SEISMIC ANALYSIS OF MULTISTOREY BUILDING WITH DIFFERENT POSITIONING OF FLOATING COLUMNS

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Abstract - *Structures encounter lateral deflections under quake loads. Extent of these parallel lateral deflections is identified with numerous factors, for example, mass of structure & mechanical properties of basic materials. Structures should be designed such that they can resist seismic tremor actuated deflections & internal forces. In this paper, impacts of Soft Storey on structures are examined. Building models, which have distinctive number of floors & floor regions, are produced by a PC program & calculations are made. Results are compared & safeguards are given with avoid harms caused by floating column under seismic tremor loads. Likewise, statements in various seismic tremor codes about floating column are analyzed. Calculations demonstrate that isolating huge building areas from each other with appropriate partition separates & increasing lateral rigidity unbending nature on weak direction of structures diminish the impact of floating column. The performance of structure is found as per procedure that is prescribed in Indian Standard 1893:2016 Code Book.*

Keywords: Displacement, Drift, Mode Shapes, Base Shear, Equivalent Static Method, Response Spectrum Method.

1. INTRODUCTION

Numerous metropolitan multistory structures in India now days have open first story as an obvious element. This is basically being utilized to oblige or gathering anterooms in the primary story. While the total tremor base shears as practiced by a structure for the period of a shake is dependent on its typical period, the tremor force dispersal is dependent upon the movement of immovability and weight along the height. The lead of a structure for the period of quakes depends on a very basic level upon its overall shape, size and figuring, in an extension to how the tremor powers are passed on the ground. The seismic quake powers made at different floor levels in a structure ought to be brought along the height to the ground by the brief way whichever divergence or brokenness this heap moves route achieves horrible appearing of the structure. Structure with erect challenges similar to the motel structure with several stories further broad than the rest causes a sudden bounce in tremor powers at the level of anomaly. Structure that have less portions or divider in a particular story or with phenomenally high storey will in general harm or breakdown which is started into storey. Various structure with open storey planned for stopping breakdown or were seriously damaged in Gujarat during 2001 bhuj seismic. Structure with part that hang or buoy on radiates at a middle of the storey and do not go right to the establish have discontinuity in the heap move way. Conventional Civil Engineering structure is planned based on quality and firmness measures. The quality is identified with extreme cutoff states, which guarantee s that the powers created in the structure stay in flexible range. The firmness is identified with usefulness, limit states which guarantees that the basic removal stays with as far as possible. If there should arise an occurrence of tremor powers the interest is for flexibility.

1.1 Floating Column

A column should to be a vertical part starting from foundation level and moving weight to the ground. The term floating segment is similarly a vertical segment which in view of basic arrangement/site situation at its lower level (end level) lays on a beam which is an even part. The beams turn move the load to various columns underneath it. There are various endeavors where floating columns are grasped especially over the GF where move supports are used with the objective that more open area is available in the GF. These open spaces may be need for get-together hallway or halting explanation. The trade supports must be arranged and quick and dirty properly, especially in earth shivers zones. The portion is a centered weight around the beam which maintains it. Without a doubt, the part is as often as possible acknowledged stuck at the bottom and is consequently taken as a point load on the replace beam. STAAD Pro, ETABS and SAP2000 can be used to do the examination of this sort of building. Floating columns are sufficiently proficient to pass on gravity loading yet move support must be of agreeable estimations stiffness with incredibly irrelevant redirection. Looking forward clearly one will continue making structure entrancing rather than dull. In any case, This requirement not be done to the detriment of vulnerable direct and tremor security of structure. Basic features that are blocking to shudder response of structures should be avoided. If not, they ought to be restricted. Exactly when irregular features are associated with structures, a broadly more raised degree of building effort is required in the fundamental arrangement however then the structure may not be as adequate as one with essential plan features. The structures recently made with such uncontrollable people are endangered in seismic areas. Regardless, those structures can't be decimated, rather study should be conceivable to sustain the structure or some mending features can be proposed. The columns of the key story can be made more grounded, the strength of these columns can be extended by retrofitting or these may be offered support to decrease the equal deformation.

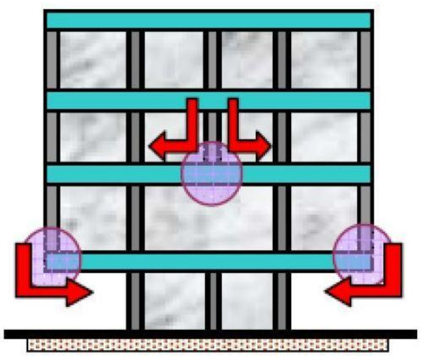


Fig 1.1 Floating Column

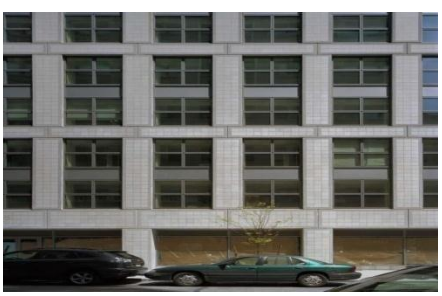


Fig 1.3 ParkAvenue South in New York, US

2. LITERATURE REVIEW

2.1. Sabari. S, Mr. Praveen J.V (2014), this paper refers to FEM examination is done for 2D and 3D multi-story frame with and without floating column contemplating the reactions of the building with various quake excitations where the RC building are with various firmness on floor wise and height of the structure, that are observed in the investigation and time length factors as constants having various frequency and featuring with elective measures including solidness equalization to decrease the unsymmetrical in the first and story above which is presented by the entirety system of frames of the building to bhuj earthquake excitations, and are provided to compare the results obtained from the analysis of all types of frame using the SAP2000 software. This paper thus concluded as results got utilizing present finite element code for the static and free vibration are validated and the RSA of frames is concentrated by different columns size and is reasoned that by expanding the columns sizes the greatest deformed and inter story drift values are decreasing.

2.2 Sreekanth Gandla Nanabala, Pradeep Kumar Ramancharla, Arunakanthi E (2014), This paper refers in which the analysis of a G+5 story typical structure and G+5 story floating column structure for outside lateral forces using SAP2000. This paper studies the variations of both buildings such as time history values by applying the intensities such as ground motions of the past earthquakes. Such that the study highlights whether the structure with floating columns are reliable or not in seismically active areas and also observe the structure is economical or uneconomical. This paper studies the G+5 storey structure with all columns that is a normal structure and the other structure without edge columns in the ground floor that is a floating column building's behavior when excited to the lateral loads. After the comparison of the buildings it is found that the G+5 floors without corner columns is not safe in seismic zone as the lateral displacement in a floating column building is higher than a standard building, so the FC structure is higher than a standard structure, so the FC structure is unsafe in seismic areas. When the lateral stiffness of both the structures are compared then it is located that the structure with FC will suffer extreme soft storey effect where on the other side the normal structure is free from soft storey effect completely. In the analysis carried out between the buildings the quantity of material steel and concrete are 40% and 42% more in floating column structure than the normal structure. Hence it is concluded that the floating column structure is unsafe and uneconomical compared with the normal column structure.

2.3 Prerna Nautiyal, Saleem Akhtara And Geeta Batham (2014) This paper examined the impact of the FC under quake excitation for various soil properties and a linear dynamic analysis is accomplished for the 2D model of the multi-story structure with and without FC to accomplish the response of the frame for more secure and efficient design of the structure under such excitations.

This paper examined the impact of a FC under quake excitation for various soil properties where for the purpose of analysis two different models are considered, they are G+3 and G+5 moment resisting frames. The result verified are the response spectrum analysis for different soil conditions and the magnification factor which is assessed for base shear and moments for both G+3 and G+5 models including the exterior and interior columns and beams. From the results thus obtained are concluded as, the BS observed for medium strata are high than the hard strata in either the cases as the tallness of the structure expands the variety in the base shear from medium to hard soil condition decreases and further it can be concluded that, as the height of the structure expands the variation of maximum BM gets reduced for various soil conditions. Hence from the results of the response spectrum analysis obtained for both the moment resistance frames shows that the position of floating columns at corners as of modeled in the cases considered are more critical than others in the present study.

2.4 A.P. Mundada and S.G. Sawdatkar (2014) This paper basically manages the investigation of building architectural and frame drawings of structure using FC. In examination a current G+7 structure is chosen for the comparable ESA of load circulation on FC and different impacts because of it are introduced by STAAD pro V8i. Along these lines the principle target of this paper is to locate the different analytical properties of the frame and furthermore comprehend a precise and affordable design of the structure. This investigation is done on a existing G+7 residential structure with and without floating columns where the models of the structure include all the segments that impact mass, quality, solidness and deformability of the structure. Here in this investigation the Equivalent static analysis method where the lateral loads are determined and afterward dispersed along the height of the structure according empirical equation conditions given in the Indian code IS 1893 (part 1)-2002. Various parameters, for example, axial load, moment distribution, significance of line of activity of power and seismic elements are read for the models. The primer examination is done on a structure contrasting three model cases where the principle target of the investigation is to improve the seismic exhibition of the structure with floating columns and to improve a legitimate plan of the structure with floating columns and along these lines the results obtained are discussed as the probability of fail of the building without FC is less then the structure with FC.

2.5 Ibrahim Serkan Misir (2014) In this paper they utilized another sort of infill walls to diminish the soft story creation in strengthened solid casings structure .The new kind of infill is bolted block infill walls because of this secured block infill a structure due this infill walls decrease the soft story creation in a structure .And they did nonlinear static time history analysis for the structure with just upper stories are in dispatched with secured block request creation the vertical abnormality .These bolted blocks are have shear enters the opposite way so as to build the out of plane solidness of the infill and these bolted block infill walls has the exceptionally potential to lessen the soft story creation correlation with standard block infill due bolted block walls shear sliding component. What's more, these new kinds of infill lessen the issue identified with vertical and even inconsistencies of infill, and furthermore diminish the fatalities falling risks and wounds while during seismic tremor impacts.

2.6 Bhensdadia H. (2015 considered pushover analysis with FC and soft story building in different earthquake location. Push-over analysis will reflect the presentation level of structures, for planned limit affirmed till the event of failure, it helps in finding the breakdown or failure load and ductile limit of the surrounded framed structures. For conveying concentrates on the exhibition response levels of the structure, the analysis is done through both linear static and non-linear static frameworks in concurrence with IS:1893-2002 (part-1). ETABS, a finite element method based building database is utilized for analysis and configuration purposes. Results advocates that push over analysis is exact and efficient method of analysis, and furthermore the drift and movement of structure begins increasing from minor earthquake prone areas to major tremor prone areas.

2.7 ISHA ROHILLA et. al. [2015], Discussed the critical situation of FC in vertically unsymmetrical structures for G+5 RC structures and G+7 RC structures for zone 2 and zone 5 on Type - II soil. The parameters used for study are drift, displacement and storey shear using ETAB software. On the bases of ESA and results following conclusions have been made:

1. Floating columns structure having poor performance in zone 5 it should be avoids in tall structures.
2. Displacement and drift value increases in the presence of floating column.
3. Storey shear decrease causes reduction mass of columns in structure when using floating column.
4. To decrease drift and displacement value should be greater size in 2 consecutive storey dimensions of beams and columns for better performance of structure.

2.8 Ms. Waykule S.B, et al (2016) In investigation of execution of FC for tremor examination of multistory structure played out the investigation and evaluation of working with and without FC in particularly tremor slanted zone 5. Four models were made by varying the spot of FC. Straight ESA and THA investigation were performed on all the models and the results were differentiated and each other. From time history investigation, responses of the clear huge number of four models were plotted. In this paper, they gathered that the floating column at divergent placed results into difference in interesting response and working with FC has observed more story deformed in examination with standard structure.

3. AIM, OBJECTIVES AND SCOPE

3.1 Aim: An examination multi-story structures having without and with Floating column at different positioning.

3.2 Objectives of the Study

- To study the seismic behavior and the structural performance of multi storied structure with and without floating columns in zone III using ETABS Software.
- To study flow of forces and variations in column forces with floating columns at varying positions.
- To study safe and reliable position of floating column building under the seismic response.

3.3 Scope of the Study:

This study investigates the seismic effect on multistoried building with different positioning of floating column i.e. corner floating column, middle floating column, centre floating column and without floating column under seismic zone III in medium type soil. The models are analyzed using ETABS software. Parameter considering are Displacement, drift, mode shapes and Base Shear. RSA is carried out in accordance with IS 1893:2016 (part1)

4. METHODOLOGY

4.1 General

- Create the standard RC frame building with and without floating column using software ETABS 2005
- Analyze the structure for vertical (DL, LL) and Lateral load SPEC as primary load cases. Load combination as mentioned in IS codes are considered for designs.
- Analysis includes response spectrum analysis
- Analysis of produced models and study with comparison of the result obtained from analysis
- Compare the analysis results of structure obtained from ETABS 2005 with and without floating column building.

4.2 Preamble

- In this present study E-tabs 2005 (Extended 3D Analysis of Building System) software is used for analyzing the structure.
- It is a high accurate and flexible software, which is specially used for analysis and designed for the program developed especially for the building system.
- Extended three analysis of building system (ETABS) is the software which has a powerful graphical interface coupled with modeling analysis design and detailing of the structure
- A static, dynamic, linear and nonlinear seismic analysis of the structure can be performed and which gives precise outcomes
- At last, the software is simple, snappy and simple to utilize.

4.3 Description of Model

- In this comparative study different types of model are produced to understand the behavior of structure.
- The plan, slab depth, column and beam size, shear wall thickness, live load, wall load, super dead load, seismic load, remains as it is for all the models but height of the building changes i.e at level where so
- Analysis is completed by considering about a fixed support at the base of the structure.

4.4 Building Details

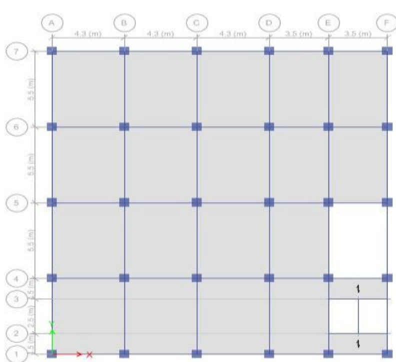
Table 4.1 Material Used & Geometrical Properties

Depth of foundation	1.5m
Floor to floor height	3m
Building dimension	(19.9 X 22)m
Number of gridlines in X	6

Number of gridlines in Y	7
Type of steel	Fe-500
Grade of concrete	M-30
Column size	(600x600)mm
Beam size	(300x600)mm
Thickness of masonry wall	20mm
Slab thickness	150mm
Live load	3kN/m³
Floor finishes	1.5kN/m
Wall load	10.2kN/m
Seismic zone, Z	III
Importance factor, I	1.5
Response reduction factor,	5
Soil type	Medium
Building height	49.5m

Model Geometry and Basic plan: - The details of the model geometry are gives as follows

- No of stories = 15
- No of grid lines in x direction = 6
- No of gridlines in Y direction = 7
- Length in X direction = 19.9 m
- Length in Y direction = 22
- Type of soil type = II (medium soil)



4.1 Fig Model 1 plan view

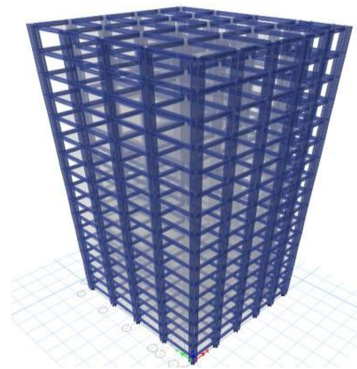


Fig 4.2 Model 1 3D view

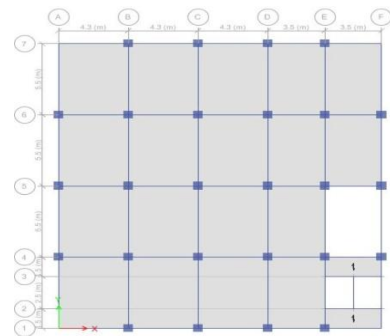


Fig 4.3 Model 2 plan view

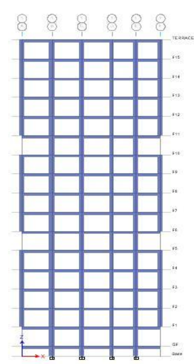


Fig 4.4 Model 2 Elevation view

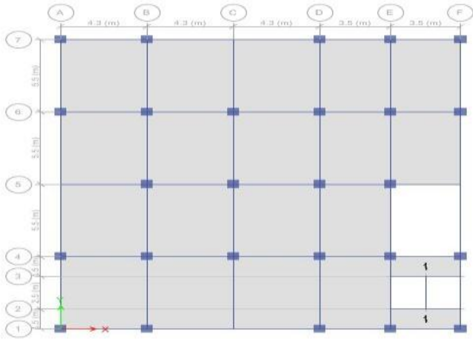


Fig 4.5 Model 3 plan view

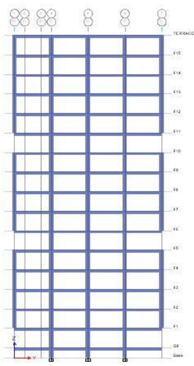


Fig 4.6 Model 3 Elevation view

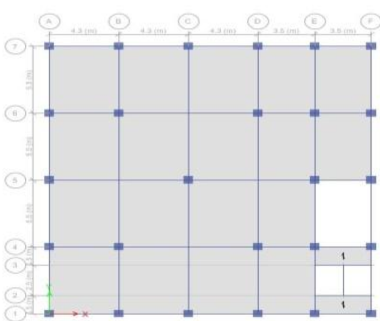


Fig 4.7 Model 4 plan view

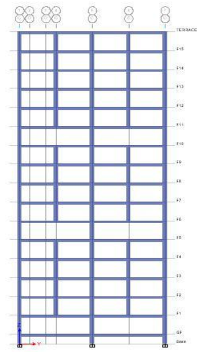


Fig 4.8 Model 4 Elevation view

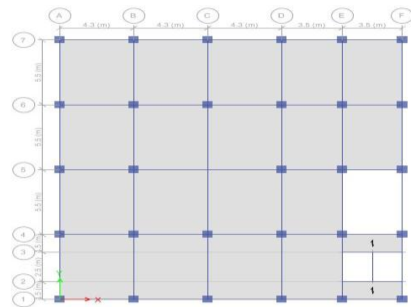


Fig 4.9 Model 5 plan view

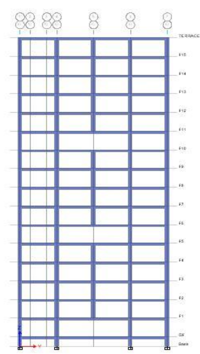


Fig 4.10 Model 5 Elevation view

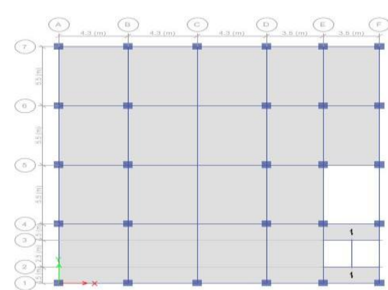


Fig 4.11 Model 6 plan view

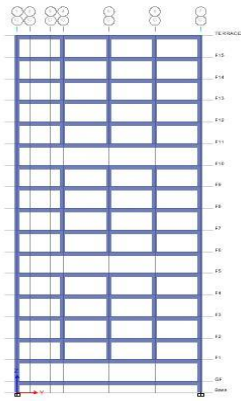


Fig 4.12 Model 6 Elevation view

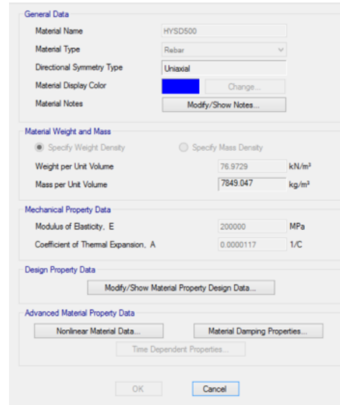


Fig 4.14 Rebar Material Property from ETABS

Defining of Material Properties

Materials at first characterized as per the kind of materials utilized for the designing of structure. In the event that RCC is utilized as a primary material for development, at that point Fck and Fy with its analysis and design property information's as indicated by Indian benchmarks are characterized preceding undertaking.

Concrete	M30 grade
Rebar	HYSD 500

Fig 4.13 Concrete Material Property from ETABS

Defining of Frame and Shell Section Properties

Sectional properties of Frames and shells are defined prior to the assignment to the floor plan with their materials, properties (Dimensional data) and property modifiers. As shown in fig below

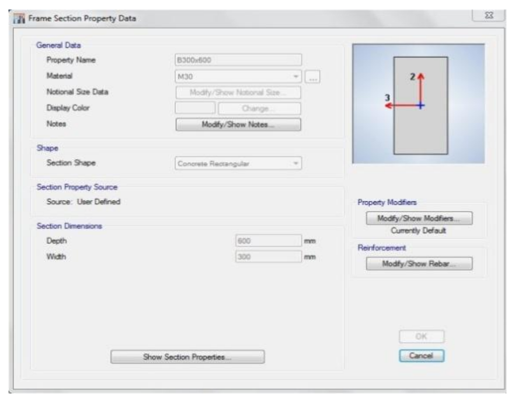


Fig 4.15 Beam Property from ETABS

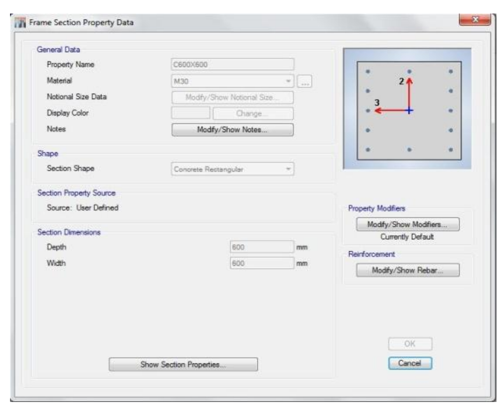


Fig 4.16 Column Property from ETABS

Table 4.2: Brief about models

Modal no	No of story model	Description	Height
1	G+15	It is a standard model with all storey height 3m and no vertical irregularity	49.5 m
2	G+15	Floating column providing four corner of the building at different storey i.e. ground,5th and 10th floor	49.5 m
3	G+15	Floating column providing four side of the building at different storey i.e. ground,5th and 10th floor	49.5 m
4	G+15	Floating column providing four eccentric side of the building at different storey i.e. ground, 5th and 10th floor	49.5 m
5	G+15	One Floating column providing at the centre of the building at different storey i.e. ground, 5th and 10th floor	49.5 m
6	G+15	Three Floating column providing at the centre of the building at different storey i.e. ground, 5th and 10th floor	49.5 m

Details of Loading patterns and loading cases.

Load Patterns

To define static load cases and patterns of all load cases self weight multiplier should be zero other than dead load. Once the input of dead load and live load on a structure is added or provided to software. Now we apply the seismic loads.

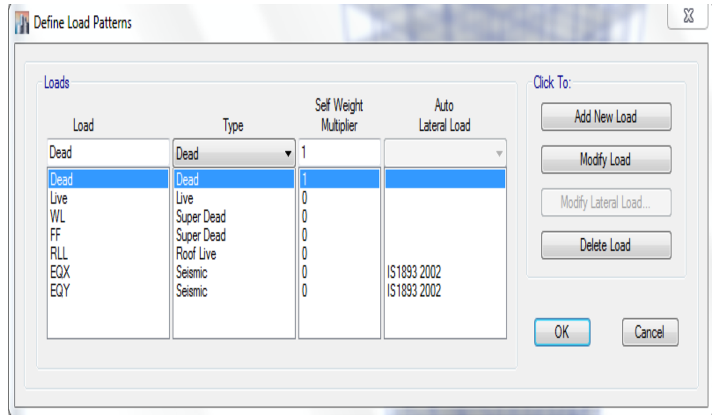


Fig 4.17 Loading Pattern

Calculation of wall loads

Wall load: 200mm brick thick wall whose density is 2000kg/m^3

Wall load = .20 x (3-.45) x 20

= 10.2 kN/m

Live load:

According to IS 875:1987 part 2 live load is expressed as uniformly distributed shell load . According to IS code, floor of different kinds of structures sorted into various types and live loads comparing to them have been indicated in the code IS 875 part 2.

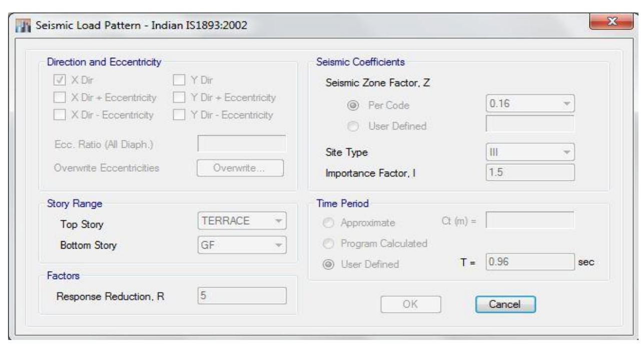


Fig 4.18 Earthquake Load in X Direction

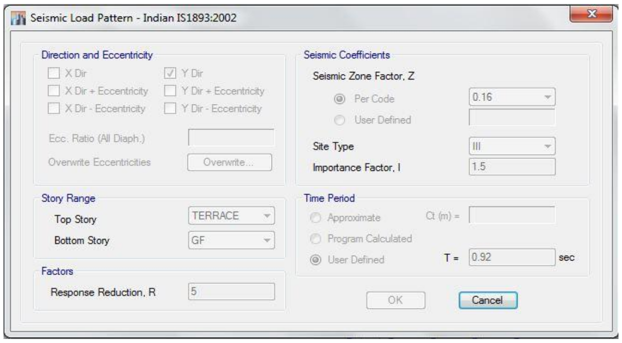


Fig 4.19 Earthquake load in Y Direction

4.6 Mass Source ETAB Model

The significance of mass source in basic building to indicate the rate measure of live load to be taken for the examination of seismic power on the off chance that live burden is not exactly or equivalent to 3 kN/m² at that point utilize 25% mass source, on the off chance that live burden is more than 3 kN/m² Then utilize 50% mass source.

Live Load = 3kN/m² 25%

Live Load >3kN/m² 50%

4.7 Load Cases

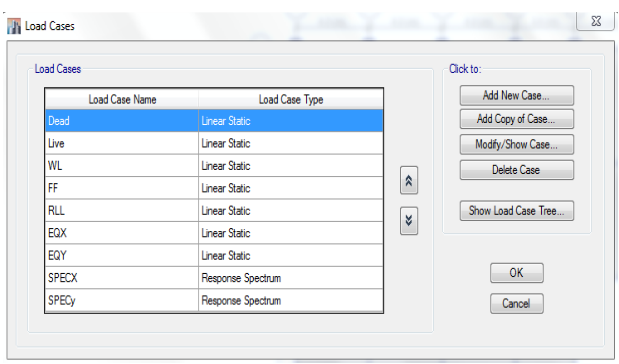


Fig 4.20 Load cases

4.8 Load Combinations

1.5(DL)

1.5(DL+LL)

1.5(DL+EQX)

1.5(DL-EQX)

1.5(DL+EQY)

1.5(DL-EQY)

1.2(DL+LL+EQX)

1.2(DL+LL-EQX)

1.2(DL+LL+EQY)

1.2(DL+LL-EQY)

0.9 DL+1.5EQX

0.9 DL-1.5EQX

0.9 DL+1.5EQY

0.9 DL-1.5EQY

1.5 DL+1.5SPECX

1.5 DL+1.5SPECY

1.2 DL+1.2LL+1.2SPECX

1.2 DL+1.2LL+1.2SPECY

0.9 DL+1.5SPECX

0.9DL+1.5SPECY

5. RESULTS AND DISCUSSIONS

5.1 Seismic analysis of Multi Storey Building with Different Positioning of Floating Columns.

This chapter presents results of Response spectrum analysis of all the models considered as per the model analysis which was discussed in chapter 1. The result and discussions given are considered in detail with reference to required table and figures.

Story Displacement: - The storey displacement parameter which has been considered in this section to study the behavior of multi-storey building having floating column at various levels. The storey displacement values are obtained for equilateral static analysis (ESA) and

Response spectrum analysis (RSA) in x and y direction is as tabulated below. Plots of the storey displacement versus storey level are made for the six models all are values on a similar diagram. The chart are exhibited in fig 5.1, 5.2, 5.3, and 5.4.The values for displacement for different structural forms are tabulated in table 5.1, 5.2, 5.3 and 5.4.

Table No 5.1 Story Displacements in X Direction by ESA

STOREY DISPLACEMENT (EQX)						
STOREY LEVEL	M 1	M 2	M 3	M 4	M 5	M 6
16th	74.8	86.7	80.3	76.8	75.2	76.2
15th	73.1	84.4	78.4	75	73.5	74.5
14th	70.7	81.4	75.8	72.6	71.1	72
13th	67.6	77.7	72.4	69.5	68	68.9
12th	63.9	73.4	68.4	65.7	64.3	65.2
11th	59.6	68.6	64	61.4	60	60.9
10th	54.9	63	58.7	56.3	55.2	55.9
9th	49.8	57.2	53.3	51.2	50.1	50.8
8th	44.4	51	47.6	45.8	44.7	45.4
7th	38.9	44.6	41.7	40.3	39.2	39.9
6th	33.2	38.2	35.8	34.6	33.5	34.1
5th	27.5	31.5	29.4	28.4	27.7	28.1
4th	21.7	25	23.4	22.6	21.9	22.3
3rd	16	18.5	17.4	16.8	16.2	16.6
2nd	10.4	12.1	11.5	11.2	10.6	11
1st	5.1	6	5.9	5.9	5.3	5.6
GF	0.8	0.9	0.9	0.9	0.8	0.9

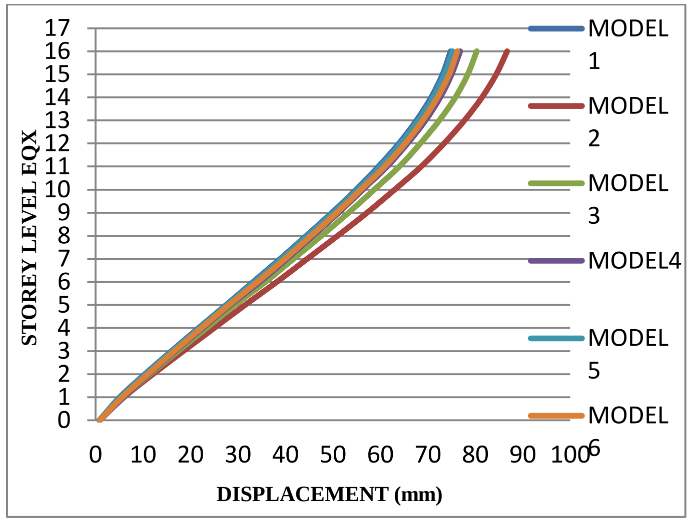


Fig 5.1 Story Displacements in X Direction by ESA

Discussion:

- In static analysis results showed that model 1 displacement of 74.8mm and in floating column buildings model 2, 3, 4, 5, and 6 respectively are 15.9%, 7.35%, 2.67%, 0.53% and 1.87% increasing value in percentage compared to model 1 without floating column building.

- More economical and safe are model 5 and model 6 floating column building.
- All the value were within permissible limit.

Table No 5.2 Story Displacements in X Direction by RSA

STOREY DISPLACEMENT (SPECX)						
STOREY LEVEL	M 1	M 2	M 3	M 4	M 5	M 6
16th	59.2	67.1	62.8	60.4	59.4	60
15th	58	65.5	61.5	59.2	58.3	58.9
14th	56.4	63.5	59.7	57.6	56.6	57.2
13th	54.3	61	57.5	55.5	54.6	55.2
12th	51.8	58.1	54.8	53	52	52.6
11th	48.9	54.9	51.8	50.1	49.1	49.7
10th	45.6	51.2	48.2	46.6	45.8	46.3
9th	42.1	47.1	44.5	43	42.3	42.7

8th	38.2	42.8	40.4	39.2	38.4	38.9
7th	34.1	38.2	36.2	35.1	34.3	34.8
6th	29.7	33.4	31.7	30.7	29.9	30.4
5th	25.1	28.1	26.6	25.8	25.2	25.6
4th	20.3	22.8	21.6	20.9	20.4	20.7
3rd	15.2	17.2	16.3	15.9	15.4	15.7
2nd	10.1	11.4	11	10.8	10.2	10.6
1st	5	5.8	5.7	5.7	5.1	5.5
GF	0.8	0.9	0.9	0.9	0.8	0.9

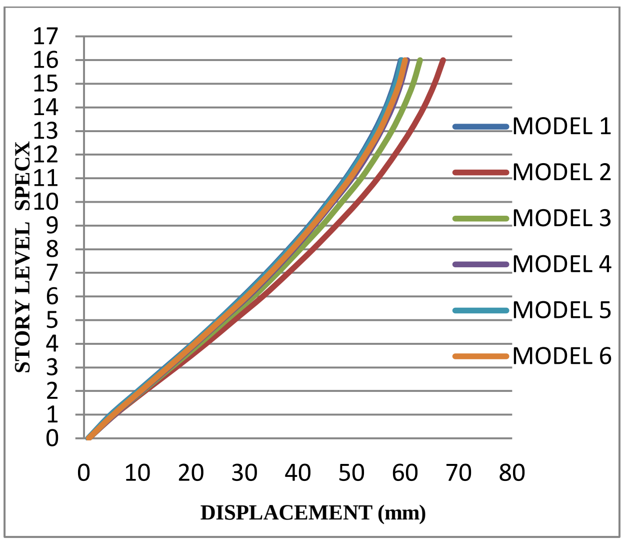


Fig 5.2 Story Displacements in X Direction by RSA

Discussion:

- In Response spectrum analysis, results showed that Model 1 value has 59.2mm and in floating column buildings model 2, 3, 4, 5 and 6 respectively are 13.34%, 6.08%, 2.02%, 0.33% and 1.35% increasing value in percentage compared to model 1 without floating column building.
- Displacement in x direction by Equilateral static analysis getting higher value then Response spectrum analysis it means building is more critical in static loading.
- All the values were within the limits.

Table No 5.3 Story Displacements in Y Direction by ESA

STOREY DISPLACEMENT (SPECX)						
STOREY LEVEL	**M 1**	**M 2**	**M 3**	**M 4**	**M 5**	**M 6**
16th	93.8	102.5	98.2	96.3	94.4	95.4
15th	92.2	100.4	96.3	94.6	92.7	93.8
14th	89.5	97.3	93.6	92	90.1	91.1
13th	86	93.3	89.8	88.5	86.5	87.6
12th	81.5	88.4	85.2	84	82.1	83.1
11th	76.3	82.9	79.9	78.8	76.9	77.9
10th	70.5	76.4	73.5	72.5	70.9	71.8
9th	64.2	69.5	67	66.1	64.6	65.4
8th	57.5	62.2	60.1	59.4	57.9	58.7
7th	50.4	54.6	52.9	52.3	50.8	51.7
6th	43.2	46.9	45.5	45	43.6	44.4
5th	35.8	38.7	37.4	37	36	36.6
4th	28.3	30.7	29.8	29.5	28.6	29.1
3rd	20.8	22.8	22.1	22	21.1	21.6
2nd	13.5	14.9	14.6	14.6	13.7	14.2
1st	6.5	7.4	7.4	7.5	6.7	7.1
GF	1	1.1	1.1	1.2	1	1.1

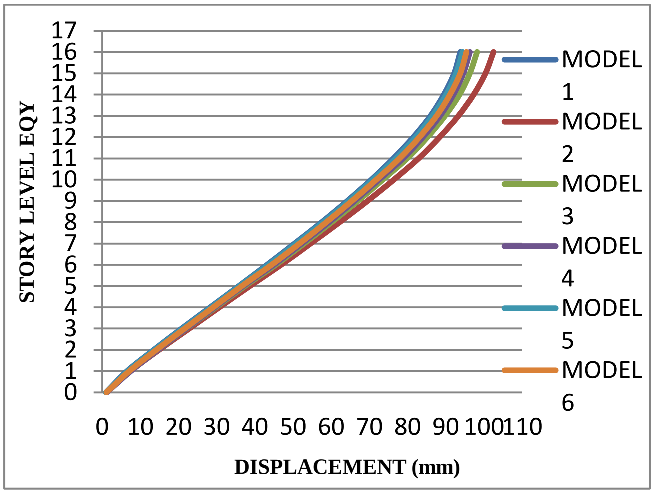


Fig 5.3 Story Displacements in Y Direction by ESA

Discussion:

- In static analysis result showed that model 1 displacement is 93.8mm and in floating column building model 2, 3, 4 , 5, and 6 respectively are 9.27%, 4.69%, 2.66% , 0.63% and 1.7% increasing value in percentage compared to model 1 without floating column building.
- Permissible limit is 99 mm and model 2 value is 102.5 mm exceeding the limit and it can be decrease by increasing the dimension size of beams and columns.

Table No 5.4 Story Displacements in Y Direction by RSA

STOREY DISPLACEMENT (SPECY)						
STOREY LEVEL	**M 1**	**M 2**	**M 3**	**M 4**	**M 5**	**M 6**
16th	75.4	81	78.8	77.7	75.9	76.9
15th	74.3	79.6	77.5	76.6	74.8	75.8
14th	72.6	77.6	75.7	74.9	73.1	74.1
13th	70.2	74.9	73.2	72.5	70.7	71.7
12th	67.2	71.7	70.1	69.5	67.7	68.7
11th	63.7	68	66.5	66	64.2	65.1
10th	59.7	63.6	62.1	61.6	60.1	60.9
9th	55.2	58.8	57.6	57.1	55.6	56.4
8th	50.4	53.6	52.5	52.2	50.7	51.5
7th	45.1	48	47.1	46.9	45.4	46.3
6th	39.4	42.1	41.4	41.2	39.8	40.5
5th	33.3	35.4	34.8	34.6	33.6	34.2
4th	26.9	28.7	28.3	28.2	27.2	27.7
3rd	20.2	21.7	21.4	21.4	20.4	21
2nd	13.3	14.4	14.4	14.5	13.5	14
1st	6.5	7.4	7.4	7.5	6.7	7.1
GF	1	1.1	1.2	1.2	1	1.1

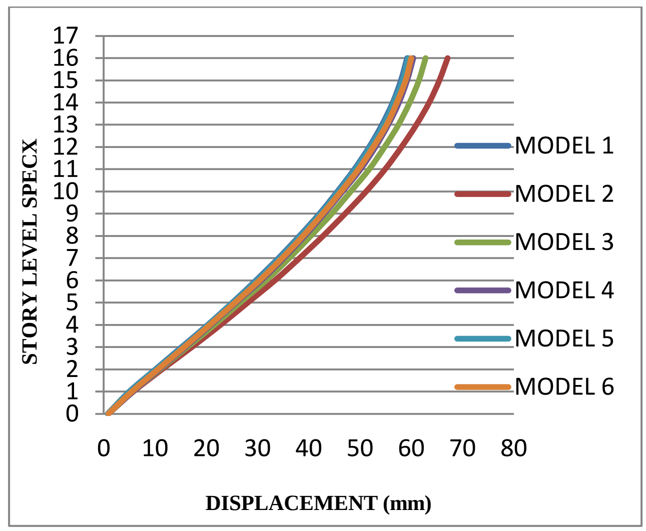


Fig 5.4 Story Displacements in Y Direction by RSA

Discussion:

- In Response spectrum analysis value shows that model 1 displacement is 75.4mm and floating column building model 2, 3, 4, 5, and 6 respectively are 7.4%, 4.5%, 3.05%, 0.66%, and 1.98% increasing the value in percentage compared to model 1 without floating column building.
- Reliable and safe model 5 and model 6 compared to other remaining floating column buildings.
- All the values were within permissible limit.
- Displacement in y direction by Equilateral static analysis getting higher value then Response spectrum analysis and building is more critical in static loading.

STOREY DRIFT: - The storey drift parameter which has been considered in this section to study the behavior of multi-storey building having floating column at various levels. The storey drift values obtained for both Equilateral Static analysis (ESA) and Response spectrum analysis (RSA) in x and y directions are as tabulate below. Plots of the storey drift versus storey are made for the six models all are values on a similar chart. The charts are introduced in fig 5.5, 5.6, 5.7 and 5.8. The values for drift for different structural forms are tabulated in table's shows below.

Table No 5.5 Story Drift in X Direction by ESA

STOREY DRIFT (EQX)						
STOREY LEVEL	**M 1**	**M 2**	**M 3**	**M 4**	**M 5**	**M 6**
16th	0.00057	0.00077	0.00065	0.00058	0.00057	0.00058
15th	0.00080	0.00099	0.00088	0.00080	0.00080	0.00080
14th	0.00103	0.00122	0.00111	0.00104	0.00103	0.00104
13th	0.00124	0.00144	0.00133	0.00125	0.00124	0.00125
12th	0.00142	0.00161	0.00151	0.00144	0.00143	0.00144
11th	0.00157	0.00185	0.00176	0.00172	0.00160	0.00168
10th	0.00169	0.00195	0.00180	0.00171	0.00169	0.00170
9th	0.00178	0.00205	0.00189	0.00178	0.00178	0.00178
8th	0.00184	0.00213	0.00195	0.00185	0.00184	0.00185
7th	0.00189	0.00217	0.00200	0.00191	0.00189	0.00190
6th	0.00191	0.00224	0.00213	0.00210	0.00195	0.00204
5th	0.00191	0.00216	0.00201	0.00194	0.00192	0.00193
4th	0.00190	0.00216	0.00200	0.00190	0.00190	0.00190
3rd	0.00186	0.00213	0.00197	0.00187	0.00186	0.00187
2nd	0.00177	0.00205	0.00189	0.00181	0.00178	0.00180
1st	0.00144	0.00169	0.00164	0.00164	0.00148	0.00157
GF	0.00051	0.00059	0.0006	0.00061	0.00053	0.00058

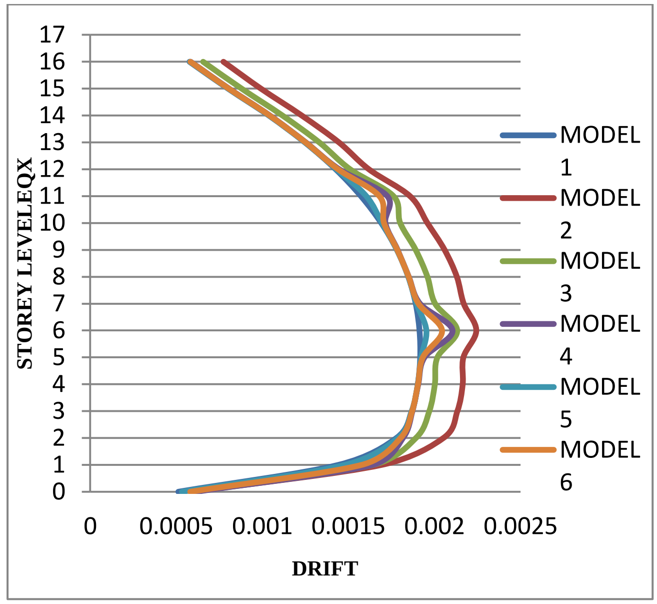


Fig 5.5 Story Drift in X Direction by ESA

Discussion:

- In static analysis it was observed from the table the storey drift values for model 1 without floating column building corresponding to 5th story was found 0.00191 and floating column building at 6th storey model 2, 3, 4, 5, and 6 respectively are 17.27%, 11.51%, 9.94%, 2.09%, and 6.80% increasing in percentage compared to model 1.
- Model 5 getting least value then remaining other models of floating column building.
- All models were within permissible limit.

Table No 5.6 Story Drift in X Direction by RSA

STOREY DRIFT (SPECX)						
STOREY LEVEL	**M 1**	**M 2**	**M 3**	**M 4**	**M 5**	**M 6**
16th	0.00044	0.000595	0.00050	0.00044	0.00044	0.00044
15th	0.00062	0.000781	0.00069	0.00063	0.00062	0.00062
14th	0.00082	0.000983	0.00089	0.00083	0.00082	0.00083
13th	0.001	0.001157	0.00106	0.00100	0.001	0.00100
12th	0.00113	0.001286	0.00120	0.00115	0.00114	0.00115

11th	0.00124	0.001465	0.00139	0.00135	0.00126	0.00132
10th	0.00133	0.001529	0.00141	0.00135	0.00134	0.00134
9th	0.00141	0.001605	0.00148	0.00140	0.00141	0.00140
8th	0.00147	0.001666	0.00154	0.00147	0.00147	0.00147
7th	0.00153	0.001712	0.00160	0.00154	0.00153	0.00154
6th	0.00159	0.001821	0.00175	0.00171	0.00161	0.00167
5th	0.00164	0.001823	0.00171	0.00165	0.00164	0.00165
4th	0.00169	0.001886	0.00176	0.00168	0.00169	0.00168
3rd	0.00172	0.001925	0.00179	0.00171	0.00172	0.00172
2nd	0.0017	0.001901	0.00178	0.00172	0.00170	0.00171
1st	0.00141	0.001627	0.00159	0.00158	0.00144	0.00153
GF	0.00050	0.000587	0.00059	0.00060	0.00052	0.00057

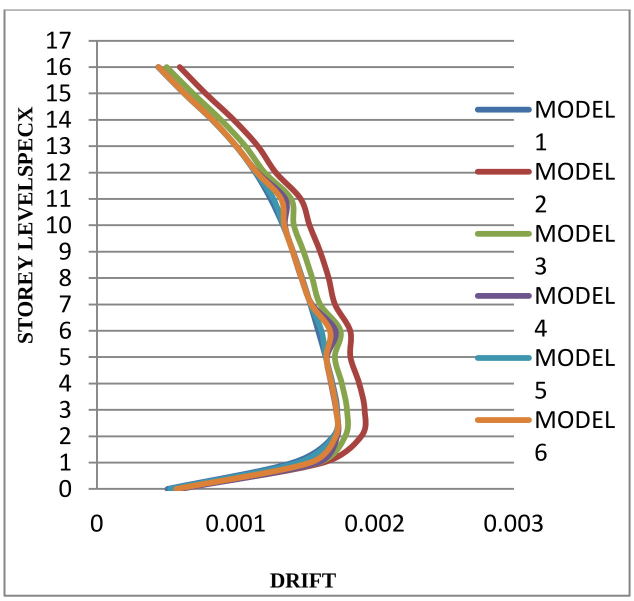


Fig 5.6 Story Drift in X Direction by RSA

Discussion:

- In response spectrum analysis it was observed from the table storey drift value for model 1 without floating column building corresponding to 3rd story was found 0.00172m and floating column building at 3rd storey model 2 and 3 respectively 11.62% and 4.06% increasing in percentage compared to model 1 building.
- Model 4, 5, and 6 getting same value as compared to model 1 this are the more safe compared to model 2 and 3.
- All the values were within permissible limit.
- Drift in x direction by Equilateral static analysis getting higher value then Response spectrum analysis and building is more critical in static loading.

Table No 5.7 Storey Drift in Y Direction by ESA

STOREY DRIFT (EQY)						
STOREY LEVEL	**M 1**	**M 2**	**M 3**	**M 4**	**M 5**	**M 6**
16th	0.00057	0.00070	0.00063	0.00058	0.00057	0.00057
15th	0.00086	0.00101	0.00092	0.00087	0.00087	0.00087
14th	0.00119	0.00133	0.00124	0.00119	0.00119	0.00119
13th	0.00148	0.00163	0.00154	0.00148	0.00148	0.00148
12th	0.00173	0.00186	0.00178	0.00174	0.00173	0.00174
11th	0.00193	0.00219	0.00211	0.00210	0.00197	0.00204
10th	0.00210	0.00229	0.00218	0.00212	0.00211	0.00212
9th	0.00224	0.00243	0.00231	0.00224	0.00224	0.00224
8th	0.00234	0.00254	0.00241	0.00234	0.00234	0.00234
7th	0.00241	0.00259	0.00248	0.00243	0.00242	0.00243
6th	0.00246	0.00275	0.00267	0.00268	0.00251	0.00260
5th	0.00248	0.00264	0.00254	0.00251	0.00249	0.00250
4th	0.00249	0.00266	0.00255	0.00289	0.00249	0.00248
3rd	0.00245	0.00263	0.00252	0.00246	0.00245	0.00245
2nd	0.00233	0.00250	0.00241	0.00237	0.00234	0.00236
1st	0.00183	0.00209	0.00207	0.00211	0.00189	0.00201
GF	0.00064	0.00074	0.00076	0.00078	0.00067	0.00073

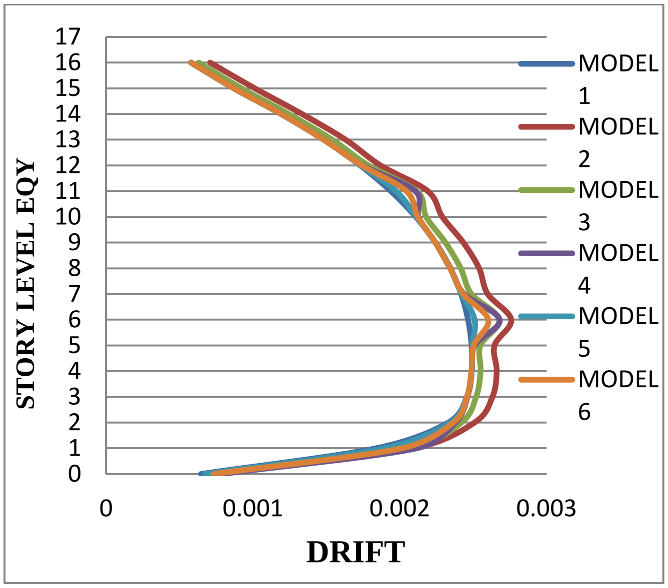


Fig 5.7 Story Drift in Y Direction by ESA

Discussion:

- In static analysis it was observed from the table storey drift value for model 1 without floating column building corresponding to 4th story was found 0.00249 and floating column building at storey model 2, 3, 4, 5, and 6 respectively are 10.44%, 7.22%, 7.63% 0.80% and 4.41% increasing in percentages compared to model 1 building.
- Model 5 is better performing then remaining models.
- All the models were within permissible limit.

Table No 5.8 Story Drift in Y Direction by RSA

STOREY DRIFT (SPECY)						
STOREY LEVEL	**M 1**	**M 2**	**M 3**	**M 4**	**M 5**	**M 6**
16th	0.00 044	0.00 054	0.00 048	0.00 044	0.00 044	0.00 044
15th	0.00 070	0.00 08	0.00 074	0.00 070	0.00 070	0.00 070
14th	0.00 098	0.00 107	0.00 102	0.00 098	0.00 098	0.00 098
13th	0.00 122	0.00 132	0.00 127	0.00 123	0.00 122	0.00 122
12th	0.00 142	0.00 151	0.00 147	0.00 144	0.00 143	0.00 143
11th	0.00 158	0.00 176	0.00 172	0.00 172	0.00 161	0.00 167
10th	0.00 170	0.00 181	0.00 175	0.00 172	0.00 170	0.00 171
9th	0.00 180	0.00 192	0.00 185	0.00 181	0.00 180	0.00 181
8th	0.00 190	0.00 202	0.00 195	0.00 190	0.00 190	0.00 190
7th	0.00 199	0.00 210	0.00 204	0.00 202	0.00 200	0.00 201
6th	0.00 209	0.00 230	0.00 226	0.00 227	0.00 213	0.00 221
5th	0.00 218	0.00 228	0.00 222	0.00 220	0.00 218	0.00 219
4th	0.00 226	0.00 237	0.00 230	0.00 226	0.00 226	0.00 226
3rd	0.00 231	0.00 243	0.00 236	0.00 232	0.00 231	0.00 232
2nd	0.00 227	0.00 239	0.00 234	0.00 232	0.00 228	0.00 230
1st	0.00 183	0.00 207	0.00 207	0.00 211	0.00 189	0.00 201
GF	0.00 065	0.00 075	0.00 077	0.00 079	0.00 068	0.00 074

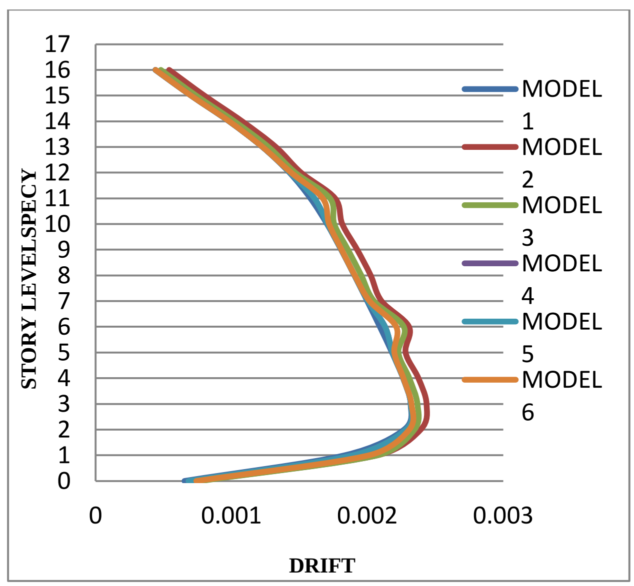


Fig 5.8 Story Drift in Y Direction by RSA

Discussion:

- In response spectrum analysis it was observed from the tables storey drift values for without floating column building corresponding to 3rd story was found 0.00231 and floating column building at storey model 2, 3, 4, and 6 respectively are 5.19%, 2.16% 0.43% and 0.43% increasing in percentage compared to model 1 building.

- Model 5 getting same value as compared to model 1 and also having a good perform model 4 and model 6 building.
- All the models were within permissible limit.
- Drift in y direction by Equilateral static analysis getting higher value then Response spectrum analysis and building is more critical in static loading.

MODE SHAPES: - The Mode Shapes parameter which has been considered to study the behavior of multi-storey building is having with and without floating column at various levels. The Mode Shapes values obtained in x direction are as tabulated below. Plots of the Storey level versus mode shape made for all six models .The values for Mode shapes for different structural forms are shown in fig

Table No 5.9 Mode Shape Model 1 in X Direction

MODEL 1 IN X DIRECTION AT TIME 0.119 SEC	
STOREY LEVEL	**DISPLACEMENT IN (mm)**
TERRACE	0.01522
15th	-0.00019
14th	-0.01261
13th	-0.00735
12th	0.008079
11th	0.01245
10th	-0.00024
9th	-0.01258
8th	-0.00763
7th	0.007813
6th	0.01255
5th	8.5E-05
4th	-0.01248
3rd	-0.00789
2nd	0.007586
1st	0.01296
GF	0.002788

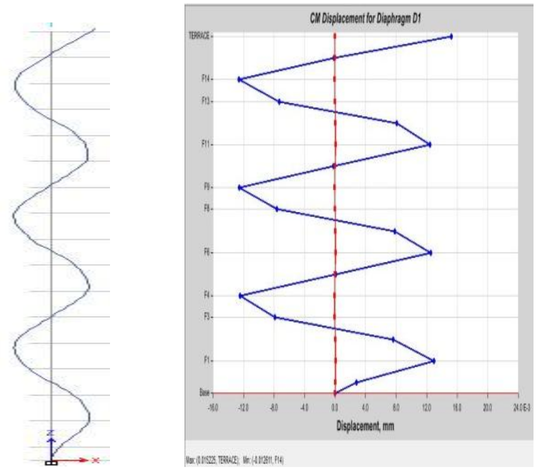


Fig 5.9 Mode Shape model 1 in X Direction

Table No 5.10 Mode Shape Model 2 in X Direction

MODE SHAPE IN X DIRECTION AT TIME 0.121 SEC	
STOREY LEVEL	**DISPLACEMENT IN (mm)**
TERRACE	-0.01553
15th	-4.23E-05
14th	0.01275
13th	0.007998
12th	-0.00765
11th	-0.01313
10th	-0.0003
9th	0.01224
8th	0.008143
7th	-0.00699
6th	-0.01282
5th	-0.00068
4th	0.01176
3rd	0.008226
2nd	-0.00648
1st	-0.01273
GF	-0.00283

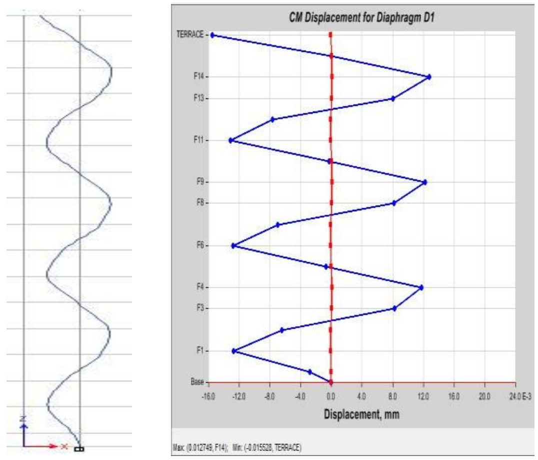


Fig 5.10 Mode Shape model 2 in X Direction

Table No 5.11 Mode Shape Model 3 in X Direction

MODE SHAPE IN X DIRECTION AT TIME 0.121 SEC	
STOREY LEVEL	**DISPLACEMENT IN (mm)**
TERRACE	0.0157
15th	0.000124
14th	-0.01285
13th	-0.00819
12th	0.007555
11th	0.01339
10th	0.000186
9th	-0.01224
8th	-0.00818
7th	0.006897
6th	0.01294
5th	0.000557
4th	-0.01162
3rd	-0.00814
2nd	0.006328
1st	0.01272
GF	0.00282

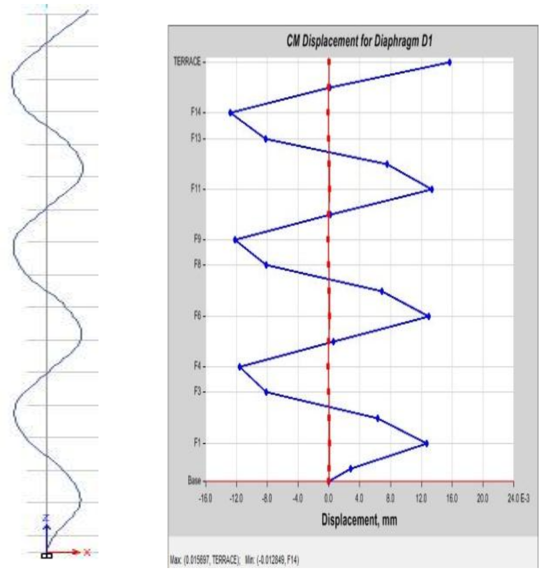


Fig 5.11 Mode Shape model 3 in X Direction

Table No 5.12 Mode Shape Model 4 in X Direction

MODE SHAPE IN X DIRECTION AT TIME 0.122 SEC	
STOREY LEVEL	**DISPLACEMENT IN (mm)**
TERRACE	-0.01595
15th	-0.00022
14th	0.01302
13th	0.008465
12th	-0.00748
11th	-0.01375
10th	-8.72E-05
9th	0.0122
8th	0.008257
7th	-0.00676
6th	-0.01304
5th	-0.00044
4th	0.01137
3rd	0.008053
2nd	-0.00609
1st	-0.01259
GF	-0.00282

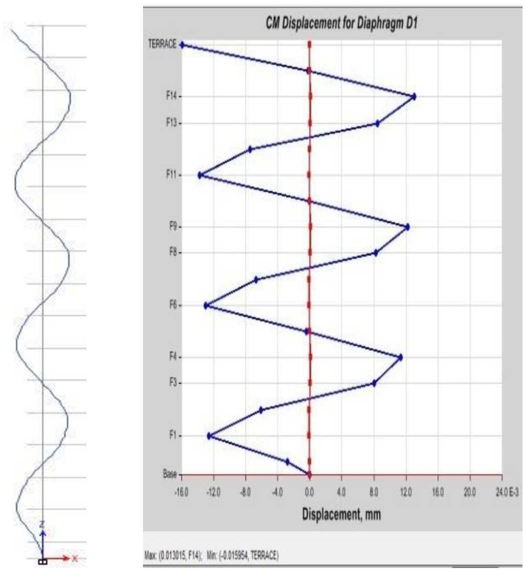


Fig 5.12 Mode Shape model 4 in X Direction

Table No 5.13 Mode Shape Model 5 in X Direction

MODE SHAPE IN X DIRECTION AT TIME 0.120 SEC	
STOREY LEVEL	**DISPLACEMENT IN (mm)**
TERRACE	0.01537
15th	-9.36E-05
14th	-0.01269
13th	-0.007588
12th	0.007902
11th	0.01285
10th	-0.0002573
9th	-0.01247
8th	-0.00778
7th	0.007536
6th	0.01279
5th	8.08E-05
4th	-0.01222
3rd	-0.00795
2nd	0.00721
1st	0.01301
GF	0.002819

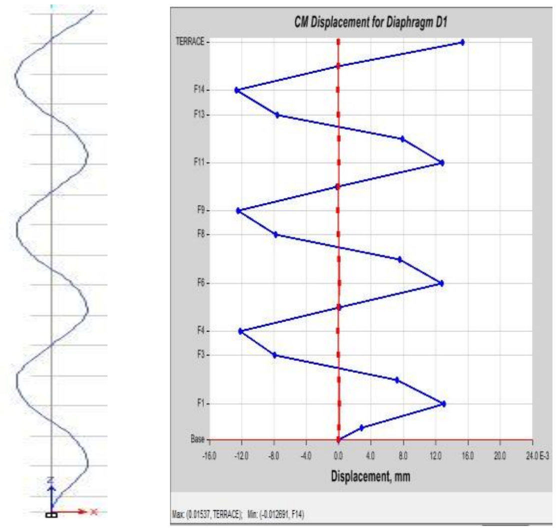


Fig 5.13 Mode Shape model 5 in X Direction

Table No 5.14 Mode Shape Model 6 in X Direction

MODE SHAPE IN X DIRECTION AT TIME 0.121 SEC	
STOREY LEVEL	**DISPLACEMENT IN (mm)**
TERRACE	-0.01595
15th	-0.00022
14th	0.01302
13th	0.008465
12th	-0.00748
11th	-0.01375
10th	-8.72E-05
9th	0.0122
8th	0.008257
7th	-0.00676
6th	-0.01304
5th	-0.00044
4th	0.01137
3rd	0.008053
2nd	-0.00609
1st	-0.01259
GF	-0.00282

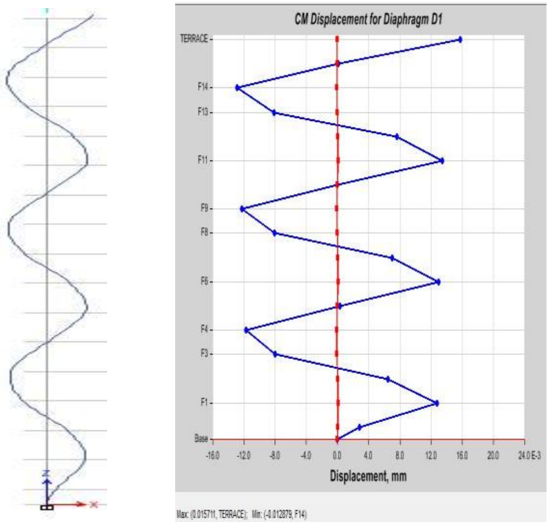


Fig 5.14 Mode Shape model 6 in X Direction

Discussion:

All models are symmetrical or in regular shape. According to comparison of all models mode shapes prefer to move first in principle plane direction x and y direction at the event of earthquake and with the help of mode shapes animation come know there is no unrestraint or disconnected members and there is a slightly higher deformed pattern in model 4 and model 6.

BASE SHEAR: - Base shear is calculated from the highest lateral force that will happen due to earthquake ground action at the base of the structure. Hence weight of the building structure is directly proportional to the base shear values; the regular building structure is having minimum loads compared to the other building structures. Base shear calculation depends on soil conditions at the site and also seismic activities. The base shear values are obtained for the different structural forms in the shown below table 5.29and table 5.30 and graph are shown in fig 5.9 and 5.10

Table 5.15 Base shear values of different building form in EQX direction

EQX	M 1	M 2	M 3	M 4	M 5	M 6
Base shear in kN	451 6.05	450 7.00	450 7.20	4508 .004	4513 .9 85	4511 .209

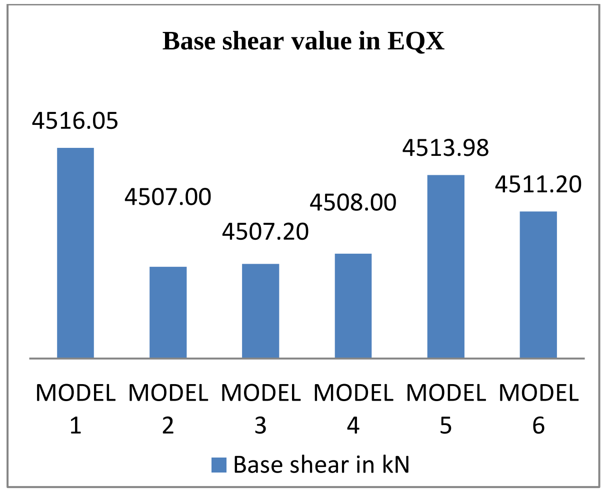


Fig 5.15 Graph of Base shear for the analysis of different building form in EQX direction

Table 5.16 Base shear values of different building form in EQY direction

EQY	M 1	M 2	M 3	M 4	M 5	M 6
Base shear in kN	4712. 99	4702. 00	4703. 00	4704. 01	4710. 96	4707. 04

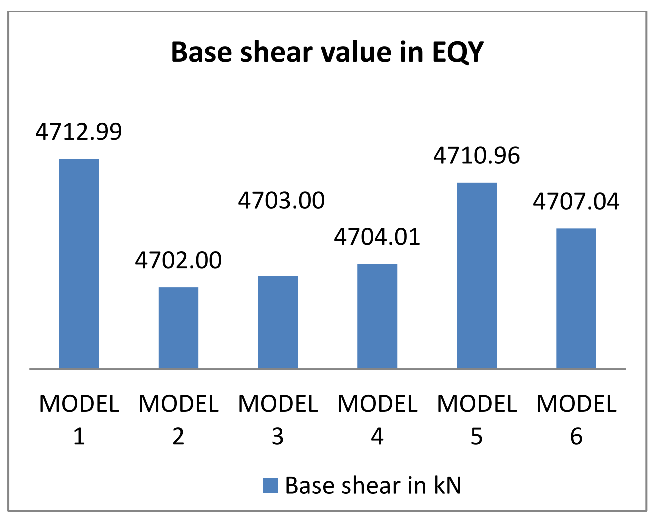


Fig 5.16 Graph of Base shear for the analysis of different building form in EQY direction

Discussion:

- It was observed from the table 5.15 and 5.16 the base shear values for model 1 was found 4516.05 kN and 4712.99 kN and in floating column building model 2, 3 and 4 having a lesser value compared to model 1 building and model 5 and 6 getting a same value as compared to model 1 building
- However comparison of all floating column building not more than 0.2% of base shear value then model 1 without floating column building.

5. CONCLUSIONS

- In analysis displacement values shows with floating column building more critical model 2, 3 and model 3 as compared to model 5 and 6 building.
- It was observed from the tables of storey drift values with floating column building good performance of model 5 and model 6 as compared to model 2, 3 and 4 building.
- Mode shapes shows all models are in symmetrical and good condition.
- Base shear is max in model 1 in which 4516.05 kN and floating column has been provided building model 2 lesser value 4507.00 kN
- Model 2 displacement getting exceeding value then permissible limit in static analysis, it can be decrease the displacement and drift values by increasing dimension of column and beam size.
- Most economical and safe building is model 5 and model 6 with Floating column

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