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CHARACTERSTIC STUDY OF LIGHT WEIGHT AGGREGATES AND ITS APPLICATION IN CONCRETE FILLED STEEL TUBES

R. Ramasubramani, Aravind. G, Vajradeep Koshika, Komal Sai Kumar. K and Eshwar Chandra N
Department of Civil Engineering, SRM University, Kattankulathur, Tamil Nadu, India
E-Mail: aravindgovind.3@gmail.com

ABSTRACT

The research on Concrete Filled Steel Tubes (CFST) has been done to study the construction of framed structures in high-rise buildings. As CFST give fine appearance, high-bearing capacity and ductility, fast construction, and reduce time and cost of the construction, there is no need for the use of shuttering during concrete construction. CFST comprises of steel hollow section of circular or rectangular or square shape filled with plain or reinforced concrete. Due to its many benefits the advantages of CFST have been widely exploited and have led to the extensive use of concrete filled tubular structures in civil engineering structures.

Keywords: CFST in high-rise building, use of brick bats, light weight aggregate concrete.

1. INTRODUCTION

1.1. General

Steel In low-rise buildings, to protect steel from fire and corrosion, steel columns are often encased in concrete. CFST columns can also be used for high-rise building for the sake of appearance. The important property of CFST columns is that they are stiffer than non-composite steel columns. Due to the high tensile strength and ductility of steel members, they are used for erection of the building and for resisting construction loads.

1.2. Objective of the study

- To study the characteristics light weight aggregate and find its suitability of application in concrete filled steel tubes.
- To conduct steel coupon test on CFST to determine yield stress.
- To cast and test Composite columns made of LWAC.
- To study the load - deflection behavior, load - strain behavior and failure modes of CFST.

1.3. Scope of the project

- To replace the natural coarse aggregate with Brick Bats for concrete that has to be filled in concrete filled steel tubes.
- The replacements are made as 5%, 10%, 15%, 20% and 25%.

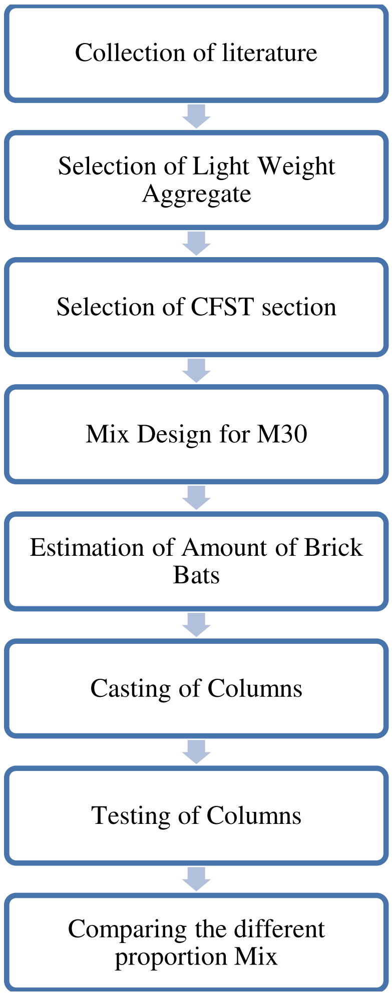
1.4. Need for this study

A large variety of materials is used to make the concrete in CFST. Study of Brick Bats has also been done in this paper. Although Brick Bats do not come under "light weight", it is used to make the low weight concrete. Hence, in this paper, study of Brick Bats is incorporated in CFST to make the concrete

2. METHODOLOGY

2.1. General

The methodology flow chart which explains the procedure follows in whole project that from start to end.



3. ANALYTICAL STUDY

3.1. Light weight aggregate concrete

The structural light weight aggregate concrete had been taken on the order of 1440 to 1840 kg/m³ compared to normal weight concrete a density in the range of 2240 to 2400 kg/m³. Lightweight coarse aggregate is used in making up the concrete mixture. Also, fine aggregate is used in the product. Lightweight aggregates used in structural lightweight concrete were typically expanded shale, clay or slate materials that had been fired in a rotary kiln to develop a porous structure. Air-cooled blast furnace slag was also used. There were fewer micro cracks in lightweight aggregate concrete and the uniform stress distribution at the micro level in lightweight concrete enhanced the durability in severe environments. The two types of light weight aggregates are natural light weight aggregate - Pumice, Diatomite, Scoria, Volcanic cinders, Sawdust, Rice husk, Oil Palm Shells, and artificial light weight aggregate - Artificial cinders, Brick bats, Coke breeze, Foamed slag, Bloated clay, Sintered fly ash, Expanded perlite.

3.2. Brick bats

Brick Bats are nothing but over burnt bricks that are left as waste. The unit weight of brick aggregate concrete is less than stone aggregates. The use of mix of brick aggregate and stone aggregate improves the strength and stiffness of concrete. The use of aggregate reduces the wastage and helps in the preservation of natural aggregate resources.

3.3. Specimen used

Cube of size 150 x 150 x 150 mm was used for making conventional concrete. Cylinders of 150 mm diameter and 300 mm height had been considered for making conventional concrete. Square Steel Hollow sections of 100 x 100 mm cross sections with thickness of 1.6mm and length of 500mm were also used. The outer surface of the specimens were coated with anti - corrosive coating. Table 1 shows the properties of the section.

Table-1. Properties of steel section.

$A_s = 6.2316$ cm^2	**$W_s = 4.89$ kg/m**
$I_{xx} = I_{yy} = 100$ cm^4	$Z_x = Z_y = 20$ cm^3
$S_x = S_y = 22.90$ cm^3	$R_x = R_y = 4$ cm

4. MATERIALS

4.1. Cement

The cement used for this study is Portland Pozzolanic Cement is conforming to Indian Standard IS 12269 - 1987 of grade 53. Specific gravity of cement, Fineness test, Consistency and Setting time of cement were determined and the values are shown in Table-2.

Table-2. Test on cement.

Test	Results
Specific gravity of cement	3.10
Fineness of cement	10
Consistency of Cement	33%
Initial Setting time of Cement	30Min

4.2. Fine aggregate

The sand is used as fine aggregate and it is collected from nearby area. The sand has been sieved in 4.75 mm sieve. Specific gravity of Fine Aggregate and its Fineness were determined and the values are shown in Table-3.

Table-3. Test on fine aggregate.

Test	Results
Specific gravity of Fine aggregate	2.62
Fineness of Fine aggregate	3.14

4.3. Coarse aggregate

The coarse aggregate is choosen by shape as per IS 2386 (Part I) 1963, surface texture characteritics of aggregate is classified as in IS 383 - 1970. The maximum size of aggregate taken is 20 mm. Specific gravity of coarse aggregate, Fineness, Impact Value and the Crushing value of Coarse Aggregate were determined and the values are shown in Table-4.

Table-4. Test on coarse aggregate.

Test	Results
Specific gravity of Coarse aggregate	2.74
Fineness of Coarse aggregate	8.04
Impact value of Coarse Aggregate	21.4%
Crushing value of Coarse Aggregate	37.9%

5. EXPERIMENTAL INVESTIGATION

5.1. Compression test

Compression strength of concrete f_{ck} = Load applied on the cube specimen / Gross area of the cube. Table-5 shows the test of compressive strength of concrete at 7 days for various Brick Bat replacements.

Table-5. Compression strength of concrete at 7 days.

Description	Compressive strength (N/mm^2)
M30	18.26
5%	23.60
10%	21.08
15%	20.75
20%	24.22
25%	28.77

Table-6 shows the test of compressive strength of concrete at 28 days for various Brick Bat replacements.

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Table-6. Compression strength of concrete at 28 days.

Description	Compressive strength (N/mm^2)
M30	41.20
5%	37.37
10%	33.91
15%	30.32
20%	39.20
25%	41.06

5.2. Modulus of elasticity test

Modulus of elasticity of concrete was tested for 7 days were conducted and the results are shown in Table-7.

Table-7. Modulus of elasticity of concrete at 7 days.

Description	Modulus of elasticity (N/mm^2)
M30	17610
5%	21330
10%	20494
15%	19937
20%	21412
25%	23168

Modulus of elasticity of concrete was tested for 28 days were conducted and the results are shown in Table-5.2.2.

Table-8. Modulus of elasticity of concrete at 7 days.

Description	Modulus of elasticity (N/mm^2)
M30	26870
5%	25554
10%	24627
15%	23214
20%	25967
25%	26453

6. TESTING OF CFST

The CFST specimens that were casted for M30 concrete, 5%, 10%, 15%, 20% and 25% BB replacements were cured for 7 days and 28 days. They were tested for the ultimate load carrying capacity. The testing was done in a loading frame of capacity 300 tones. The load was measured. Deformation and strain of the column were measured by using dial gauges. At first, the column was kept in the CTM for testing. Dial gauge was fixed in bottom of the specimen. For every 10kN increase of loads by CTM, Deflection and strain values were noted using dial gauge. Now the arrangement was ready for performing the experiment and the dial gauges were set to zero. Then the axial load was constantly applied through the hydraulic jack. The column was subjected to a constant deflection till the ultimate load was reached. Buckling were visible all-round the column.

Figure-1. Specimen in compression testing machine for testing.

6.1. Comparison of theoretical vs experimental load at 7 days

Ultimate load carrying capacity comparison of theoretical load and experimental load for CFST @ 7 days for brick bat replacement.

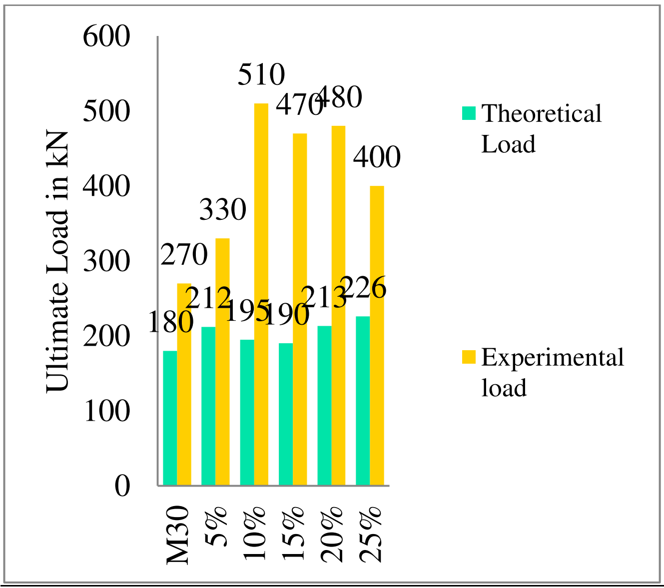

Figure-2. Comparison of theoretical vs experimental load at 7 day.

6.2. Comparison of load vs deflection for 7 days curing

The load vs deflection plot for each of the specimens are plotted and made as single graph and is shown in Figure-2.

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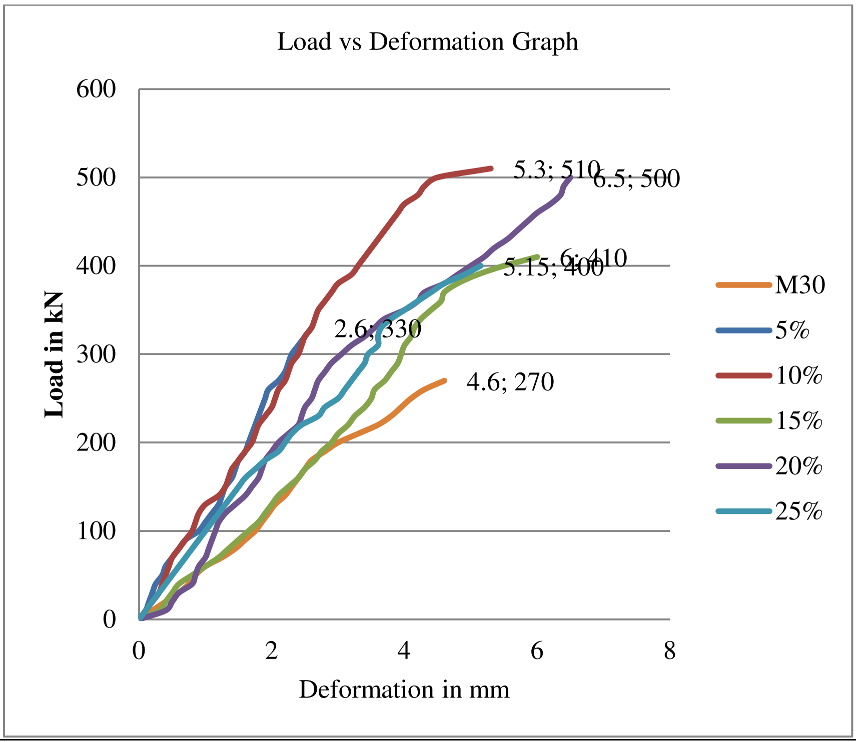

Figure-3. Load vs deflection for 7 days.

Figure-4. Buckling of 28 day specimen.

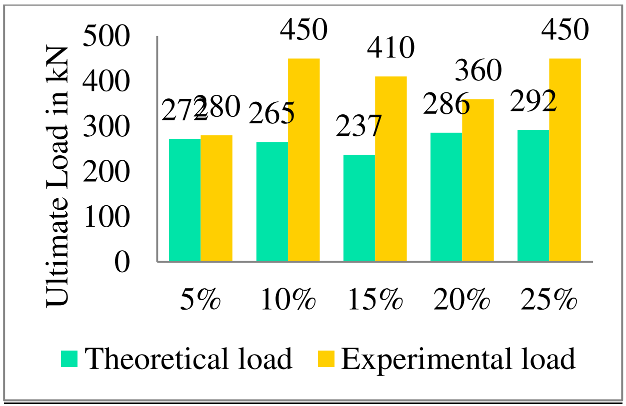

Figure-5. Comparison of theoretical vs experimental load at 28 days.

6.3. Comparison of theoretical vs experimental load at 28 days

Ultimate load carrying capacity comparison of Theoretical Load and Experimental Load for CFST @ 28days for Brick Bat replacement is shown in Figure-3.

6.4. Comparison of load vs deflection for 28 days curing

The load vs deflection plot for each of the specimens are plotted and made as single graph and is shown in Figure-4.

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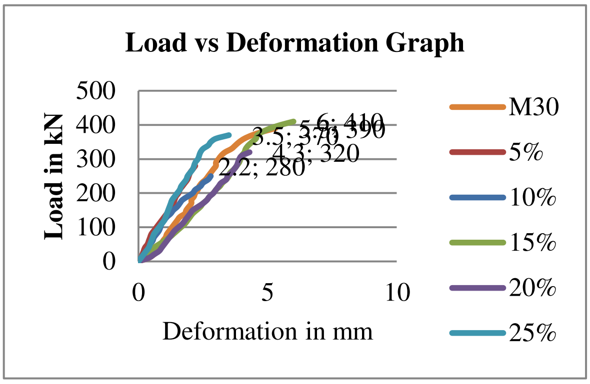

Figure-6. Load vs deflection for 28 days.

7. FAILURE OF COLUMNS

Column fails by Buckling. The initial buckling appeared at one of the top or bottom faces of the column and slowly propagated to the entire depth of the face. For 7 days curing of various Brick Bat replacements, Buckling occurs at only one end. Either at top or at bottom. Buckling occurs in the middle of section during 28 days curing. The column stops to take load at the start of the Buckling. Lateral deflection for column is compared for both experimental and theoretical study.

7.1. Load vs deflection graph for M30 concrete at 7 days curing

The comparative graph for analytical deflection and Experimental deflection is shown in Figure-5.

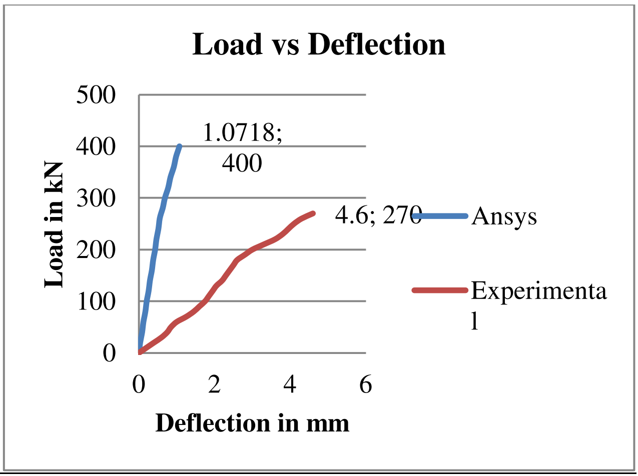

Figure-7. Load vs deflection graph for M30 concrete at 7 days curing.

7.2. Load vs deflection graph for M30 concrete at 28 days curing

The comparative graph for Analytical deflection and Experimental deflection is shown in Figure-6.

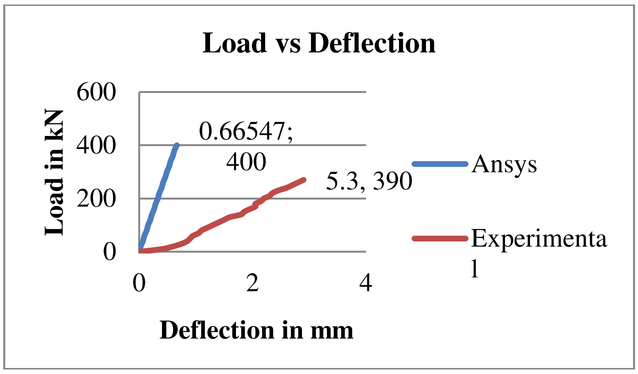

Figure-8. Load vs deflection for M30 at 28 days curing.

8. CONCLUSIONS

It has to be concluded that ultimate load in the columns are better than theoretical load. Also, while taking out the results, it has to be found that the deflection using theoretical is very low as compared with experimental work. Hence, the deflection from numerical investigation shows linear behavior whereas experimental shows nonlinear behavior. While testing with local buckling, the columns begun to fail. The another point appeared was that with the use of Brick Bats the 7 days specimen showed better strength than 28 days and anti-shrinkage materials can be use while replacing coarse aggregate with Brick Bats. For 7 days curing of columns, local buckling occurs either at top or at bottom whereas 28 days curing columns shows it in the middle.

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