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PERFORMANCE OF BUILDINGS WITH SPECIAL CFST COLUMNS CONNECTED BY DOUBLE STEEL LINKING PLATES

FATHIMA BINSY A M[1], PRIYANKA DILIP P[2]

[1]PG Student, Dept. of Civil Engineering, AWH Engineering College, Kuttikkattoor, Calicut, India
[2]Professor, Dept. of Civil Engineering, AWH Engineering College, Kuttikkattoor, Calicut, India

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Abstract-*This study examines the performance of a new type of composite columns: special shaped columns comprising concrete-filled steel tubes connected by double-vertical steel plates (CFST-D). G+12 Storey has been considered. Models with five different shapes of special CFST columns were proposed. The modeling and analysis are executed in ETAB software. Time history analysis was carried out. El Centro earthquake has been considered for the analysis. The results showed that special CFST columns connected by double steel linking plates have higher bearing capacity and L shaped CFST-D have better seismic performance.*

Key Words: Time history analysis, L shaped, T shaped, LCFST-D columns, specially shaped columns, steel linking plates, El Centro earthquake

1. INTRODUCTION

Special shaped columns can be embedded into walls and thus help avoid column protrusion, making them beneficial from an architectural design viewpoint. L, T, cross and Z shaped reinforced concrete columns have frequently been employed in residential structures. However, such columns fail to meet the requirements of high rise buildings with respect to heavy loads such as might occur during strong earthquakes. Studies have shown that the special-shaped columns comprising CFST connected by double vertical steel plates can meet the requirements of high-rise steel housing construction in terms of the bearing capacity. This pattern not only helps to increase bearing capacity but also improve the confinement of the core concrete and flexural rigidity. The bearing capacity was proportional to the thickness of the vertical steel plate. Because of the increase in the width of the vertical steel plate, local buckling of the vertical steel plate easily occurred. Increasing the thickness of the vertical steel plate reduced local buckling, thereby enhancing the confinement to the core concrete.

In this study, models with five different type cross sections of special CFST connected by double steel linking plates are proposed. Non linear dynamic analysis of models are carried out. This analysis is aims at setting up an environment which imitates the real time earthquake ground motions and gives a more realistic picture of the possible deformation and collapse mechanism formed in a structure. Time history method of analysis makes use of ground motion data of previously occurred earthquakes to assess the structural behavior. In this method, the structure will be assigned with plastic hinges to study the structural behavior in the non linear region or in other words material non linearity is considered. In this study, the ground motion of El Centro (1940) has been considered.

The modeling and analysis are executed in ETABS software, which is one of the leading design software in the market.

1.1 Objectives

The main objective of the proposed work

- To perform nonlinear dynamic analysis of different models of special CFST columns connected by double steel linking plates.
- To study and compare base shear capacity of different buildings under consideration.
- To find out the best column which can resist earthquake forces.

2. MODELLING

The study is carried out on (G+ 12) buildings having different cross sections of special CFST columns connected by steel linking plates. The buildings are modeled using the software ETABS 2017. The dimensions of the beams, columns and slabs, the loads applied and other details are summarized in Table1.

Models are considered for time-history analysis under real ground motion records. El Centro as a near fault motion has been selected to perform the analysis. These ground motion data were applied to the building to study the behavior of the building under an actual earthquake.

Table- 1: Details and dimensions of building models

Plan	36 x 16 m
Number of storeys	G + 12
Grade of concrete and steel	M30 and Fe345
Size of beam	300 x 600 mm
Thickness of slab	200 mm
Size of steel tube	200 x 200 x 10 mm
Size of vertical steel plate	Width = 200 mm Thickness=10 mm
Live load	3.5 kN/m^2

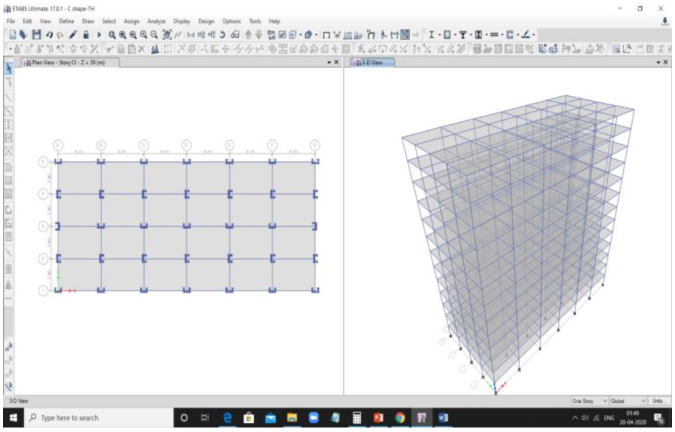

FIG -1: C-CFST-D(Plan and 3D View)

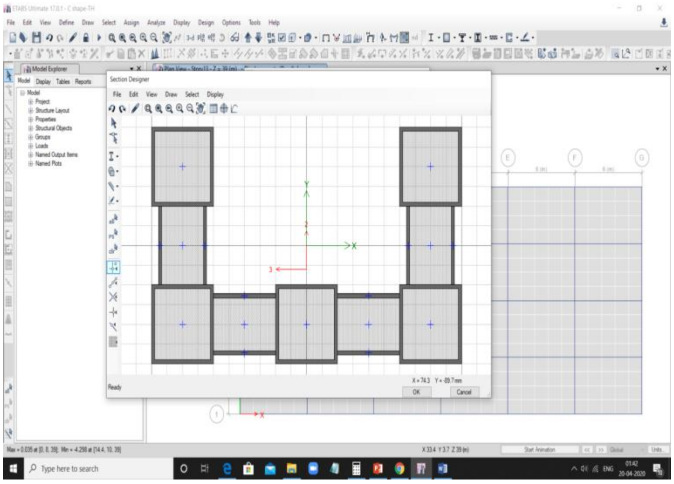

FIG-2: Cross sectionof C-CFST-D

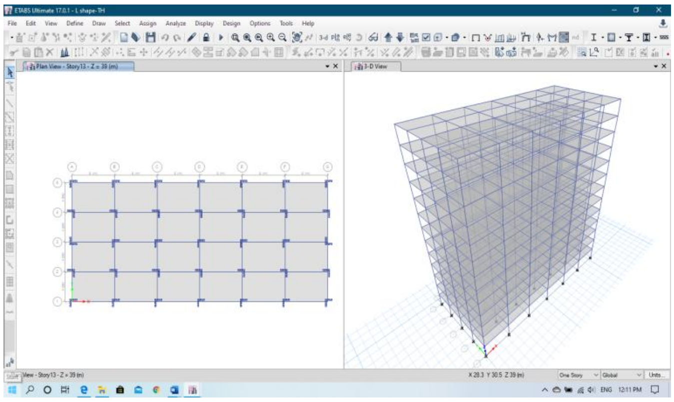

FIG -3: L-CFST-D (Plan and 3D View)

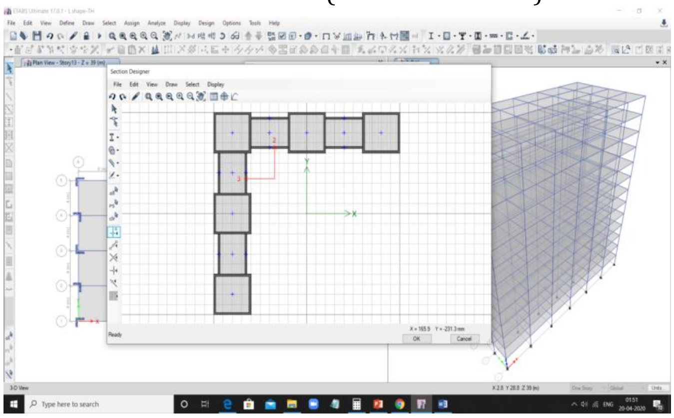

FIG-4: Cross Section of L-CFST-D

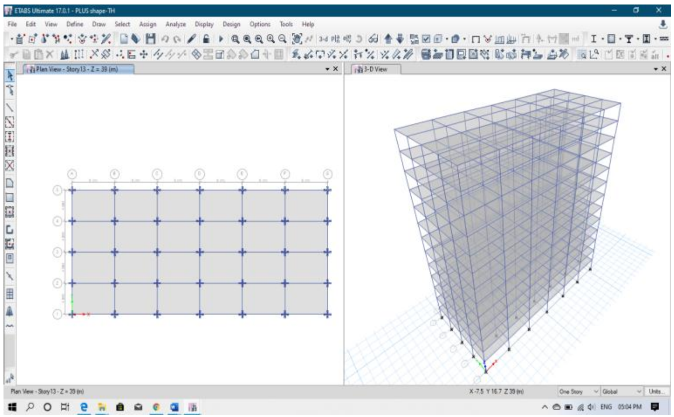

FIG-5: Cross-CFST-D(Plan and 3D View)

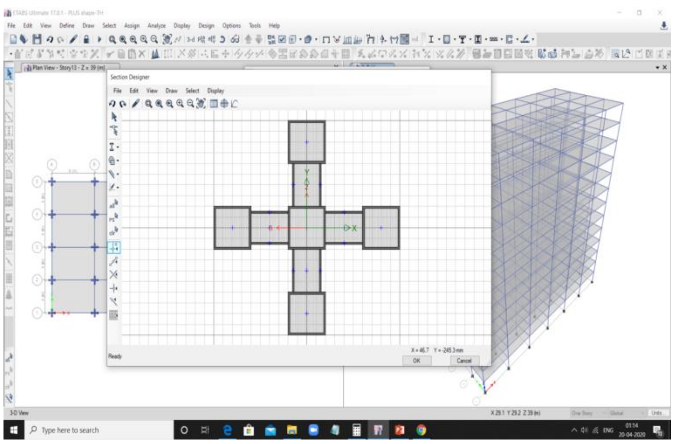

FIG-6: Cross section of C-CFST-D

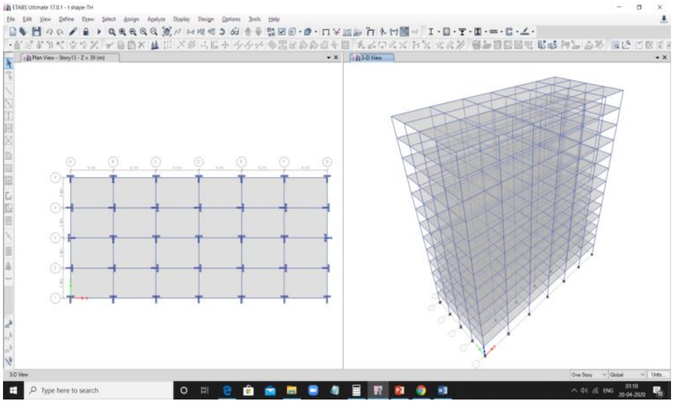

FIG-7: T-CFST-D(Plan and 3D View)

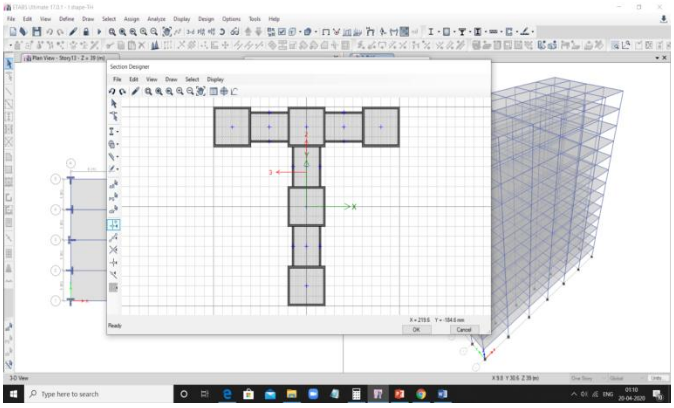

FIG-8: Cross section of T-CFST-D

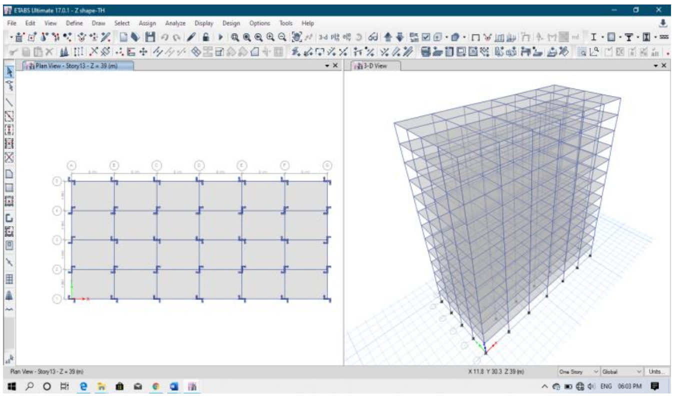

FIG-9:Z-CFST-D(Plan and 3D View)

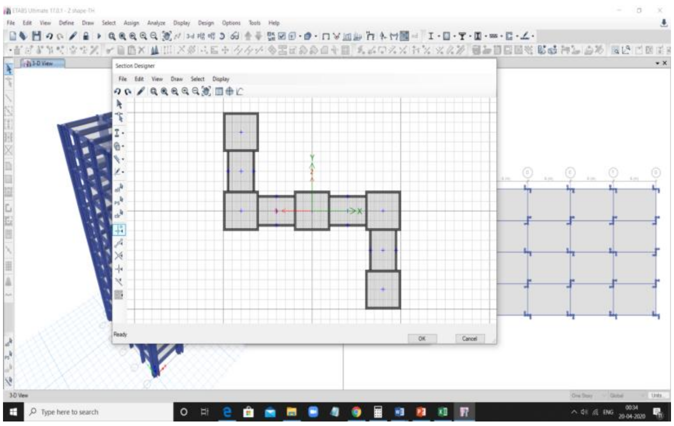

FIG-10: Cross section of Z-CFST-D

3. RESULTS AND DISCUSSIONS

3.1 Maximum Story Displacement

Story displacement is the total displacement of ith story with respect to ground. In other words,it is the lateral displacement of the story relative to the base.

Table –2: Maximum Story Displacement

Models	Maximum Story Displacement (mm) Y Direction
C Shaped	96.2
L Shaped	67.8
Cross Shaped	111.8
Tee Shaped	87.4
Z Shaped	68.9

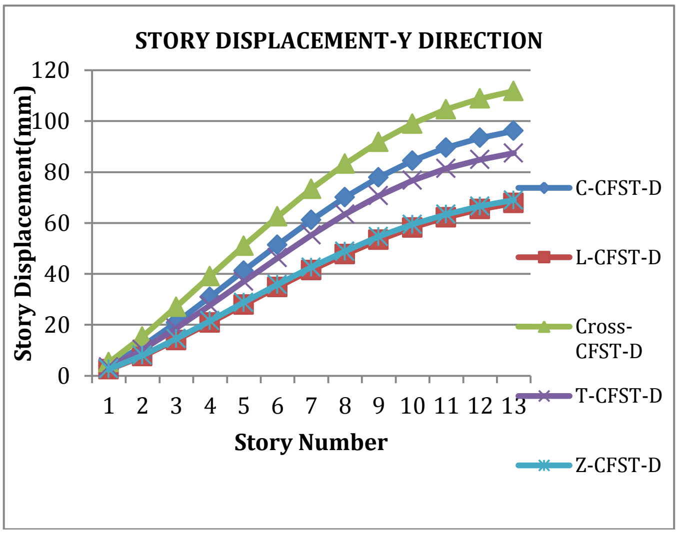

Chart-1: Maximum Story Displacement

From above figure, model with L-CFST column connected by double vertical steel plates showed less value of maximum story displacement. maximum story displacement increased by 29.52%, 39.35%, 22.42% and 1.6% for models with C, cross, T, and Z CFST-D columns respectively than model with L-CFST-D column

3.2 Maximum Story Drift

Story drift is the difference of displacements between two consecutive stories divided by the height of that story.

Table -3: Story Drift

Models	Maximum Story Drift Y Direction
C Shaped	0.00343
L Shaped	0.00234
Cross Shaped	0.00402
Tee Shaped	0.00311
Z Shaped	0.00242

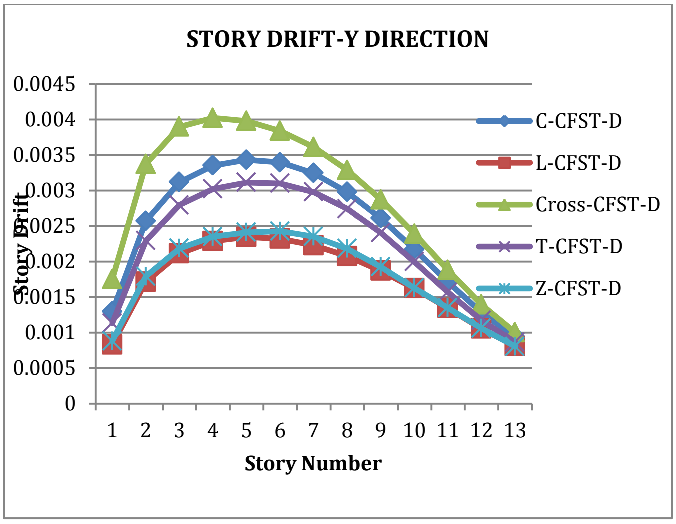

Chart-2: Story Drift

Table 3 shows the story drift of the different models, from table and figure above it is clearly see that the model L-CFST-D exhibits minimum value of maximum drift. i.e. maximum story drift increased by 31.7%, 41.8%, 24.75% and 3.3% for models with C, cross, T, and Z CFST-D columns respectively than Model with L-CFST-D column.

3.3 Story Shear

Shear force is a forceacting in the lateral direction. Here, maximum value of story shear is taken for comparison.

Table -4: Story Shear

Models	Story Shear (kN) Y Direction
C Shaped	11522
L Shaped	13734
Cross Shaped	10227
Tee Shaped	11998
Z Shaped	13200

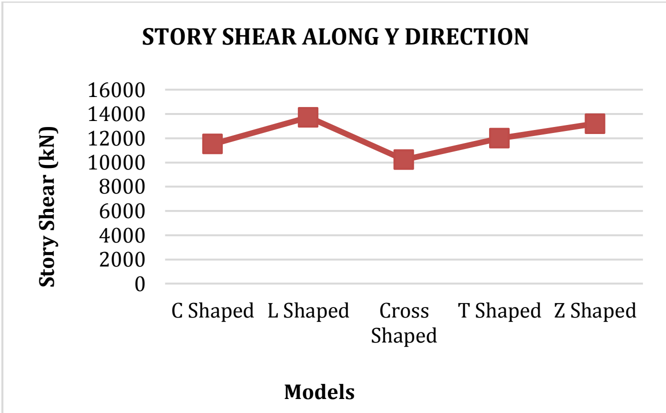

Chart-3: Story Shear

From Figure above, it can be observed that the base shear was maximum for model with L CFST column, i.e. L column has 16.1%, 25.5%, 12.6% and 3.8% more base shear capacity than C, L, T and Z CFST column models respectively.

4. CONCLUSIONS

The following conclusions were obtained from the analysis carried out in this study.

- Special shaped CFST columns connected by double steel linking plates functions well together. Such a structure has high bearing capacity.
- L-CFST column performed well among other special shaped CFST columns.
- For L-CFST column connected by double steel linking plate the % reduction in story displacement and story drift was about 23% and 25% respectively.
- There was around 10% higher increase in bearing capacity.

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