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Comparative Seismic Analysis of Encased Steel Composite Column Frames

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Abstract: In these days there is a rapid increase in the construction of multi-storied buildings. They are vulnerable to earthquakes. Nowadays composite columns are used to resist earthquakes. . In this paper for seismic resistance composite columns are investigated. This paper refers to the comparison between fully and partially composite building frames. The composite column is fully encased. In fully encased steel composite column the steel section act as reinforcement and also act as formwork during the construction process and hence decreases the labor cost. The behavior of concrete-filled rectangular tubular columns allows the use of smaller sections than required for reinforced concrete columns with similar loading. Partially encased composite column having steel core of I section is used for the analysis. In this paper an eight storied office building is analyzed using ETABS software.

Keywords: composite building, sesimic resistance encased steel, conventional building

I. INTRODUCTION

Steel-concrete composite columns are columns where steel and concrete compositely acts together. Steel-concrete composite columns are compression member, comprising either a concrete encased or concrete filled tubular section of hot-rolled steel. These are used as a load-bearing member in a composite framed structure. Composite column resist the external loading by the combined interaction of steel and concrete. Concrete encasement prevents excessive spalling of concrete. The shell also improves the structural behavior of the column and increase the resistance to bending moment, shear force, and column buckling. The enhanced behavior of concrete-filled rectangular tubular columns allows the use of smaller sections than required for conventionally reinforced concrete columns with similar loading. Concrete filled rectangular tubular columns improves the ductile behavior of the concrete and yielding of the flange plate, but to a certain extent.

Partially encased steel composite column has high bending stiffness and buckling resistance. Composite columns are of different types and shapes.

II. SCOPE

The scopes of the study are

- To get a better idea of modern building techniques and on composite models of structures.
- The comparative study between fully and partially encased steel composite.
- To investigate the effect of story displacement, drift and shear in both frames.

III. COMPOSITE COLUMN CHARACTERISTICS

There are different types of encased columns available. In this study the composite column used is fully encased steel composite column. Composite column increases stiffness and reduce local buckling. Studies show that partially encased column has lesser deformation. Composite column can replace large columns and hence increase the floor area. According to the design codes there should be at least 4% structural steel in composite column. Composite column has economic advantage and in the case of high rise building it is efficient .Also they can increase the flexural, shear and tensile strength of the structure.

IV. MODEL AND ANALYSIS

In this study the primary objective is to investigate the behavior of encased steel composite column. An 8 storied (G+7) office building is considered. The response spectrum analysis of the frame is done using ETABS. The building description is shown in table 1.The cross sectional details of the fully and partially encased column is shown in fig1 and fig 2, fig 3 shows the plan of the building.

TABLE 1. Building Description

No of Stories	8 (G +7)
Beam size	300mm X 400mm
Column size	400mm X 400mm
Slab thickness	150mm
Zone	IV
Importance factor	1
Floor load	2.5 kN/m
Roof load	1.5 kN/m^2
Floor finish	1 kN/m^2
Roof finish	1 kN/m^2
Story height	3m
Bays in x and y direction	4

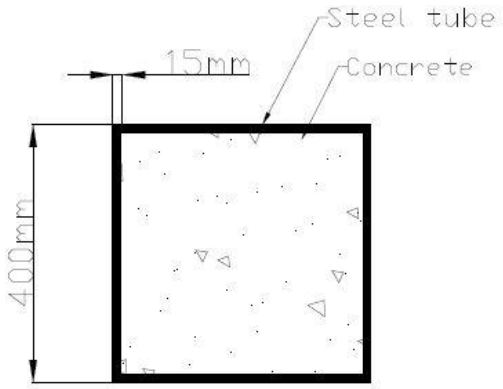


Fig. 1.Cross section details of fully encased square column

In partially encased steel composite column, column with an I section core is used. The I section used is ISMB250. A cover of 30mm is given to the reinforcement.

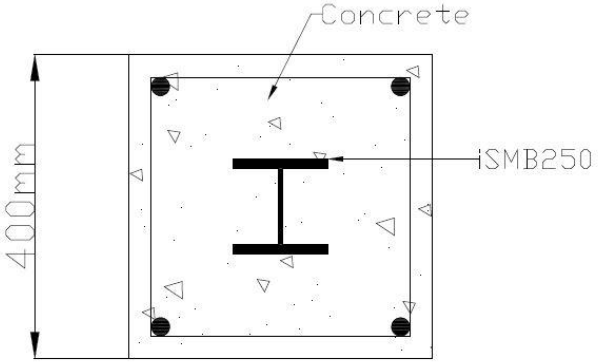


Fig. 2.Cross section details of partially encased square column

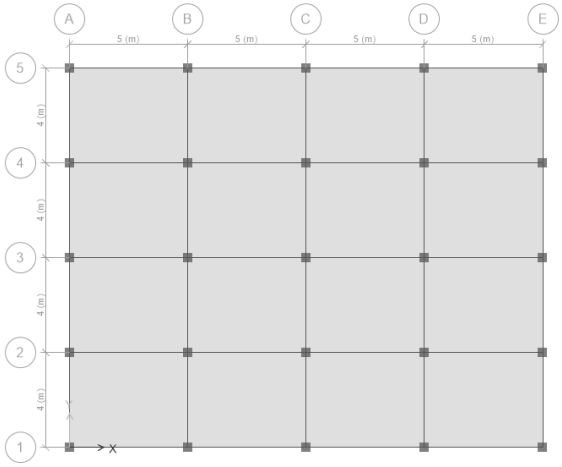


Fig. 3. Plan of building

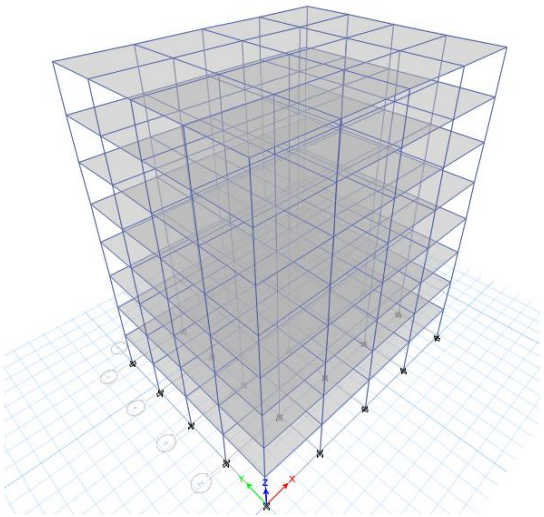


Fig. 4. Model of building

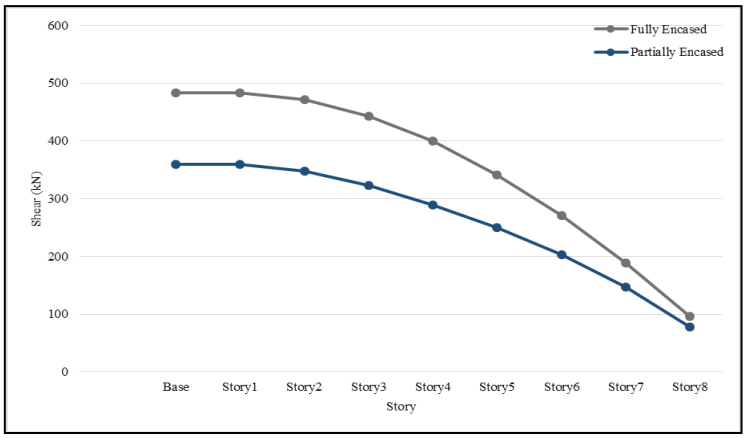
V. RESULTS AND DISCUSSION

In the frames loads are given .Analysis is done using E-TABS software. Response spectrum analysis is done to find out the seismic behavior of the composite and conventional building. The tables for story drift, story displacement, time period and story shear are obtained. Corresponding graphs are plotted with the tables obtained. The tables and graphs obtained are shown below.

TABLE 2. Story Shear for Composite Buildings

Story	**Elevation**	**Story shear (kN)**	
	m	**Fully encased**	**Partially encased**
Story8	24.1	96.0063	78.5452
Story7	21.1	189.1108	147.434
Story6	18.1	271.195	203.6096
Story5	15.1	341.6561	250.3295
Story4	12.1	399.4265	289.7182
Story3	9.1	443.0708	322.5062
Story2	6.1	471.0957	347.2289
Story1	3.1	482.6158	360.0765
Base	0	482.6158	360.0765

Fig.5 . Story Shear in each story



It is seen that fully encased steel composite column bears higher base shear than that of partially encased column frame.

TABLE 4. Story Drift for Composite Buildings

Story	Elevation	Story Drift	
	m	Fully encased	Partially encased
Story8	24.1	0.000163	0.000134
Story7	21.1	0.000262	0.000227
Story6	18.1	0.000365	0.000312
Story5	15.1	0.000456	0.000382
Story4	12.1	0.000526	0.000441
Story3	9.1	0.000563	0.000484
Story2	6.1	0.000532	0.000492
Story1	3.1	0.000297	0.000326
Base	0	0	0

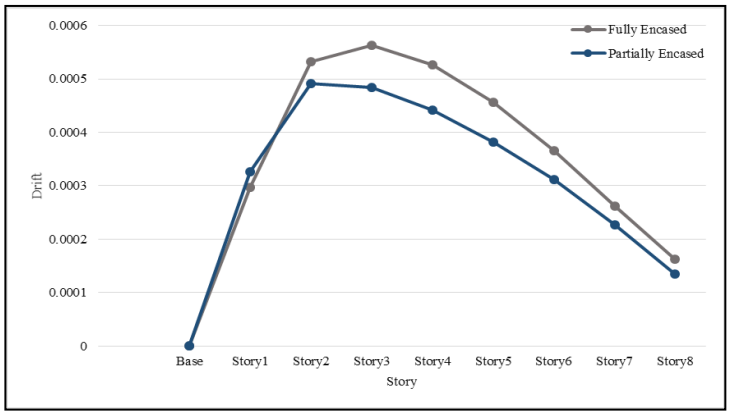


Fig.6. Story Drift for each story

TABLE 3. Maximum Story Displacement for Composite Buildings

Story	**Elevation**	**Story Displacement(mm)**	
	m	**Fully encased**	**Partially encased**
Story8	24.1	9.446	8.202
Story7	21.1	8.976	7.846
Story6	18.1	8.208	7.222
Story5	15.1	7.131	6.34
Story4	12.1	5.776	5.232
Story3	9.1	4.204	3.93
Story2	6.1	2.516	2.485
Story1	3.1	0.922	1.011
Base	0	0	0

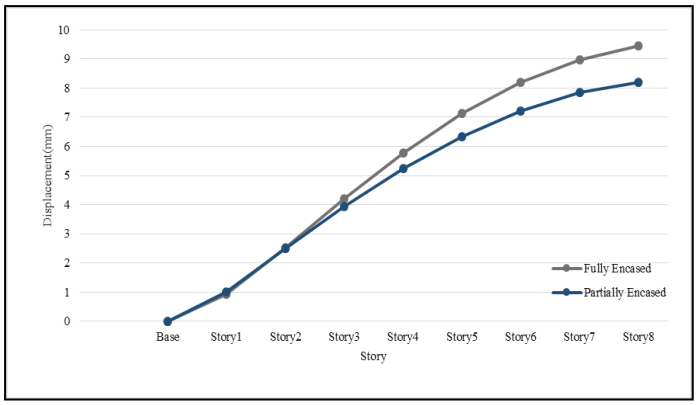


Fig. 7. Maximum story displacement for each stories

TABLE 5. Time period for Composite Buildings

Mode No:	Period (sec)	
	Fully encased	**Partially encased**
1	0.902	1.004
2	0.84	0.944
3	0.762	0.849
4	0.283	0.325
5	0.266	0.307
6	0.24	0.276
7	0.153	0.184
8	0.146	0.175
9	0.132	0.158
10	0.098	0.124
11	0.094	0.119
12	0.085	0.107

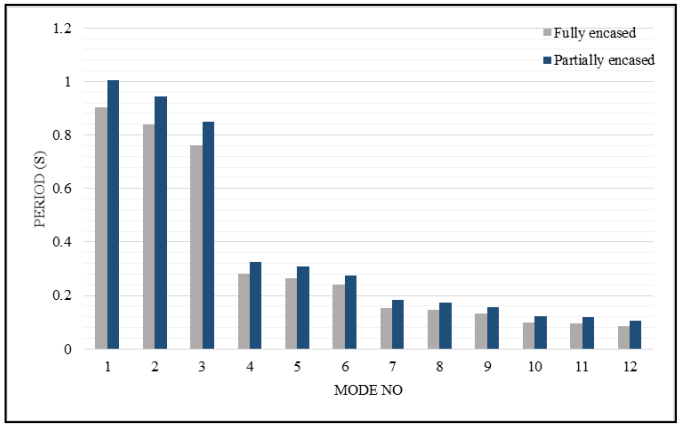


Fig.8. Time period for each mode

VI. CONCLUSIONS

Comparison between fully and partially encased steel composite buildings was done and the following conclusions were made.

- There is 23% increase in base shear for fully encased when compared with partially encased composite frame.
- Story drift is higher in the case of fully encased column frame.
- It is noted that the displacement of fully encased has 15% displacement than partially encased.
- Time period is higher in partially encased column frame.

VII. FUTURE SCOPE

- Investigation on the other types of composite column.
- Study on the effect of composite beam and column in frame.
- Investigation on different materials for encasing.
- Study on the effect on encasing thickness and cost.

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