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OPTIMUM LOCATION OF FLOATING COLUMN IN RECTANGULAR AND IRREGULAR L-SHAPED BUILDING UNDER SEISMIC RESPONSE

Mahendra Vishwakarma*[1], Prof. Sumit Singh Shekhawat*[2]

*[1]PG Student, Department Of Civil Engineering, Sushila Devi Bansal College Of Engineering, Indore (MP), India.

*[2]Professor, Department Of Civil Engineering, Sushila Devi Bansal College Of Engineering, Indore (MP), India.

ABSTRACT

In recent decades, the trend of constructing multi-story buildings and competition between architectural fields has increased to build landmark projects. For architectural purposes, aesthetic view and unique planning are more important and this requirement is the origin of the floating column concept. In these articles a multi-story construction for residential, industrial and commercial use has become a common feature. This multi-story construction needs ample parking or open space below or in the middle of the building for a great room, etc. And this requirement can be met by introducing floating columns. Generally providing floating columns is not as simple as providing regular columns. In this article to analysed the FC concept consider the 10 different cases of rectangular and irregular L shaped planed with vary the location of floating columns (FC). The earthquake performance is taken as per the two required methods which is equivalent static analysis (ESA) and response spectrum analysis (RSA). The building models can be modelled by CSI-ETABS Software. The result parameters to get the optimum building model with effective FC position taken are Storey displacement, drift & stiffness of the building.

Keywords: Floating Columns (FC), Storey Displacement, Storey Drift, Response Spectrum Analysis, Equivalent Static Analysis, Stiffness.

I. INTRODUCTION

A column is a vertical element in a structural system, from the foundation level to the entire height of the structure. The column transfers the gravitational load and the lateral load of the structure to the ground using the foundation. The floating column concept was introduced into the structural system to fulfill architectural requirements such as open space on the ground floor level for utilities such as parking, lobby, reception or assembly hall and closely spaced columns on the top floor. Sometimes an aesthetic appearance is more imperative than other parameters when many columns have to end on floors and floating columns have to be introduced. From the literature reviews, the following reviews are discussed. Floating column buildings are popular with architects because they provide more freedom for a good layout and a good aesthetic appearance. The floating column is supported by a transfer beam, which is supported by columns directly connected to the ground level. Floating column design becomes critical in seismically active areas. As we know, the distribution of the earthquake force depends on the mass and stiffness of the structure, and the presence of floating columns can change the uniform distribution of the earthquake force, since the floating columns directly affect the rigidity of the structure. In addition, the structure should have the shortest load path that transfers the lateral loads occurring at different floor levels to the ground without damaging the structure, but the presence of floating columns interrupts the load path and makes the structure unstable against lateral load resistance. This instability of the structure can cause the development of a tipping force, buckling of the columns and deformation failure of the beam column connection and complete collapse of the structure.

II. MODELLING OF STRUCUTURE

A storey of G+5 with the 6 X 8 bays in X and Y direction respectively for rectangular and irregular L shape building model. The storey height and bay width of G+5 storey frame is 3.2 m and 4 m. respectively. The frames are assumed to be located in seismic zone IV, the soil type chosen is medium (Type II). The details of models taken are mentioned in table 1.

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Table 1: Models Descriptions

S. No.	Frame Tag	Description
I	Rec. WOT FC	Rectangle building without floating column
II	Rec. WT FC at BC	Rectangle building with floating column at bottom corner
III	Rec. WT FC at BM	Rectangle building with floating column at bottom middle
IV	Rec. WT FC at TC	Rectangle building with floating column at top corner
V	Rec. WT FC at TM	Rectangle building with floating column at top middle
VI	IL Shape WOT FC	Irregular L Shape building without floating column
VII	IL Shape WT FC at BC	Irregular L Shape building with floating column at bottom corner
VIII	IL Shape WT FC at BM	Irregular L Shape building with floating column at bottom middle
IX	IL Shape WT FC at TC	Irregular L Shape building with floating column at top corner
X	IL Shape WT FC at TM	Irregular L Shape building with floating column at top middle

Models: Each Model Description content the three part i.e. a) Plan b) Elevation & c) 3D view Rectangular and Irregular L Shaped Buildings

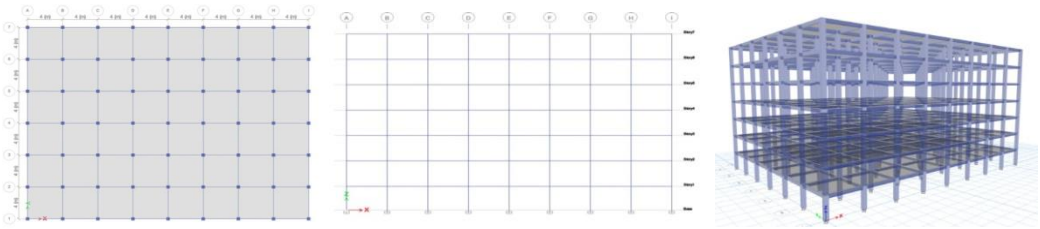

Fig.1: Plan and section of Rectangle building without floating column

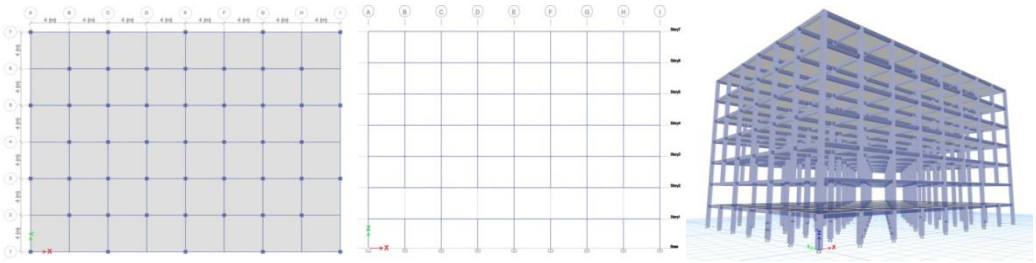

Fig.2: Plan and section of Rectangle building with floating column at bottom corner

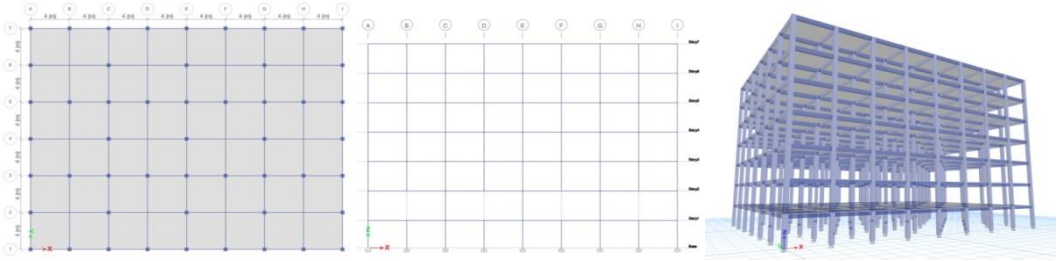

Fig.3: Plan and section of square building with floating column at bottom middle

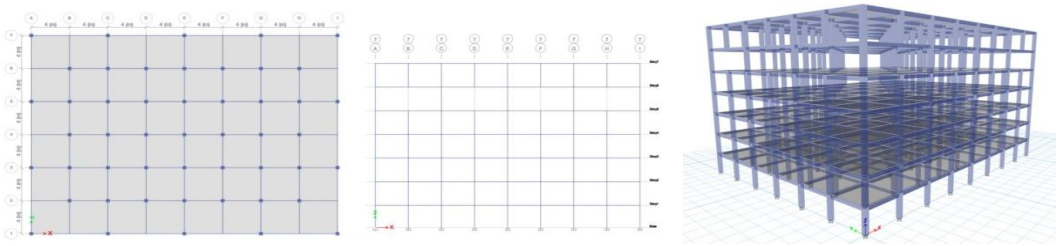

Fig.4: Plan and section of square building with floating column at top corner

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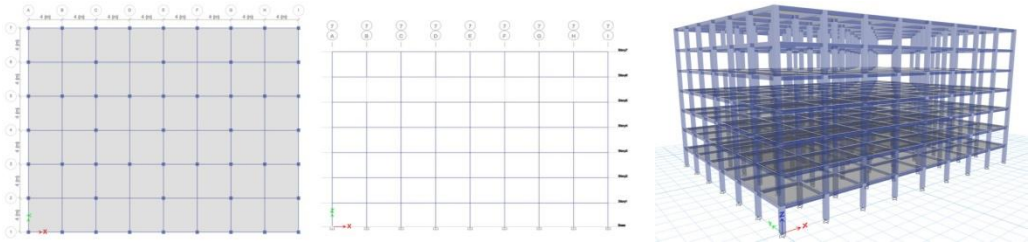

Fig.5: Plan and section of square building with floating column at top middle

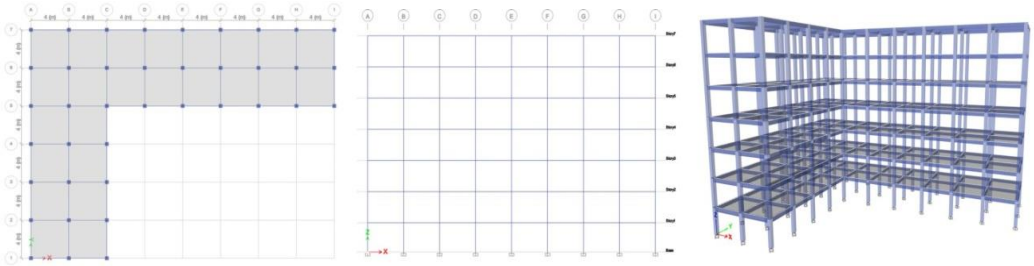

Fig.6: Plan and section of IL shape building without floating column

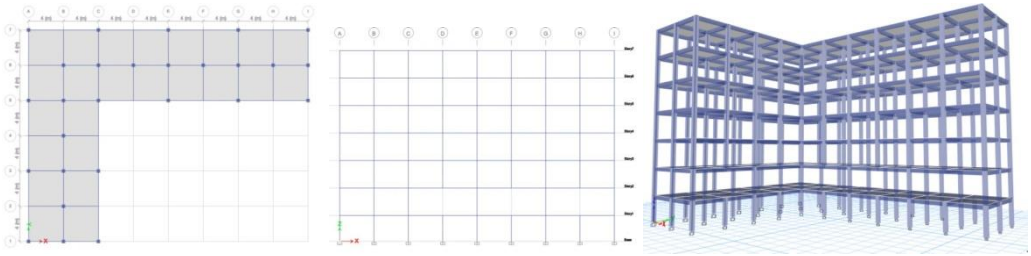

Fig.7: Plan and section of IL shape building with floating column bottom corner

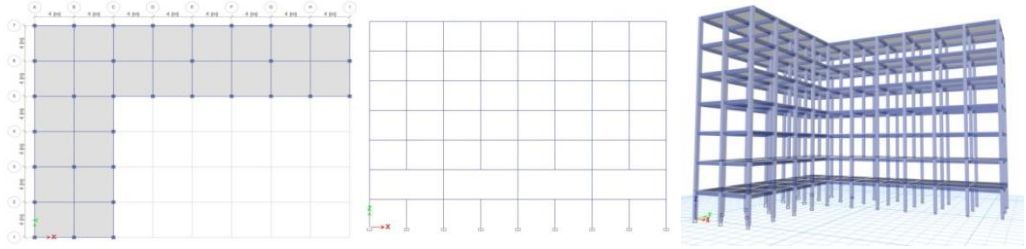

Fig.8: Plan and section of IL shape building with floating column bottom middle

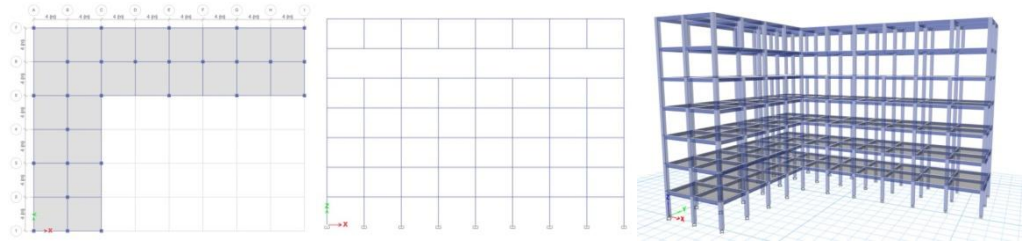

Fig.9: Plan and section of IL shape building with floating column at top corner

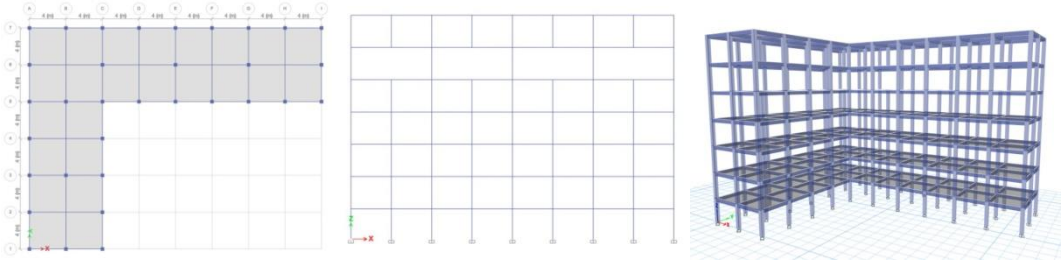

Fig.10: Plan and section of IL shape building with floating column top middle

Seismic Data: Zone IV, R factor: 5, I factor: 1, Soil type Type II, RSA method

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Material Properties: Concrete Grade: 25 MPa. The grade rebar: Fe 500 for both main and secondary rebar. The live load of 2 KN/m2 on floor and 1.5 KN/m2 on roof is taken. The unit weight of concrete and brick masonry wall is takes as 25 KN/m3 and 20 KN/m3 (including weight of plaster) respectively. The thickness of the slab is considered as 150 mm with floor finish load of 1.25 KN/m2 on all floors. The thickness of the brick masonry wall is assumed 230 mm (including plaster).

III. RESULT AND DISCUSSION

Parameter 1; Storey Displacement Result (curve between displacement vs. storey no.)

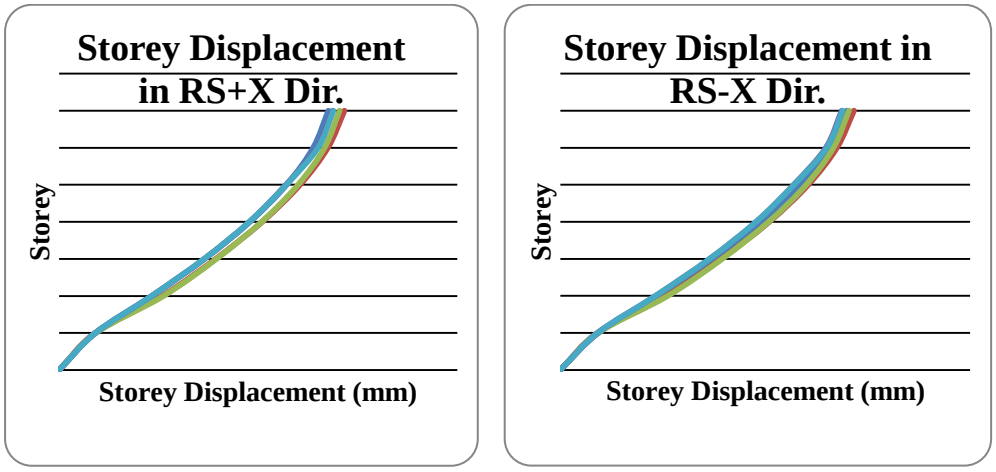

Fig.11: Rectangle Shape Building Storey Displacement in RS + X & RS - X Direction

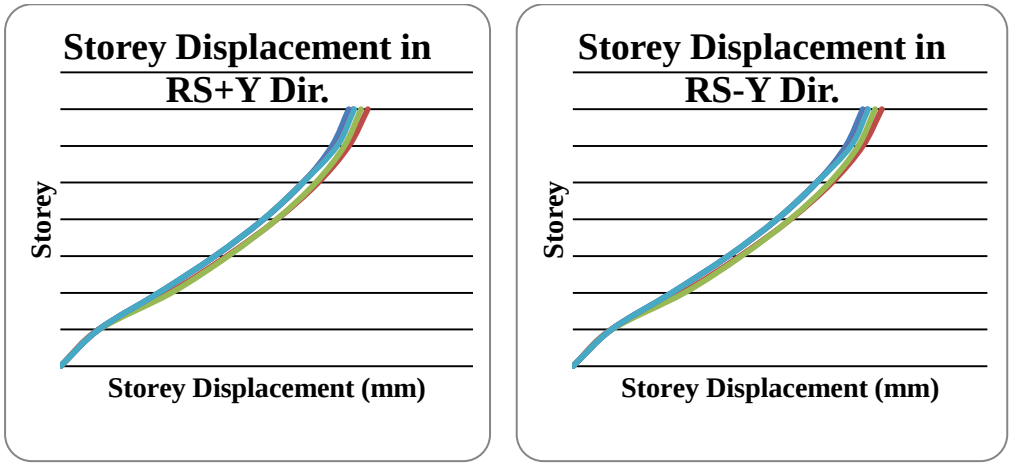

Fig.12: Rectangle Shape Building Storey Displacement in RS + Y & RS - Y Direction

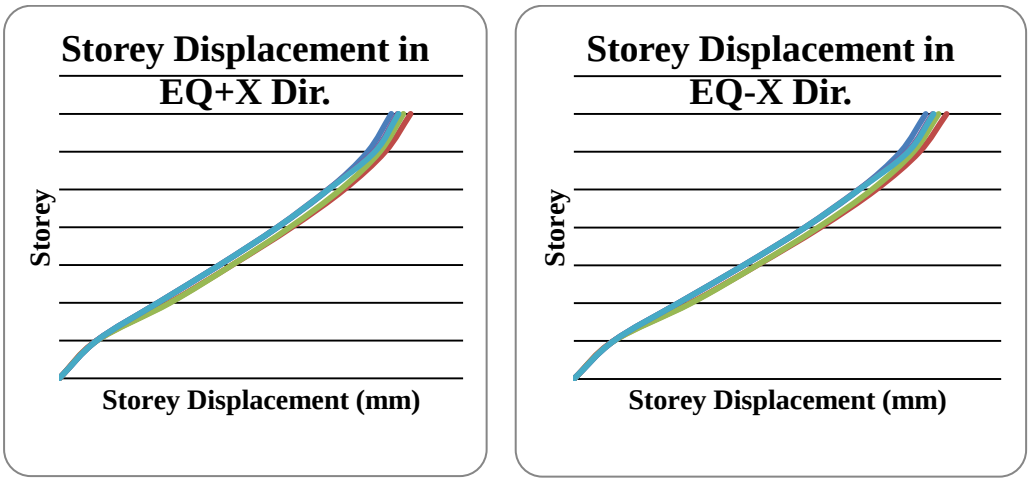

Fig.13: Rectangle Shape Building Storey Displacement in EQ +X & EQ -X Direction

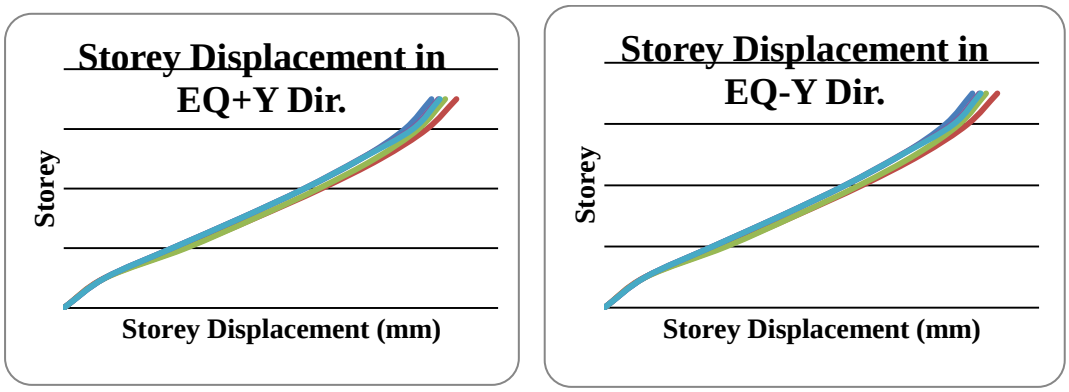

Fig.14: Rectangle Shape Building Storey Displacement in EQ +Y & EQ -Y Direction

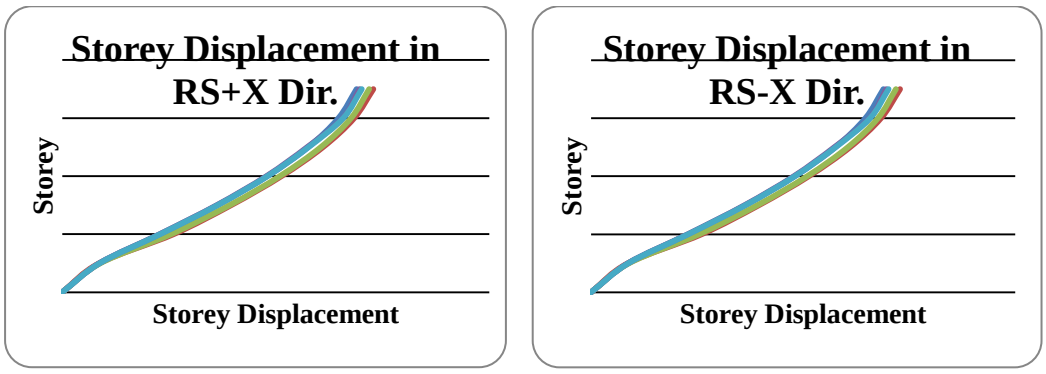

Fig.15: IL- Shape Building Storey Displacement in RS + X & RS - X Direction

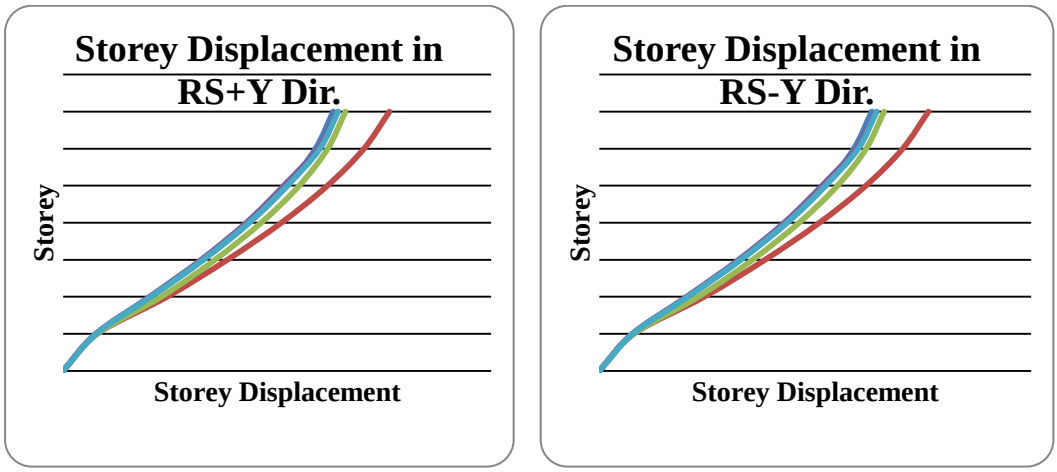

Fig.16: IL- Shape Building Storey Displacement in RS + Y & RS - Y Direction

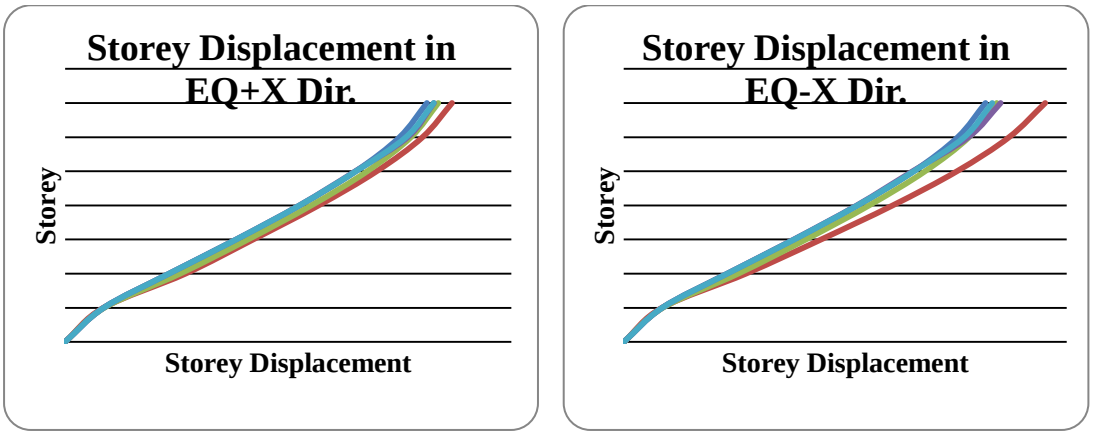

Fig.17: IL- Shape Building Storey Displacement in EQ + X & EQ - X Direction

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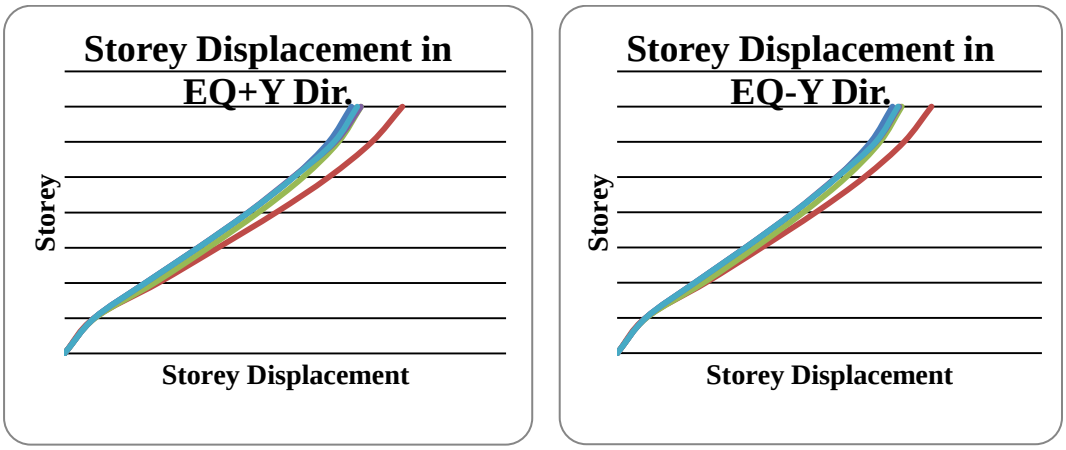

Fig.18: IL- Shape Building Storey Displacement in EQ + Y & EQ - Y Direction

Parameter 2: Storey Drift:

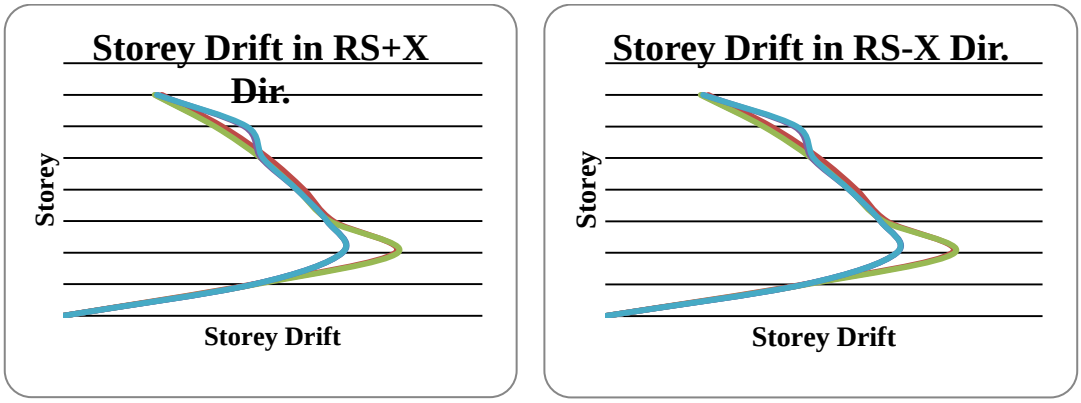

Fig.19: Rectangle Shape Building Storey Drift in RS + X & RS - X Direction

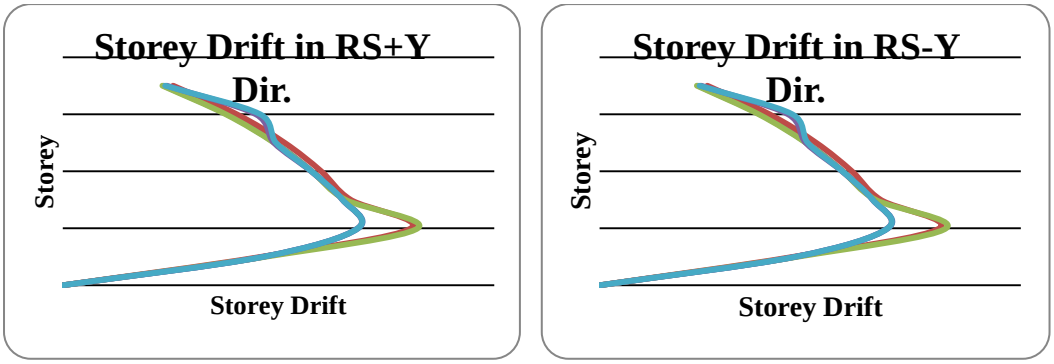

Fig.20 : Rectangle Shape Building Storey Drift in RS + Y & RS - Y Direction

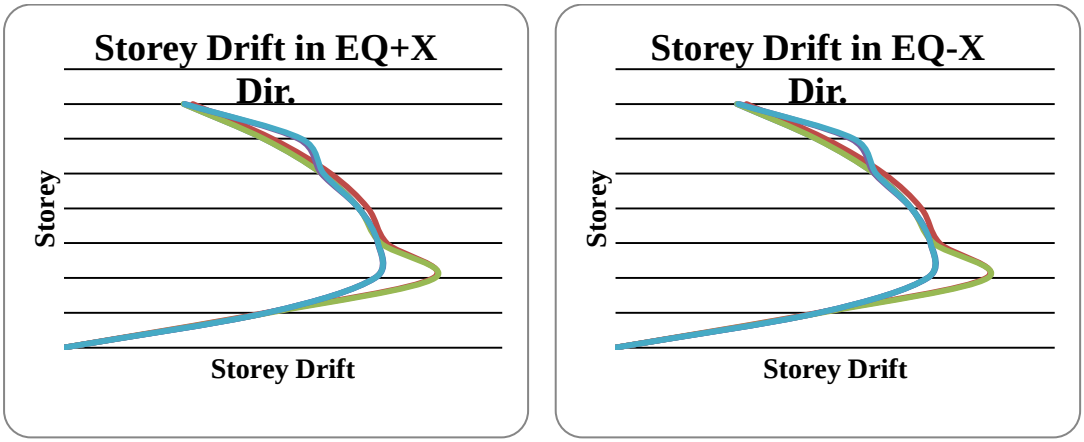

Fig.21 : Rectangle Shape Building Storey Drift in EQ + X & EQ - X Direction

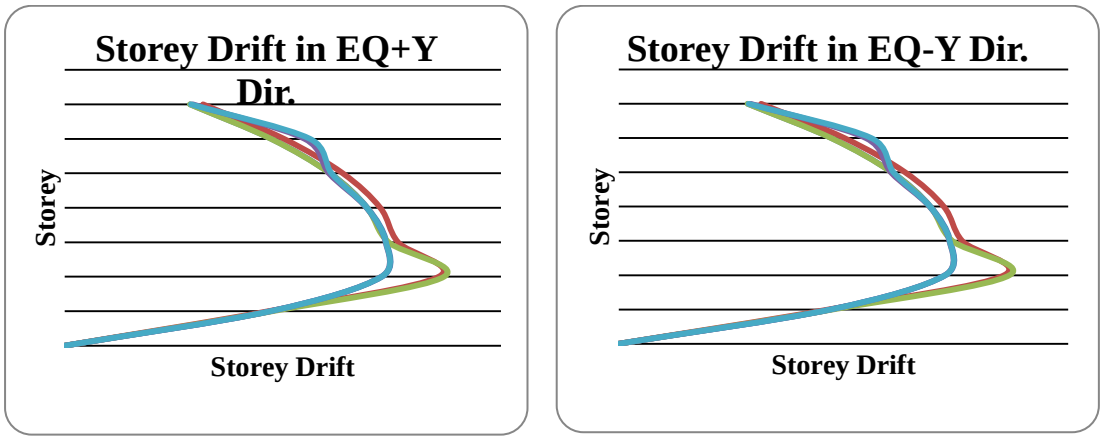

Fig.22: Rectangle Shape Building Storey Drift in EQ + Y & EQ - Y Direction

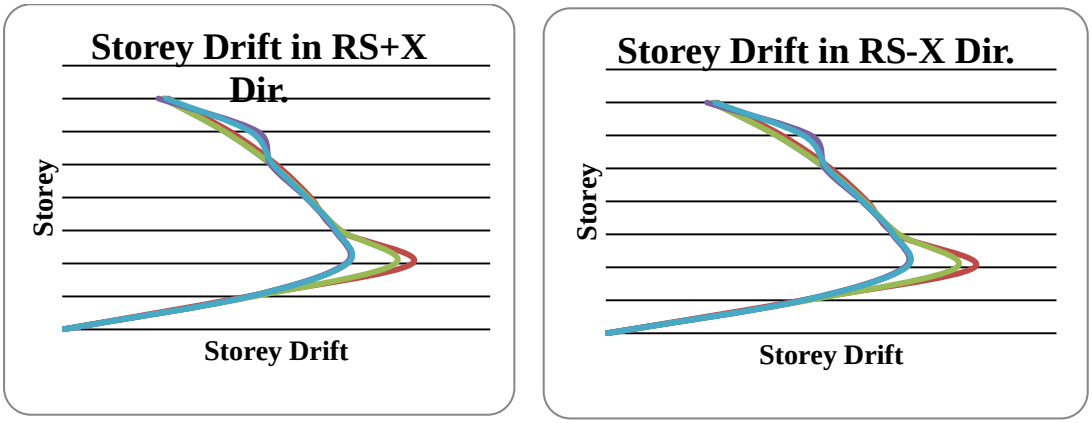

Fig.23 : IL Shape Building Storey Drift in RS + X & RS - X Direction

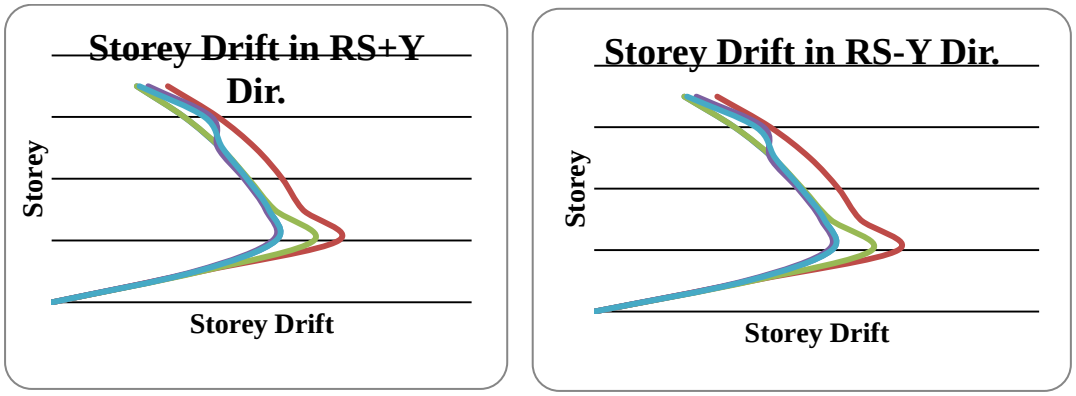

Fig.24: IL Shape Building Storey Drift in RS + Y & RS - Y Direction

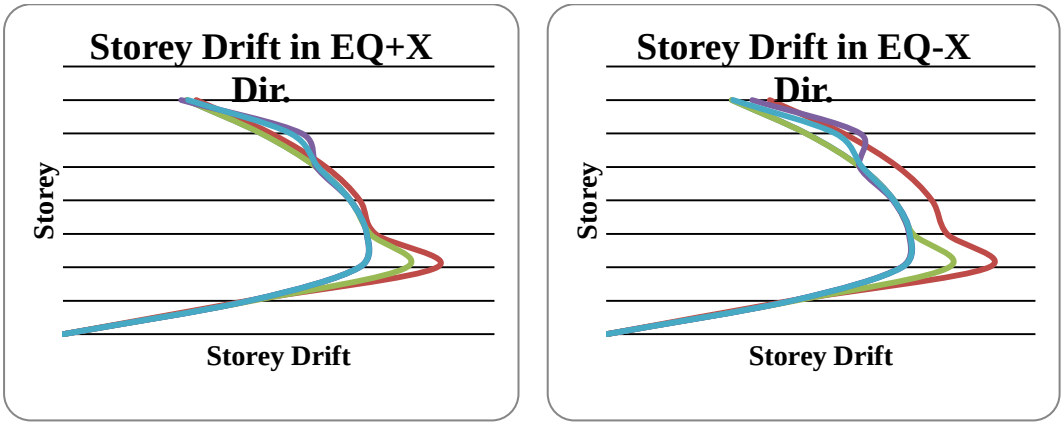

Fig.25: IL Shape Building Storey Drift in EQ + X & EQ - X Direction

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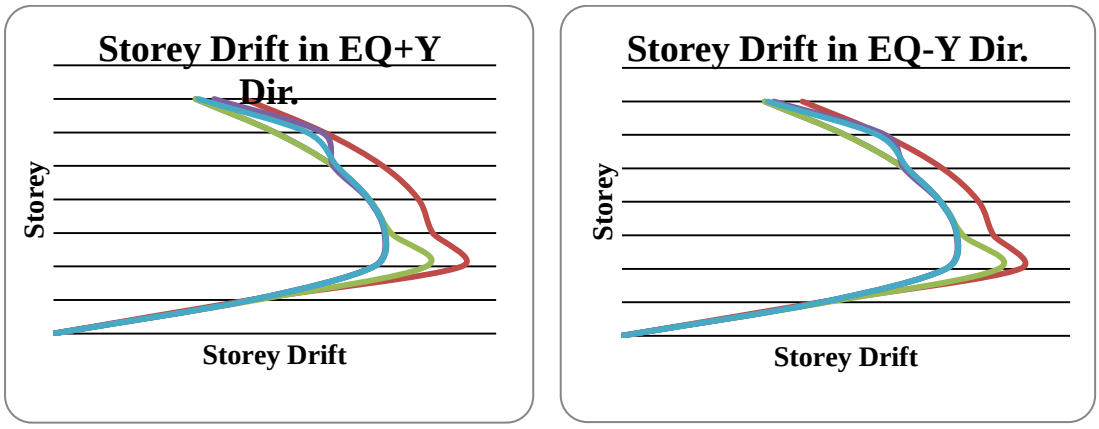

Fig.26: IL Shape Building Storey Drift in EQ + X & EQ - Y Direction

Parameter 3: Storey Stiffness:

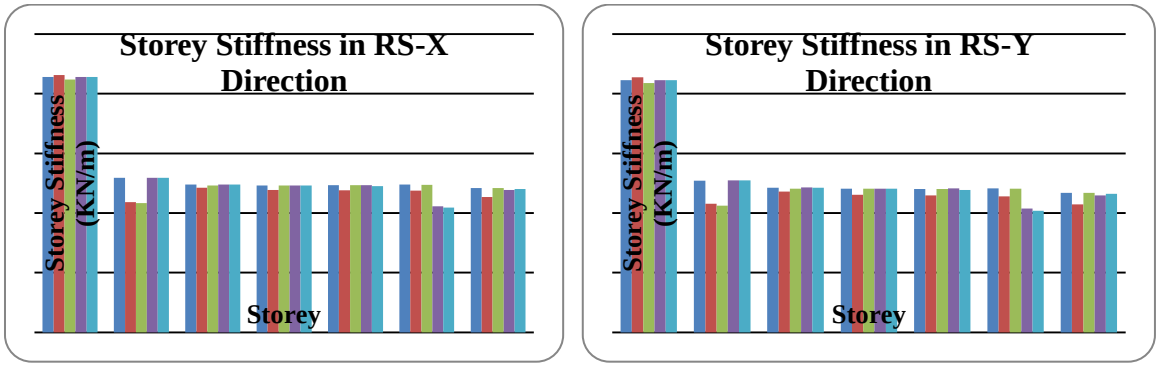

Fig.27 : Rectangle Shape Building Stiffness in RS-X & RS-Y Direction

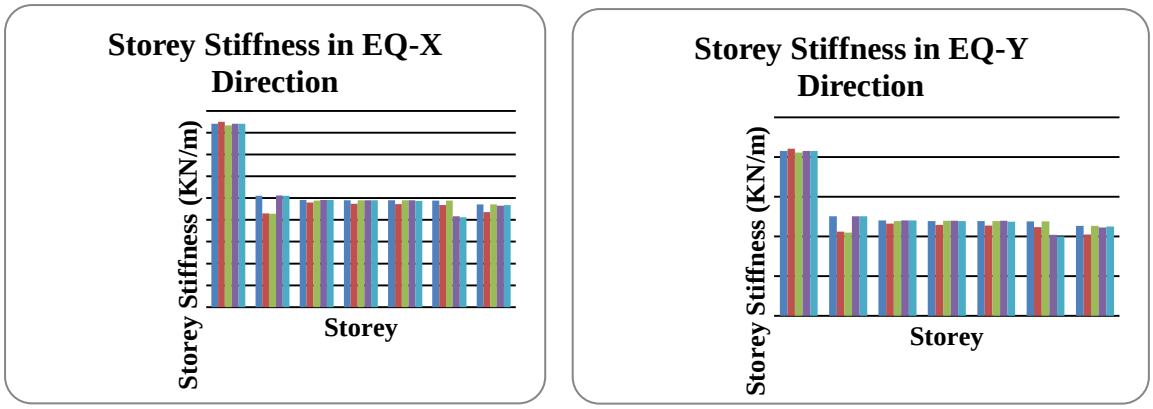

Fig.28: Rectangle Shape Building Stiffness in EQ-X & EQ-Y Direction

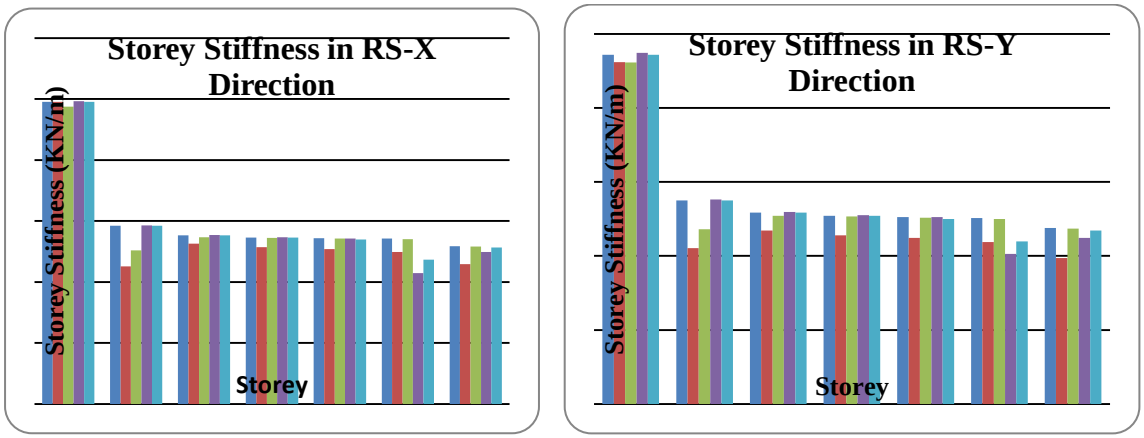

Fig.29: IL- Shape Building Stiffness in RS-X & RS-Y Direction

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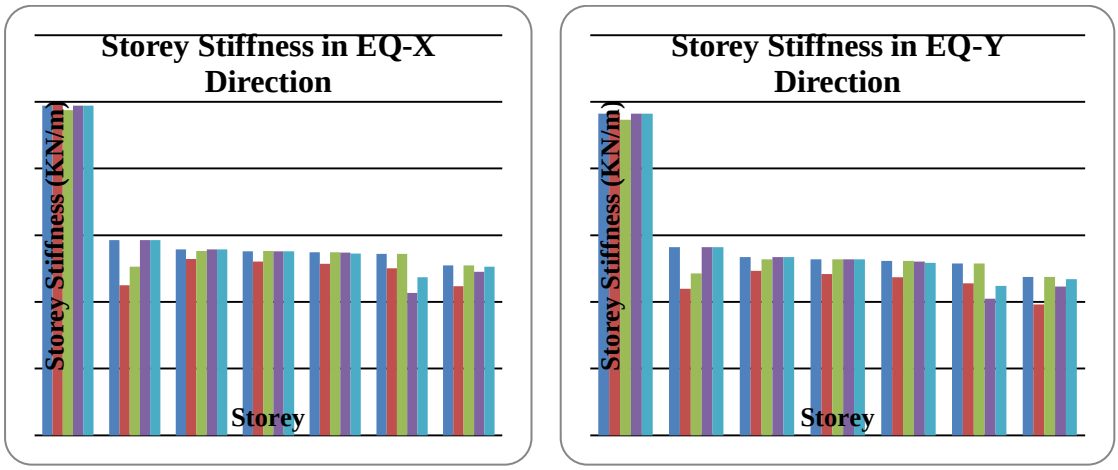

Fig.30: IL- Shape Building Stiffness in EQ-X & EQ-Y Direction

Colour Notation used:

IV. CONCLUSIONS

Based on the 10 models of rectangular and Irregular L shaped earthquake analysis on normal and including FC in the models the following conclusions are to be made which are as follows:

- The critical position for floating column is at corner location under the observation made by displacement of the storey.
- On comparing the models of with and without FC more displacement is under buildings with floating column since the reduction is stiffness will be observed.
- The rectangular building is more effective than IR L shaped under adoption of Floating Column.
- The displacement is more for floating column buildings because as the columns are removed the stiffness gets reduced and hence drift also increases. From the above discussion it has been concluded that providing floating columns at corner location is critical in terms of storey drift.
- Presence of floating columns at bottom corner location affect the stiffness at all floor level.
- Presence of floating columns at bottom middle location affects the storey level stiffness.
- Presence of floating columns at top corner and top middle affects the storey level stiffness.

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