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SEISMIC PERFORMANCE OF HIGH RISE BUILDINGS WITH FLOATING COLUMNS AND SHEAR WALL

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Abstract - *An attempt is made to compare response of Study the structure behaviors whether it has floating columns, floating columns and shear walls, and compare the results to the behavior of a normal building models. Additionally, compare the time period, storey displacements, storey drift, and storey shear. Three models for a G+20-story [M1, M2, M3] and three model of G+10 structure [P1, P2, P3]. The normal building will be taken into account for the first model [M1], building with floating columns will be second model [M2], and model with floating column and shear wall are considered third model [M3]. The response spectrum methods are used to analyse the seismic analysis of the G+20 storey and G+10 structure. Used pushover curve to find of performance point of the building. ETABS-2019 software and Indian Standard code IS 1893(Part-1) 2002. Obtained parameter likes storey displacements, storey shear, storey drift and time period for seismic zone IV. Obtained pushover curve for the M2 & M3 model and checked the performance point of buildings. Also compared the result between G+20 &G+10 storey buildings. The story displacements is increased 6% in (M2), decreased 27% in (M3). The story shears is decreased 4.5% in (M2), and increased 12% in model (M3) on comparing model [M1].Comparing all three models the time period of floating column building model II (M2) is greater between all three model. The storey shear increased by 24 percent in model III, by 23 percent in model IV, and by 4.5 percent in model II as compared to a normal structure. When comparing the three models, the floating column building model [M2] has a longer lifespan than the other three buildings. Comparing all variants, Model [M3] offers greater performances with lower displacements and more strength.*

***Key Words*: ETABS, Floating column, Shear wall, Response spectrum method, Pushover curve.**

1 INTRODUCTION

The first floor opening of many urban multi-story structures in our nation is an inevitable future development. This is being used to accommodate parking for cars, reception of lobbies, among other things, in the first floor. The distribution of stiffness and mass along of the height affects the seismic force distribution and the total seismic base shear of the building during an earthquake. In addition of how the sesmic forces are transmitted to the ground, a building's overall design, size, and geometry have a significant impact on how it responds to earthquakes. The architect will probably use a variety of techniques to increase the amount of space available for one or more storeys inside the multi-story building. One of these techniques is the use of floating columns, which means that the ends of any vertical elements rest on a beam and cause a discontinuity in the columns in such multi-story buildings. Shear walls have therefore been utilised in their direction of orientation to provide the buildings more strength and stiffness.

1.1 Floating column

A column is intended to be a vertical element that begins at the foundation level and transfers weight to the ground. The phrase "floating column" also refers to a vertical element where the column ends rest on a beam that is a horizontal member due to structural design or site conditions. These beams change how the load is transferred to the columns below. The load on these columns was regarded as the point load. Where there are floating columns, the floor and the floors below it should have hefty beams and columns made of heavy materials. The size of the beams and columns should be increased because floating columns act on concentrated loads and transfer loads horizontally.

1.2 Shear wall

A shear wall is that is used to withstand shear that is caused by lateral forces or seismic stresses. Shear walls are frequently present in high-rise structures. It will be started at the ground level and extended to the height of the building. Shear walls can range in thickness of 150mm to 400mm. Shear walls are oriented vertically, like wide beams, to withstand lateral stresses that would otherwise push them downward into the base. Shear walls are typically provided by the breadth and length of the constructions. Shear walls are offered when there is a greater than 30% difference between the building's centre of gravity and the load it is carrying. In order to bring the centre of gravity and the centre, concrete shear walls will be provided. Shear wall structures are identical to regular framed structures in every manner. When it comes to the transference of lateral loads, however, there are substantial differences. Shear walls are vertical stiffening components made to withstand the lateral stresses that wind or earthquakes can apply to a structure. Shear walls are vertical components of the system whichresists horizontal forces.

2. OBJECTIVES

1. Formulation of problem statement, development of methodology, and possible validation with high quality research article.
2. Evaluate seismic response of high rise RCC buildings with floating columns.
3. Evaluate the seismic response of high rise RCC framed buildings with floating columns and shear walls.
4. To compare response parameters of the structures considering non linear analysis results obtained.

3. STRUCTURAL MODELS CONSIDERED

Table 1 Model details

Height of building	64m
Plan Area	1050m^2
Plan Dimension	30X35m
Column size	600X600mm
Beam size	300X450mm
Thickness of Slab	150mm
Unit weight of Concrete	25kN/m3
Grade of Concrete	M25
Grade of Steel	Fe415
Seismic zone	4
Importance factor	1
Response reduction factor	5
Type of soil	II

4. MEMBER SIZES AND PROPERTIES

Steel Grade: Fe500

Concrete Grade: M40

Floor height: 3m

Shear wall thickness: 250 mm

Thickness of slab: 150 mm

5. LOADING DATA

1. Wind

Basic Wind Speed: 50 m/s
Terrain Category: II
Soil Type: II
Importance Factor: 1
K_1 & K_3 : 1

2. Earthquake

Seismic Zone: III
Seismic Zone Factor: 0.16
Soil Type: II
Importance Factor: 1
Response Reduction Factor: 5

3.Other Loads

Basic Wind Speed: 50 m/s
Terrain Category: II
Soil Type: II
Importance Factor: 1
K_1 & K_3: 1

6. STRUCTURE FIGURES

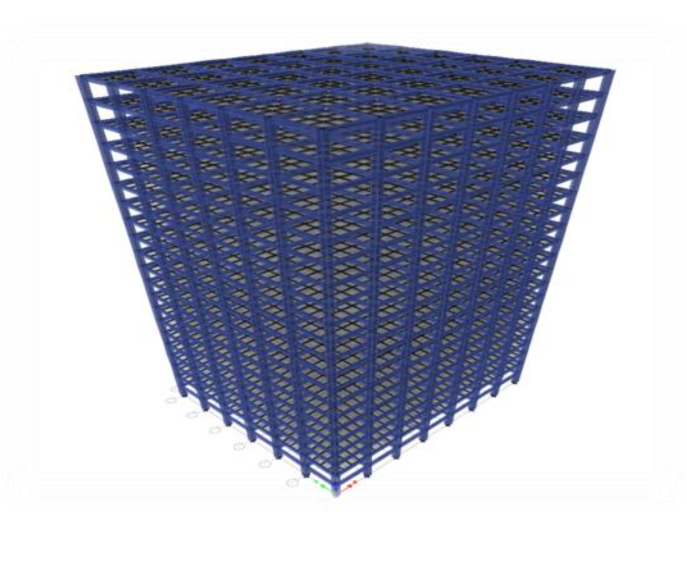

Fig -1 3D Structural model

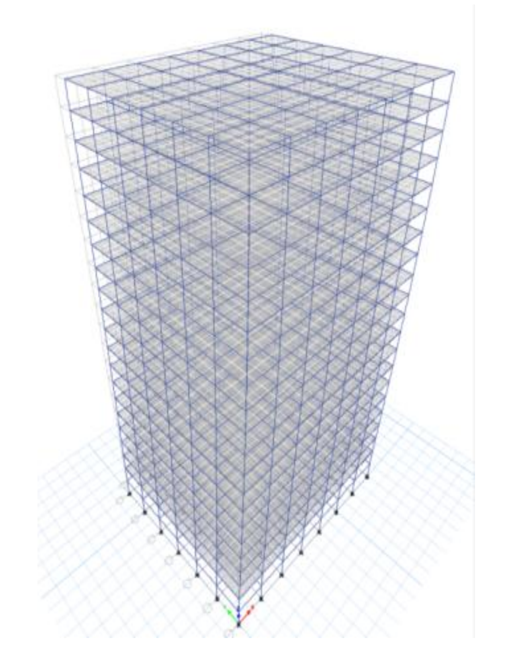

Fig -4 Deformed shape in X-direction

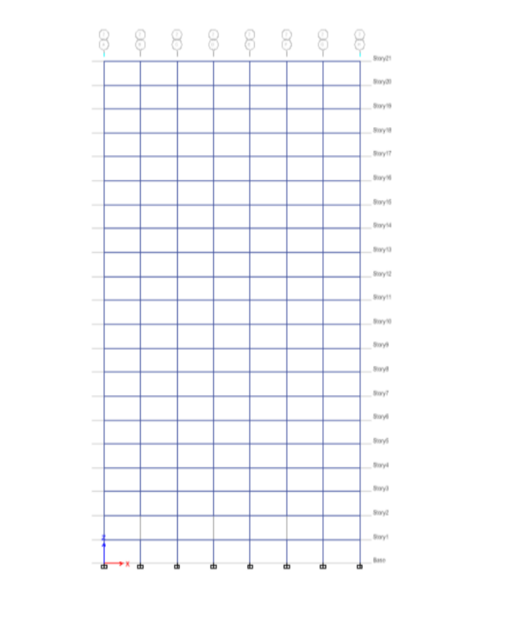

Figure 2 Elevation view (M2)

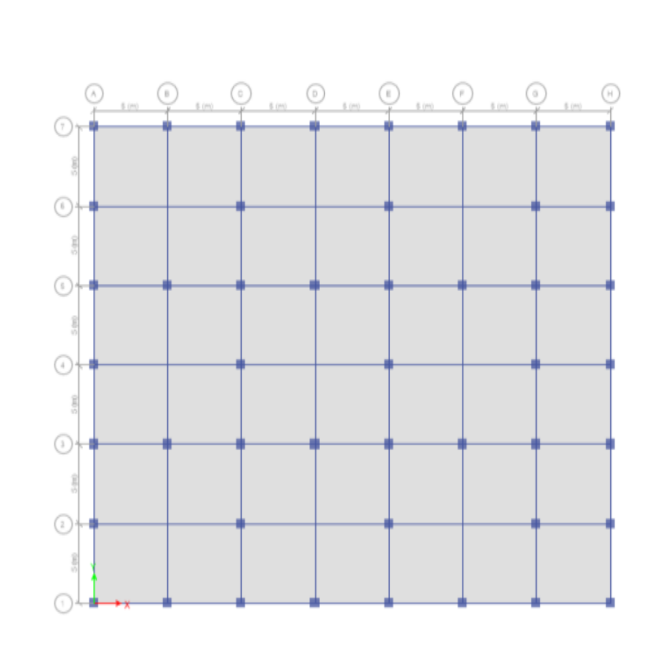

Fig -3 Floor Plan of building

Mode shapes [M1]

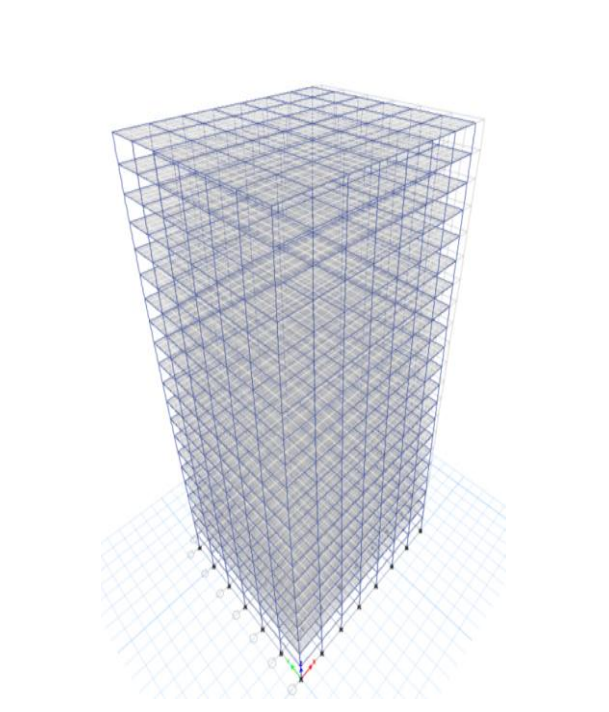

Fig -5 Deformed shape in Y-direction

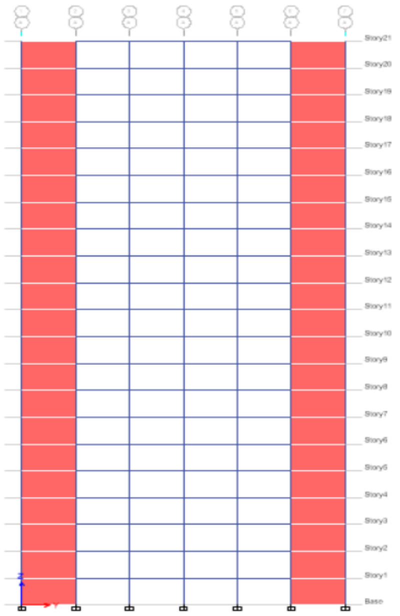

Figure 11 Elevation (M3)

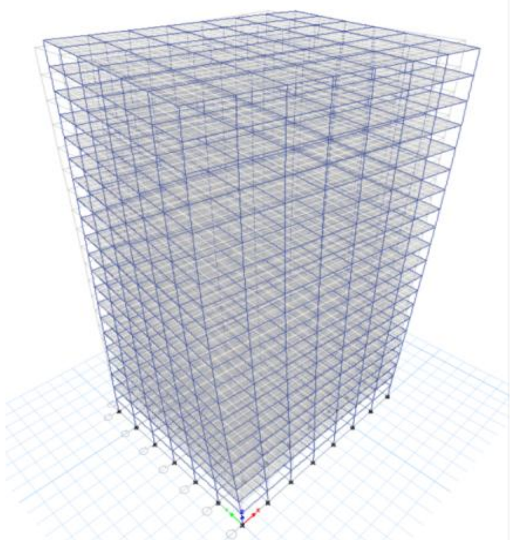

Fig -6 Deformed shape in torsion

Mode shapes [M2]

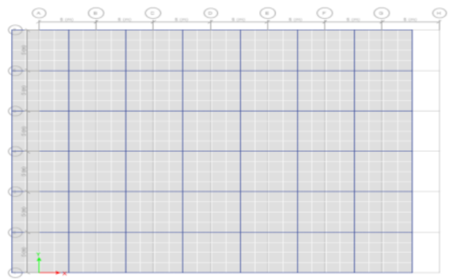

Fig -7 Deformed shape in X-direction

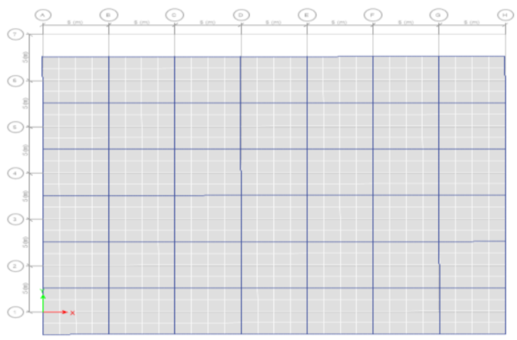

Fig -8 Deformed shape in Y-direction

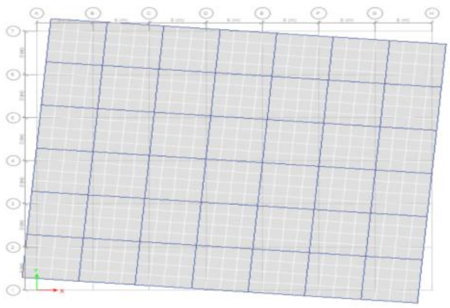

Fig -9 Deformed shape in torsion

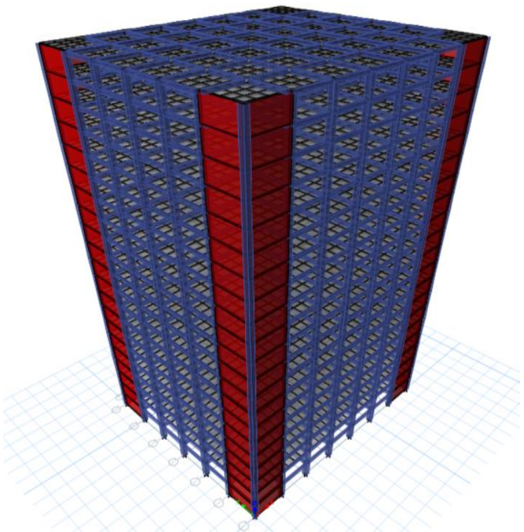

Figure 10 3Dview (M3)

G+20 results

Table 2 Time period

Mode No.	M1	M2	M3
1	2.509	2.55	1.768
2	2.482	2.495	1.754
3	2.279	2.28	1.229
4	0.821	0.829	0.456
5	0.813	0.818	0.454
6	0.748	0.748	0.277
7	0.473	0.473	0.206
8	0.469	0.469	0.206
9	0.435	0.435	0.123
10	0.325	0.325	0.122
11	0.323	0.323	0.119
12	0.3	0.31	0.085

Mode shapes [M3]

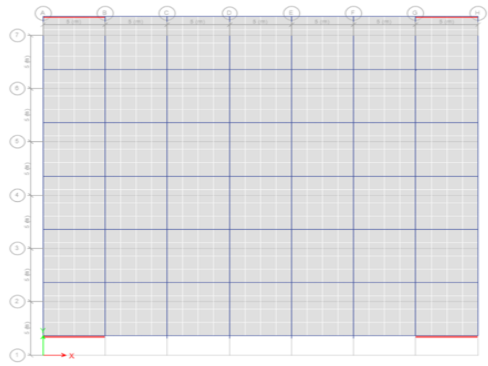

Fig -12 Deformed shape in Y-direction

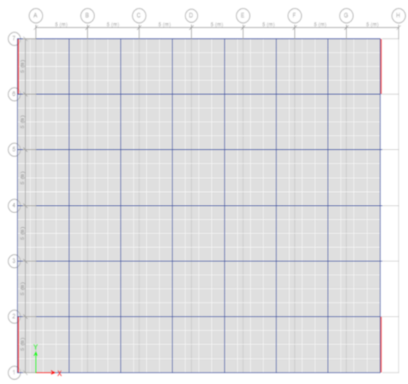

Fig -13 Deformed shape in X-direction

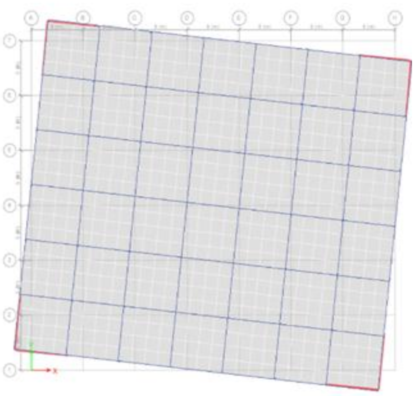

Fig -14 Deformed shape in torsion

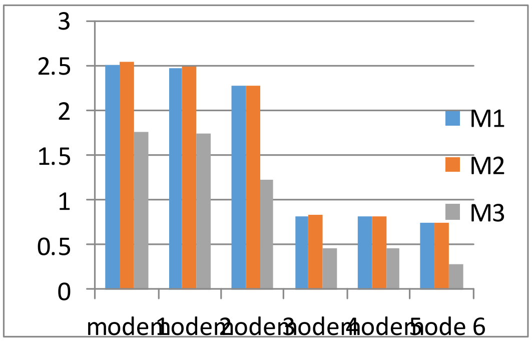

Figure 15 Time period

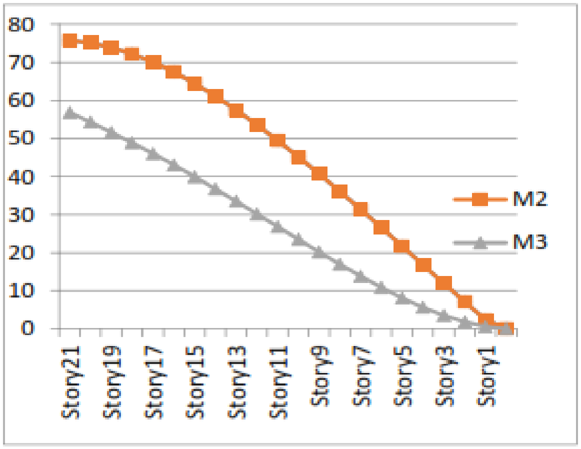

Figure 16 Displacement vs storey

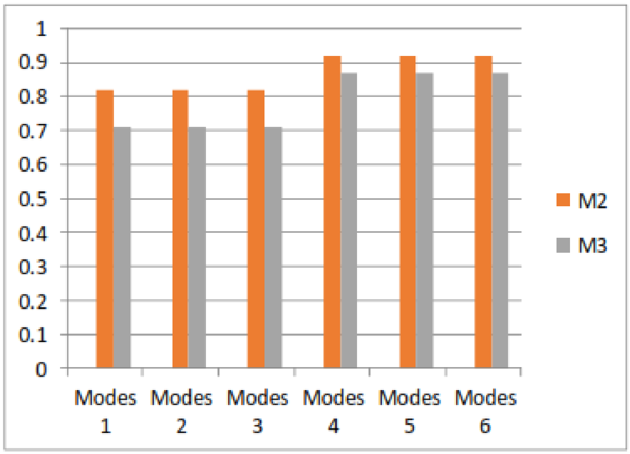

Figure 17 Mode vs mass partition ratio

Table 3: Story shear

Story	M1	M2	M3
Story21	0.000237	0.000234	0.000845
Story20	0.000393	0.000395	0.000885
Story19	0.000562	0.000562	0.000919
Story18	0.000722	0.000722	0.000956
Story17	0.000868	0.000868	0.000994
Story16	0.000998	0.000998	0.00103
Story15	0.001113	0.001113	0.001062
Story14	0.001213	0.001213	0.001088
Story13	0.0013	0.0013	0.001107
Story12	0.001375	0.001375	0.001117
Story11	0.001438	0.001438	0.001116
Story10	0.001491	0.001491	0.001104
Story9	0.001535	0.001535	0.00108
Story8	0.00157	0.00157	0.001041
Story7	0.001598	0.001598	0.000987
Story6	0.001619	0.001619	0.000915
Story5	0.001633	0.001633	0.000824
Story4	0.001636	0.001636	0.000711
Story3	0.001613	0.001613	0.000573
Story2	0.001576	0.001576	0.000407
Story1	0.000788	0.000788	0.000189
Base	0	0	0

7.1 Response Spectrum Method

This method is applicable for those structures where modes other than the fundamental one affect significantly the response of the structure In this method the response of Multi-Degree of freedom (MDOF) system is expressed as the modal response, each modal response determined by the spectral analysis of single degree of freedom (SDOF) system, which are then combined to compute the total response Modal analysis leads to the response history of the structure to a specified round motion, the method is usually used in conjunction with a response spectrum

Following steps of spectrum analysis

- To Select design spectrum
- Determine the mode shapes and period of vibration to be included in the analysis
- Read level forresponse from the spectrum for the period of each of the modes considered
- Calculate the participation for each mode corresponding to the single degree of freedom
- read the response from the curve
- Add the effects of modes to obtain combine maximum response
-
- Convert the combined maximum response for shears and moments for using in design of structure
- Analyze the building for the resultant moments and the shear in for same manner

G+10 story results

Parameter Studied	M2 model			M3 model		
Time Period (Sec)	Modes			Modes		
	1st	2nd	3rd	1st	2nd	3rd
	2.509	2.482	2.279	1.768	1.754	1.229
Story Shear (KN)	EQ X	1.2(DL+LL+FF+EQ X)		EQ X	1.2(DL+LL+FF+EQ X)	
	3353.93	4024.73		4261.3007	5113.56	
Top Story displacement(mm)	75			66		
Mass Participation Ratio(%)	91.93			86.96		

7.2 Pushover Analysis

- Pushover analysis is an approximate analysis method in which the structure is subjected to increasing of lateral forces with an invariant height related distribution until a target displacement is reached and Pushover analysis consists of a series of iteration of elastic analyses, superimposed to a force-displacement curve of the overall structure.

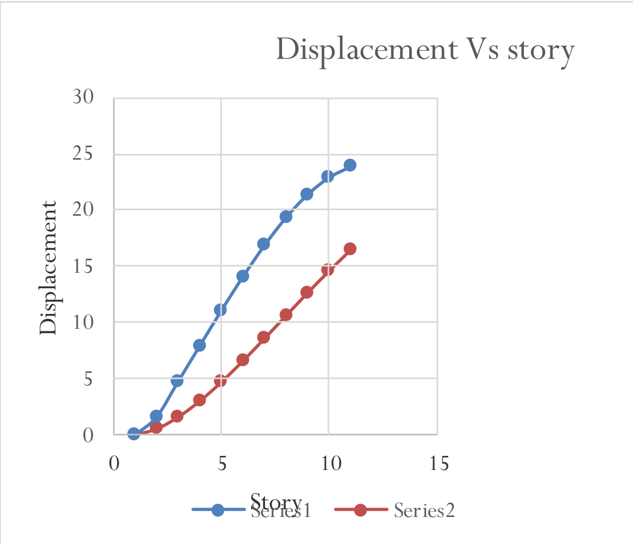

Figure 18 story vs displacement

Table 4 Displacement

Story		
Base	0	0
Story1	1.601	0.529
Story2	4.757	1.587
Story3	7.92	3.001
Story4	11.056	4.692
Story5	14.064	6.573
Story6	16.852	8.565
Story7	19.321	10.601
Story8	21.365	12.621
Story9	22.886	14.584
Story10	23.857	16.437

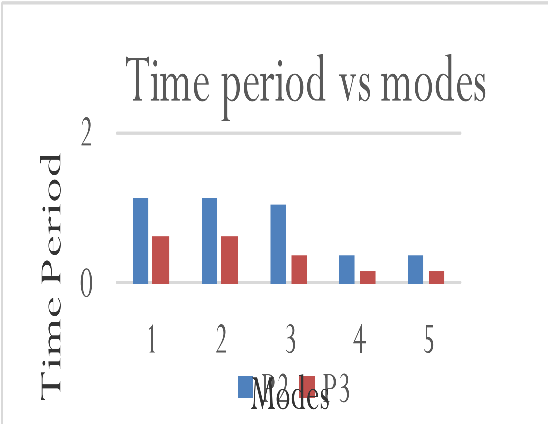

Figure 19Time Modes

Table 5 Time period

Story	P2	P3
Story10	659.0916	1274.423
Story9	1258.754	2486.076
Story8	1732.561	3443.431
Story7	2095.319	4176.407
Story6	2361.836	4714.919
Story5	2546.917	5088.886
Story4	2665.368	5328.225
Story3	2731.998	5462.853
Story2	2761.245	5522.022
Story1	2764.287	5529.033
Base	0	0

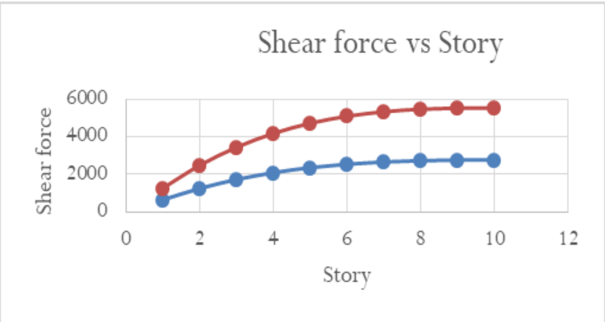

Figure 20 Shear force vs story

Table 6 Base shear

Mode	P2	P3
1	1.142	0.632
2	1.133	0.63
3	1.047	0.39
4	0.362	0.154
5	0.359	0.153
6	0.332	0.091
7	0.198	0.071
8	0.197	0.071
9	0.182	0.045
10	0.127	0.045
11	0.127	0.043
12	0.117	0.033

Table 7 Frequency

Mode	P2	P3
1	5.5031	1.583
2	5.5446	1.588
3	6.0033	2.566
4	17.3776	6.514
5	17.4958	6.522
6	18.934	10.937
7	31.7189	14.096
8	31.8823	14.105
9	34.4457	22.256
10	49.4021	22.266
11	49.6028	23.285
12	53.609	30.375

8. CONCLUSIONS

1. Structure which having floating column will reduce dead load of structure.

2. Story drift is decreasing with increasing height of structure in every model.

3. Maximum story drift and displacement values are increasing for floating column.

4. As the transfer of load of floating columns to conventional columns because of that axial forces are increasing in conventional columns.

5. It is found that the displacement more in floating column building as compare to building without floating column.

6. Providing shear wall will give up to 70 % more strength and stability to the structure. Displacement in shear wall model will be lesser as compare to other structure.

7. Installation of shear wall in having lesser height won't be as of economic note.

8. Push over analysis is used to determine performance point and target displacement method is used and targeted displacement is 250 mm which is in limit.

9. Base shear is increased with increase in number of story and also in shear wall case.

10. Base shear is much higher in pushover analysis than linear analysis.

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