

A REVIEW ON COMPARATIVE STUDY AND BEHAVIOUR OF CFST COLUMN

Vinay N. Lumbhani¹, Grishma Thaker², Disha parmar³

¹Student, m.tech, Civil Engineering Department, ChhotubhaiGopalbhaipatel Institute of Technology, bardoli, Gujarat, india.

²Assistant professor, Civil Engineering Department, ChhotubhaiGopalbhaipatel Institute of Technology, bardoli, Gujarat, india.

³Assistant professor, Civil Engineering Department, ChhotubhaiGopalbhaipatel Institute of Technology, bardoli, Gujarat, india.

Abstract —Concrete filled steel tube is gaining more popularity now a days in construction field. concrete filled steel tube is component with good performance resulting from the confinement effect of steel with concrete and design versatility. Concrete-filled steel tubes are gaining increasing prominence in a variety of engineering structures, with the principal cross-section shapes being square, rectangular and circular hollow sections. Columns are designed to resist the majority of axial force by concrete alone can be further economized by the use of thin walled steel tube. The study about the behaviour and the characteristics of CFST columns is the prime need. This Paper present a review about the investigation done on behaviour of concrete filled steel tube columns by various researchers with reference to various codal provisions.

Keywords- behavior of cfstcolumn ,Design codes, seismic behavior, Cross section component, Analytical and numerical studies, Design standards .

I. INTRODUCTION

Concrete filled steel tubes (CFST) are Structural member. CFST structure is a type of the composite steel-concrete structures used presently in civil engineering and consists of steel tube and concrete core inside it. In which hollow steel section is filled with high strength concrete. Combining the advantages of both hollow structural steel and concrete. Composite columns are structural members, which are subjected mainly to axial compressive forces and end moments. The general term 'composite column' refers to any compression member in which the steel element acts compositely with the concrete. so that both elements contribute to the strength.

Rectangular concrete filled steel tubes (RCFST) and Circular concrete filled steel tubes (CCFST) are being used widely in real civil engineering projects due to their excellent static and earthquake resistant properties, such as high strength, high ductility and large energy absorption capacity. Concrete filled steel tubes (CFST) are also used extensively in other modern civil engineering applications. When they are used as structural columns, especially in high-rise buildings, the composite members may be subjected to high shearing force as well as moments under wind or seismic actions.

It may be Noted here that mechanical and economic benefits can be achieved if CFST columns are constructed taking advantages of high-strength materials. For example, high-strength concrete infill contributes greater damping and stiffness to CFST columns compare to normal strength concrete. Moreover, high-strength CFST columns require a smaller cross-section to withstand the load, which is appreciated by architects and building engineers. New developments, including the use of high strength concrete and the credit of the enhanced local buckling capacity of the steel has allowed much more economical designs to evolve. The main economy achieved by using high strength concrete in thin steel casings is that the structural steel cost is minimized and the majority of the load in compression is resisted by the high strength concrete .However, bare steel or reinforced concrete columns are still used more extensively than CFSTs due to the lack of knowledge and experience that Engineers have with CFST structural systems.

Different design regulations were produced for various cross-sections of CFST structures. Different approaches and design philosophies have been adopted in different design codes (Xinbo et al. 2006). In China, there are circular CFST structure design regulation, square structure design regulation, rectangular structure design regulation, and circular

hollow CFST structure design regulation. In these regulations, the design methods are different. In China and Japan, the standard for designing the composite columns is based on a simple method of superposition that uses the allowable stresses of the materials or then working stress method. ACI-318 adopts the traditional reinforced concrete approach. AS 3600:1994 also uses the concept of reinforced concrete.

1.1. Advantage of using CFST column.

- The concrete infill is confined by the steel tube. This confinement effect increases the strength and ductility of the concrete core in steel tubes.
- The combined capacity of the steel and concrete significantly increases the stiffness and ultimate strength of CFST columns which makes them very suitable for columns and other compressive members.
- The steel tube serves as longitudinal reinforcement and permanent formwork for the concrete core, which results in rapid construction and significant saving in materials.
- The steel tube can also support a considerable amount of construction and permanent loads prior to the pumping of wet concrete.

II. LITERATURE REVIEW

[A] “Strength of Concrete Filled Steel Tubular Columns” Muhammad Naseem Baig, FAN Jiansheng, NIE Jianguo, tsinghua science and technology issn 1007-0214 05/15 pp657-666 volume 11, number 6, december 2006.

Author presents an experimental study on the behavior of short concrete-filled steel tubular columns (CFT) axially loaded in compression to failure. The test results are compared with the theoretical results and previous studies. An analytical study was also done and compared with the results. A total of 28 specimens (16 were filled with concrete and 12 were kept hollow) with different cross-sections were tested to investigate the load capacity. The length-to-diameter ratios of these columns were between 4 and 9. Parameters for the tests were tube shape and diameter-to-thickness ratio. Some of the concrete-filled columns had internal bracing of 3Ø deformed bars. The steel pipes were made up of mild steel of grade 36 (250 MPa) thickness varying from 1.98 mm to 10 mm. Also, the sizes of pipes available are from 50-mm diameter to 450-mm diameter. Lengths of pipes available are 6 m each but only with the circular cross section. Tests carried out on 200-mm-long steel tubes subjected to axial compression gave a mean compressive strength of 250 MPa. For each batch of concrete, three concrete cylinders were cast and tested. Cylinder sizes were 150 mm diameter and 300 mm length. The vertical displacement was measured by a displacement transducer.

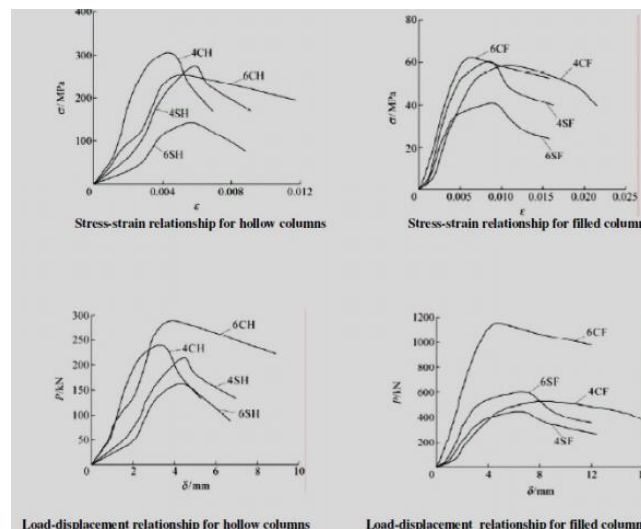


Figure 1. Graph result of experiment.

Author conclude that a set of detailed experiments have been conducted on hollow and filled short steel tubular columns. The experiments have shown that strength increases in circular columns much more than in square columns. Increase in strength of circular columns of one series was more than 60%. Local wall buckling was observed in square columns both

hollow and filled. The strength increase may be due to the good quality of the concrete caused by the retention of moisture. Almost all filled columns behaved in a fairly ductile manner. Further experiments should be carried out on double skinned short columns DSCFTs filled with normal strength concrete and having different geometries.

[B] “Elastoplastic Behavior of Panel Zone in Steel Beam-to-Concrete Filled Steel Tube Column Moment Connections”, Toshiyuki Fukumoto and Koji Morita, 10.1061/ASCE0733-94452005, 131:121841, 2005.

Author conducted test on the panel zone within steel beam to concrete filled steel tube CFT column moment connections made from high-strength material to investigate their elastoplastic behaviour. The writers propose a nonlinear shear force deformation model for the panel zone in beam-to-column CFT connections for predicting the elastoplastic behavior of the panel zones. The proposed model includes a superposed model based on a trilinear shear deformation relationship for the steel tube superposed on one for the concrete core, and a simple model provided as a trilinear model having a yield strength point and an ultimate strength point for this panel zone, as a practical model for design. The writers also propose a method for evaluating load resistance, in which a new theoretical compression strut mechanism is utilized, taking into account the confinement of the tube flange. The results predicted using the superposed and the simple model are found to agree approximately with the experimental results up to a large shear deformation of 0.04 rad.

[C] “Recent developments on concrete-filled steel tube members in japan”, Shosuke Morino, Earthquake Engineering and Engineering Seismology, Vol. 4, No.1 2003.

Obtain the Recent developments in Japan on the research, design and construction of a framing system consisting of concrete-filled steel tube (CFT) columns and H-shaped beams are presented, introducing the work done in a five-year research project on CFT column system carried out as a part of the U.S.-Japan Cooperative Earthquake Research Program. He gave equation for the Ultimate strength for the centrally loaded circular CFT column. And compare with the experiments and give exact equation for it.

[D] “Performance of Short CFST Columns using SCC with Blended Cement” ASCE Structures Congress 2006, Joint ASCE/SEI Conference, May 18 – 20, 2006, St Louis, Missouri USA, 2006.

Author Give Research on structural performance of confined self-consolidating concrete (SCC) tubes as short columns is scarce and there is little data available. Similarly there is little research on use of blended cement containing agricultural waste i.e. rice husk ash as cementations material in normal/high strength concrete. Limited research has shown better performance of such blended cements with increased strength by up to 30% and improved durability, reduced permeability and shrinkage. Its behavior under confined conditions is still to be studied. This paper provides valuable research in this area with special focus on the use of blended cement SCC confined in steel tubes applicable for columns of bridges, buildings as well as in deep foundation applications. This paper presents an experimental study on the behavior of short, SCC, with blended cement containing 75% ordinary Portland cement and 25% rice husk ash, filled steel tubular columns axially loaded in compression to failure and comparing the results with testing on similar hollow tubes and tubes filled with normal concrete. Almost 350 to 460% increase in strength was observed by filling steel tubes with SCC (containing blended cement) in square and circular tubes respectively. Failure strains were also reduced by 40 to 45%. Smaller steel sections and use of blended cement containing rice husk ash increases efficiency, reduces cost of construction along with reducing the disposal problems of this massively produced agricultural waste in the rice growing regions.

[E] “Experimental Study of the bearing capacity of double CFST member” Zhongfu XIANG and Yang YU Bearing Capacity of Roads, Railways and Airfields – Tutumluer & Al-Qadi (eds) © 2009 Taylor & Francis Group, London, ISBN 978-0-415-87199-0 in 2009.

Author Investigated the bearing capacity of double CFST (concrete filled steel tube) members is analysed and simulated tested, aim at SFST member sections which is composed by coating steel tube covered outside conventional CFST with the stress state that inner CFST have initial stress, this article puts forward the ultimate bearing capacity calculation formula. It has a positive reference value for double CFST arch ring reinforcement design of this kind. They give

equation for the bearing capacity of the single CFST column and for Double CFST column and compare with the experimental results.

[F] “Finite Element Approach To Study The Elastic Instability Of Concrete Filled Steel Tubular Column Under Axial Loads” Veerabhadragouda. P. Patil ISSN 2250-2459, Volume 2, Issue 11, November 2012.

Author obtain behavior of Concrete filled steel tubular column on the compressive response due to axial loads. Three-dimensional nonlinear finite element models are developed to study the force transfer between steel tube and concrete core. The nonlinear finite element program ABAQUS 6.8 is used. The interaction between steel tube and concrete core is the discussing issue for understanding the behavior of concrete-filled steel tube columns (CFST). The elasto-plastic model is based on the Drucker-Prager yield criterion. A comparison of experimental failure loads with the predicted failure loads in accordance with the method described in Euro code Part-4 showed good agreement for axially loaded columns. He studied, two and three dimensional finite element models and developed to investigate the load transfer by the concrete core of concrete filled steel tubes under axial compression.

[G] “Effective use of U-Link in Concrete Filled Steel Tubes Beams” Madiha Z.J. Ammari, Moayyad M. Al-Nasra1 and Abdelqader Najmi (Online): 2319 – 6734, ISSN (Print): 2319 – 6726 Volume 2 Issue 4 || April. 2013 || PP.59-66 2013.

Author give a new technique of U-links in concrete filled tube, to join the steel tube with the concrete core in large confinement of the concrete core. They tested two tubes of CFST for the study of the use of the U-link as additional reinforcement columns subjected to the flexure loads. They conclude that inside of the concrete shown no crushing of the concrete when the columns were cut open at the location of the plastic hinge. Strain measurements revealed that the compressive strain in concrete was 5-6 times the concrete crushing strain. The experimental data showed that the use of U-link as additional reinforcement in the concrete filled tubes improved the beam flexural capacity, stiffness, and ductility.

[H] “Improved behavior of concrete-filled-Steel-tube columns with external confinement” Johnny Ching Ming ho Australian Earthquake Engineering Society 2011 Conference, Nov 18-20, Barossa Valley, South Australia.

Obtain the new technique for minimizing imperfectness of steel concrete interface bonding at the elastic stage as steel dilates more than concrete in compression. To resolve the problem he use external steel confinement in the form of rings and tie rods to restrict the dilation of steel tubes. For verification he conduct the series of test on confined CFST column to study the effectiveness of external confinement. From the result he conclude that ,

- (1) Both rings and ties improved the stiffness of the CFST columns.
- (2) The rings improve significantly the axial strength of the CFST columns while the ties did not improve the axial strength.
- (3) All externally confined CFST columns can reach a strain of at least 20% before failure occurs.

[I] “push-over analysis of the seismic behavior of a concrete-filled rectangular tubular frame structure” niejianguo, qin kai and xiaoyantsinghua science and technology ,issn 1007-0214 20/21 pp124-130 volume 11, number 1, february 2006.

To investigate the seismic behavior of concrete-filled rectangular steel tube (CFRT) structures, author conducted a push-over analysis of a 10-story moment resisting frame (MRF) composed of CFRT columns and steel beams was conducted. The results show that push-over analysis is sensitive to the lateral load patterns, so the use of at least two load patterns that are expected to bound the inertia force distributions is recommended. The M- ϕ curves and N-M interaction surfaces of the CFRT columns calculated either by Han's formulae or by the USC-RC program (reinforced concrete program put forward by University of Southern California) are suitable for future push-over analyses of CFRT structures. The P- Δ effect affects the MRF seismic behavior seriously, and so should be taken into account in MRF seismic analysis. In

addition, three kinds of RC structures were analysed to allow a comparison of the earthquake resistance behavior of CFRT structures and RC structures. The results show that the ductility and seismic performance of CFRT structures are superior to those of RC structures. Consequently, CFRT structures are recommended in seismic regions.

III. CONCLUSION

From above literature we conclude that,

- Among all other worldwide codal provision Euro Code part 4 is most suitable and give more efficient result than any other Code for design of composite section.
- From above literatures it is clear that CFST is more beneficial than any other kind of composite.
- The use of CFST gives economical design by 30-40% than the hollow Steel Tube column, because of confined effect of concrete and steel.
- Using Rectangular HSS columns is 20-25 % costlier than the CFST columns of same thickness & varying overall size.
- CFST columns gives more rigidity to the structure during lateral loading.

REFERENCES

- [1] Atorod Azizinamini and Ahmed Elremaily, "Behavior of circular concrete filled steel tube columns", journal of Constructional Steel Research in 2001.
- [2] Johnny chingming ho, "Improved behaviour of concrete-filled-Steel-tube columns with external confinement" Australian Earthquake Engineering Society 2011 Conference, Nov 18-20, Barossa Valley, South Australia.
- [3] Madiha Z.J. Ammari, Abdelqader Najmi and Moayyad M. Al-Nasra, "Effective use of U-Link in Concrete Filled Steel Tubes Beams", (Online): 2319 – 6734, ISSN (Print): 2319 – 6726 Volume 2 Issue 4 | April. 2013 | PP.59-66.
- [4] Muhammad Naseem Baig, FAN Jiansheng NIE Jianguo, "Journal of Department of Civil Engineering Tsinghua University", Beijing 100084, China.
- [5] Shosuke Morino, "Recent developments on concrete-filled steel tube members in Japan" Earthquake Engineering and Engineering Seismology, Vol. 4, No.1 2003.
- [6] Tahir Kibriya, "Performance of Short CFST Columns using SCC with Blended Cement", ASCE Structures Congress 2006, Joint ASCE/SEI Conference, May 18 – 20, 2006, St Louis, Missouri USA, 2006.
- [7] Toshiyuki Fukumoto and Koji Morita, "Elastoplastic Behaviour of Panel Zone in Steel Beam-to-Concrete Filled Steel Tube Column Moment Connections", 10.1061/ASCE0733-94452005, 131:121841, 2005.
- [8] Veerabhadragouda. P. Patil, "Finite Element Approach To Study The Elastic Instability Of Concrete Filled Steel Tubular Column Under Axial Loads, ISSN 2250-2459, Volume 2, Issue 11, November 2012.
- [9] XIAO Yan, NIE Jianguo and QIN Kai, "Push-Over Analysis of the Seismic Behavior of a Concrete-Filled Rectangular Tubular Frame Structure", TSINGHUA SCIENCE AND TECHNOLOGY, ISSN 1007-0214 20/21 pp124-130 Volume 11, Number 1, February 2006.
- [10] Zhongfu Xiang and Yang YU, "Experimental Study of the bearing capacity of double CFST member", Bearing Capacity of Roads, Railways and Airfields – Tutumluer & Al-Qadi (eds) © 2009 Taylor & Francis Group, London, ISBN 978-0-415-87199-0 in 2009.