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Experimental Study on Natural and Synthetic Fibre Reinforced Concrete in CFST Column

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***Abstract*: A Concrete-Filled Steel Tube (CFST) column comprises steel hollow section of circular or rectangular cross section filled with plain or reinforced concrete. Steel confinement helps to reduce columns size and confined columns possess excellent earthquake-resistance and fire resistance properties. The study was conducted on 18 specimens with artificial (Glass fibre) and natural (Coir fibre) fibres with varying volume percentages of 0, 0.50, 0.75, 1.00 and 1.25. Mild-Steel tube specimens are of diameter 5cm, height 60 cm and thicknesses 3 mm. This paper presents an experimental study on glass and coir fibre reinforced concrete filled steel tube short columns under compression.**

***Keywords*: CFST Column, CFRCFST, Deformation, Fibres, GFRCFST, Ultimate Load.**

1. Introduction

Concrete filled steel tube consists of steel hollow section of circular or rectangular cross section filled with plain or reinforced concrete. CFST structure offers numerous structural benefits, including high strength and fire resistances, favorable ductility and large energy absorption capacities. In recent years, many steel and CFST structures have been found to be suffering from a variety of deteriorations. There are several strengthening or remedy techniques that can be applied to improve performance including section extension, outer bonding using steel plates and strengthening of concrete using fibres. Fibre reinforced concrete is light weight, durable, and resistant to corrosion and premature spalling of concrete cover. In recent years, there have been many investigations on the use of fibres to strengthen the concrete structures emerged.

2. Materials property

Circular hollow mild mild-steel tube having an inner diameter of 50 mm was used in this study. The thickness of the hollow steel tube was about 3.0mm and the height of the stub column was 600mm. The yield strength of the mild steel was 250N/mm2. The concrete mix proportion was designed using the IS method to achieve strength of 20 N/mm2, and the mix ratio was 1: 2.1: 2.17. Ordinary Portland cement of 53 grade was used in this study as a binding material. The specific gravity of the cement was tested, and was found to be about 3.1. The M-sand passing through 4.75 mm was used as fine aggregate. The specific gravity of the sand and the coarse aggregate was about 2.67 and 2.76. Concrete cubes specimens were cast for each batching and tested at the age of 28 days to determine the compressive strength of the concrete. The average compressive strength of the concrete was about 29.4 N/mm^2. Glass (artificial fibre) and coir (natural fibre) fibres were used to strengthen the infilling concrete. These fibres when added to concrete it improves properties such as fracture toughness, ductility, impact resistance and reduces the plastic cracking in concrete structures.

Fig. 1. Coir fibre

Fig. 2. Glass Fiber

3. Experimental investigation

An extensive experimental research has been done to study the axial compressive behavior of circular CFST short column in filled with different types of fibre reinforced concrete such as glass fibre reinforced concrete (GFRC) and coir fibre reinforced concrete (CFRC) with different ratios. 18 specimens were casted in glass and coir fibre with different volume percentages of 0.00, 0.50, 0.75, 1.00 and 1.25.

Fig. 3. CFST Column Specimens

Fig. 4. Materials with glass fibre before mixing

Fig. 5. Materials with Coir Fibre Before Mixing

4. Test setup and test procedure

The test set up consists of a Universal Testing Machine of (compression testing machine) 600 kN Capacity. The test specimens were placed appropriately on the center of the end bearing plates of compression testing machine. The specimens were instrumented to measure the longitudinal axial compression. Axial load was applied to the column. The axial deformation of the column was measured using a dial gauge which was kept on top of the jack. The column was then tested to failure by applying the compressive load in small increments, and observations of occurrences such as axial deformation and ultimate load were carefully recorded. The test setup was shown in figure 5.7. At every 0.5 mm axial deformation increment, axial load was measured. Axial deformation was measured using dial gauge and the ultimate loads were recorded.

Fig. 6. Test setup for compression test

5. Test results and discussions

The behavior of natural and artificial fibre reinforced CFST columns can be observed by plotting the load deformation curve. It is observed that the strengthening of in-filled concrete using glass fibre & coir fibre provide greater load carrying capacity to the CFST columns and improved ductility.

A. *Ultimate Loads of GFRCFST Columns*

Table 1
Ultimate Load of GFRCFST Columns

Glass Fibre (%) in CFST Columns	Ultimate Load (kN)
0.00	200
0.50	214
0.75	222
1.00	217
1.25	216

Table 1 gives the result of ultimate loads of CFST specimens reinforced with varying percentage of glass fibre. In this the ultimate load obtained was 222 kN corresponding to 0.75 % glass fibre reinforced concrete filled steel tube.

The behaviour of CFST specimens strengthened using various percentage glass fibres can be observed by plotting the load deformation curve.

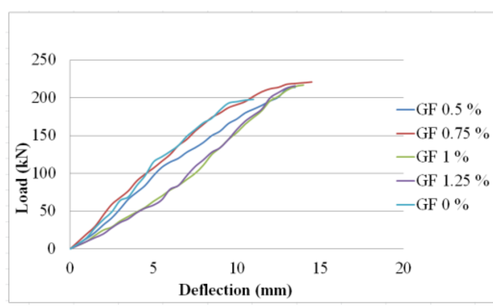

Fig. 7. Load deformation curve of GFRCFST columns

Figure 7 shows load deformation curve of CFST column in-filled with different percentage glass fibre (0.00%, 0.50%, 0.75%, 1.00% and 1.25%). From the graph it is clear that 0.75 % is the optimal amount of the glass fibre. Load deformation curve of GFRC filled steel tube columns clearly indicated improved ductility when compared to normal filled concrete columns.

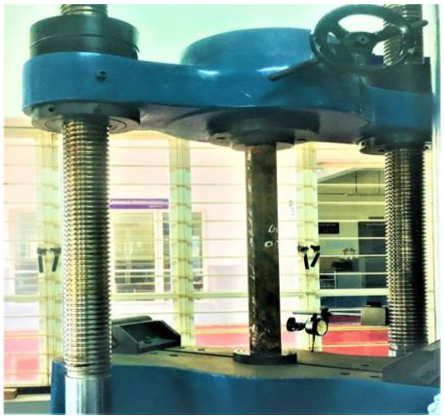

Fig. 8. Specimen with 0.75 % glass fibre Before Loading

Fig. 9. Specimen with 0.5 % glass fibre after loading

B. *Ultimate Loads of CFRCFST Columns*

Table 2
Ultimate Load of CFRCFST Columns

Coir Fibre (%) in CFST Columns	Ultimate Load (kN)
0.00	200
0.50	208
0.75	211
1.00	217
1.25	215

Table 2 gives the result of ultimate loads of CFRCFST columns with varying percentages of coir fibre. In this the maximum ultimate load obtained corresponding to 1.00 % coir fibre reinforced concrete filled steel tube. The ultimate load obtained was 217 kN.

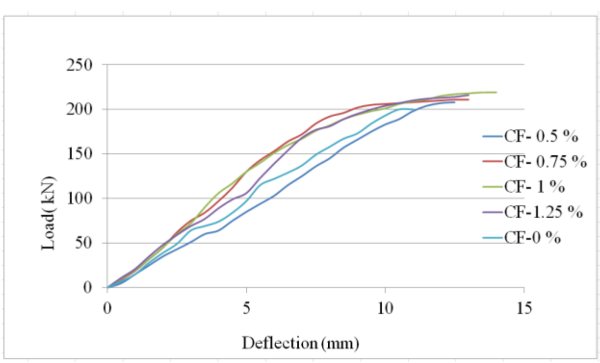

Fig. 10. load deformation Curve of CFRCFST columns

Figure 10 shows load deformation curve of CFST column in-filled with different percentage coir fibre (0.00%, 0.50%, 0.75%, 1.00% and 1.25%). From the graph it is clear that 1.00 % is the optimal amount of the glass fibre. Load deformation curve of CFRC filled steel tube columns clearly indicated improved ductility when compared to normal filled concrete columns.

Fig. 11 Specimen with 1 % glass fibre before loading

Fig.12. Specimen with 1 % glass fibre After Loading

The ultimate load carrying capacity increased in case of the GFRCFST & CFRCFST specimens comparing with control specimens. It can be observed that strengthening of in-filled concrete using glass and coir fibres in CFST columns improves the load carrying capacity.

6. Conclusions

- Strengthening of in-filled concrete using natural and synthetic fibres provide greater load carrying capacity to the CFST columns.
- From experiments, the GFRCFST shows best performance for a dosage of 0.75 % where as CFRCFST for 1.00 %.

- GFRCFST & CFRCFST columns exhibit higher ultimate loads in comparison with control specimen.
- Addition of fibers improves the composite action between the steel tube and concrete core, and leads to a higher concrete core strength enhancement.
- The ultimate load carrying capacity increased by11 % and 8.5 % by the inclusion of glass & coir fibre than that of control specimen.
- From these series of tests result confirms that, strengthening of In-filled concrete plays a major role in the enhancement of ductility, shear frictional resistance, ability of resisting local buckling and interface bonding condition of CFST short columns.

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