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Analysis of Framed Structure with Conventional and Composite Column

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ABSTRACT- The previous few decades have seen exceptional advances in the utilization of composite materials in structural applications. Structural members that are comprised of at least two distinct materials are known as composite elements. The principle advantage of composite elements is that the properties of every material can be joined to frame a solitary unit that performs preferable generally speaking over its different constituent parts. Composite columns are a blend of two customary underlying structures: primary steel and primary cement. As composite columns were by and large created after steel columns and supported concrete columns, their plan approach might have been founded on one or the other steel or substantial plan techniques. In this thesis G+10, G15, G+30 storey conventional building models are been compared with composite column and compared their behaviour under zone III seismic condition using etabs. Change in the shape and size of composite column gives better result.

KEYWORDS- Response spectrum analysis, concrete encased steel section, conventional column, Composite column.

I. INTRODUCTION

Composite material is one in which the mix of at least one material built up, plated and blended while cementing [1]. This material withstand the more burden contrasted with gentle steel structure[2]. This assumes halfway part in picking title as composite connector which associate the primary individuals in joints of the substantial [3]. Composite Construction will enjoy the benefits of both pre-assembled and projected in situ development [4]. Balance out supports during transportation and development

- Do not need stiffeners in light of high focus of gravity
- Avoid the utilization of supports for cementing of leftover in-situ plates
- Make the errand of framework of cement plated un-required.

II. SCOPE OF STUDY

Presently a day India will eventually need to accommodate tall structures [5]. The upward improvement is the draftsmen's response to the test of populace blast in metropolitan territories where land is scant and is getting progressively expensive for that reason we require greater solidness and firm design and composite development is the most good perspective to satisfy these condition, by this examination we can ready to know conduct of various sort of composite section like square, rectangular and round under pivotally pressure stacking, how it respond to stack in various conditions like changing in its 'viewpoint proportion, evaluation of cement, and so forth This strategy will be the .fate of development in agricultural nations like India since this procedure give more strength when contrasted with ordinary RCC areas of same cross-sectional region [6-8]. This strategy additionally diminishes the expense and season of development [9].

III. MODELLING

This study models 6 conventional and concrete encased steel structures of 10 storey and 15 storey [10]. The models are located on seismic zone 5 with medium soil profile. These type of RC structures with storey levels of 3 to 10 are commonly found in countries like Nepal, India, Bangladesh, Bhutan etc [11-12]. All the models were designed following Indian standard codes, IS 456:2000 and IS 1893 (Part 1): 2016. Figure 1 shows the model:

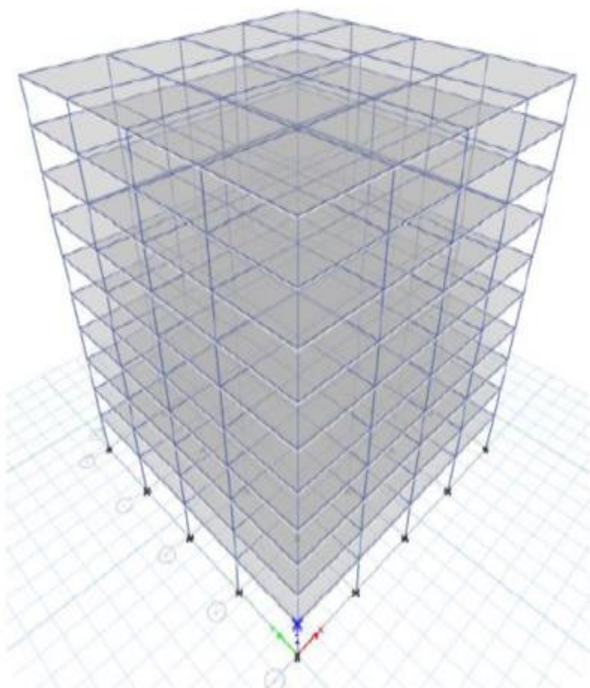

Figure 1: MODEL 1

Table 1: Model 1 structural parameter

Parameters	RCC Column	Encased Composite Columns
No. of. Storey	G+10	G+10
Typical Floor height	3.5m	3.5m
Ground Floor height	4.5m	4.5m
Plan dimension	30m	30m
Beam size	300mm x 300mm	300mm x 300mm
Column size	300 x 600 mm	600 x 900 mm
Thickness of slab	150mm	150mm
Concrete grade	M30	M30
Seismic Zone	ZONE 3	ZONE 3
Type of Soil	Site class D	Site class D
Response Reduction Factor (R)	5	5
Importance Factor (I)	1.5	1.5

Table 2: Model 2 structural parameter

STRUCTURAL PROPERTIES OF BUILDING	CONVENTIONAL BUILDING	BUILDING WITH COMPOSITE COLUMNS OF ENCASED I SECTION
Grade of concrete	M-30	M-30
Grade of reinforcing steel	Fe-415	Fe-415
Unit wt of concrete	25 kN/m3	25 kN/m3
Column type	Circular	Circular
Column size	D=800 & t=9mm	D=800 & t=9mm
Beam Size	ISWB600	ISWB600
No of bays in x direction	7	7
No of bays in y direction	5	5
Width of bay in x direction	6m	6m
Width of bay in y direction	5m	5m
Type of support	fixed	Fixed

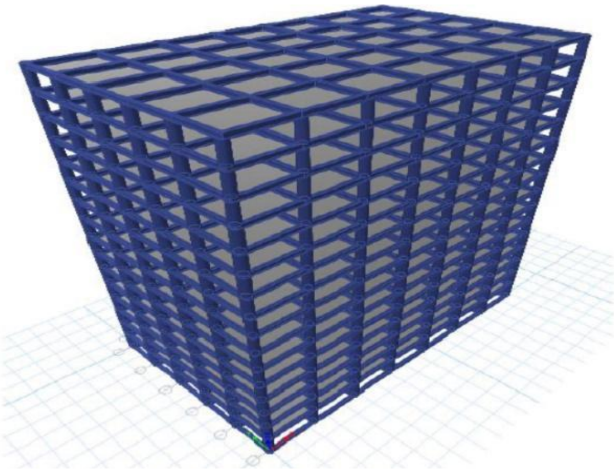

Figure 2: Model 2 rectangle shaped

In this from Table 2 -6 shows the different structural parameters of conventional and Encased columns and Table 7 shows the seismic parameters.

From Figure 2 to Figure 6 shows the different models in different shapes.Figure 7 to Figure 10 shows the graph of Base Shear. Figure 11 to Figure 21 shows the Drift and Displacement of conventional & Encased columns.

Table 3: Model 3 structural parameter

STRUCTURAL PROPERTIES OF BUILDING	CONVENTIONAL BUILDING	BUILDING WITH COMPOSITE COLUMNS OF ENCASED I SECTION
Grade of concrete	M-30	M-30
Grade of reinforcing steel	Fe-415	Fe-415
Unit wt of concrete	25 kN/m3	25 kN/m3
Column type	Circular	Circular
Column size	D=800 & t=9mm	D=800 & t=9mm
Beam Size	ISWB600	ISWB600
No of bays in x direction	7	7
No of bays in y direction	5	5
Width of bay in x direction	6m	6m
Width of bay in y direction	5m	5m
Type of support	fixed	Fixed

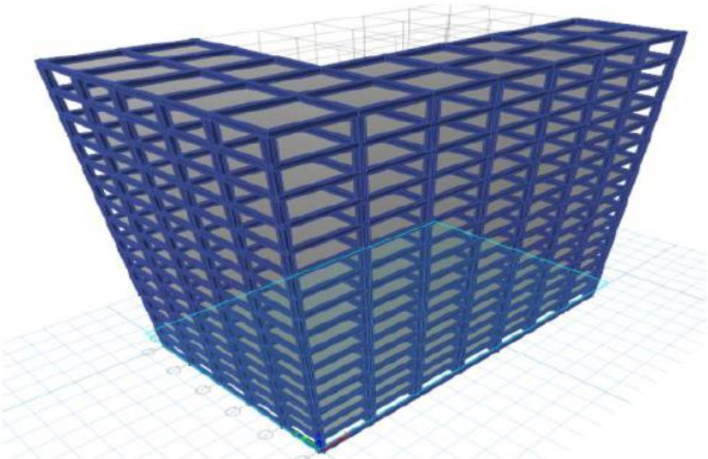

Figure 3: Model 3 L-shaped

Table 4: Model 4 structural parameter

STRUCTURAL PROPERTIES OF BUILDING	CONVENTIONAL BUILDING	BUILDING WITH COMPOSITE COLUMNS OF ENCASED I SECTION
Grade of concrete	M-30	M-30
Grade of reinforcing steel	Fe-415	Fe-415
Unit wt of concrete	25 kN/m3	25 kN/m3
Column type	Circular	Circular
Column size	D=800 & t=9mm	D=800 & t=9mm
Beam Size	ISWB600	ISWB600
No of bays in x direction	7	7
No of bays in y direction	5	5
Width of bay in x direction	6m	6m
Width of bay in y direction	5m	5m
Type of support	fixed	Fixed

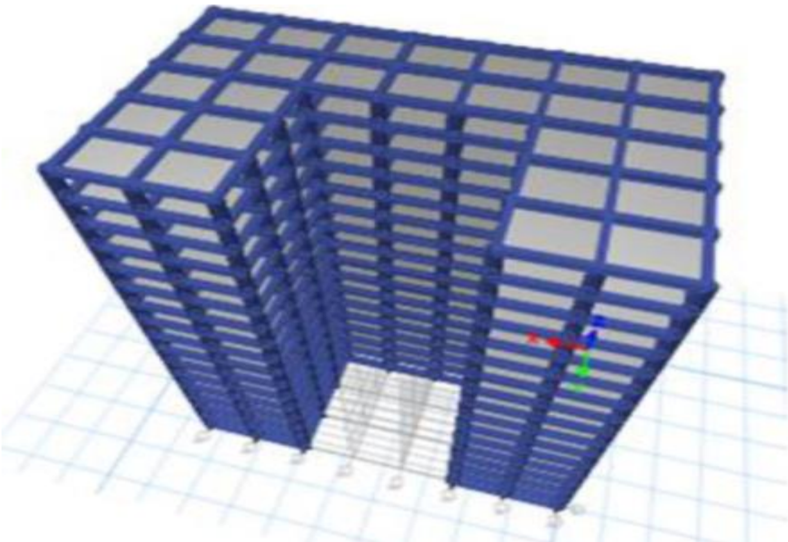

Figure 4: Model 4 C-shaped

Table 5: Model 5 structural parame

STRUCTURAL PROPERTIES OF BUILDING	CONVENTIONAL BUILDING	BUILDING WITH COMPOSITE COLUMNS OF ENCASED I SECTION
Grade of concrete	M-30	M-30
Grade of reinforcing steel	Fe-415	Fe-415
Unit wt of concrete	25 kN/m3	25 kN/m3
Column type	Circular	Circular
Column size	D=800 & t=9mm	D=800 & t=9mm
Beam Size	ISWB600	ISWB600
No of bays in x direction	7	7
No of bays in y direction	5	5
Width of bay in x direction	6m	6m
Width of bay in y direction	5m	5m
Type of support	fixed	Fixed

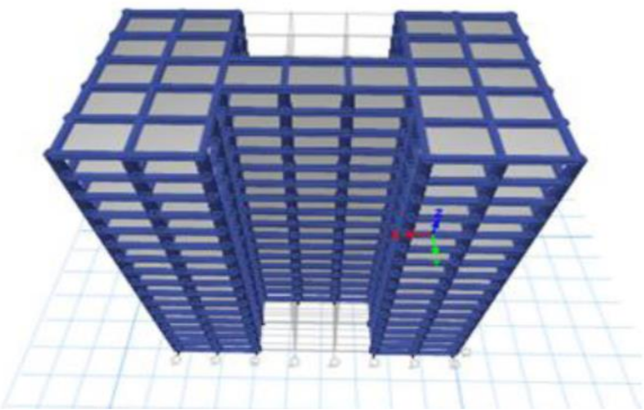

Figure 5: Model 5 H-shaped

Table 6: Model 6 structural parameter

STRUCTURAL PROPERTIES OF BUILDING	CONVENTIONAL BUILDING	BUILDING WITH COMPOSITE COLUMNS OF ENCASED I SECTION
Grade of concrete	M-30	M-30
Grade of reinforcing steel	Fe-415	Fe-415
Unit wt of concrete	25 kN/m3	25 kN/m3
Column type	rectangle	rectangle
Column size	230 mm x 600 mm	230mm x 600mm
Beam Size	230 mm x 450 mm	230mm x 450mm
Type of support	fixed	Fixed

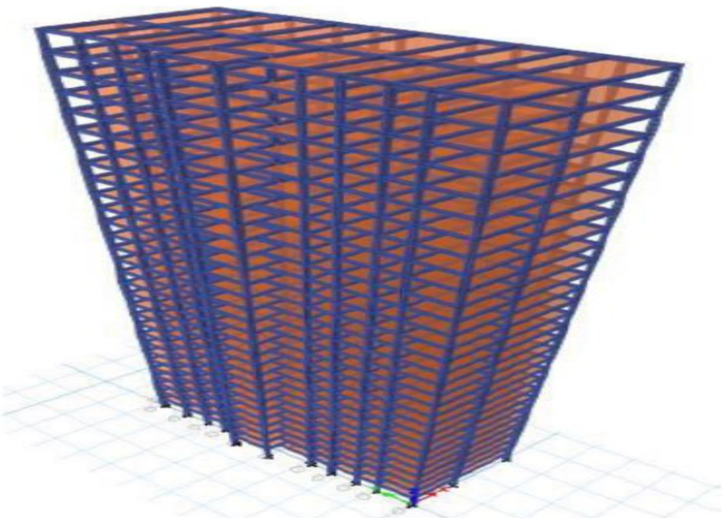

Figure 6: Model 6 G+30

Various types of load considered are discussed in succeeding sections.

- Live load had been taken as 4 kN/m2 (IS : 875 (Part 2)– 1987)
- Dead load on each floor = 1.5 kN/m2(IS :875 (Part 1)– 1987).
- Live Load at roof level =1.5 kN/m2
- Seismic loads are calculated as per IS: 1893 (Part 1)-2

IV. SEISMIC CONSIDERATION

The seismic load is applied to the building in ETABS [13]. This load case is assumed static linear and all the necessary data are given as per the following conditions.To determine the seismic load, it is considered that the model lies in the seismic zone III according to IS 1893:2000 [14]. The soil type is considered as medium with 5% damping to determine average response acceleration.Other factors considered for seismic load calculations are asin Table 7 below:

Table 7: Seismic parameters

STRUCTURAL PROPERTIES OF BUILDING	CONVENTIONAL BUILDING	BUILDING WITH COMPOSITE COLUMNS OF ENCASED I SECTION
Earthquake zone	III	III
Damping ratio	5%	5%
Importance factor	1	1
Type of soil	Medium soil	Medium soil
Response reduction factor	5	5
Poisson's ratio	0.15	0.15

V. RESULTS

A. Base Shear

The base shear at each storey level for both conventional column and encased I section column buildings of 10 storey, 15 storey, 30 storey are obtained for both X and Y directions presented in charts by response spectrum analysis below. The maximum base shear values are plotted against number of storey in X direction and Y direction

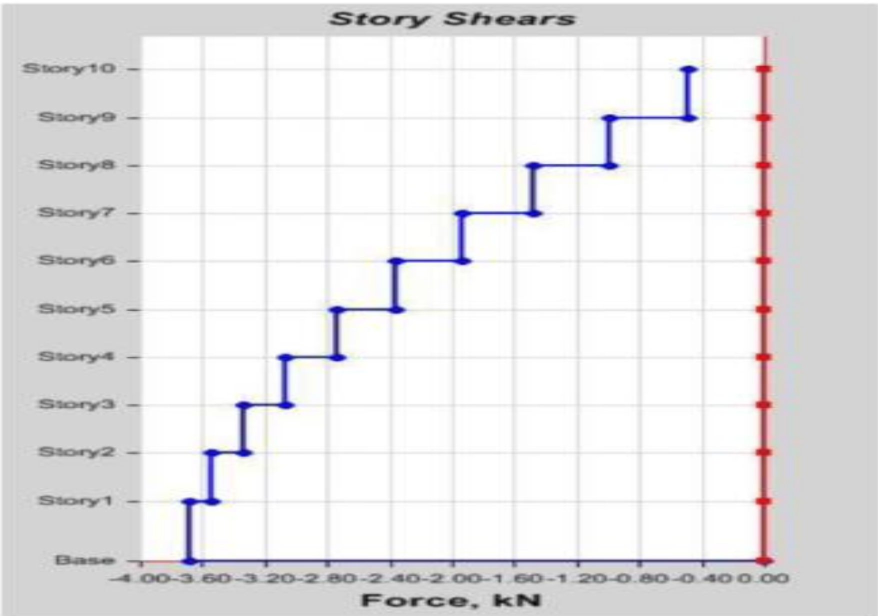

Figure 7: Base shear (kn) of G+10storey conventional column building

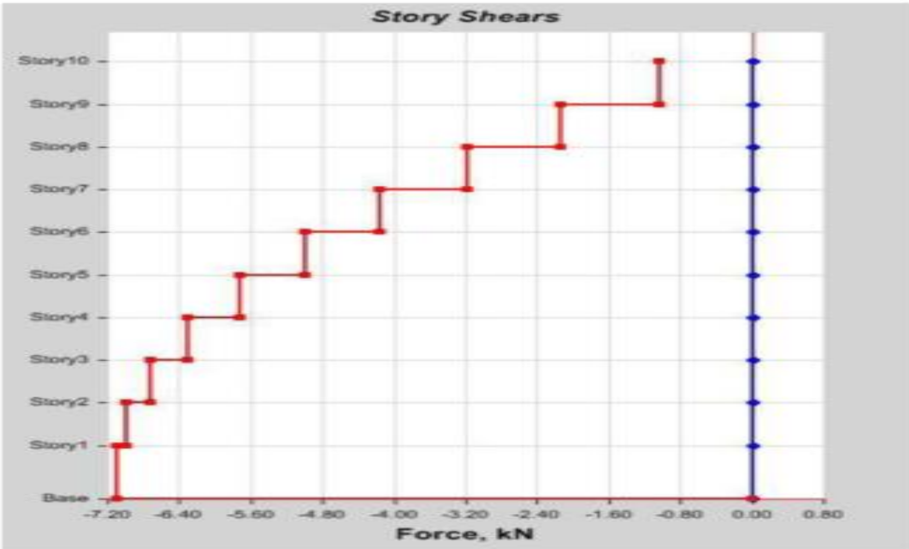

Figure 8: Base shear (Kn) of G+10 storey concrete encased I section column building

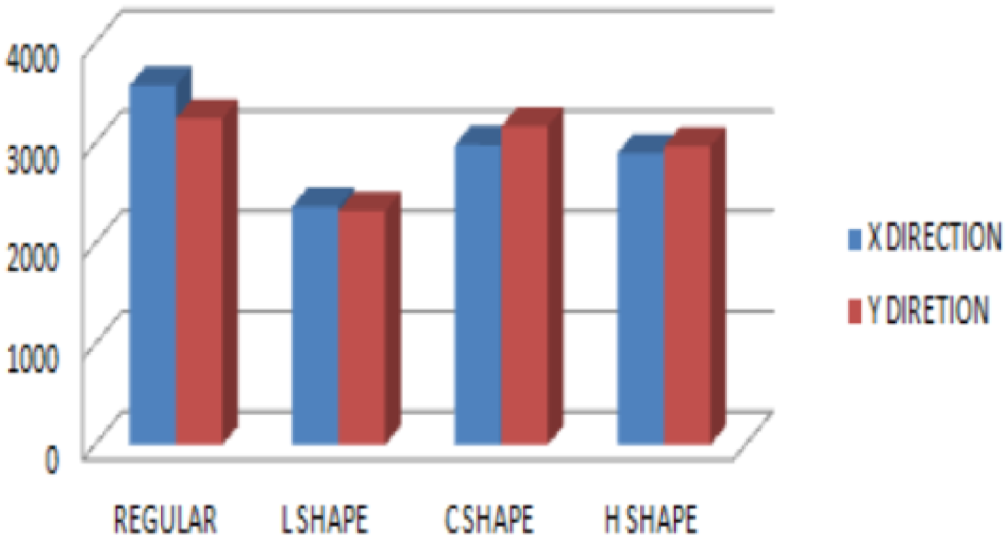

Figure 9: Base shear (kn) of G+15 storey conventional column building

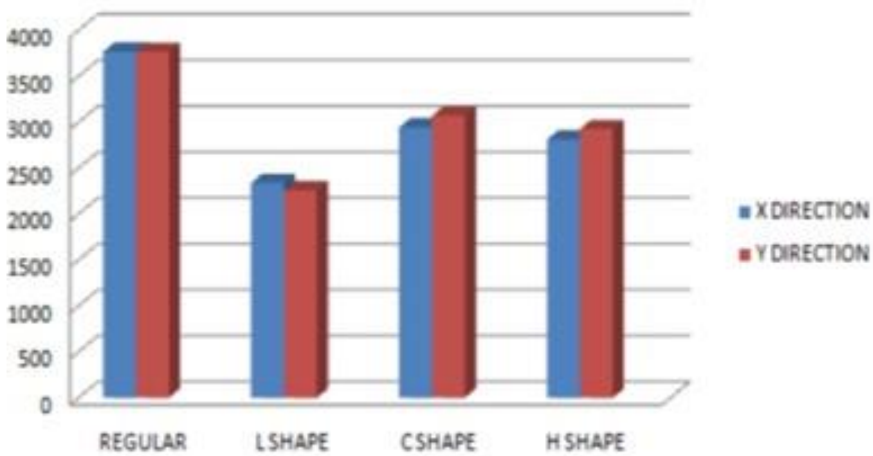

Figure 10: Base shear (Kn) of G+15 storey concrete encased I section column building

On the basis of base shear regular building with conventional column is performed well. In irregular buildings concrete filled encased I section buildings are performed well in L then H and C shape buildings .It can be seen from above charts, In regular buildings base shear in case of conventional column is less compared to encased I section column [15]. Storey shear value at base will be greater than that of top storey. In regular buildings with conventional column buildings show greater storey shear value when compared with other building. In G+10Storey Shear reduces in composite than in conventional column building. Due to reduction in self-weight of as compared to conventional column building which in turn reduces the foundation cost of the structure.In G+15 regular shape building with conventional column building performed well in terms of base shear percentage reduction of 4.6% in X direction and 14.32% in Y directions compared to concrete filledencased I section columns.In G+15 L shape building, on the basis of base shear building with concrete filled encased I sectioncolumn is performed well in X and Y directions, percentage reduction of 1.68% in X direction and 3.21% in Y directions compared to conventional column building.In G+15 C shape building, on the basis of base shear building with concrete filled encased I section column is performed well in X and Y directions, percentage reduction of 1.4% in X direction and 3.6% in Y directions compared to conventional columns.In case of G+15 H shape building, on the basis of base shear building with concrete filled encased I section column is performed well in X and Y directions, percentage reduction of 4% in X direction and 2% in Y directions compared to conventional columns.

B. Storey Drift

The maximum storey drift values are plotted against number of storey in X direction and Y direction.

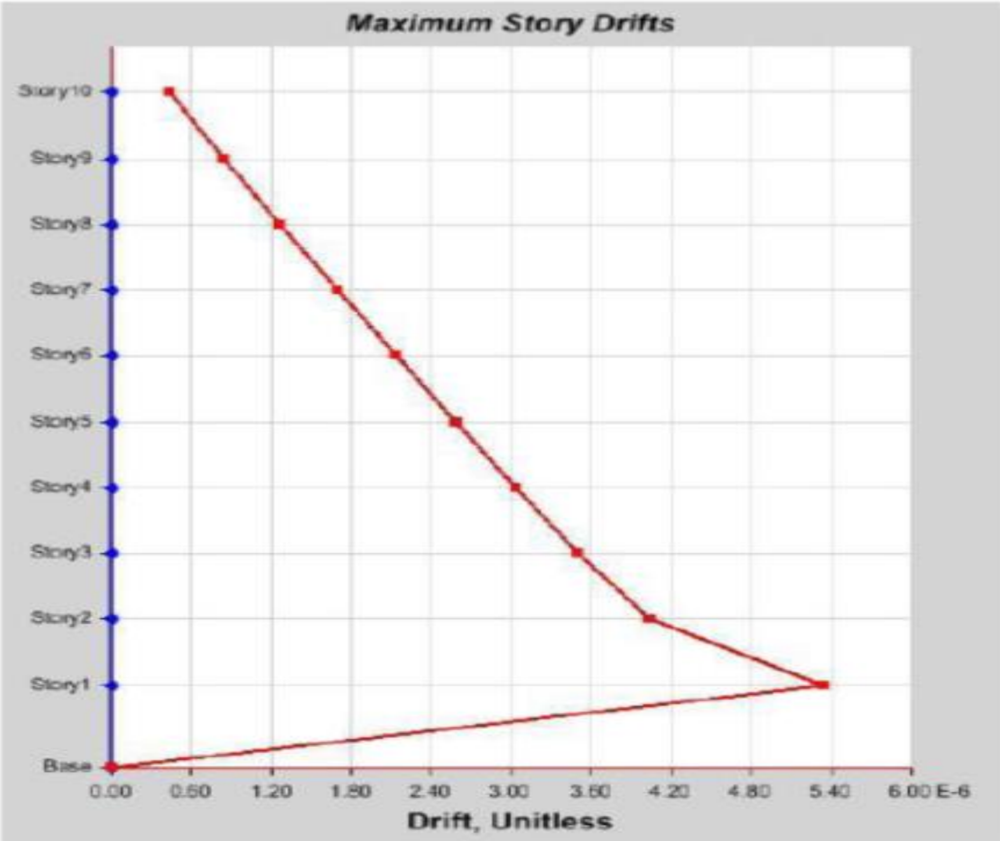

Figure 11: Storey drift of G+10storey conventional column building

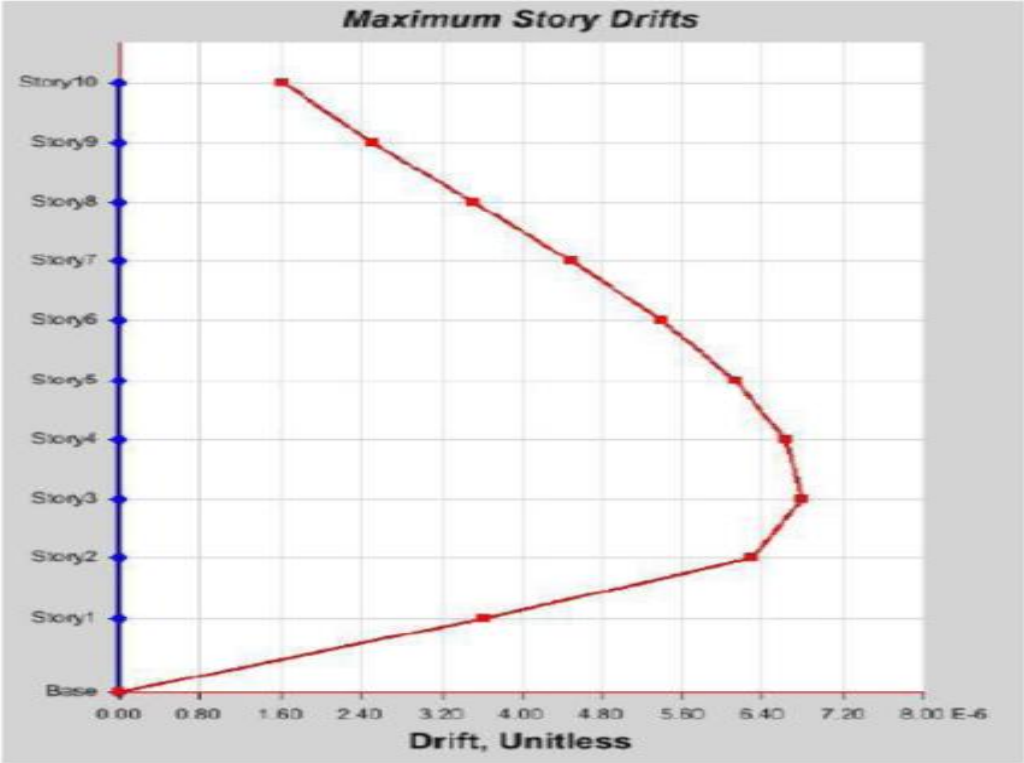

Figure 12: Storey drift of G+10 storey concrete encased I section column building

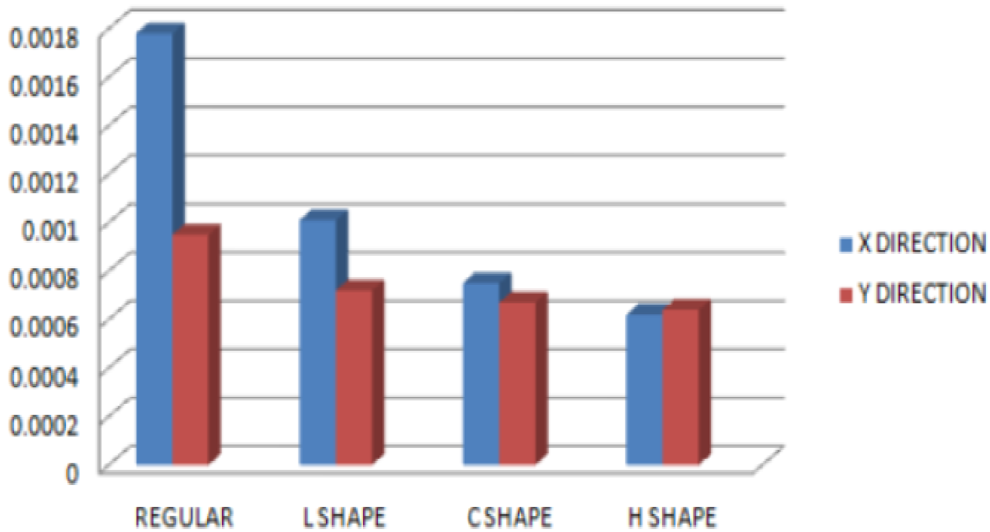

Figure 13: Storey drift of G+15 storey conventional column building

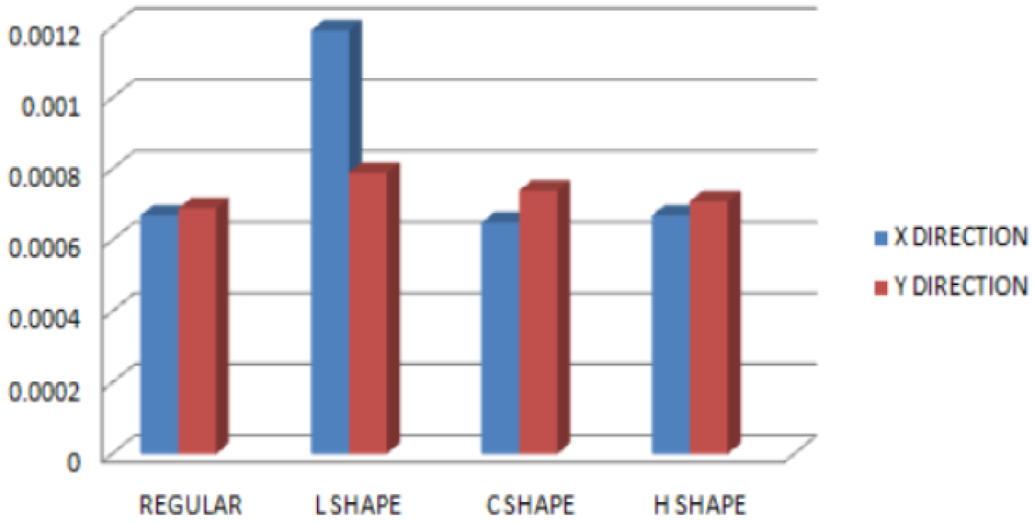

Figure 14: Storey drift of G+15 storey concrete encased I section column building

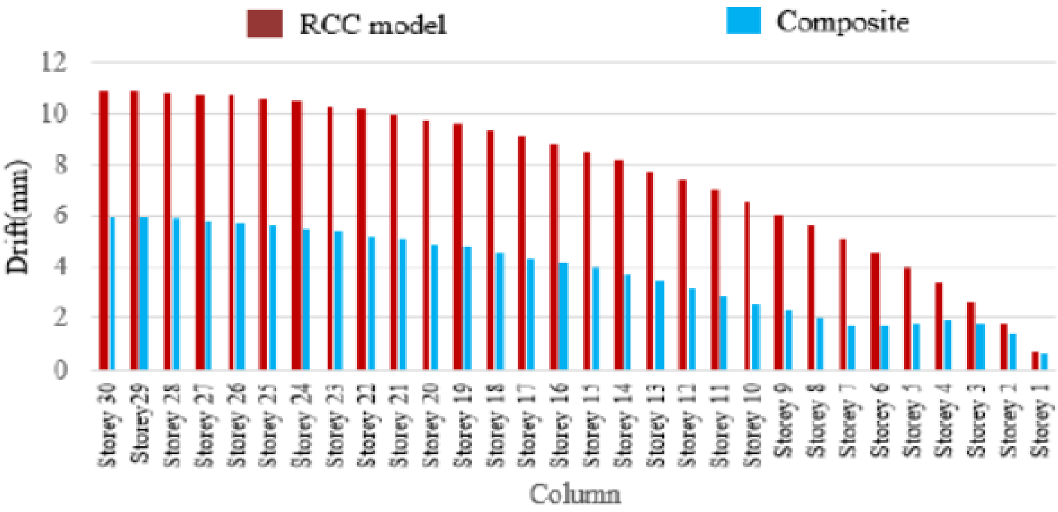

Figure 15: Storey drift of G+30 storey

In G+15 storey drift of L shape building with concrete filled steel tube columns performed well in X and Y directions, percentage reduction of 1.85% in X direction and 10% in Y directions compared to concrete filled encased I section columns. In G+15 storey drift of c shape building with concrete filled steel tube columns performed well in X and Y directions, percentage reduction of 2.5% in X direction and 18% in Y directions compared to concrete filled encased I section columns. In G+15 storey drift of H shape building with concrete filled steel tube columns is performed well in X and Y In G+10 Storey drift reduces in composite structures as compared to conventional column building, because composite structures have higher stiffness and different moment of inertia for columns than that of conventional column building [16-17]. But for both conventional column building and composite structures, storey drift are within permissible limit0.004 times the height of storey. On the basis of storey drift regular building with concrete filled encased I section column is performed well, but in irregular buildings encased I section buildings are performed well in L shape building only and building with conventional column is performed good in H and C shape buildings. [18] In G+15 storey drift of regular building with concrete filled encased I section column performed well in X and Y directions, percentage reduction of 6.17% in X direction and 27% in Y directions compared to concrete filled steel tube columns. Directions, percentage reduction of 8% in X direction and 6% in Y directions compared to concrete filled encased I section columns. In G+30Storey drift is compared by using bar graph and results are plotted. RCC structures have storey drift in top storey is 12.90mm and composite structures have storey drift top storey is 7.20mm. Hence it clearly shows that composite structures have less storey drift than RCC structure.

C. Storey Displacement

The maximum storey displacement values are plotted against number of storey in X direction and Y direction.

Figure 16: Storey displacement (mm) of G+10storey conventional column building

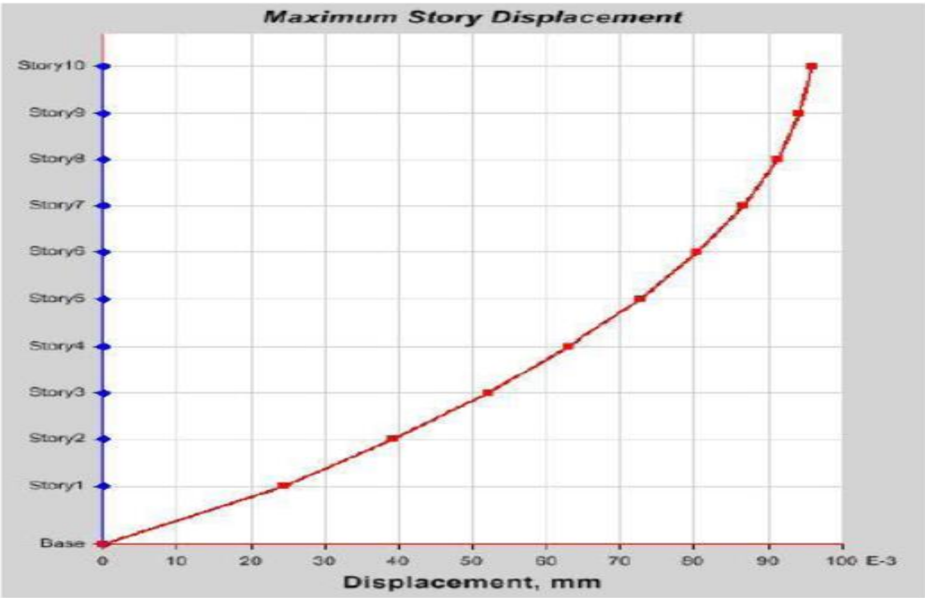

Figure 17: Storey displacement(mm) of G+10 storey concrete encased I section column building

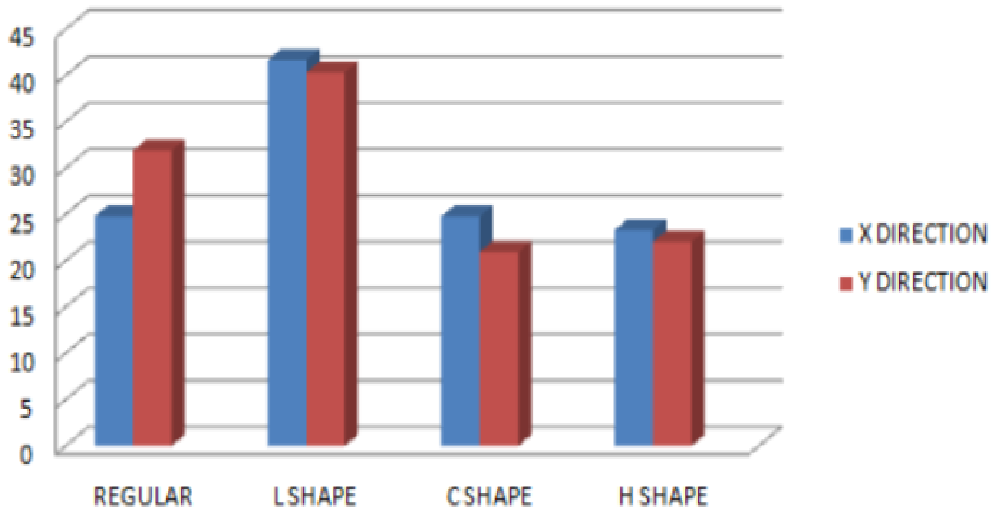

Figure 18: Storey displacement (mm) of G+15 storey conventional column building

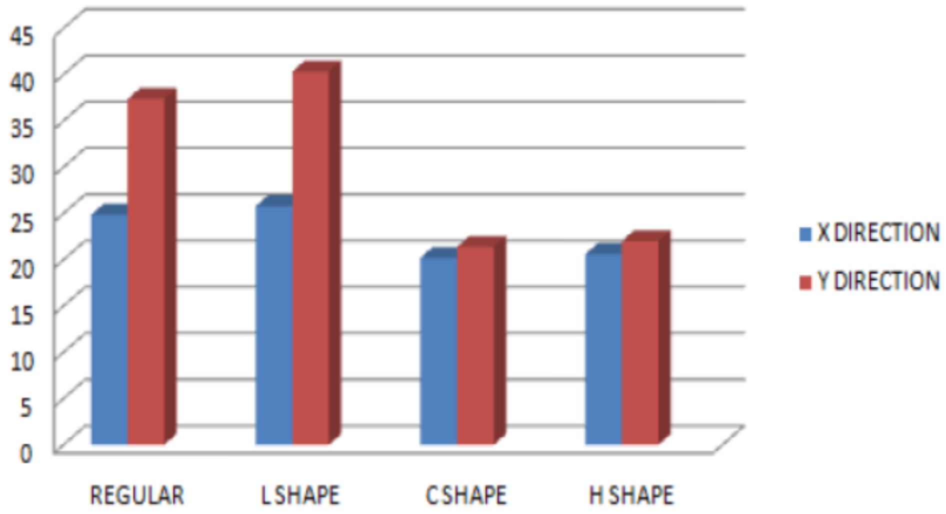

Figure 19: Storey displacement(mm) of G+15 storey concrete encased I section column building

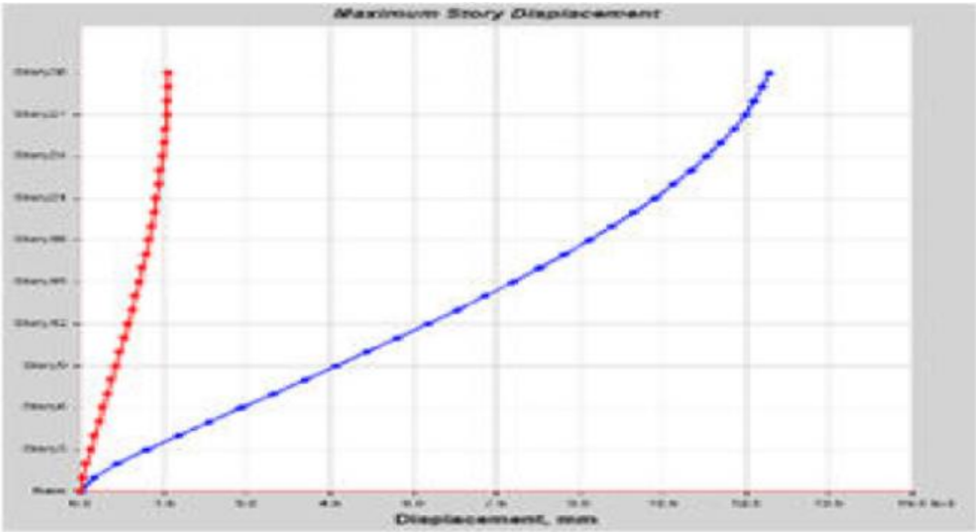

Figure 20: Storey displacement(mm) of G+30 storey conventional column building

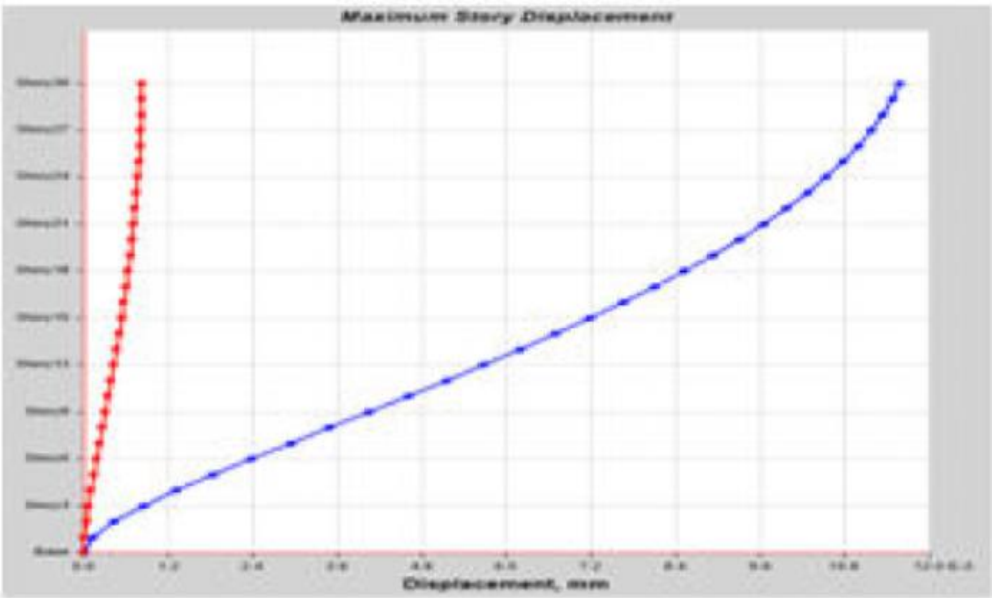

Figure 21: Storey displacement(mm) of G+30 storey concrete encased I section column building

Displacement in concrete encased I section column building showed is less than the conventional column building [19]. In G+ 10 storey building conventional building has lowest displacement due to its high stiffness [20]. In G+15 regular shape building storey displacement percentage reduction of 2.5% in X direction and 16% in Y directions compared to concrete filled encased I section columns in both X and Y directions. In G+15 L shape building storey displacement percentage reduction of 5% in X direction and 7% in Y directions compared to conventional column in both X and Y directions. In G+15 C shape building storey displacement percentage reduction of 18% in X direction and 2.5% in Y directions compared to conventional column in both X and Y directions. In G+15 H shape building storey displacement percentage reduction of 11.5% in X direction and 1.3% in Y directions compared to concrete filled steel tube columns in both X and Y directions. In G+30The storey displacements graphs of both RCC and composite structures are plotted and comparisons are made. The RCC structures have storey displacement 14 mm and composite structure have storey displacement 12 mm. it clearly shows that composite structures have more resistance against RCC structures.

VI. CONCLUSION

The present study mainly focused on the seismic performance of conventional and composite column building of 10 storey, 15 storey and 20 storey configuration located at seismic zone III.Response spectrum has been used to compare the stability of conventional with composite column building.

The following conclusions are derived from the study:

- From the above results from the response spectrum analysis the conventional column building are found to be stiffer and perform well under dynamic loading than Composite columns.
- Under earth quake conditions steel encased concrete column building performs well as they are more ductile compared to RCC columns.
- The story drift, axial loads and base shear are very much satisfactory in case of steel encased concrete column due to low dead weights.
- Using shear connectors in composite column shows good results with reduction in drift and displacement.

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