CONCRETE FILLED STEEL TUBULAR COLUMN: A REVIEW

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ABSTRACT

In a CFST column steel tube surrounds the concrete. Thus the steel tube acts as both longitudinal and transverse reinforcement hence it is subjected to biaxial stresses. In addition to this the steel tube also acts as confinement for the concrete. The main advantage of CFST column is that the steel tube in it acts as a permanent confinement for the concrete and also prevents spalling of concrete. Similarly, the concrete inside the steel tube prevents local buckling of tube inside, hence adds to the strength of the column. In general, as compared to conventional reinforced concrete column, CFST columns have more stiffness and load carrying capacity due to the combined effect of concrete and steel tube. In this review paper, a study is conducted on the behaviour of CFST columns subjected to failure under axial load. The results obtained were compared with the codal provisions and by finite element designing of the CFST column by ANSYS.

Keywords: Stainless steel, Mild steel, CFST, axial loading, local buckling, failure.

I. INTRODUCTION

The basic concept of Concrete Filled Steel tube (CFST) is that when the tube made of steel is provided as a casing outside the concrete filling, its properties are modified by to combined effect steel as well as concrete. In CFST concrete core of high as it contains goodness of both high strength steel as well as strength of high strength concrete. The most common CFST column.

It possesses both static plus the earthquake resistant properties. It is more ductile and absorbs larger energy thus making it perfect for earthquake resistant buildings.
CFST members are mostly used as supports in high buildings. Due to their earthquake resistant properties it is perfect for structural columns, where they are subjected to high shear stresses along with wind and seismic forces. In past numerous studies are done to study the behaviour of CFST columns under axial loads and bending stresses but still the research done is not satisfying all the areas of CFST. Still some gap is left in the researches. If high strength materials are used, the properties of the columns and the economy of the high buildings are greatly affected in a good way. If high strength concrete is used in CFST column, it attains high damping as well as stiffness is increased. Similarly if we use high strength steel for steel tube, smaller sections is used to carry the same load thus improving economy which is important in projects. The important aspect of CFST column is that due to interaction between steel casing and infill concrete, the concrete prevents and postpones local buckling in the steel and the steel surrounding the concrete prevents it from spalling providing confinement to the concrete and increasing its compressive strength. Mainly Concrete Filled Steel Tubes are used in seismic designs, roofs of storage tanks, and piers in bridges and many other structures. CFST have been used in a bridge in Quebec. This bridge having a span of sixty metres contains steel tubes as diagonal truss members in which high strength concrete in form of powder is compressed in steel tubes.

II. LITERATURE REVIEW

A significant amount of research work has been done on studying the concrete filled steel tube by many investigators using different techniques such as,

1. Muhammad Naseem Baig, FAN Jiansheng NIE Jianguo

In this paper experiments were carried out on 28 specimens out of which 16 were filled with concrete and the rest 12 were hollow. An experimental study has been carried out to study the effect and behaviour of concrete filled steel tubes under only axial loads.
The results that were obtained experimentally were also compared with other previous published results and theoretical procedures. An extensive analytical study was also conducted for comparison of the results.
The 28 Specimens that were used consisted of 12 concrete filled specimens and 12 hollow steel tubes. Load carrying capacity of the column was found out experimentally. This specimen had length to diameter ratio lying between 4 to 9.

2. De Nardin and A. L. H. C. El Debs

This study was done to check the applicability of design codes to find out the load carrying capacity and their accuracy. The material was analysed for its behaviour. The authors had carried out investigations on concentric specimens and find out the pattern of their failure along with their load capacity. This paper is mainly dedicated to the effect of thickness and shape of the steel tube on the load capacity of the specimens.
They also studied the behaviour of concrete filled tubes formed by cold rolled steel. Rectangular specimens were also studied in this study. There were six short columns that were subjected to loading which was concentric in nature. Square, rectangular as well as circular sections of different thickness were studied and all of them were filled with concrete of high strength.
This work gave the results for ductility, maximum load for failure and how the CFST columns behave under concentric loading. LVDT were used to measure vertical shortening for all the four faces of the specimen.

3. Georgios Giakoumelis Dennis Lam

This study depicts the strength and behaviour of CFST filled with concrete of different strength under the effect of axial load. Along with this, the effect of tube thickness on the strength of column, Effect of confinement of steel on concrete and bond between concrete and steel was studied. The results were compared with the codal provisions given in Eurocode 4, American codes and Australian codes. It was evident that the value of the experiments was found out to be greater than those that were obtained by all the three codes. Suggestions were made to the American and Australian codes to include effect of confinement and that there should be a value that would differentiate between the behaviour of the sample that were greased and ungreased from the inner side. The results were in agreement with Eurocode 4. The tests were within the range of 17% by Eurocode 4. For high strength concrete very good results are obtained.

4. Dalin Liu, Wie-Min Gho Jie

They experimentally studied the load capacity of the stub columns having concrete filled steel hollow section (CFSHS) the results obtained from the experiments were compared with those of the codes. It was evident that as the cross sectional area increases, the strength of the stub columns decreases. The results were found to be same as the previous researches. There were 22 rectangular CFSHS columns having aspect ratios 1, 1.5 and 2 were subjected under concentric loading till failure was reached. High strength materials were used in construction of the tubes. It was found that the concrete had strength 70.8MPa and 82.1 MPa whereas the yield strength of steel was at 550MPa.A 5000KN test rig having linear voltage displacement transducer (LVDT) was employed to test each of the specimens and axial shortening was measured. At each face of thee the specimen, two single element strain gauges were used at mid height for calculations of strains.

By comparison from codes, it was found out that the American Concrete Institute and AISC gives lesser values of loads for failure. The values obtained were lesser by 14% and 16% respectively. It was because in these codes, the effect of confinement is not taken into account and due to this confinement actual value is increased. While using the Eurocode 4, the values differ only by 6%. As compared to circular and square specimen, the rectangular specimen showed very little variation in strength.

5. Lin-Hai Han, Guo-Huang Yao

In this study, the effect of compaction on the strength of CFST column is investigated. It is well understood that for normal concrete, compaction plays an important role in strength. But what role it plays in CFST column, this is investigated in this research. This research finds out the effect of the method of compaction on the strength as well as samples by different method of compaction of concrete are prepared. The obtained results are compared with the values given in codes. It is depicted that the concrete compaction method and efficiency affects the strength as well as the interaction between the concrete core and steel tube.

A sum of 35 samples was tested under eccentric as well as concentric loading. Both maximum loading capacity and the behaviour up to failure was studied. The concrete used was of characteristic compressive strength of 22 MPa after 28 days. Cubes were well compacted by hand and poker vibrator (3layers having 40 strokes for every layer).A total of eight transducers was used for calculation of deformation at each face. In addition to this two transducers are used for measuring axial deformation. The increment in load was about one -tenth of the estimated load capacity. For 2-3 minutes. It was fund that due to lesser efficiency of buckling, the specimens that were compacted by hand had more buckling and steel tube buckled earlier. It was found that the specimens reached maximum load within 30 minutes and 1.5 hours were taken for failure. All specimens were loaded to failure. Each test took approximately 30.

Thus, the strength obtained by poker vibrator was much more than that compacted by hand. The strength of samples compacted by poker vibrator was 3 to 30% higher than that compacted by hand.

6. Bao-Chun Chen

This paper briefly introduces the present situation of concrete filled steel tube CFST arch bridges in China. More than 200 CFST arch bridges were investigated and analysed based on the factor of type, span, erection method, geometric parameters, and material. Some key issue in design calculation were presented, such as check of strength, calculation of section stiffness and joint fatigue strength. It will provide comprehensive references of CFST arch bridge for the bridge designers and builders.

7. Quin Quan Liang

This paper presents an effective theoretical model for nonlinear inelastic analysis of circular CFST short column under eccentric loading. Accurate material constitutive relationship for normal and high strength concrete confined by under normal or high strength circular steel tubes are incorporated in the theoretical model to account of confinement effects that increase both the strength and ductility of concrete. The fundamental behaviour of circular CFST column with various diameters to thickness ratios, concrete compressive strength, steel yield strength and sectional shapes is studied using the vertical theoretical model. Based on extensive numerical studies, a new design model for determining the ultimate pure bending strength of circular CFST column is proposed.

III. CONCLUSION

Here in investigation, an investigation was carried out to determine the behaviour in CFST columns and then compare them with the codal procedures for designing in axial loading. Along with concrete filled in tubes, plain concrete specimens were also tested which had same dimension as the steel tube. By roughening the surface of some of the steel tubes, and greasing inside surface of some tubes, the behaviour of bond between steel tube and concrete core is also studied. The results obtained are compared to codes, namely, ACI, EC4 and LRFD. The codes gave the values for the experiment. Finite Element Analysis (FEA) is also done by using ANSYS for linear analysis. ANSYS gave the stress distribution pattern and the pattern of deflection. Some of results that are already published are also used to verify the results.

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