Comparison of Behaviour of Regular and Irregular Buildings with Floating Column in Different Seismic Zones

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Abstract— In developing country like India where urbanization is at a faster rate, buildings with floating column has been introduced. The main focus is on the importance of structure with floating column under different plan irregularities in construction particularly in G+4 structures. It clears the idea of floating column, its scope and benefits. Meanwhile it depicts the comparison of structures with regular and irregular shapes under different positioning of floating column in zone II and zone V using STAAD Pro software. Experiment results show storey drift comparison with of all the structures. This will help us to find the various analytical properties of the structure and we may also have a very systematic and economical design for the structure.

Key words: Floating Column, STAAD. Pro Software

I. INTRODUCTION

A column is supposed to be a vertical member starting from foundation level and transferring the load to the ground. The term floating column is also a vertical element which ends (due to architectural design/ site situation) at its lower level (termination Level) rests on a beam which is a horizontal member. The beams in turn transfer the load to other columns below it. Such columns where the load was considered as point load. Floating columns are usually adopted above the ground storey level. So that maximum space is made available in the ground floor which is essentially required in apartments, mall or other commercial buildings where parking is a major problem.

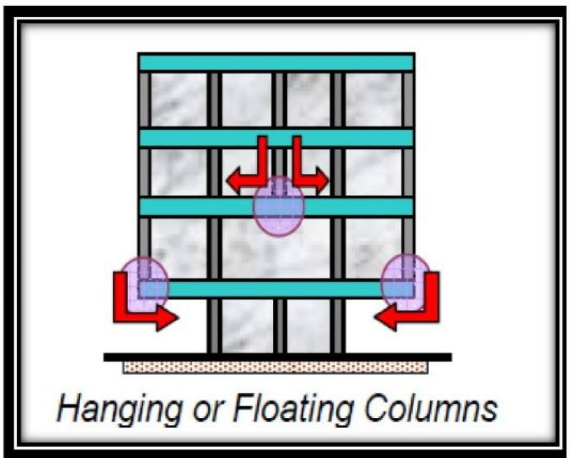

Fig. 1: Hanging or Floating Columns

When irregular features such as floating columns are included in buildings, a considerably higher level of engineering effort is required in the structural design and yet the building may not be as good as one with simple architectural features, so the normal regular and irregular structures are compared with floating column structures with different position.

II. BUILDING DESCRIPTION

The study is carried out on a regular and irregular shaped building with floating column and normal column. The layout of the building is shown in the figure. The building considered is a multi-storey building having G+4 structures.

A. Regular G+4 Normal Structures

It is a five storey building with one roof. The length and width of each floor is 12m and 8m. The total height of structure is 21m.This model has been analysed by creating fixed support on ground storey, by assigning dead load, live load and earthquake load with accidental load in zone II and zone V.

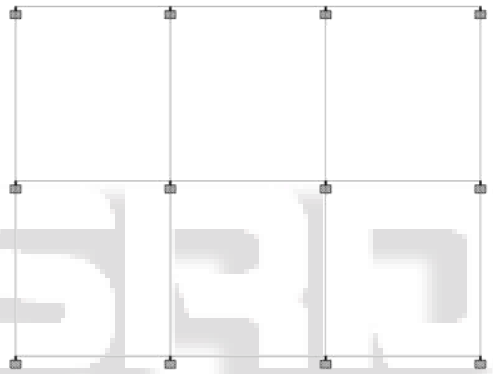

Fig. 2: A regular building with normal column

B. Regular G+4 Floating Column Structure

It is a five storey building with one roof. The length and width of each floor is 12m and 8m. The total height of structure is 21m.This model has been analysed by creating fixed support on ground storey, by assigning dead load, live load and earthquake load with accidental load in zone II and zone V.

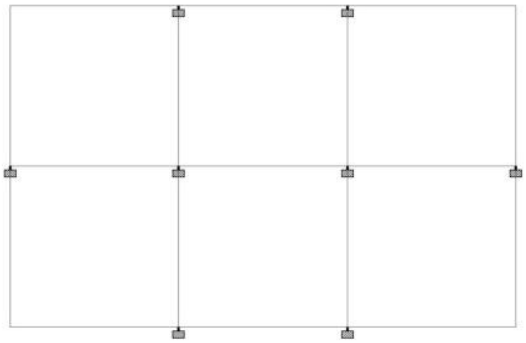

Fig. 3: A regular building with floating column in corners

C. Regular G+4 Floating Column Structure

It is a five storey building with one roof. The length and width of each floor is 12m and 8m.

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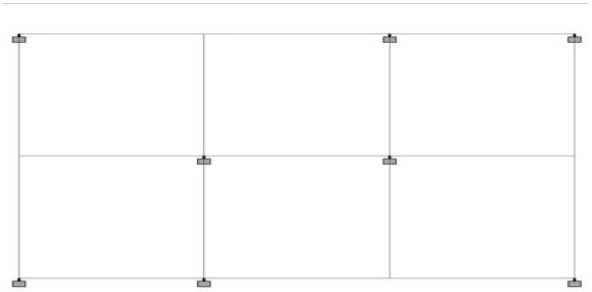

Fig. 4: A regular building with floating column in middle

The total height of structure is 21m.This model has been analysed by creating fixed support on ground storey, by assigning dead load, live load and earthquake load with accidental load in zone II and zone V with different position of floating column.

D. Irregular G+4 Normal Structure

It is a five storey building with one roof. The length and width of each floor is 20m and 16m. The total height of structure is 21m.This model has been analysed by creating fixed support on ground storey, by assigning dead load, live load and earthquake load with accidental load in zone II and zone V.

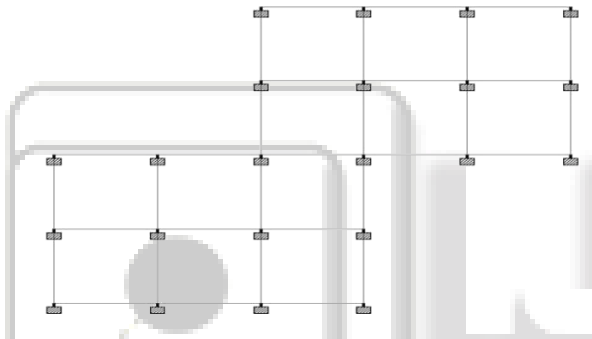

Fig. 5: An irregular building with normal column

E. Irregular G+4 Floating Column Structure:

It is a five storey building with one roof. The length and width of each floor is 20m and 16m. The total height of structure is 21m.This model has been analysed by creating fixed support on ground storey, by assigning dead load, live load and earthquake load with accidental load in zone II and zone V.

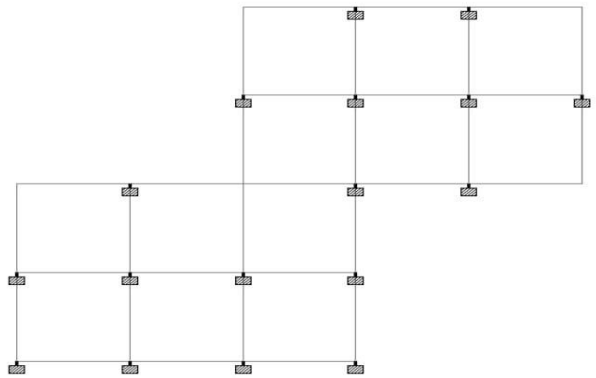

Fig. 6: A regular building with floating column in corners

F. Irregular G+4 Floating Column Structure:

It is a five storey building with one roof. The length and width of each floor is 20m and 16m. The total height of structure is 21m.This model has been analysed by creating fixed support on ground storey, by assigning dead load, live load and earthquake load with accidental load in zone II and zone V with different position of floating column

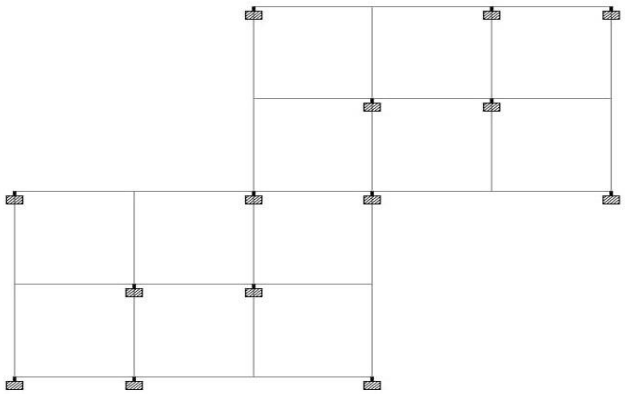

Fig. 7:

III. LOAD COMBINATION

For design of reinforced concrete structures, the load combination 1.5(DL + LL+EQ) in X and Z directions are used.

IV. ANALYSIS OF STRUCTURE

STOREY DRIFTS CALCULATION: -

STOREY DRIFTS CALCULATION IN X DIRECTION						
Building with zones	Ground Plinth	1st Floor	2nd Floor	3rd Floor	4th Floor	Roof
REGULAR ZONE II (R II)	0.1706	0.2286	0.329	0.2948	0.2293	0.1298
REGULAR ZONE V (R V)	0.6142	0.8229	1.1848	1.0617	0.8253	0.4695
IRREGULAR ZONE II (IR II)	0.1743	0.2324	0.3358	0.301	0.2344	0.1331
IRREGULAR ZONE V (IR V)	0.6275	0.8359	1.2090	1.0893	0.8437	0.4792
FLOATING REGULAR ZONE II (FR II)	0.2455	0.2626	0.3628	0.329	0.2647	0.1688
FLOATING REGULAR ZONE V (FR-V)	0.884	0.9452	1.3057	1.1844	0.9533	0.6076
NEW FLOATING REGULAR ZONE II (NFR II)	0.3055	0.3012	0.4224	0.3798	0.2985	0.1769
NEW FLOATING REGULAR ZONE V (NFR V)	0.9132	0.8876	1.2396	1.1191	0.8872	0.5382

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N FLOATING IRREGULAR ZONE II (NFIR II)	0.258	0.2377	0.3361	0.3027	0.2384	0.1401
N FLOATING IRREGULAR ZONE V (NFIR V)	0.9286	0.8556	1.2104	1.0894	0.8579	0.5048
FLOATING IRREGULAR ZONE II (FIR II)	0.2654	0.296	0.3975	0.3592	0.2893	0.1840
FLOATING IRREGULAR ZONE V(FIR-V)	0.9198	1.0766	1.4095	1.2785	1.0356	0.6713

Table 1:

STOREY DRIFTS CALCULATION IN Z DIRECTION						
Building with zones	Ground Plinth	1st Floor	2nd Floor	3rd Floor	4th Floor	Roof
REGULAR ZONE II (R II)	0.0761	0.1358	0.1773	0.1649	0.1307	0.0827
REGULAR ZONE V (R V)	0.2737	0.4888	0.6386	0.5913	0.4709	0.2974
IRREGULAR ZONE II (IR II)	0.0748	0.1312	0.1719	0.1583	0.1252	0.0779
IRREGULAR ZONE V (IR V)	0.2693	0.4723	0.619	0.5697	0.4512	0.2807
FLOATING REGULAR ZONE II (FR II)	0.1207	0.1933	0.2345	0.2219	0.1895	0.1429
FLOATING REGULAR ZONE V (FR-V)	0.4341	0.6960	0.844	0.7988	0.6821	0.5141
NEW FLOATING REGULAR ZONE II (NFR II)	0.1467	0.2148	0.2453	0.2236	0.1812	0.1226
NEW FLOATING REGULAR ZONE V (NFR V)	0.3907	0.5762	0.6931	0.6403	0.5216	0.3521
N FLOATING IRREGULAR ZONE II (NFIR II)	0.1027	0.1432	0.1790	0.1651	0.1334	0.0874
N FLOATING IRREGULAR ZONE V (NFIR V)	0.3698	0.5163	0.6447	0.5947	0.4798	0.3145
FLOATING IRREGULAR ZONE II (FIR II)	0.1216	0.1932	0.2398	0.2222	0.1858	0.1357
FLOATING IRREGULAR ZONE V(FIR-V)	0.4921	0.7781	0.8601	0.7928	0.6688	0.4974

Table 2:

V. RESULTS

Storey Drift Graph:-

A. *Results of Storey Drift in Z Direction:*

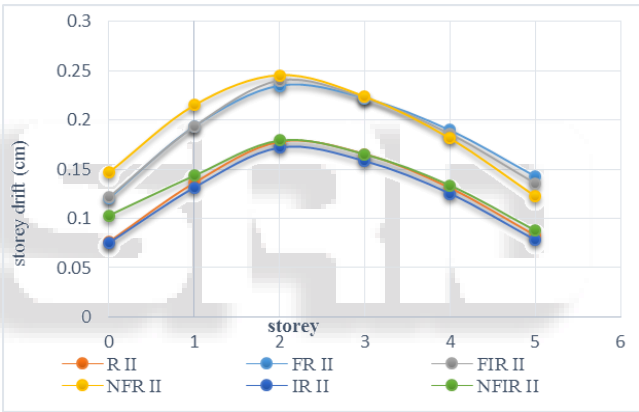

Fig. 8: Graph showing storey drift of zone II buildings in Z directions.

Graph showing all the structures with zone II. Building without floating columns shows the small drift than structures with floating columns. Regular buildings with four floating columns show the highest drift. After that structures with irregular frames in different positions of floating column shows high storey drift. The least drift is shown in regular structure. All the buildings show their maximum drift in storey 1st. This is due to the initial static condition which resists the structure and shows maximum drift in g+1.

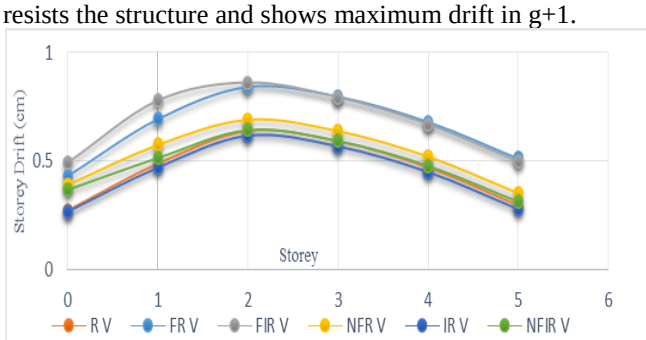

Fig. 9: Graph showing storey drift of zone V buildings in Z directions

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The highest drift is shown by floating column of irregular shape. At g+2, both irregular and regular floating column structure shows approx. same drift. So it is clear that regular structures with floating columns at corners are not advisable as it resembles drift same as irregular structures. Also providing floating columns at the centre in the ground storey in irregular are more resistant.

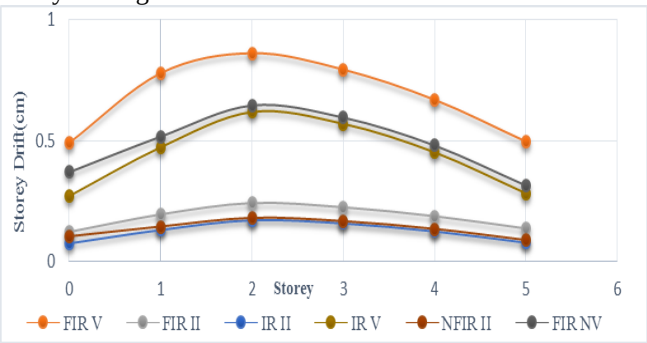

Fig. 10: Graph showing storey drift of all irregular buildings in Z directions

The maximum drift is shown by building with floating column at the centre and the minimum by irregular building with zone II. Thus as per aesthetic view the irregular building can be made in low seismic zones. Building in zone V shows much higher drift as compared to Zone II.

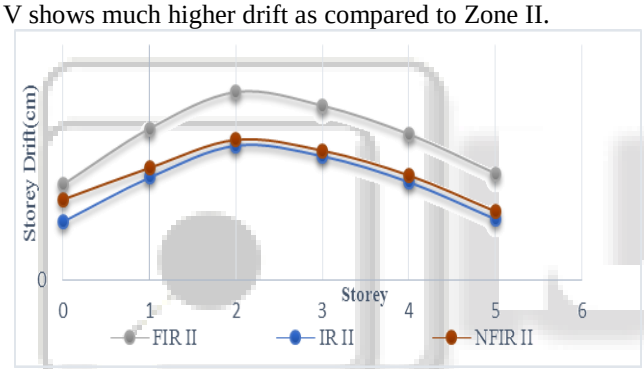

Fig. 11: Graph showing storey drift of all irregular Buildings of zone II in Z directions

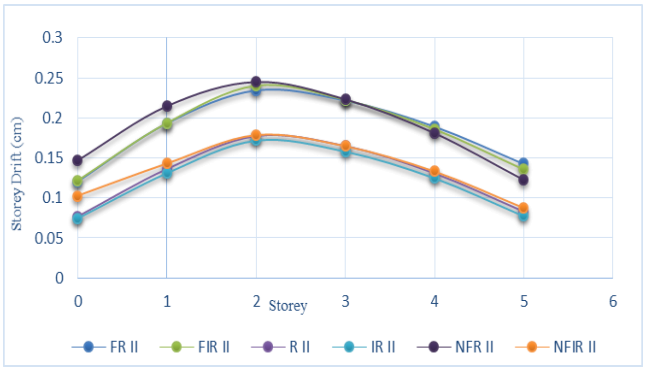

Fig. 12: Graph showing storey drift of all zone II buildings in Z directions

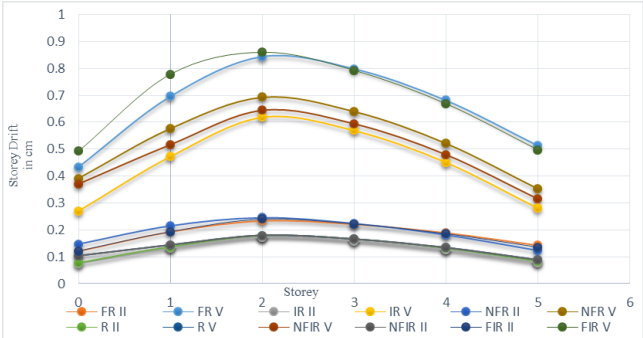

Fig. 13: Graph showing storey drift of all buildings in Z direction

B. Storey Graph in X Axis:

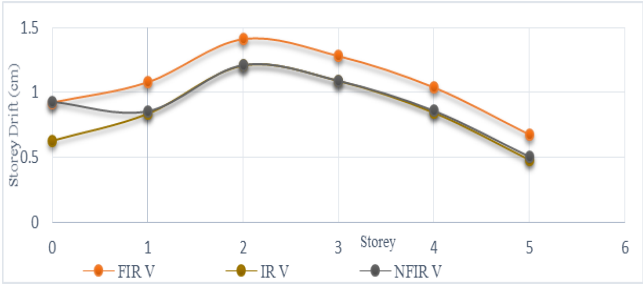

Fig. 14: Graph showing storey drift of all irregular buildings of zone V in X directions:

The drift of irregular and irregular floating structure is approximately same in 1st and 2nd storey. Also this irregular structure with floating column at the centre in the ground floor shows decrease in drift from plinth to ground floor. The floating column provided at the corners shows maximum displacement and is initially overlapped with the floating column provided at the centres of outer faces. Irregular normal building and building with floating column coincides as in some storey.

Fig. 15: Graph showing storey drift of all buildings of zone II in X directions

The drift with regular building shows least displacement and floating column in regular zone shows maximum. This means building with floating column in corners shows maximum drift. Also floating column in irregular building shows slightly higher drift as compared to regular and irregular building. Hence providing floating column in zone II can be used.

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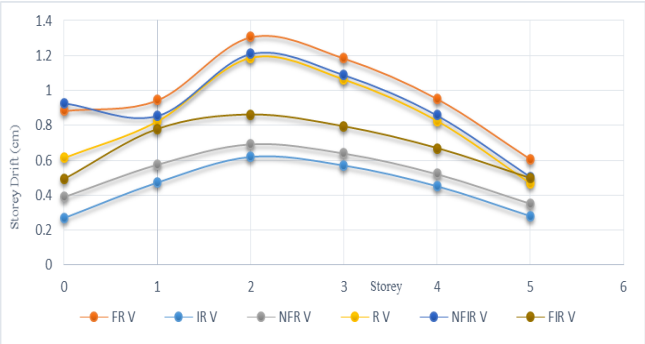

Fig. 16: Graph showing storey drift of all buildings of zone V in X directions

Irregular structure shows minimum drift while regular structure shows high variation. Floating column in regular structure shows higher drift because the structural configuration of building varies due to floating column provided in the corners. Thus such type of structure is not advisable.

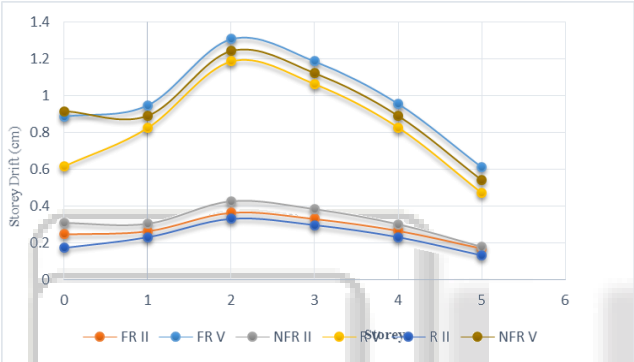

Fig. 17: Graph showing storey drift of all regular buildings in X directions

From the graph it is clear that zone V buildings show more than twice higher drift than zone II buildings. Floating structure show variation from plinth to ground level.

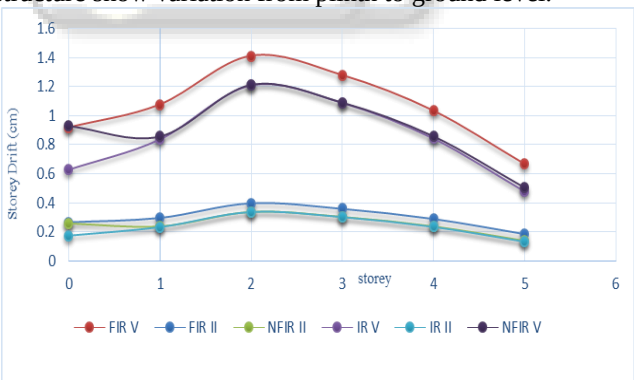

Fig. 18: Graph showing storey drift of all irregular buildings in X direction

Floating column in irregular zone V exhibits some structure configuration and thus varying in initial storey drift due to static initial condition.

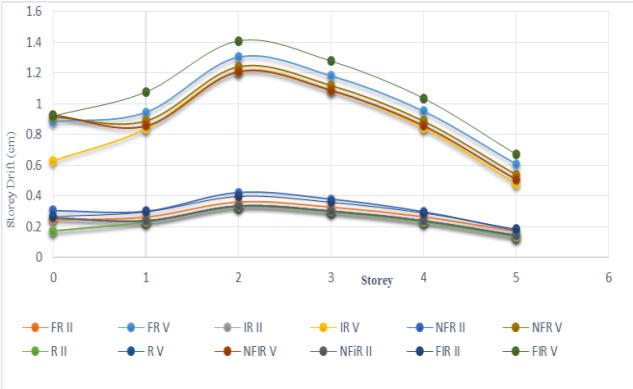

Fig. 19: Graph showing storey drift of all the frame structures in X direction

Irregular floating structure shows variation in initial storey drift from ground floor. This may depend on the type of soil and the weight of structure and also the number of heavy columns resting on ground. Storey drift is higher for floating structures and increases with higher seismic zone. Regular structures show lesser drift than irregular structure. Thus floating column should be avoided in irregular structures and for higher seismic zones.

VI. CONCLUSION

1) The storey drift in Z direction is less than in X direction... Figure indicates the maximum drift pattern of models at each floor level. It is observed that the building with floating column has more drift.
2) In the framed structure with no floating columns the nodal displacements is minimum with uniform distribution of stresses at all beams and columns. As a result it is most economical
3) Regular structure with floating column in the centre shows maximum storey drift in Z direction due to presence of many floating columns in the ground floor and mass irregularity in zone II.
4) Drift in zone V is more than 2.5 times drift of zone II structures.
5) Irregular structure with floating column at the corners show maximum drift in both X and Z direction of zones V.
6) Regular structure shows least drift in both X and Z direction in their respective zones.
7) The G+4 regular structures are safe in both the zones II and zone V

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