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Study on Seismic Behavior of Multi Storied RCC Building Considering CFST Columns

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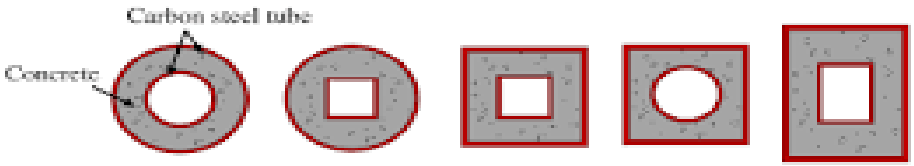
Abstract - *In now days, the large growth in population, deficiency of land and migration towards cities have made it obligatory to resort to high rise building construction. The failure of multi-storey or high rise RCC buildings mainly occurs due to earthquake forces. Also, on account of large axial forces and moments, the high rise buildings are requiring bulky columns which further cause reduction in the functional area. To overcome such problem, use of Concrete Filled Steel Tube (CFST) columns for high rise RCC buildings becomes better option. CFST column is a composite section formed by filling concrete into a hollow steel tube and it resists the applied load through the composite action of concrete and steel. This advantageous interactive behavior between steel tube and concrete increases the strength of CFST section. In the present paper, seismic behavior of a RCC multistoried building provided with RCC and CFST columns has been compared using ETABS 15.0 software. The results of study indicate that the building with CFST columns performs better against seismic forces.*

Key Words: **Concrete Filled Steel Tube(CFST), ETABS, Reinforced Cement Concrete, multi-storey, Seismic behavior.**

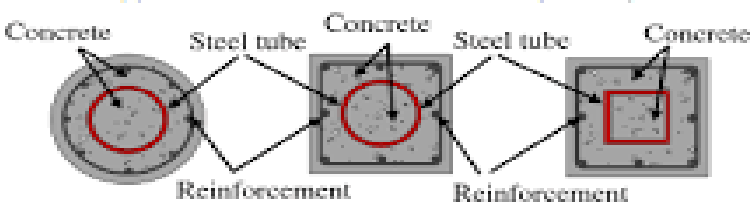
Introduction

The CFST is composite section formed by filling concrete into a hollow steel tube section and offers resistance to applied load through the composite action of steel and concrete. In CFST, the steel tube lies at the outer perimeter which acts as longitudinal as well as transverse reinforcement to resist effectively the tension and bending along with increase in stiffness because steel has high modulus of elasticity. It also provides good confinement to the inner concrete core and contributes in increasing the compressive strength. The inner concrete core also plays an important part in delaying the inward buckling of steel tube and thus improves the behavior of CFST.CFST possesses high ductility, strength, stiffness and energy absorption capacities which are very important for structures located in earthquake prone areas. CFST sections have additional advantage that the steel tube of the section serves as a form work during construction, thus helps in saving additional cost required for formwork and also the time required for construction.

1. To investigate the seismic behavior of multi storey (G+10) RCC building structure by changing the shape of CFST (circular and rectangular) column.
2. To compare the behavior of RCC multi storey (G+10) building structure considering conventional RCC and CFST column.
3. To validate the results of seismic analysis of multi storey RCC structure obtained by software and manually analysis.



(c) Concrete-filled double skin tubes (CFDST)



(d) Reinforced Concrete-filled double skin tubes (CFDST)

Review of Previous Studies

Asha B. R. & Sowjanya G.V.[7], investigated the seismic behavior of G+12 storey steel building structure considering steel and composite column (CFST) for Zone III. The complete analysis of structure is carried out by using ETAB software as per IS 1893-2002 with the static equivalent method. After the complete analysis of structure in both cases, earthquake response parameters are compared namely base shear, storey drift, and roof displacement. This study shows that base shear, storey drift and roof displacement of the structure is reduced up to 22% to 26% using CFST column.

Abhay Guleria[12] investigation "Structural Analysis of a Multi-Storeyed Building using ETABS for different Plan Configurations" The case study in this paper mainly emphasizes on structural behavior of multi-storey building for different plan configurations like rectangular, C, L and I-shape. Modelling of 15- storeys R.C.C. framed building is done on the ETABS software for analyzed. The analysis of the multi-storeyed building reflected that the storey overturning moment varies inversely with storey height. Moreover, L-shape, I-shape type buildings give almost similar response against the overturning moment. Storey drift displacement increased with storey height up to 6th storey reaching to maximum value and then started decreasing. From dynamic analysis, mode shapes are generated and it can be concluded that asymmetrical plans undergo more deformation than symmetrical plans.

Shilpa Sara Kurian et al. [10] Study on " Study on Concrete Filled Steel Tube" study is an attempt to understand the behavior of Concrete filled steel tubular column under axial load. A concrete-filled steel tubular (CFST) column is formed by filling a steel tube with concrete. It is well known that concrete-filled steel tubular (CFST) columns are currently being increasingly used in the construction of buildings, due to their excellent static and earthquake-resistant properties, such as high strength, high ductility, large energy absorption capacity, bending stiffness, fire performance along with favorable construction ability etc. Recently, the behavior of the CFST columns has become of great interest to design engineers, infrastructure owners and researchers, therefore to understand the load deformation characteristics of composite columns critically, numerical finite element analysis using software package ANSYS is carried out in this paper. This paper focuses on modeling of concrete filled steel tube (CFST) column under axial loading.

Faizulla Z Shariff & Suma devi [8] Study on "Comparative study on rcc and CFT multi-storied buildings" Use of composite material is of particular interest, due to its significant potential in improving the overall performance through rather modest changes in manufacturing and constructional technologies. Steel-concrete composite columns are used extensively in modern buildings. Extensive researches on composite columns in which structural steel section are encased in concrete have been carried out. In-filled composite columns, however have received limited attention compared to encased columns. In this study E-Tabs nonlinear software is used for simulation of steel concrete composite (CFT) with steel reinforced concrete structures (RCC) of G+14, G+19 and G+24 stories each are considered for comparative study. Comparison of parameters like base shear, axial force and bending moment is done.

Analysis and Design

The seismic analysis and design of G+10 storied RCC building provided with RCC and CFST columns has been carried out as per code IS: 1893- 2002 using ETABS 2016 software. Loadings on building are considered as per code IS 875: 1987 Part I, Part II ,Part III and Part V. Typical floor plan and 3D model of the building developed using ETABS 2016 is shown in Fig.2 and Fig.3 respectively. Also, details of material data, structural configuration, seismic data and building details are given in table no.1.The analysis of building structure provided with CFST and RCC column is carried out by Response Spectrum method of seismic analysis. After analysis, design of RCC building is carried out using code IS 456: 2000 and for designing CFST columns of building AISC 360:10 code is used. The results of analysis and design are compared to know the behaviour of building structure provided with CFST and RCC columns.

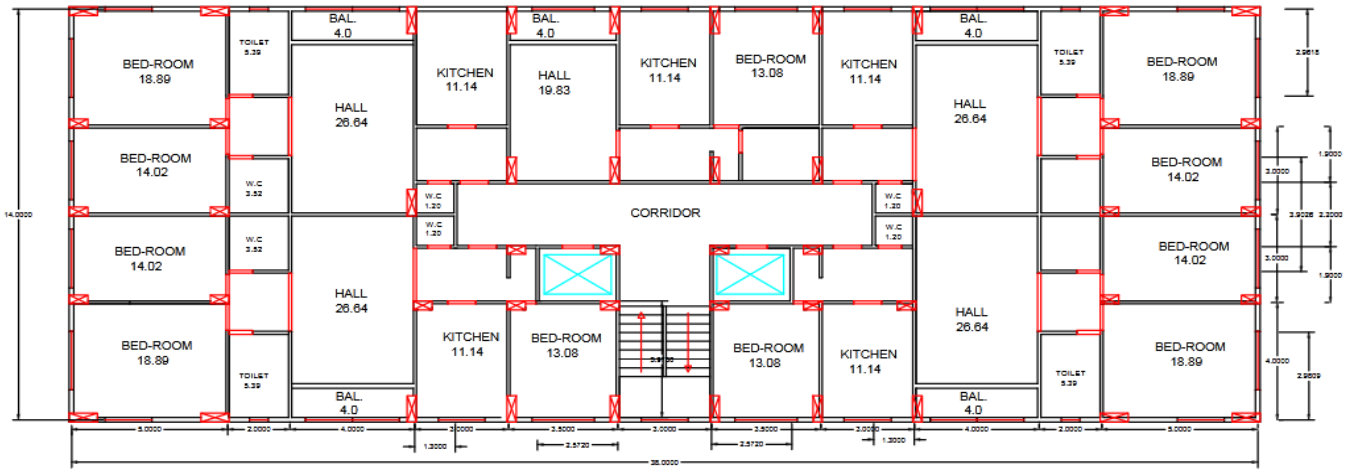


Fig. No.1 : Typical floor plan selected for proposed work.

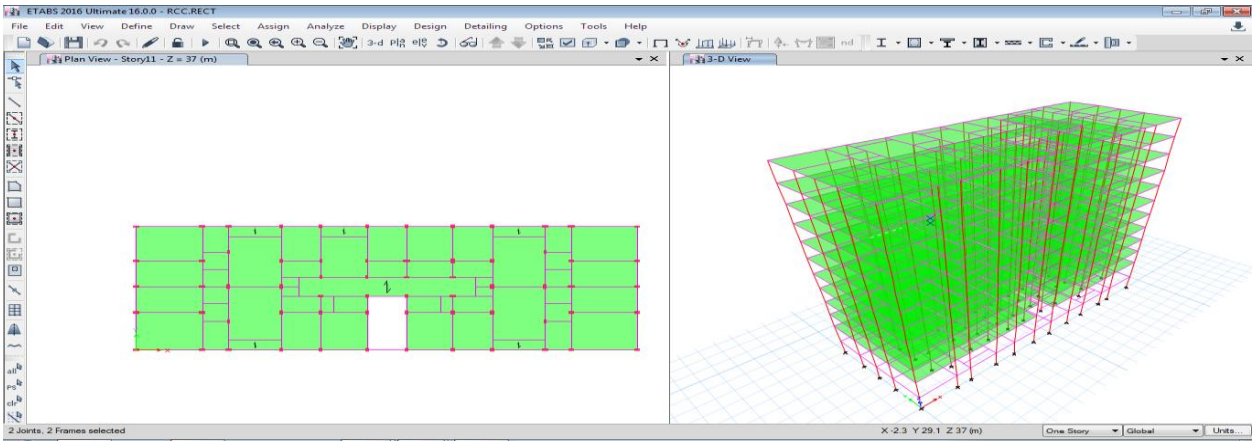


Fig. No.2 : Plan and Elevation of building in ETABS 2016

Results and Discussion

The results of analysis and design of aG+10 RCC multistoried building provided with circular and rectangular CFST columns using response spectrum method are presented and discussed in the following manner:

1) Verification of analysis results of G+2 storied building by manually with the results of ETABS 2015 software using Equivalent Static Analysis method.
2) Storey shear of building provided with CFST and RCC columns
3) Lateral displacement of building provided with CFST and RCC columns.

1) Verification of analysis results of G+2 storied building by manually with the results of ETABS software using Equivalent Static Analysis method.

In order to verify the applicability of ETABS software, a G+2 storied building provided with CFST columns has been analyzed and designed by manually as well as in ETABS 2016 software using Equivalent Static Analysis method of seismic analysis. The analysis (base shear) and design (Section capacities) results obtained from the manually and ETABS 2016 software are presented in Table

Table No. 1: Analysis results of G+2 storied buildings provided with CFST

Sr. No.	CFST Section	Base Shear in kN		% Difference
		Manual Results	ETABS Results	
1	Rectangular	361.20	367.41	1.69
2	Circular	353.87	358.21	1.20

Table No. 2: Design results of G+2 storied buildings provided with CFST

Sr. No.	CFST Section	Manual Results			ETABS Results			% Difference		
		P_d kN	Mx kNm	My kNm	P_d kN	Mx kNm	My kNm	P_d	Mx	My
1	Rectangular	1749	134	121	1773	136	123	1.35	1.47	1.62
2	Circular	1224	71.12	71.12	1244	72.4	72.4	1.6	1.76	1.76

From the values of base shear and section capacities obtained by manually and ETABS 2016 software (Table No. 1&2), it is observed that the percentage difference in analysis and design results of the building under consideration is very small and hence, the analysis and design of any building provided with CFST columns can be safely carried out using ETABS 2016 software.

2) Storey shear of building provided with CFST and RCC columns:

Storey shear values at each storey level of building with RCC and CFST column in both X and Y- directions are represented below.

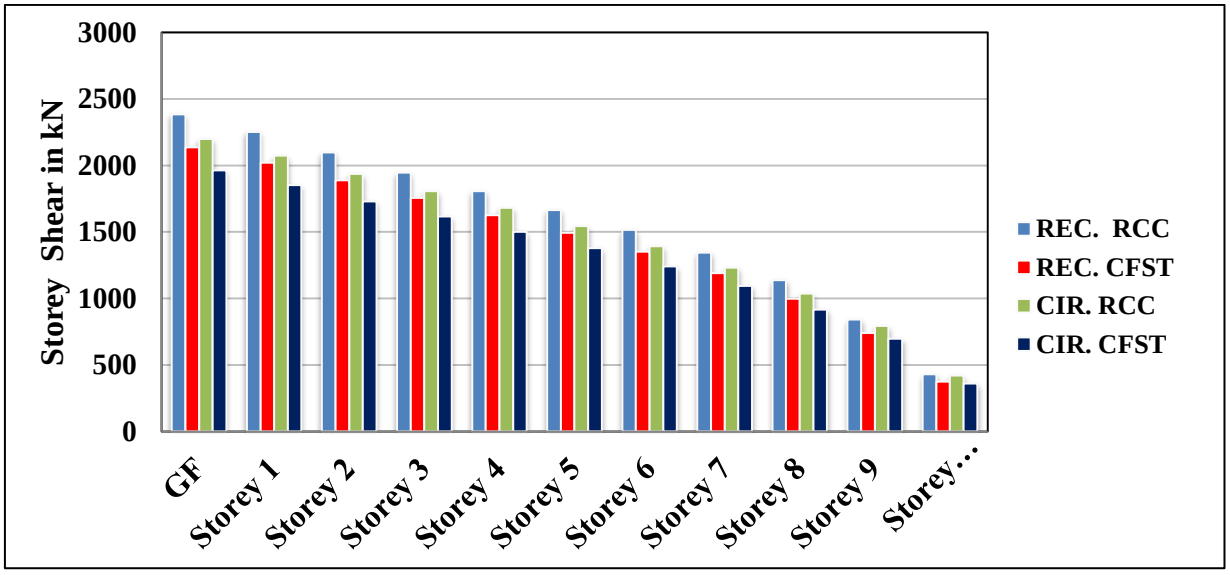


Fig.No. 3: Comparison of storey shear of building in X-direction

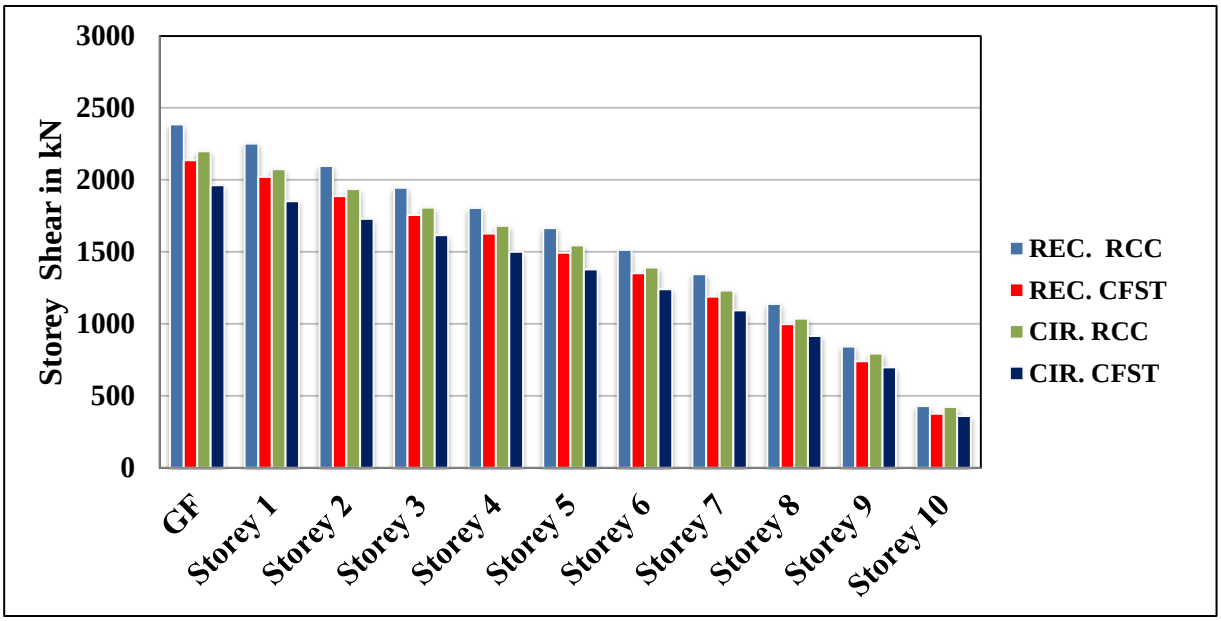


Fig.No.4: Comparison of storey shear of building in Y-direction

From above figures it is clearly seen that storey shear is minimum in building which is provided with CFST column as compared to ordinary RCC column building.

3) Lateral displacement of building provided with CFST and RCC columns:

The variations of storey lateral displacements in both X and Y direction for CFST and RCC column building are represented as follows

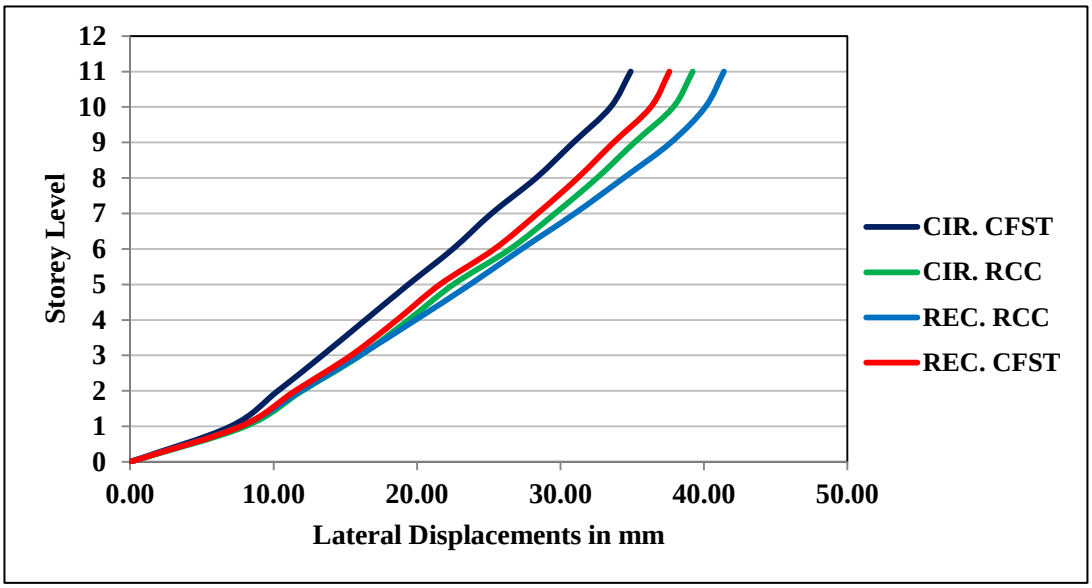


Fig. No. 5: Comparison of lateral displacement of building in X-direction

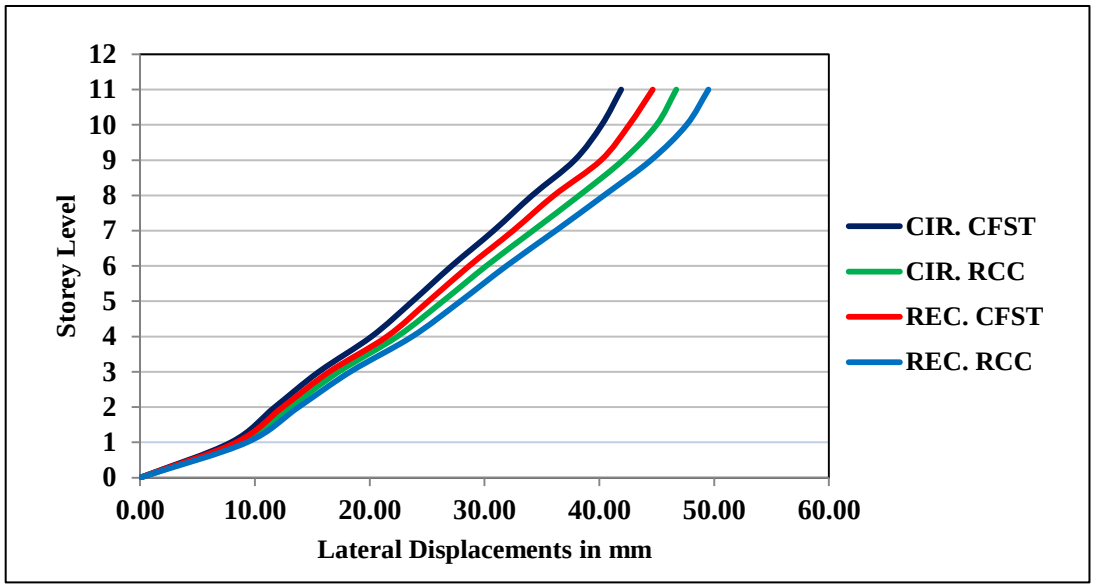


Fig. No. 6: Comparison of lateral displacement of building in Y-direction

Above figure shows that the lateral displacements are minimum in building which is provided with CFST column as compared to ordinary RCC column building which indicates the stiffness of building with CFST column is more.

Conclusions

1. The results of analysis as obtained by Equivalent Static Analysis method (manual analysis) and ETABS 2015 software for G+2 storied building provided with CFST columns are found to be almost same and therefore, it can be concluded that the analysis and design of the building gets validated.
2. The storey shear and lateral displacement values obtained in the seismic analysis of a G+10 storied building provided with rectangular and circular CFST columns are found to be approximately less than 10% as compared to the values obtained for the buildings with RCC columns of similar c/s section. Also, storey shear and lateral displacement values are found to be approximately less than 8% and 6% for circular CFST columns compared to the rectangular CFST columns respectively.

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