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Dynamic Response of RC Framed Structure withFloating Columns and Shear Walls

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Abstract:— **In present scenario buildings with floating column is a typical feature in the modern multistory construction in urban India. Such features are highly undesirable in building built in seismically active areas. This study highlights the importance of explicitly recognizing the presence of the floating column in the analysis of building. SAP 2000 software used for develop 3D multi storey RC framed structure with and without floating columns and shear walls. Response-spectrum analysis is carried out to determine dynamic response of structures such as storey displacement, storey shear and inter storey drift for normal RC framed structure, RC framed structure with floating columns and RC framed structure with floating columns and shear walls.**

Keywords:-- **Floating Columns, SAP 2000 18, RC framed structure, Shear walls.**

I. INTRODUCTION

Many urban multistorey buildings in India today have open first storey as an unavoidable feature. This is primarily being adopted to accommodate parking or reception lobbies in the first storey. Whereas the total seismic base shear as experienced by a building during an earthquake is dependent on its natural period, the seismic force distribution is dependent on the distribution of stiffness and mass along the height.

The behavior of a building during earthquakes depends critically on its overall shape, size and geometry, in addition to how the earthquake forces are carried to the ground. The earthquake forces developed at different floor levels in a building need to be brought down along the height to the ground by the shortest path; any deviation or discontinuity in this load transfer path results in poor performance of the building. Buildings with vertical setbacks (like the hotel buildings with a few storey wider than the rest) cause a sudden jump in earthquake forces at the level of discontinuity. Buildings that have fewer columns or walls in a particular storey or with unusually tall storey tend to damage or collapse which is initiated in that storey. Many buildings with an open ground storey intended for parking collapsed or were severely damaged in Gujarat during the 2001 Bhuj earthquake. Buildings with columns that hang or float on beams at an intermediate storey and do not go all the way to the foundation, have discontinuities in the load transfer path.

1.1 WHAT IS FLOATING COLUMN

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 (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.

1.2 WHAT IS SHEAR WALL

Shear wall are one of the excellent means of providing earthquake resistance to multistoried reinforced concrete building. The structure is still damaged due to some or the other reason during earthquakes. Behavior of structure during earthquake motion depends on distribution of weight, stiffness and strength in both horizontal and planes of building. To reduce the effect of earthquake reinforced concrete shear walls are used in the building. These can be used for improving seismic response of buildings. Structural design of buildings for seismic loading is primarily concerned with structural safety during major Earthquakes, in tall buildings, it is very important to ensure adequate lateral stiffness to resist lateral load. The provision of shear walls in building to achieve rigidity has been found effective and economical. When buildings are tall, beam, column sizes are quite heavy and steel required is large. So there is lot of congestion at these joint and it is difficult to place and vibrate concrete at these place and displacement is quite heavy. Shear walls are usually used in tall building to avoid collapse of buildings. When shear wall is situated in advantageous positions in the building, they can form an efficient lateral force resisting system.

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1.3 OBJECTIVE AND SCOPE OF PRESENT WORK

To analyze dynamic response of RC framed structure with and without floating columns and shear walls using response spectrum analysis.

To analyze response of soft storey building such as storey drift, storey displacement, storey shear and inter storey drift.

1.4 METHODOLOGY

1. Review of existing literatures by different researchers.
2. Selection of types of structures.
3. Modelling of the selected structures under the following cases.
a) Model 1:RC framed structure without floating columns.
b) Model 2:RC framed structure with floating columns.
c) Model 3:RC framed structure with floating columns and shear walls

1.5 RESPONSE SPECTRUM ANALYSIS:

This approach permits the multiple modes of response of a building to be taken into account. This is required in many building codes for all except for very simple or very complex structures. The structural response can be defined as a combination of many modes. Computer analysis can be used to determine these modes for a structure. For each mode, a response is obtained from the design spectrum, corresponding to the modal frequency and the modal mass, and then they are combined to estimate the total response of the structure. In this the magnitude of forces in all directions is calculated and then effects on the building is observed. Following are the types of combination methods:

1. absolute - peak values are added together
2. square root of the sum of the squares (SRSS)
3. complete quadratic combination (CQC) - a method that is an improvement on SRSS for closely spaced modes

II MODELLING

Analysis deals with comparison of G+13 storey commercial building with and without floating columns and shear walls.

2.1 PARAMETERS

Table (a) parameters

Name of parameter	Model-1	Model-2	Model-3
No of storey	G+13	G+13	G+13
Storey height	3m	3m	3m
Ground floor height	4m	4m	4m
Height of building	45m	45m	45m
Grade of concrete	M30	M30	M30
Grade of steel -Longitudinal	Fe415	Fe415	Fe415
Size of Beam	375x600mm	375x600mm	375x600mm
Size of column	450x450mm	450x450mm	450x450mm
	600x600	600x600	600x600
Wall thickness	230mm	230mm	230mm
Geometry of building	symmetrical	symmetrical	symmetrical
Size of shear wall	-	-	2m (corners of building)
Plan dimension	22.5x31.5m	22.5x31.5m	22.5x31.5m

Table (b) Loads as per IS 875 (Part 2) -1987

Live Load	4KN/m2
Floor Finish	1KN/m2
Terrace finish	1KN/m2

Table (c) Earthquake loads as per IS1893 (part-1) 2002

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Seismic zone	v
Zone factor	0.36 (very severe)
Importance factor	1
Response reduction Factor	5
Soil type	II- medium soil
Damping	5%

Model-1: RC framed structure without floating columns.

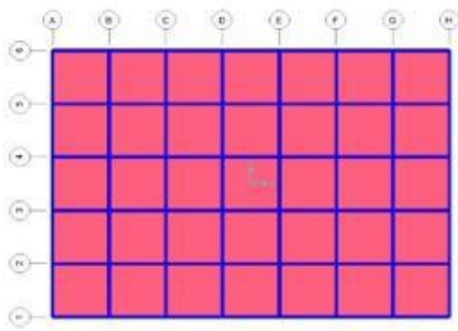

Fig (a) plan view model-1
x-axis has 7 bays, each bays 4.5m span
y-axis has 5 bays, each bays 4.5m span

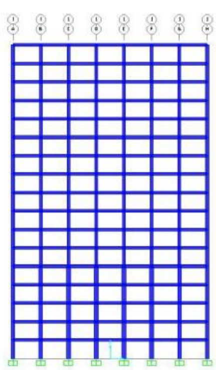

Fig (b) elevation view model-1

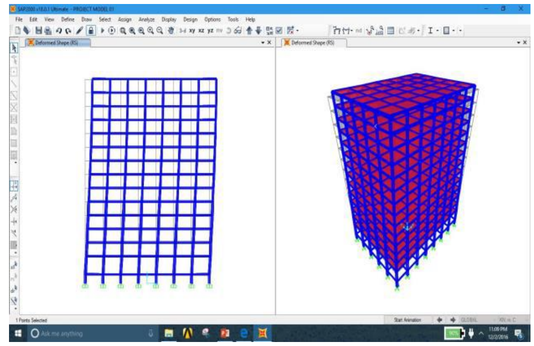

fig (c) deformed shape of the structure model-1

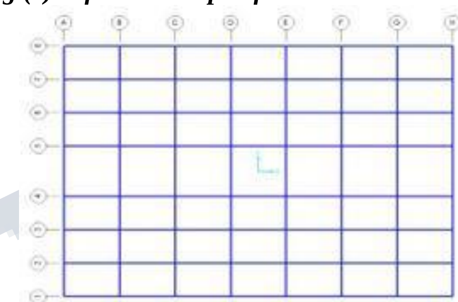

Fig (d) plan view model-2

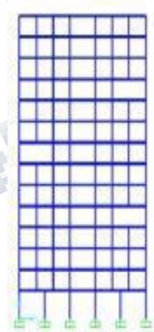

Fig (e) elevation view model-2

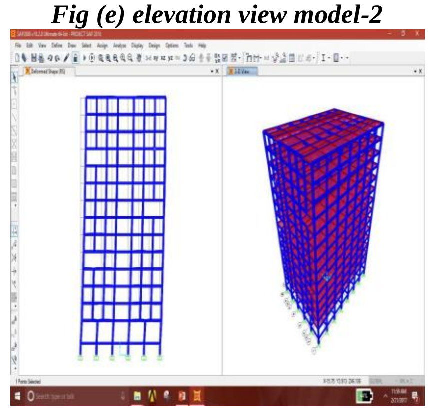

Fig (f) deformed shape of the structure model-2

Model-3: RC framed structure with floating columns and shear walls.

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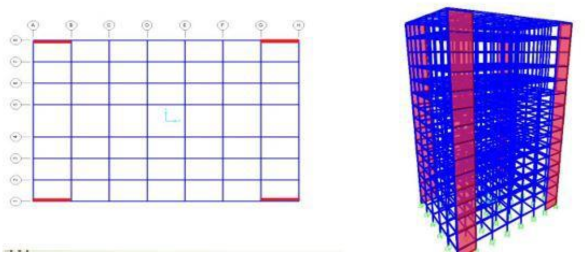
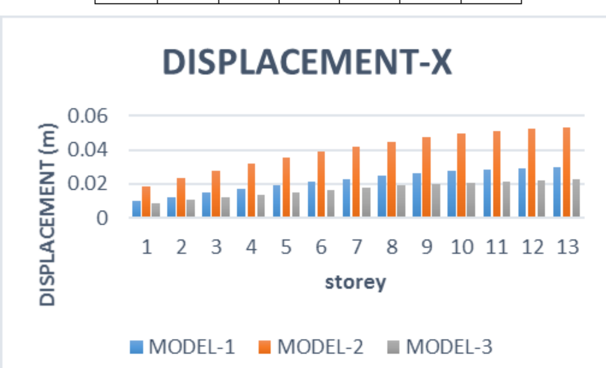


Fig (g) plan and elevation view model-3
All the models have same plan area and bay with in both x and y axis.

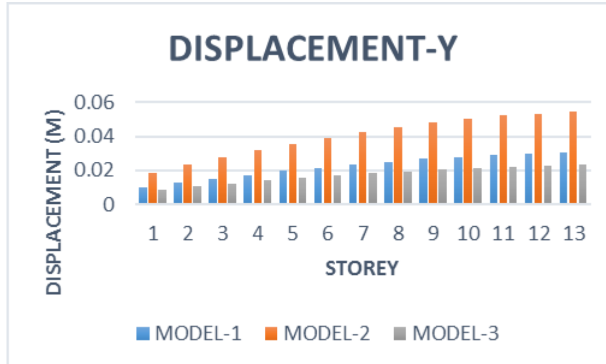
III.RESULTS

Table (d) displacement model-1

storey	Model-1		Model-2		Model-3	
	x	y	x	y	x	y
1	0.01	0.01	0.018	0.019	0.009	0.009
2	0.012	0.012	0.023	0.023	0.01	0.011
3	0.015	0.015	0.027	0.028	0.012	0.012
4	0.017	0.017	0.032	0.032	0.014	0.014
5	0.019	0.019	0.035	0.036	0.015	0.015
6	0.021	0.022	0.039	0.039	0.016	0.017
7	0.023	0.023	0.042	0.042	0.018	0.018
8	0.025	0.025	0.045	0.045	0.019	0.019
9	0.026	0.027	0.047	0.048	0.02	0.02
10	0.027	0.028	0.05	0.05	0.021	0.021
11	0.028	0.029	0.051	0.052	0.021	0.022
12	0.029	0.03	0.053	0.053	0.022	0.023
13	0.03	0.03	0.053	0.054	0.022	0.023



Graph (a) displacement x-direction



Graph (b) displacement y-direction

Table (e) storey drif

storey	Model-1		Model-2	
	x	y	x	y
1	0.00030	0.00049	0.0006	0.0006
2	0.00053	0.000521	0.0009	0.0008
3	0.00060	0.000688	0.001	0.001
4	0.00069	0.00071	0.001	0.0011
4	0.00070	0.00072	0.001	0.0012
6	0.00065	0.00067	0.0011	0.0011
7	0.000603	0.00062	0.0010	0.0010
8	0.00054	0.00056	0.00095	0.00098
9	0.00048	0.00050	0.00083	0.00087
10	0.00041	0.00044	0.00070	0.00074
11	0.00033	0.00036	0.00056	0.00060
12	0.00024	0.00027	0.00041	0.00044
13	0.00015	0.00018	0.00025	0.00028

Table (f) inter storey drift

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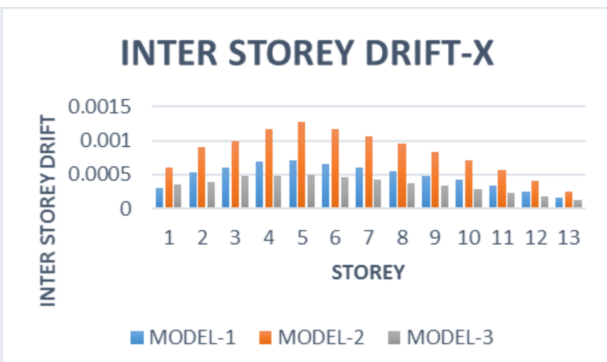
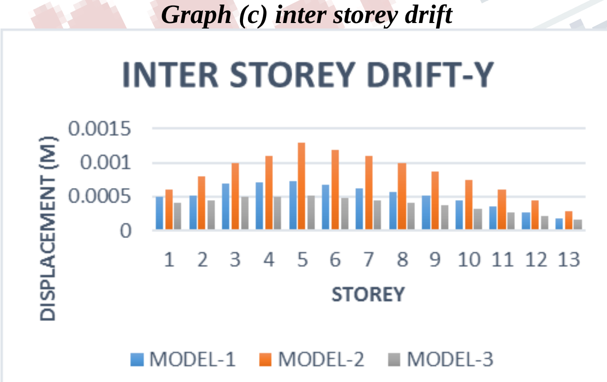
storey	Model-3	
	x	y
1	0.0006	0.000399
2	0.0008	0.00044
3	0.001	0.000488
4	0.0011	0.00049
5	0.0012887	0.0005
6	0.00119	0.00047
7	0.00109	0.0004
8	0.0009	0.00040
9	0.00087	0.00036
10	0.00074	0.00031
11	0.00060	0.00026
12	0.00044	0.00021
13	0.00028	0.00016

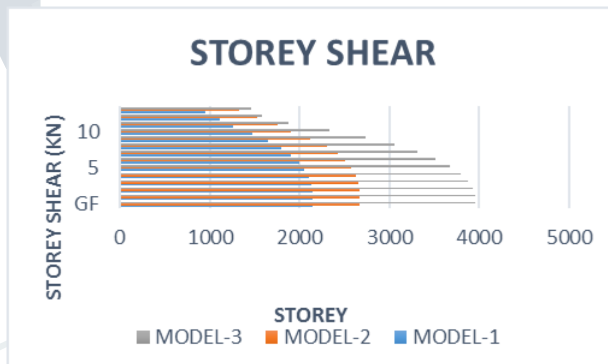


Graph (c) inter storey drift



Graph (d) inter storey drift

storey	Model-1	Model-2	Model-3
1	2149.3	2673.7	3962.8
2	2148.9	2673.2	3957.4
3	2143.3	2667.4	3928.3
4	2128.7	2652	3876.7
5	2101.3	2624.1	3796
6	2058	2579.3	3679.8
7	1995.9	2515.3	3521.6
8	1909.9	2425.3	3315
9	1796.2	2310.1	3053.5
10	1650.9	2115.9	2730.7
11	1470.1	1905.2	2340
12	1257.8	1761.6	1875.2
13	1115.6	1531.6	1588.2



Graph (E) storey shear

Table (h) maximum values of inter storey drift, storey shear and storey displacemnt

PARAMETERS (MAX)	INTER STOREY DRIFT	BASE SHEAR (KN)	STOREY DISPLACEMENT (M)
MODEL-1	0.000726	2149.33	0.030379
MODEL-2	0.00128	2673.70	0.054306
MODEL-3	0.000509	3962.75	0.023326

IV. CONCLUSION

- The displacement of building with floating columns is 45% more than that of normal building. After providing shear wall it is reduced up to 57%

- The inter storey drift of building with floating columns is 43.28% more than that of normal building. After providing shear wall it is reduced up to 60.23%
- The storey shear of building with floating columns is 19.61% more than that of normal building. After providing shear wall it is increased up to 32.53%
- Building with floating columns will suffer extreme storey drift compared to normal buildings.
- Building with floating columns experienced more storey shear than that of the normal building. This is due to the use of more quantity of materials than a normal building. So the floating column building is uneconomical to that of a normal building.
- Building with floating columns gives more lateral displacements. So the floating column building is unsafe for construction when compared to a normal building.

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