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Comparative Study of Concrete Filled Steel Tube Structure with Traditional Reinforced Concrete and Steel Structure

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***Abstract* –In this work, review is carried out on composite columns with emphasis on analytical work. It includes review of research work that has been carried out, accounting the effects of local buckling, bond strength, lateral loading, confinement of concrete and behaviour of steelconcrete composite columns. The objective of this present study is to understand the behaviour of the CFST system for high-rise building and to design structural systems including effects of the lateral loading. Also study of the confinement effect of concrete due to steel tube is done. Building of 20-storey and having C-shape had been taken for study.**

***Index Terms* – CFST, Lateral Loading, Composite Column, Local Buckling, Bond Strength**

I. INTRODUCTION

A Concrete filled steel tube (CFST) column is a structural system with excellent structural characteristics, which is the result of combining the advantages of a steel tube and those of concrete[1]. A CFST column is constructed by filling a hollow rectangular or circular structural steel tube with concrete. As a structural system, a CFST column has a high load bearing capacity, excellent earthquake resistance, good ductility, high fire resistance and its higher stiffness which delays the onset of local buckling. Besides that, the steel tube can function as permanent formwork as well as reinforcement, thus more economical to be utilized. The increasing costs and project works delay in construction industries in our country require certain measures to be taken as to reduce the costs and increase the speed of construction.[2] One of the solutions worth considering is by applying the Industrialized Building System (IBS), where concrete filled steel columns can be considered as one of the structural elements. The promising features of a CFST column as an excellent earthquake resistance might be of interest for structural engineers or designers in finding a solution to the increasing threat of earthquake in our country.[3]

II. STRUCTURAL BEHAVIOR OF CFST COLUMN

The initial Poisson's ratio of concrete (approximately 0.15 to 0.25) is below that of steel (approximately 0.3). Thus, as the strain in the materials during the early loading is different there is often little initial confinement of the concrete in a CFST. However, as the concrete begins to crack, it expands faster than the steel tube and becomes well confined at higher load value[4].

Although the effect of confinement to increase load carrying capacity is limited for many cases, confinement has a significant effect on the ductility of columns. After the maximum concrete compressive strength has been reached, the steel tube prevents the concrete from spelling and the concrete core continues to carry high stresses with increased strains, thereby increasing the ductility of the CFST column.[5]

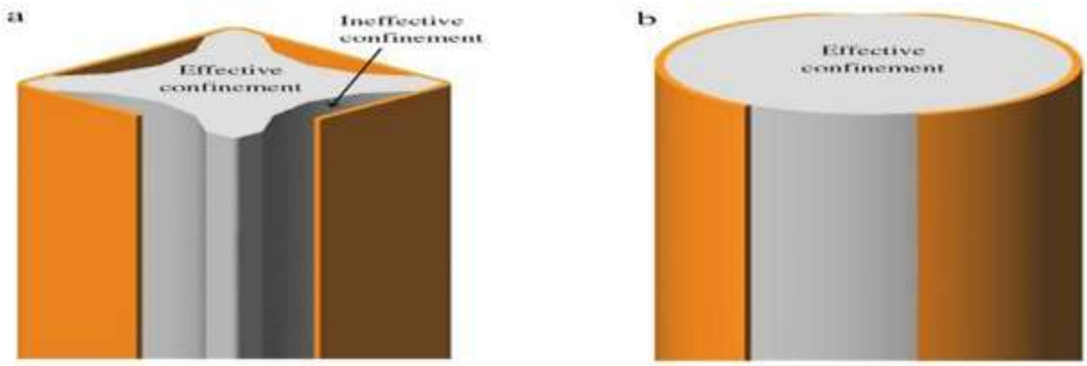

Figure 1: Confinement action in Concrete filled Steel Tubes

III. Modeling process of C-shaped building

Here, building had been of C-shape with G+19 storey and shear wall at corner and at end of the building. Storey height taken 3 m. Live load, Dead load, Earthquake load, wind load, Floor finish applied on the structure. Different load combinations had been taken as per IS 456:2000. Zone III was selected for earthquake loading. Thickness of slab was 150 mm. Beam and Column size taken as below:

Table 1: Beam and Column size

No. of Storey	**20-storey**
CFT Building	ISWB600
RCC Building	230x600
Steel Building	ISWB600

No. of Storey	**20-storey**
CFT Building	400x800 mm with 8 mm plates on all sides
RCC Building	450x900 (1 to 10 floors)
Steel Building	450x600 (11 to 20 floors)

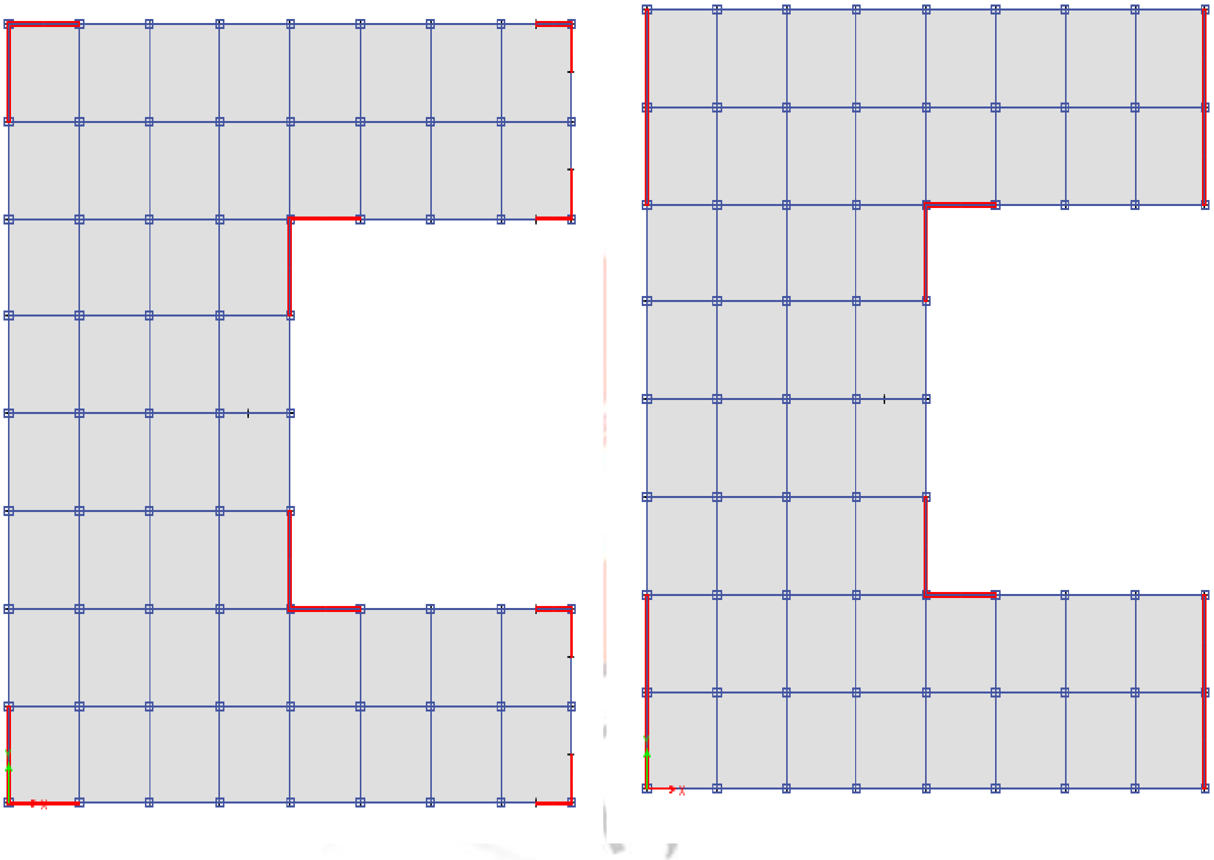

Figure 2: Plan of building with shear wall at corner and at end.

IV. Analysis process

After completion of modeling process next step which carried out was analysis of building. Here we carried out non-linear dynamic Time History analysis. For this analysis, we applied the acceleration data of El Centro Earthquake occurred in past. Wind load anlaysis done as per IS 875 (Part-3) and Earthquake analysis done as per IS 1893:2002.

V. RESULTS

Here, results were developed in terms of different building configurations like Time Period, Frequency, Base Shear, Load intensity.

Load Comparisons

Table 2: Load Comparison

Structure	CFT shear wall at CORNER	CFT shear wall at END	RCC shear wall at CORNER	RCC shear wall at END	STEEL shear wall at CORNER	STEEL shear wall at END
Dead Load (KN)	150331.77 KN	152581.77 KN	178097.84 KN	178107.45 KN	125080.97 KN	152581.77 KN
Live Load (KN)	48000 KN	48000 KN	48000 KN	48000 KN	48000 KN	48000 KN
Floor Finish (KN)	24000 KN	24000 KN	24000 KN	24000 KN	24000 KN	24000 KN
Total Load (KN)	222331.77 KN	224581.77 KN	250097.84 KN	250107.45 KN	197080.97 KN	224581.77 KN
Load Intensity	8.92 KN/mt^2	9.10 KN/mt^2	10.42 KN/mt^2	10.42 KN/mt^2	8.21 KN/mt^2	9.357 KN/mt^2

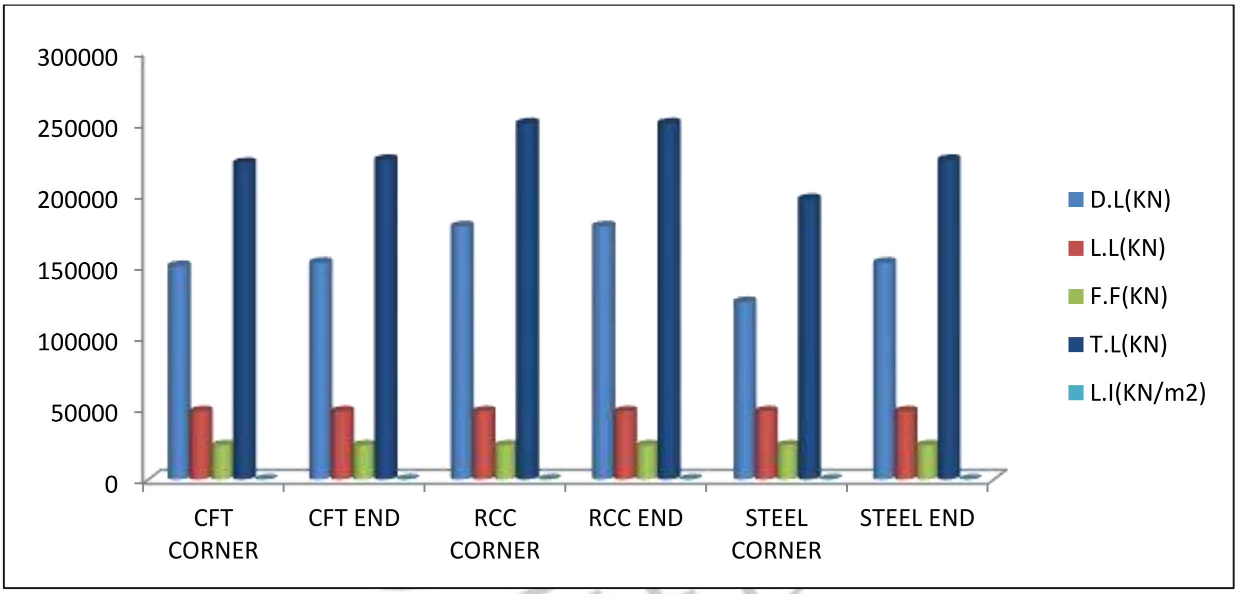

Figure 3: Graph showing load comparison for 20-storey CFT, RCC and Steel Building

Time Period

Graphical representation of Time period shown in Figure indicates that CFT building has lesser time period compared to both RCC and Steel building. Percentage reduction in time period of CFT building is 13.63% and 38.17% with compared to RCC and Steel building respectively. Also, Percentage reduction in time period of CFT building with shear wall at Corner 8.82 % and 21.50% with compared to RCC and Steel building respectively.

Table 3: Time Period Comparison for 20-storey CFT, RCC and Steel Buildings

Type	CFT shear wall at Corner	CFT shear wall at End	RCC shear wall at Corner	RCC shear wall at End	STEEL shear wall at Corner	STEEL shear wall at End
Time Period for 1st mode	2.055 sec	1.489 sec	1.610 sec	1.468 sec	1.897 sec	1.724 sec

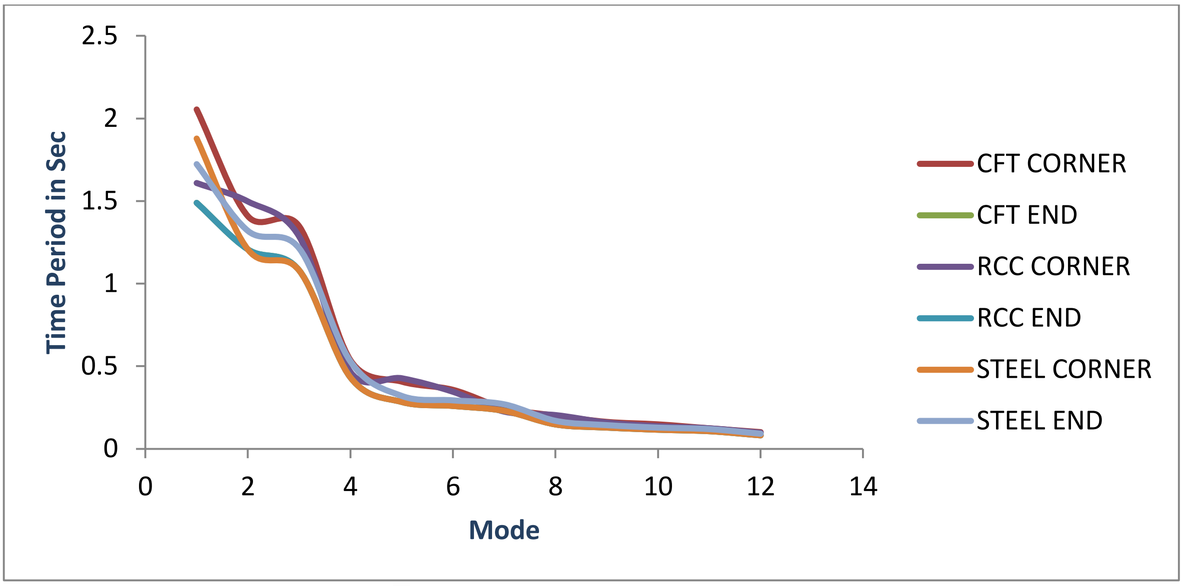

Figure 4: Graph of time Period comparisons for CFT, RCC and Steel Buildings

Axial Compressive Force

Table 4: Axial Force Comparison for 20-storey CFT, RCC and Steel Buildings

Column No.	CFT shear wall at Corner	CFT shear wall at End	RCC shear wall at Corner	RCC shear wall at Corner	STEEL shear wall at Corner	STEEL shear wall at End
C29 (KN)	4025.63	3810.39	4561.01	4424.02	4190.79	3970.42

It is observed that for CFT Column force is less while for Steel it is lesser than RCC but more than CFT. CFT building with shear wall at Corner observed less axial force in column than the RCC and Steel both building respectively.

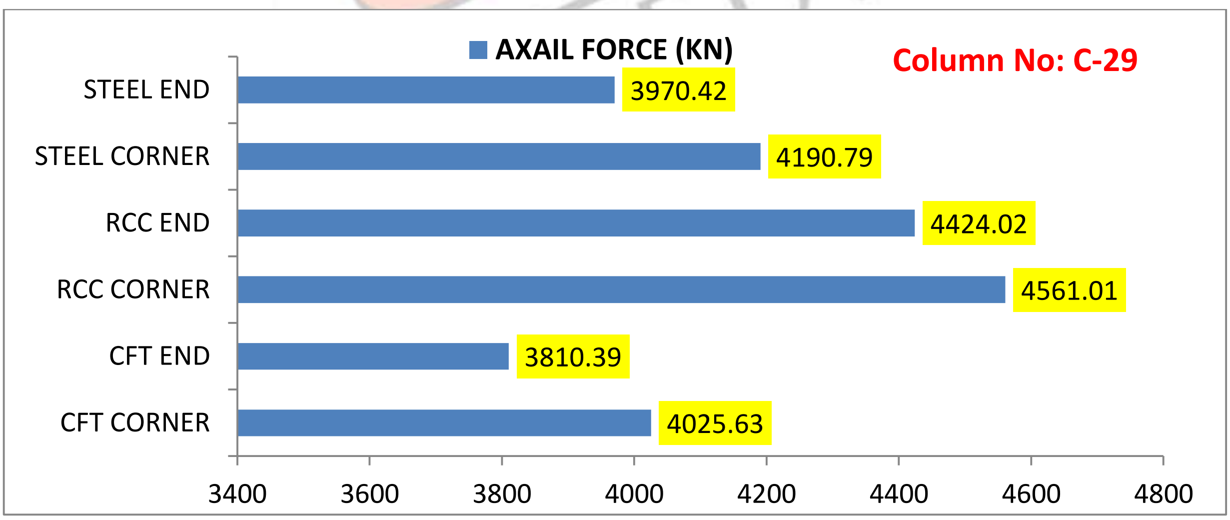

Figure 5: Axial Force Comparison for 20-storey CFT, RCC and Steel Building column

VI. Conclusion

- In this chapter comparison of 20 building for Load intensity, Time period, Base shear, Maximum load carrying capacity, axial force and Top storey displacement of CFT, RCC and Steel building was done.
- Result shows that the CFT building is effective in performance wise compared to RCC building in terms of 20 story building increase in the time period by 21.65%, Top storey displacement by 22.73 % and increase in load carrying capacity by 14.93%.
- Also where compared with Steel building, the CFT building with shear wall at End is effective in performance wise in terms of 20 story building with increase in time period by 14.68%, top storey displacement by 10.63% and increase load carrying capacity 4.95%.
- Axial force in CFT column is minimum compare to RCC and Steel column structure which is 21.74% and 12.94% respectively. For 20 storey building CFT with shear wall at Corner found much better than the RCC and Steel building.

VII. Acknowledgment

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VIII. References

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