Comparative Study on Behavior & Characteristics of Concrete Filled Steel Tube

Syed Nouman[1], Abdul Rehaman[2]

[1]PG Students, Dept. of Civil Engineering, Ghousia College of Engineering, Ramanagara, 562159, India
[2]Assistant Professor, Dept. of Civil Engineering, Ghousia College of Engineering, Ramanagara, 562159, India

---***---

Abstract – Concrete filled steel tube (CFST) in construction area now a days becoming more popularity. Concrete filled steel tube is a component with good performance resulting from the confinement effect of steel with concrete & design versatility. Concrete filled steel tube square measure gaining increasing prominence during a form of engineering structures with the principle cross-section shape being square, rectangular & circular hollow sections. Columns specially designed to resist the majority of axial force by concrete alone. In this paper, the comparative study about the behavior & characteristics of CFST columns.

Key Words: RCFST, CCFST, Composite column, Cross section, Design codes

1.INTRODUCTION

Concrete filled steel tubes (CFST) are structural member & it is a type of composite steel-concrete structures used in civil engineering and consist of a steel tube & concrete core inside it. In which hallow steel section is filled with high strength concrete.

Rectangular concrete filled steel tubes (RCFST) and Circular concrete filled steel tubes (CCFST) are getting used wide in real civil engineering comes thanks to their glorious static and earthquake resistant properties, like high strength, high plasticity and huge energy absorption capacity. Concrete filled steel tubes (CFST) are also used extensively alternative trendy civil engineering applications. once they are used as structural columns, particularly in high-rise

buildings, the composite members could also be subjected to high cut force similarly as moments under wind or unstable actions. It may be noted here that mechanical & economical benefits will be achieved if CFST columns are constructed taking blessings of high-strength materials. for instance, high-strength concrete infill contributes larger damping and stiffness to CFST columns compare to traditional strength concrete. Moreover, high-strength CFST columns need a smaller cross-sectional to resist the load, which is appreciated by architects and building engineers. New developments, as well as the employment of high strength concrete and therefore the credit of the improved local buckling capability of the steel has allowed much more economical styles to evolve. The main economy achieved by mistreatment high strength concrete in skinny steel casings is that the structural steel price is reduced and therefore the majority of the load in compression is resisted by the high strength concrete. However, clean steel or bolstered concrete columns are still used additional extensively than CFSTs thanks to the dearth of information and experience that Engineers have with CFST structural systems.

1.1 Study of Design Codes

Different style rules were created for varied cross sections of CFST structures. Different approaches and style philosophies have been adopted in several style codes (Xinbo et al. 2006). In China, there are circular CFST structure style regulation, sq. structure design regulation, rectangular structure style regulation, and circular hollow CFST structure design regulation. In these rules, the design methods are totally different. In China and Japan, the standard for coming up with the composite columns is based on an easy methodology of superposition that uses the allowable stresses of the materials or then operating stress methodology. ACI-318 adopts the traditional concrete approach. AS 3600-1994 additionally uses the conception of concrete design. The AISC-LRFD relies on the conception of structural steel. The Euro code four, being a dedicated code for composite construction, combines the planning approach of each structural steelwork and concrete columns.

Different limitations on the compressive strength of concrete, steel yield strength, diameter to thickness magnitude relation, steel magnitude relation and confining constant are prescribed in different codes.

1.2 Study on Behavior & Characteristics of Concrete Filled Steel Tube

Artiomas Kuranovas, pol Goode ,Audronis Kazimieras Kvedaras, Shantong Zhong done analysis of 1303 specimens of CFST experimental knowledge. take a look at results area unit compared with EC4 provided technique for crucial the loadbearing capability of those composite parts.
Several varieties of CFSTs were tested: each circular and rectangular cross-sections with solid and hollow concrete

core with axial load applied without and with moment, with sustained load and preloading. For circular cross-sectional columns there is an honest agreement between the take a look at failure load and also the EC4 calculation for each short and long columns with and while not moment. For rectangular cross-sectional columns the agreement is good except once the concrete cylinder strength was larger than seventy five MPa, when many tests unsuccessful below the strength foreseen by EC4.

X.H. Dai et al the structural fireplace behaviour of a series of concrete crammed steel hollow tube columns with four typical column sectional shapes in normal fireplace. the chosen concrete crammed steel tube stub columns area unit divided into 3 teams by equal section strength at close temperature, equal steel cross sectional areas and equal, concrete core cross sectional areas. The temperature distribution, crucial temperature and fire exposing time etc. of chosen composite columns area unit extracted by numerical simulations using industrial Fe package ABAQUS. Based on the analysis and comparison of typical parameters, the impact of column sectional shapes on member temperature distribution and structural fire behaviours mentioned.

Jerom Hajjar reported a review of the behavior of circular and rectangular concrete-filled steel tube beam-columns and braces, and particularly focused on their behavior when subjected to cyclic seismic loading. He explained the monotonic behavior of CFTs subjected to axial, flexural, and torsional loading, summarizing the effects of CFT behavior including creep, shrinkage, composite action and residual stresses.

Lin-Hai Hana, Zhong Tab, Guo-Huang Yaob had had used ABAQUS Programming in this paper for the analysis of CFST subjected to shear and constant axial compression. A comparison of results calculated using this model shows good agreement with the test results in general. The theoretical model was used to investigate the influence of important parameters that determine the ultimate shearing strength of the composite members. The parametric studies provide information for the development of formulae to calculate the ultimate strength of CFST members subjected to shear and constant axial compression Preloading the steel tube before filling with concrete seems to have no effect on the strength. This paper also presents the stress distribution, confinement distribution and complete average longitudinal stress-strain curves for concrete-filled steel tubular elements.

Dr. B.R Niranjan, Eramma had created AN attempt to use this composite support as a column with a modification of flutes on the steel tube which reinforces the aesthetics and development space of sheet by that the instant of inertia gets enhanced by concerning seventeen to forty you look after rectangular flutes and nine to twenty three you look after triangular flutes. Confining concrete by providing triangular and rectangular form fluted steel tube has been investigated by a purposeful experimental work on twenty six concrete filled steel fluted columns (CFSFC). The parameters chosen for the study are (i) pure mathematics of the specimen – Triangular fluted columns (TFC) and rectangular fluted columns (RFC) (ii) completely different L/D ratios (size of the columns) (iii) Longitudinal reinforcement. Three series of specimens having completely different L/D ratios, 2500mm long are tested with M20 grade of self-compacting concrete (SCC). it's discovered that the load resistance is healthier in rectangular fluted columns as compared to the triangular fluted columns by one.31 %, 1.05 % and 9.92% respectively for L/D magnitude relation of fifteen, 20 and 25. The moment of inertia gets enhanced by about17% to 40% for RFC and 9/11 to twenty third for TFC.

Shams and Saadeghvaziri conferred the state of the art for concrete-filled steel tube(CFST) columns as well as experimental and analytical work. They mentioned the overall response of CFT columns and therefore the use of steel jacketing. They conjointly conferred an summary of analytical work for CFTs, as well as a comparison between the various style codes. Aritra Mandal conducted experimental study was conducted to grasp the behavior of Short Concrete filled Steel tube Columns (CSFT) below axial compression to failure. An analytical study was conjointly done to match with the experimental results. a complete of sixty nine specimens (63 specimens were stuffed with concrete, 3 specimens were unbroken hollow and three specimens were solely concrete) having totally different cross-sections were tested to research the load carrying capability especially and behavior as a whole.

Keigo TSUDA1, Chiaki MATSUI2 and Eiji MINO conducted tests on the concrete filled steel square and circular tubular columns. The test is composed of two Series. In Series I, columns are subjected to concentric and eccentric axial force at both ends. In Series II, columns are cantilever columns, and subjected to alternating horizontal load under constant vertical load. As a main experimental parameter, buckling length - section depth ratio of a column is selected. Strength and behavior are examined, and design methods for slender composite columns are investigated.

J. Zeghichea, K. Chaouib had conducted tests on 27 concrete-filled steel tubular columns and result are reported. Test parameters were the column slenderness, the load eccentricity covering axially and eccentrically loaded columns with single or double curvature bending and the compressive strength of the concrete core. The test results demonstrate the influence of these parameters on the strength and behavior of concrete-filled steel tubular columns. A comparison of experimental failure loads with the predicted failure loads in accordance with the method described in Euro code 4 Part 1.1 showed good agreement for axially and eccentrically loaded columns with single curvature bending whereas for columns with double curvature bending the Euro code loads were higher and on the unsafe side. More tests are needed for the case of double curvature bending.

P.K. Gupta, S.M. Sarda, M.S. Kumar have done an experimental and computational study on the behavior of circular concentrically loaded concrete filled steel tube columns till failure. Eighty-one specimens were tested to investigate the effect of diameter and D/t ratio of a steel tube on the load carrying capacity of the concrete filled tubular columns. The effect of the grade of concrete and volume of fly ash in concrete was also investigated. The effect of these parameters on the confinement of the concrete core was also studied. Diameter to wall thickness ratio between 25 < D/t < 39, and the length to tube diameter ratio of 3 < L/D < 8 was investigated. Strength results of Concrete Filled Tubular columns were compared with the corresponding findings of the available literature. Also a nonlinear finite element model was developed to study the load carrying mechanism of CFTs using the Finite Element code ANSYS. This model was validated by comparison of the experimental and computational results of load–deformation curves and their corresponding modes of collapse. From the experimental and computational study, it was found that for both modes of collapse of concrete filled tubular columns at a given deflection the load carrying capacity decreases with the increase in % volume of fly ash up to 20% but it again increases at 25% fly ash volume in concrete.

Qing Quan Liang and Sam Fragomeni [2009]: Quin and Sam had presented accurate constitutive models for normal and high strength concrete confined by either normal or high strength circular steel tubes. A generic fiber element model that includes the proposed constitutive models of confined concrete was created for simulating the nonlinear inelastic behavior of circular CFST short columns under axial loading. The confinement effect provided by the steel tube with a concrete filled steel tubular (CFST) short column increases the strength of the concrete core. The generic fiber element model developed was verified by comparisons of computational results with existing experimental data. Extensive parametric studies were conducted to inspect the accuracy of various confining pressure models and the effects of 1. The tube diameter-to-thickness ratio, 2. Concrete compressive strengths and 3. Steel yield strengths On the fundamental behavior of circular CFST columns. A new design formula accounting for concrete confinement effects was also proposed for circular CFST columns. It is demonstrated that the generic fiber element model and design formula adequately forecast the ultimate strength and behavior of axially loaded CFST columns and can be used in the design of normal and high strength CFST columns. Paul J. Barr, Baochun Chen and ZhijingOu [2011]: An experimental and analytical investigation of concrete-filled steel tubular (CFST) laced columns was carried out. The columns consist of four concrete-filled steel tubes which are laced together. A total of 27 experimental tests was carried out to quantify the column failure mechanism at ultimate loads. The experiments were performed to obtain the load-deflection curves. Experimental results showed that the compression force in the longitudinal members dominated the failure mechanism in the CFST columns. The forces in the lacing members (diagonal and horizontal bracing) were found to be small. The experimental study was used to validate an analytical parametric study. The analytical study showed that increasing slenderness ratios and eccentricities reduced the ultimate load carrying capacity. On the basis of the analytical results, a new methodology for calculating the ultimate load-carrying capacity was proposed. The proposed methodology was compared with five different building codes like AISC, Eurocode4 and china codes (DL/T 5085- 1999, JCJ 01-89, CECS 28:90) to quantify the accuracy.

Vipulkumar Ishvarbhai Patel (2012) carried out experimental and numerical research on full-scale high strength thin-walled rectangular steel slender tubes filled with high strength concrete. Experimental ultimate strengths and load deflection responses of CFST slender beam columns were tested by independent researchers and used to verify the accuracy of the numerical model. The verified numerical model was then utilized to investigate the effects of local buckling, column slenderness ratio, and depth-to-thickness ratio, loading eccentricity ratio, concrete compressive strengths and steel yield strengths on the behavior of high strength thin walled CFST slender beam-columns.

Yu-Feng A, Lin-Hai Han and Xiao-Ling Zhao carried out test on the behavior of very slender, thin-walled concrete filled steel tubular (CFST) columns under axial compression was studied by the authors. A finite element analysis (FEA) was used to carry out the behavior of compressive columns. Generally, a good agreement was obtained between the predicted and calculated results. The FEA model was then used to perform analysis on very slender circular CFST columns. Parametric studies were conducted and the ultimate strengths from tested results and design codes were compared and discussed. The reliability analysis method was used to calibrate the existing design formulas given in DBJ/T13- 512010, ANSI/AISC 360-05 and Euro code 4.

Dennis Lam, Ehab Ellobod and Ben Young [2005]: The behavior and design of axially loaded concrete-filled steel tube circular stub columns were presented. The study was carried over a wide range of concrete cube strengths ranging from 30 to 110 MPa. The external diameter of the steel tube-to-thickness (D/t) ratio ranged from 15 to 80. An accurate finite element model was developed to carry out the study. Accurate nonlinear material models for concrete and steel tubes were used. The column strengths and load– axial shortening curves were evaluated. The results obtained from the FE analysis were verified against experimental results. An extensive parametric study was carried out to investigate the effects of different concrete strengths and cross-section geometries on the strength and behavior of concrete-filled compact steel tube circular stub columns. The column strengths predicted from the FE analysis were compared with the design strengths calculated using the American, Australian and European codes. Based on the results of the parametric study, it is found that the design strengths given by the American Specifications and Australian Standards are conservative, while those of the European Code are generally not much conservative.

2. CONCLUSIONS

This paper specializes in study and analysis done on Concrete filled steel tube. Now a days, many research goes on coming up with facet of CFST and behavior in several loading condition. A wide range of analysis has been done on behavior of CFST in line with its completely different cross section like rectangular and circular that square measure more wide spread in style field. From the review of literature its shows CFST columns give excellent unstable event resistant structural properties like high strength, high plasticity and large energy absorption capability.

These papers highlight the behavior & characteristics of CFST under axial load coaxial, eccentric, hearth property of CFST and additionally discuss advantage of CFST against RC column. in step with literature major work is finished on CFST is experimental still, there is a want for numerical study to envision the parameters that have an effect on the final word strength. As there is not such work done concerning impact of cross section of CFST an in depth work will be done for selecting applicable cross section according to loading and completely different region. As Indian commonplace has not given any specification concerning Composite column there's additional analysis therein field is needed.

REFERENCES

[1] Euro code 4 (2004), Design of composite steel and concrete structures,Part1-1:General rules—structural rules for buildings. Brussels: EN1994-1-1, CEN.

[2] American concrete Institute (ACI), Building code requirements for structural concrete (ACI 318-89) and commentary

[3] Shams M., Saadeghvaziri M.A., "State of the art of concrete-filled steel tubular columns", ACI Structural Journal 94 (5): 558-571 Sep-Oct 1997.

[4]] Hajjar J.F., "Concrete-filled steel tube columns under earthquake loads", Prog. Struct. Engng Mater. 2: 72-81, 2000.

[5] Gourley, B.C., Tort, C., Hajjar, J.F., and Schiller, P.H., "A Synopsis of Studies of the Monotonic and Cyclic Behavior of ConcreteFilled Steel Tube Beam-Columns", Structural Engineering Report No. ST-01-4, Department of Civil Engineering, University of Minnesota, Minneapolis, Minnesota, Version 3.0, December, 263 pp., 2001.

[6] Spacone E., El-Tawil S., "Nonlinear analysis of steel-concrete composite structures: State of the art", Journal of Structural Engineering - ASCE 130 (2): 159-168 Feb 2004.

[7] C. Douglas GoodeDennis Lam., ―CONCRETE - FILLED STEEL TUBE COLUMNS-TESTS COMPARED WITH EUROCODE 4‖

[8] Darshika k. Shah, Merool D. Vakil, M.N.Patel,‖ Behavior of Concrete Filled Steel Tube Column‖ 2014 IJEDR | Volume 2, Issue 1 | ISSN: 2321-9939

[9] Artiomas Kuranovas, Douglas Goode, Audronis Kazimieras Kvedaras, Shantong Zhong,‖ LoadBearing Capacity of Concrete-Filled Steel Columns‖ Journal of Civil Engineering And Management March 2009

[10] Keigo Tsuda, Chiaki Matsui and Eiji MINO.,‖Strength And Behavior Of Slender Concrete Filled Steel Tubular Columns‖

[11] Aritra Mandal.,‖Concrete filled steel tube umder Axial Compression‖

[12] Ehab Ellobody, Ben Young, Dennis Lam (2006). Behaviour of normal and high strength concrete-filled compact steel tube circular stub columns.Journal of Constructional Steel Research, 62,706–71.

[13] Qing Quan Liang, S. F. (2009). Nonlinear analysis of circular concrete-filled steel tubular short columns under axial loading. Journal of Constructional Steel Research , 2186-2196.

[14] Zhijing Ou, B. C. (2011). Experimental and Analytical Investigation of Concrete Filled Steel Tubular Columns. JOURNAL OF STRUCTURAL ENGINEERING, 137, 634-645

[15] Vipulkumar Ishvarbhai Patel, Qing Quan Liang and Muhammad N S Hadi (2012), ―High strength thin-walled rectangular concrete filled steel tubular slender beamcolumns, PartIModeling‖, Journal ofConstructional Steel Research, Vol. 70, March, pp. 377-384

[16] . Dr. B.R Niranjan, Eramma. H.,‖ Effect of Shape of Cross-section and Its Performance for Concrete Filled Steel Fluted Columns‖ International Journal of Modern Engineering Research (IJMER) Vol.3, Issue.2, March-April. 2013 pp-685-691

[17] X.H. Dai, D. Lam.,‖ Shape effect on the behaviour of axially loaded concrete filled steel tubular stub columns at elevated temperature‖ Journal of constructional steel research 73(2012) 117-127

[18] Lin-Hai Hana,, Zhong Taob , Guo-Huang Yaob.,‖ Behaviour of concrete-filled steel tubular members subjected to shear and constant axial compression‖ Thin-Walled Structures 46 (2008) 765–780

[19] J. Zeghichea, K. Chaouib.,‖ An experimental behaviour of concrete-filled steel tubular columns‖ Journal of Constructional Steel Research 61 (2005) 53–66

[20] P.K. Gupta, S.M. Sarda, M.S. Kumar.,‖ Experimental and computational study of concrete filled steel tubular columns under axial loads‖ Journal of Constructional Steel Research 63 (2007) 182–193

[21] Yu-Feng An, L.-H. H.-L. (2012). Behaviour and design calculations on very slender thinwalled CFST columns. Thin-Walled Structures , 161-175.

BIOGRAPHIES

SYED NOUMAN is pursuing Post Graduation in Structural Engineering from Ghousia College of Engineering, Ramanagara.

ABDUL REHAMAN
Assistant Professor,
Department of Civil Engineering,
Ghousia College of Engineering,
Ramanagara.