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Comparative Study of Multi Storied Building with Different Sections of Conventional RC Columns and CFST Columns Under Seismic Effect- A Literature Review

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ABSTRACT—

In this study, an attempt has been made to check the feasibility of Concrete-Filled Steel Tube column in terms of both performance and cost. Due to the expansion of cities and increase in population, the need for construction of high rise buildings becomes more essential in the society. As earthquakes are of the greatest damaging natural hazards to the buildings, the design and construction of structures which are capable of resisting the adverse effects of earthquakes become necessary. The concrete-filled steel tube (CFST) is a unique steel-concrete composite construction that consists of outer steel layer with a concrete layer filled inside it. The inner hollow steel section serves as formwork and concrete reinforcement. Concrete prevents local buckling in hollow steel sections, increasing the section's ductility. CFST has a number of benefits, including high strength, bending stiffness, and earthquake and fire resistance. Evaluation of all the frames then carried out and compared. From that we can say that CFST column's performance is better than both RCC and Steel columns under dynamic loadings.

Keywords: RCC Column, Composite Columns, Concrete-filled steel tubes (CFST), RC Encased Column, Comparative Study, Finite element analysis.

1.1 Introduction -

Conventional RCC members like beams and columns are widely used for the construction. For increased load carrying capacity the use of composite columns is introduced. it combines the advantages of both steel and concrete. Steel-concrete composite columns have been widely used in modern construction industry owing to their high performance in terms of ductility, strength, energy absorption capacity as well as good constructability in comparison with reinforced concrete columns. In a concrete-filled steel tubular (CFST) column, concrete prevents the steel tube from the inward local-buckling and the steel tube acts as the permanent formwork for the concrete so that the construction cost and time can be greatly minimized.

1.2 Concrete-filled steel tubes (CFST)

Concrete-filled steel tubes (CFST) are composite structures of steel tube and in-filled concrete. Concrete filled steel tubular member uses the advantages of both steel and concrete. They comprise of two main parts, an outer steel hollow section of circular or rectangular shape and an inner filler material of plain or reinforced concrete. A CFST member consisting of a steel tube which is filled with concrete material realizes the importance of steel reinforcement to provide confinement for the concrete and to increase the load-carrying capacity of the composite member. From the structural point of view, the inner concrete material not only prevents the occurrence of inward buckling of the outer steel tube but also enhances the ductility of the CFST member up to the ultimate load. CFST member performs under composite action, i.e. both the steel and concrete will resist the external loading by interacting together by bond and friction action. In a CFST member, concrete and steel are combined together in such a fashion that the advantages from both the materials should be effectively utilized.

Advantages of concrete filled steel tubular columns are as follows:

- Due to presence of steel tube on periphery, CFST column deforms in a ductile manner and provides high resistance against lateral cyclic loading. This high ductility of CFST columns gives high strength against seismic loading.
- CFST columns have good ability to absorb energy released due to seismic forces.
- Smaller section sizes of CFST columns are required as compared to conventional RCC columns under equivalent load conditions; therefore there is considerable reduction in self-weight of structure and results in less structural and construction cost.
- Faster construction by utilizing prefabricated components helps in speedy construction and gives quicker return of the invested capital.

One of the few drawbacks of Concrete filled steel tubular members is that they get deteriorated due to the environmental effects like corrosion and ageing. The external strengthening by using fibre reinforced polymer (FRP) materials emerging as a new trend in enhancing the structural performance of CFST members to counteract the drawbacks in the past rehabilitation work. Recent years, FRP is becoming a popular material for rehabilitation due to its superior material properties like corrosion and weather resistance, high mechanical strength, less weight, ease of handling, good fatigue resistance and ductility.

CFSTs are of different shapes, mainly circular CFST, square CFST, and rectangular CFST as shown in figure below –

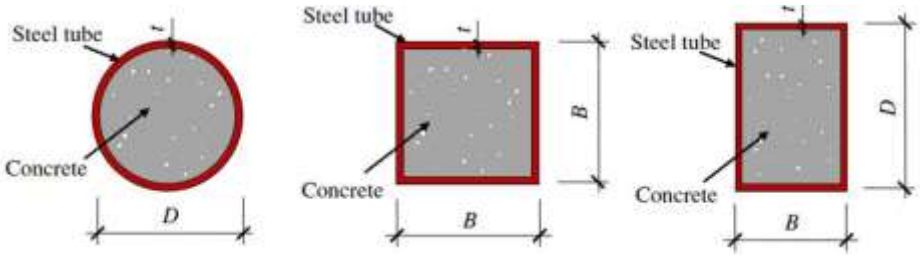


Fig. - CFST columns of different shapes

[Source: https://images.app.goo.gl/gcu6ucjcCrb18EJc7]

Stress-strain properties

Confinement of in filled concrete is the main advantage of CFST sections. Fig.3 shows the stress-strain behaviour of confined concrete. The reinforcing steel is assumed to be elastic until the yield strain y and perfectly plastic for strains between y and the hardening strain or until the limit strain Sv, represented by tri-linear relationship. However, bi-linear stress-strain relationship is still being used, and simply expressed as

fs = Es s for s ≤ y

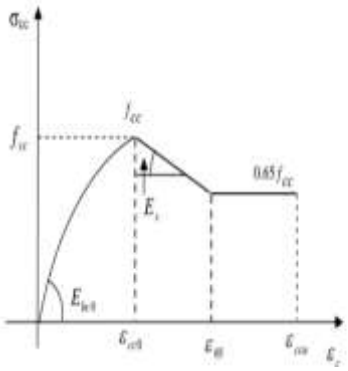
fy=fy, if s > y

fs - Stress in reinforcing steel at any level y due to s

Es - Modulus of elasticity of reinforcing steel.

Relationship between stress and strain depends on basic material composition, initial conditions, state of strain, direction of strain, and history of strain, time since initial strain, temperature, cyclic strain and rate of strain change.

STRESS



STRAIN

Fig. Stress-strain behaviour of confined concrete [Y. Bouafia et. al.(2018)]

Where,

Es – Slope of the descending curve

ε_{65} – Strain corresponding to the stress equal to 0.65fcc

σ_{cc} – Confined concrete stress

f_{cc} – Compressive strength of unconfined concrete

E_{bc0} – Initial confined concrete Young modulus

ε_{cc0} – Confined concrete strain compounding to the peak stress

ε_{ccu} – Confined concrete ultimate strain

ε_c – Confined concrete strain

Behaviour of CFST column during loading

Due to initial concentric axial loading of the CFST column both concrete infill and structural steel will deform longitudinally. Therefore, it is assumed that concentric loading is applied uniformly across the CFST section. Thus, the lateral expansion of confining tube is larger than the confined concrete. At a certain strain, the expansion of concrete infill gradually increases until it reaches the lateral expansion of steel. Expansion of structural steel remains constant and micro-cracking in the concrete begins to takes place. Longitudinal stress in the confining tube varies based on the transfer of force between steel and concrete. In the second stage of loading where the confinement of concrete is present, circumferential stresses are developed due to longitudinal stresses from loading and lateral pressure from concrete dilation.

Failure Modes

There are various modes of failure for the CFST column based on material properties and geometric configuration. The most important failure mode is local buckling. Fig.4. shows the changes in buckling mode due to the presence of infill. CFST column can delay the local buckling due to the presence of concrete core when compared with empty steel tube. The schematic failure modes of hollow steel tube, plain concrete and CFST column is shown in fig.

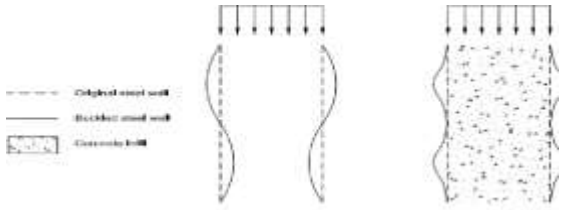
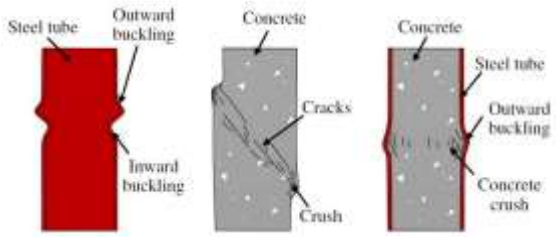


Fig. Changes in buckling mode with length due to the presence of infill [S. Abdalla(2012)]



(a).Hollow steel tube (b).Plain concrete (c).CFST

Fig. Schematic failure modes [P. Sangeetha et. al.(2018)]

1.3 Need of the Study

Review of their structural behaviour is done by changing different parameters like load conditions, geometry, material properties, temperature changes in order to observe the strength parameters like their bearing strength (with which buckling and compressive strength is taken into consideration), fire resistance and response to blast load and also the time depended behaviour which is a major issue in case of CFSTs.

2. LITERATURE REVIEW

This section provides a detailed review of the literature related to seismic analysis of concrete filled steel tubular column buildings. The concrete-filled steel tubular (CFST) structure offers several benefits, such as high strength and fire resistances, ductility and great energy absorption capacities. There is also no need for the use of shuttering during concrete construction; hence, the construction time and cost are condensed. These benefits have been widely exploited and have led to the widespread use of concrete-filled tubular structures in civil engineering structures. The literature review focuses on recent contributions related to seismic behaviour of buildings with concrete filled steel tubular columns and past efforts closely related to the present work.

Riyad S Aboutaha (2000) "Cyclic response of a new steel concrete composite frame system" The 12th World Conference on Earthquake Engineering Paper No. 61, studied about the frame system which consists of steel tube reinforced concrete columns and ordinary reinforced concrete beams with headed bars. Two full-scale steel tube columns, and two full scale beams with and without headed bars were experimentally investigated. Steel tube columns investigated in this study exhibited high ductility and energy dissipation when subjected to large lateral displacements and constant axial loads up to 0.36 Agfc'.

Amit H. Varma et al. (2002) "Seismic behavior and modeling of high-strength composite concrete-filled steel tube (CFT) beam– columns" Journal of Constructional Steel Research 58 (2002) 725–758 behaviour of square concrete-filled steel tube (CFT) beam–columns made from high strength materials was investigated experimentally in this paper. The effects of the width to- thickness ratio, yield stress of the steel tube and the axial load level on the stiffness, strength and ductility of high-strength CFT beam–columns were also studied. They have concluded that, the accuracy of the fibre-based models depends on the accuracy of the uni-axial stress–strain curves and cyclic hysteresis rules for the steel and concrete fibres of the CFT cross-section.

Hsuan-Teh Hu et al. (2005) "Finite element analysis of CFT columns subjected to an axial compressive force and bending moment in combination" Journal of Constructional Steel Research 61 (2005) 1692–1712 studied about the concrete-filled tube (CFT) columns subjected to an axial compressive force and bending moment in combination. Constitutive models were analyzed using the nonlinear finite element program ABAQUS compared against experimental data. The cross sections of the CFT columns are categorized into three groups, i.e., ones with circular sections, ones with square sections, and ones with square sections stiffened with reinforcing ties. Confining effect provided by the square CFST column is less than circular CFST columns, while square CFST columns stiffened with reinforcing ties provide the same confining effect as circular CFST columns.

Lin-Hai Han et al. (2008), Seismic behaviour of circular CFST columns and RC shear wall mixed structures: Experiment" Journal of Constructional Steel Research 65 (2008) 1249_1260 studied about Seismic behaviour of concrete-filled steel tubular frame to RC shear wall high-rise mixed structures. Objective of Paper is to evaluate the behaviour of mixed structures consisting of CFST columns under various real earthquake records and investigate the consistency of CFST frames with RC shear walls under earthquake. Two building models with 30 storey height were analyzed experimentally. The test results showed that this type of structural system exhibited a favourable behaviour under earthquakes.

LIU Jingbo et al. (2008) "Seismic behaviour analysis of steel-concrete composite frame structure systems" The 14th World Conference on Earthquake Engineering Paper No 48, has done Seismic analysis of steel-concrete composite frame structure. They investigated about seismic behaviour of steel-concrete composite structures, based on researches of composite columns and connections between beams and columns. Five models of 15 storey height were analyzed by Modal analysis, response spectrum and inelastic time history analysis. They concluded that, according to the comparisons, as a whole, the CFST frame structure has qualified seismic performance. But the effect which composite frame beams have on structural seismic behaviour should be considered comprehensively

Fei-Yu Liao et al. (2009) "Seismic behaviour of circular CFST columns and RC shear wall mixed structures: Experiment" Journal of Constructional Steel Research 65 (2009) 1582_1596 has done experimental investigation on four test models which includes circular CFST columns and RC shear wall mixed structure subjected to constant axial load and cyclic lateral load. The test parameters included axial load level in the composite column and height width ratio of the RC shear wall. The effects of these parameters on the ductility, rigidity and dissipated energy of the specimens were investigated. It was found that all the tested specimens failed in a shear-dominant mode. The ductility and energy dissipation capacity of the specimens decreased with an increase of axial load level or decrease of height width ratio.

Walter Luiz Andrade de Oliveira et al. (2009) "Influence of concrete strength and length/diameter on the axial capacity of CFT columns", Journal of Constructional Steel Research 65 (2009) 2103_2110 presents an experimental analysis of the confinement effects in steel-concrete composite columns regarding two parameters: concrete compressive strength and column slenderness. Sixteen concrete-filled steel tubular columns with circular cross section were tested under axial loading. The tested columns were filled by concrete with varying compressive strengths, and different length/diameter ratios. According to the study, the load capacity of the composite columns increased with increasing concrete strength and decreased with increasing length/diameter ratio. Ultimate load carrying capacity of column is calculated and compared by 4 code provisions: the Brazilian Code NBR 8800:2008, Euro code 4 (EN 1994-1-1:2004), AINSI/AISC 360:2005, and CAN/CSA S16-01:2001. They concluded that, the Brazilian Code was the most conservative, while Euro code 4 presented the values closest to the experimental results.

Qing Quan Liang et al. (2009) "Nonlinear analysis of circular concrete-filled steel tubular short columns under axial loading", Journal of Constructional Steel Research 65 (2009) 2186_2196 accurate constitutive models for normal and high strength concrete confined by either normal or high strength circular steel tubes are proposed in this paper. Extensive studies are conducted to examine the accuracy of various confining pressure models and the effects of the tube diameter-to-thickness ratio, concrete compressive strengths and steel yield strengths on the fundamental behaviour of circular CFST columns. It was found that increasing the tube diameter-to thickness ratio reduces the ultimate strengths of CFST columns as well as axial ductility performance and increasing the concrete compressive strength proportionally increases the ultimate axial loads but reduces the section and axial ductility performance of CFST columns.

Wenda Wang et al. (2010) "Discussion and Method on Performance Based Seismic Design for Concrete-Filled Steel Tubular Structures" Trans Tech Publications, Switzerland studied about discussion and method on performance based seismic design for concrete-filled steel tubular structures. A high rise concrete-filled circular tubular frame structure was analyzed to verify the design procedure. One model of 15 storey height was analyzed by Static pushover analysis. A pushover numerical example show that the CFST frame structure exhibited lateral stiffness to resist the lateral force after it reached plastic stage partly.

Huanjun Jiang et al. (2011) "Seismic Performance Evaluation of a Steel-concrete Hybrid Frame tube High-rise Building Structure" Trans Tech Publications, Switzerland investigated the seismic performance evaluation of a steel-concrete hybrid frame-tube high-rise building structure. In this study the seismic performance of a code-exceeding tall building with the hybrid frame-tube structure to be constructed in Beijing is evaluated by numerical analysis. Single model of 61 storey height was analyzed by nonlinear time history analysis. Numerical analysis results indicate that the hybrid structure has good seismic performance.

Khaloo. Alireza et al. (2011) "Seismic performance of structures with cfst Columns and steel beams" https://www.researchgate.net/publication/269279563 studied about seismic performance of structures with CFST columns and steel beams. This paper presents performance of structures with CFST columns and steel beams under lateral loads. Three models of 3, 5 and 10 storey were analyzed by Static pushover and dynamic time history analysis. Results show that frames with CFST columns have more strength, ductility and energy absorption than frames with ordinary RC columns.

M.R. Bambach et al. (2011) "Design of hollow and concrete filled steel and stainless steel tubular columns for transverse impact loads", Thin-Walled Structures 49 (2011) 1251–1260 investigated about nominally identically sized stainless steel tubes, tested experimentally under members subjected to transverse impact while members were restrained axially and rationally at their ends. Comparisons between the performances of the two materials are made. The influences of axial pre- load, rotational restraint at the member ends, axial restraint, metal material properties and concrete filling, are investigated. They concluded that, Stainless steel provides significant energy absorption capability benefits over steel, where fully restrained stainless steel members absorb on average 1.8 times more energy than nominally identical steel members, due to enhanced material properties

Ketan Patel et al. (2012) "Analysis of CFST, RCC and steel building Subjected to lateral loading" Procedia Engineering 51 (2013) 259 – 265 investigated about behaviour of CFST, RCC and steel building subjected to lateral loading. In this paper, comparative study of concrete filled steel tube (CFST), R.C.C. and Steel building is done. Three models of 10, 20 and 30 storey were analyzed by response spectrum analysis. Result shows CFT building is good in load carrying capacity with small cross section of column.

Mahbuba Begum et al. (2012), "Cost Analysis of Steel Concrete Composite Structures In Bangladesh" ASIAN JOURNAL OF CIVIL ENGINEERING (BHRC) VOL. 14, NO. 6 (2013) studied about cost effectiveness of composite construction for medium to high-rise buildings. in Bangladesh. Four models of 6, 12, 18 and 24 storey were analyzed for cost analysis. They concluded that, for buildings with number of stories greater than 15, composite construction becomes economic than RCC construction.

Rui Wang et al. (2012) Behavior of concrete filled steel tubular (CFST) members under lateral impact: Experiment and FEA model", Journal of Constructional Steel Research 80 (2013) 188–201 studied about the impact performance of concrete filled steel tubular (CFST) members. A series of tests were carried out to obtain the failure modes and the time history of the impact forces under lateral impact. A finite element analysis (FEA) model was developed, in which the strain rate effects of steel and concrete materials, interaction between the steel tube and the core concrete, as well as the confinement effect of the outer steel tube provided to the core concrete were considered. It was concluded that, axial load has an obvious effect on the lateral deflections of CFST members under lateral impact.

Y.F. Yang et al. (2012) "Concrete filled steel tube (CFST) columns subjected to concentrically partial compression", Thin-Walled Structures 50 (2012) 147–156 this paper studies the behaviour of thin-walled concrete filled steel tube column subjected to concentrically partial compression. A series of tests was carried out to investigate the effects of sectional type, length-to diameter (width) ratio, partial compression area ratio and bearing capacity of partially loaded CFST column. It was shown that the CFST columns under concentrically partial compression generally had reasonable bearing capacity and ductility. They have concluded that, a simplified model for predicting the bearing capacity of partially loaded CFST columns with L/D less than 6 was suggested, and generally, the predictions using the simplified model are conservative to some extent and are reasonably acceptable.

Yu-Feng An et al. (2012) "Behaviour and design calculations on very slender thin walled CFST columns", Thin-Walled Structures 53 (2012) 161–175 studied the behaviour of slender thin-walled concrete filled steel tubular (CFST) columns under axial compression. Parametric studies were carried out 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/T13-51- 2010, ANSI/AISC 360-05 and Euro code 4. They have concluded that, design formulas for compression strength of very slender CFST columns provided by DBJ/T13-51-2010, ANSI/AISC 360-05 and Euro code 4 satisfy the reliability require in the parameter limits.

Darshika k. Shah et al. (2014) "Parametric Study of Concrete Filled Steel Tube Column", International Journal of Engineering Development and Research (www.ijedr.org) studied about load deformation characteristics of composite columns and critically, numerical finite element analysis using software package ANSYS is carried out. The main parameters of FEA are circular and square column with varying grades of concrete. It is concluded that the deformation of the column is decreasing 10-15% with increasing grade of concrete. It is observed that, deformation decreases with increasing grade of concrete, but for higher grades of concrete decreasing in deformation is less and stress concentration is more at the edges of square column while in circular column, due to confining effect, stress concentration is equal throughout the whole section.

Bhushan H. Patil et al. (2014) Parametric Study of Square Concrete Filled Steel Tube Columns Subjected To Concentric Loading", Int. Journal of Engineering Research and Applications ISSN: 2248-9622, Vol. 4, Issue 8(Version 1), August 2014, pp.109-112 this study presents on the behaviour of concrete - filled steel tube (CFST) columns under axial load by changing parameters such as column diameter, length, tube thickness and grade of concrete. The study was conducted using ANSYS 13 finite element software. It is observed that, 1 mm increase in thickness of tube increases the column capacity by 15-20%, while 300 mm increase in length decreases the load carrying capacity by 60- 70%.

Asha B.R et al. (2015) "Comparison of Seismic Behavior of a Typical Multi-Storey Structure with Composite Columns and Steel Columns"www.researchpublish.com studied about comparison of seismic behaviour of a typical multi-storey structure with composite columns and steel columns. The objective of paper is to compare seismic behaviour of multi-storey framed structures consisting of Steel beam, RC slab and Concrete Filled Steel Tube (CFST). Two models of 13 storey height were analyzed by Equivalent Static Lateral Force Method. They have concluded that, base shear and storey overturning moment induced by the seismic forces are reduced by 22 to 28% for composite columns.

Deepak M Jirage et al. (2015) "Comparative Study of RCC and Composite Multi-storeyed Building", International Journal of Scientific Engineering and Applied Science (IJSEAS) - Volume-1, Issue-6, September 2015 studied about steel concrete composite with RCC options are considered for comparative study of G+20 story building which is situated in earthquake zone IV and for earthquake loading, the provisions of IS: 1893 (Part1)-2002 were considered. Study concluded that, the displacement and time period of composite structure is greater than RCC structure, while there is considerable reduction in base shear value of composite structure as compared to RCC structure.

Yongtao Bai et al. (2016) "Thin-Walled CFST Columns for Enhancing Seismic Collapse Performance of High-Rise Steel Frames" licensee MDPI, Basel, Switzerland numerically studied about collapse capacity of high-rise SMRF using CFST columns of various width-thickness ratios, subjected to successive earthquakes. It was found that the long period component of earthquakes obviously correlates the first-mode period of high-rises controlled by the total number of stories. With the equivalent flexural stiffness, thin-walled CFST columns are capable of improving the collapse margin for more than 60% of the high-rise SMRFs under identical earthquakes.

Ankur Tailor et al. (2016) "Comparative Performance Evaluation of Steel Column Building & Concrete Filled Tube Column Building under Static and Dynamic Loading" Procedia Engineering 173 (2017) 1847 – 1853 investigated about feasibility of steel column building and concrete filled steel tubular column building in terms of both performance and cost. An actual building was selected as the study frame and designed for steel sections as per IS800:2007. All the Columns of the study frame were then replaced by equivalent Concrete-Filled Steel Tube columns. Four models of 20 storey height were analyzed by Static analysis and Time history analysis. The seismic performance of the CFST column frame was found better than steel frame under both the static and dynamic loading and it also proved to be economical than the steel frame.

Sruthi K et al. (2017) "Comparison Of Seismic Behaviour Of A Typical Multi- Storey Structure With CFRP Wrapped CFST Columns And I Section Encased CFST Columns" International Research Journal of Engineering and Technology studied about comparison of seismic behaviour of a typical multi-storey structure with CFRP wrapped CFST columns and I section encased CFST columns. The present study deals with seismic behaviour of high rise buildings by response spectrum analysis with different types of composite columns. Two models of 13 and 45 storey height were analyzed by Response spectrum analysis. They have concluded that, storey displacement is reduced up to 17% and drift is reduced up to 18% in composite columns compared to RC columns.

Mohammad Manzoor Nasery et al. (2017) Investigating the Seismic Performance of the Structures with Steel, Concrete and Composite Columns", Digital Proceeding of ICOCEE-CAPPADOCIA2017 S. Sahinkaya and E. Kalıpcı (Editors) Nevsehir, TURKEY, May 8-10, 2017 examines the seismic behaviour of buildings having composite columns, steel columns and traditional concrete columns comparatively. For the analysis16structures each having 20 stories and identical plan geometry were taken into consideration with composite, steel and concrete columns respectively. It was found that, the seismic performance of the structure with composite column is superior among all investigated types and structure with composite columns had good energy absorption along with enough stiffness that means they were as good as concrete in stiffness and as ductile as steel in ductility.

Hong-Song Hu et al. 2018 "Axial Compressive Behaviour of Square CFST Columns through Direct Measurement of Load Components", Journal of Structural Engineering, ISSN 0733-9445, DOI: 10.1061/(ASCE)ST.1943- 541X.0002204, it was observed that the difference between the compressive strength of concrete in square CFST columns and the corresponding cylinder strength were small for square CFST columns and was within the commonly accepted range. Also, for square CFST columns with small B/t ratios, the axial loads sustained by the concrete infill and steel tube reach their respective maximum at the peak total load. On the other hand, the axial load capacity for columns with large B/t ratios may be reached after developing the ultimate strength of the steel tube.

Xianggang Zhang et al. 2019 "Bearing Capacity of Stone-Lightweight Aggregate Concrete-Filled Steel Tubular Stub Column Subjected to Axial Compression", KSCE Journal of Civil Engineering (2019) 23(7):3122-3134 Vol. 23, No. 7 / July 2019, DOI 10.1007/s12205-019-2287-0 in this study, instead of normal aggregate, when light weight aggregate were used in CFST (SLCFST) stub columns which was then subjected to axial compression test (and response of two D/t ratios were considered. Model Verification by Concrete-Filled Circular Steel Tube columns were done and was observed that in case of axial compression, buckling of the external steel tube occurs in SLCFST stub columns and the core SLC is crushed to varying degrees, indicating strength damage. Also the ultimate bearing capacities and peak displacements of the C-SLCFST and S-SLCFST stub columns increased with an increase in normal gravel replacement ratio. So by increasing the percentage of normal aggregates, strength seems to be increased. We can conclude from the test carried, that normal aggregate has more validity as compared to the light weight aggregate.

Khandaker et al. 2019 "Confinement of six different concretes in CFST columns having different shapes and slenderness", International Journal of Advanced Structural Engineering (2019) 11:255–270, Doi.org/10.1007/s40091-019-0228-2 While adopting different types of concrete (normal concrete, ultra high strength concrete, engineered cementations composite, light weight concrete, self-consolidating concrete and crumb rubber concrete), and analyzing, it was observed that Columns with higher-strength concrete failed by shear more often than those with low concrete strength. Also Columns with comparatively lower-strength concretes transitioned from elastic to plastic stages without a significant peak load. In general, an increase in axial strength with the increase in slenderness of columns was observed with exceptions of few columns.

Jiang ang Wei et al. 2020 "Experimental Analysis of Temperature Gradient Patterns of Concrete-Filled Steel Tubular Members", Journal of Bridge Engineering, ISSN 1084-0702, DOI: 10.1061/(ASCE)BE.1943- 5592.0001488 concluded that Axial capacity increases with improvements in the concrete strength and steel ratio of the profile steel and decreases with increases in the diameter-to-thickness ratio. Moreover, the diameter-to-thickness ratio of steel tube and concrete strength are two important influenced factors among all parameters.

Jiang Liu et al. 2020 "Prediction Formula for Temperature Gradient of Concrete-Filled Steel Tubular Member with an Arbitrary Inclination", Journal of Bridge Engineering, ISSN 1084-0702, DOI: 10.1061/(ASCE)BE.1943-5592.0001599 concluded that With comprehensive understanding of the temperature gradients of a CFST member with an arbitrary inclination on the basis of experimental and analytical investigations, it was concluded that, different inclinations have different annual variation characteristics for sun-side temperature differences, which are large in summer and small in winter for the horizontally placed member, small in summer and large in winter for the vertically placed member, and more evenly distributed in the whole year for the inclined member.

Reshma S1,2 and Bushra M A1 2020 - Effect of dimensional parameters on the seismic performance of circular CFST columns - ERTSE 2020 IOP Conf. Series: Materials Science and Engineering 989 (2020) 012012 IOP Publishing doi:10.1088/1757-899X/989/1/012012 - This study was mainly concentrated to find out the effect of dimensional parameters on the seismic performance of CFSTs. Width- thickness ratio (D/t) and slenderness ratio (L/D) were taken as two parameters and the study was carried out using circular CFST buildings. It was observed that, there will be a particular limit for D/t and L/D ratio up to which the thickness and diameter of the CFSTs can be decreased. At that point the building will show a better seismic performance.

M.Jayasri, H.Jane Helena 2021, Behaviour of Concrete-Filled Steel Tubular Columns: A State of the Art Review, International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056 Volume: 08 Issue: 08 | Aug 2021 www.irjet.net p-ISSN: 2395-0072 Concrete-filled steel tubular (CFST) sections are efficient, attractive and are increasingly used in modern construction. CFST columns have enhanced compressive load carrying capacity due to the confinement of concrete provided by the steel tube and delay in local buckling of the steel tube due to the concrete core. This paper presents the review of research carried out on CFST columns with emphasis on experimental and analytical work. The study also discusses the design specifications adopted by various codes like AISC-LRFD and Euro code 4.

Harsh G. Vaghasiya1, Vishal B. Patel2, Indrajit N. Patel3 – 2022, COMPARATIVE EVALUATION OF RCC & CONCRETE FILLED DOUBLE-SKIN STEEL TUBE BUILDING SUBJECTED TO STATIC AND DYNAMIC LOADING, International Advanced Research Journal in Science, Engineering and Technology ISO 3297:2007 Certified Impact Factor 7.105 Vol. 9, Issue 5, May 2022 DOI: 10.17148/IARJSET.2022.9590 - in this paper a building located at Vallabh Vidyanagar city was selected as the study frame and RCC column of that frame was taken as economical for given loadings. All the columns of this study frame were then replaced by equivalent CFDST columns and then by CFST columns (both circular sections) based on FE analysis results after analysing both the section in ABAQUS software. Performance evaluation of all three frames then carried out and compared. From that we can say that the forces which were present in thee RCC or CFST section were reduced by significant amount which says that CFDST column's performance is better than both RCC and CFST columns under static loadings. The seismic performance of CFDST column section was found better than RCC frame or CFST frame under four different time-history analysis with that we can say that CFDST column can be used as an improvement over RCC or CFST column section.

3. CONCLUSION

Following Conclusions have been made from the study undertaken -

- Composite frame consisting of steel tube reinforced concrete columns and ordinary reinforced concrete beams were exhibited the exhibited high ductility and energy dissipation under large lateral displacements, and constant axial loads.
- High rise SMRF with thin walled CFST columns are capable of improving collapse margin for more than 60%.
- The CFST frame structure has qualified seismic performance.
- CFST columns are significant in load carrying capacity with small cross section as compared to Conventional RC concrete.
- High rise models with CFST columns and RC shear wall subjected to shake table test showed that, this type of structural system exhibited favourable behaviour under earthquakes.
- When cost analysis of high rise buildings with CFST frame, conventional R.C. frame and steel frame is done, then it has been concluded that the CFST frame becomes economical when number of storey becomes greater than 15 storeys.
- Frames with CFST columns have better seismic performance as compared to conventional RC framed structure

4. REFERENCES

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