickness.
3. Load carrying capacity of lightweight concrete filled columns was found to be increase by about 34%to 90%, in compared with empty column of same length, same diameter, and same thickness.

From above comparison between Empty v/s different conditions, the lightweight concrete filled with sell tubes M30 grade achieves more load carrying capacity .

Rectangular v/s Circular column 60X40mm v/s 60mm diameter

1. Empty steel column = 53%
2. Steel column filled with sand = 51%
3. Steel column filled with cement mortar = 63%
4. Steel column filled with lightweight concrete = 65%

Both the cross section are having good load carrying capacity but Circular column is achieved more load carrying capacity when camped to Rectangular section. Depending upon the semi zone the section can be selected to resist earthquake load.

Different Length (150, 250, 350mm)

Here we used three different length in these length 150mm length column achieved more load carrying capacity when compared to other two length ie, the Shorter column can carry more load and energy absorption.

Depending on the diamanté and thickness column can carry more load and energy absorption against seismic load. The larger the diameter and thickness in column increase durability and stability.

LWCFST

In experiment the lightweight concrete filled sell tubes cane be constructed in zone II and zone III seismic affected areas. The LWCFST is to reduce the self weight of column in this attempt it is obtained similar strength compared to composite concrete column. Hence cinders is fully replaced with coarse aggregate and obtained similar strength in concrete core in steel column. Cinders is a Igneous rock and volcanic material it is economical in construction.

REFERENCES

[1] "Development Light Weight Concrete by Blending with LECA and Cinder" from Research Gate. IJSRD - International Journal for Scientific Research & Development, Nagashree Balasubramanya, M.S. Ramaiah Institute of Technology,
[2] "Experimental Study on Light Weight Concrete-Filled Steel Tubes" Shehdeh Ghannam, Orabi Al-Rawi and Moh'd El-Khatieb et al,
[3] "Experimental Study on Light Weight Concrete-Filled Steel Tubes", Shehdeh Ghannam, Orabi Al-Rawi and Moh'd El-Khatieb, Jordan Journal of Civil Engineering, Volume 5, No. 4, 2011.
[4] "Experimental study of steel tabular columns filled with lightweight concrete", Dr. Rageed fatehi makki, Lecturer Department Of Civil Engineering, Engineering College, University of Kufa.
[5] "Standard Practice for Selecting Proportions for Structural Lightweight Concrete" (ACI 211.2-98) Reported by ACI Committee 211.
[6] "Characteristics study of lightweight aggregate and its application in concrete filled steel tubes", R. Ramasubramani, Aravind. G, Vajradeep Koshika, Komal Sai Kumar. K and Eshwar Chandra N