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Seismic Response of a High Rise Building with and without Floating Column

Shubham Banchhod[1], Prof. Mahroof Ahmed[2]

[1]M. Tech Scholar, Department of Civil Engineering, Sushila Devi Bansal College of Engineering, Indore
[2]Assistant Professor, Department of Civil Engineering, Sushila Devi Bansal College of Engineering, Indore

ABSTRACT

The investigation on this research is to analyze Ground+ 10 storeys building on Staad pro software. In this research we have to analysis regular & irregular structures for different location of Zone V. Total 16 models as being modeled to carry out the structural analysis and research using Staad Pro *software to know the behavior of floating column (with & without) of high rise regular and vertically irregular building subjected to earthquake forces. The parameters compared in this analysis like Storey Drift with & without floating column*

Keywords: *Floating Column, Storey Drift, Staad Pro, High rise building*

I. INTRODUCTION

Earthquakes in different parts of the world showed the hazardous consequences and vulnerability of high rise structures. In inadequately designed irregular structures the effects of earthquake gets much more amplified. The current urban infrastructure comprises a large portion of irregular buildings. High rise building frames with floating columns at one or more positions have a major risk to collapse during strong earthquakes. In recent times, buildings are required with free space with lesser number of columns due to functional and aesthetical requirement. The structural response to seismic forces critically depends on the overall size, shape and geometry and also the way in which the forces are carried to the ground. During the earthquake, the forces developed at different floor levels in a structure must be transferred through the shortest path to the base or footing. Floating column present in a structure makes a discontinuous load transfer path which affects the performance of the structure and make it weak. Building which have floating column does not rest on foundation directly but rest on beams that transfer the load through the beams and adjacent columns.

II. OBJECTIVE OF STUDY

Following are the specific objectives of this research:-

1. To study and analyze the behavior of RCC framed High Rise building with and without floating column under earthquake load.
2. To study the effect of varying the location of floating column on both regular and irregular models of a multistoried building.
3. To identify the best building configuration which suffers minimum damage from the earthquake forces in high seismic region.

III. MODELLING APPROACH & LOAD COMBINATION

I. Modelling:

The building model consists of elements such as beam, column, wall, slab and foundation and the non-structural elements are not modeled. Each column and beam in a structure is modeled as two noded beam. The floor height provided is 3.2 Meter and the properties of elements are defined. The floor slabs are assumed to act as diaphragms. The walls connected rigidly to columns and beams and the wall load is distributed uniformly over the beams which transfer it further to the columns. The model is analyzed for Zone V and situated at medium soil Type II and the response is studied to determine the seismic weight, storey drift, node displacement, base shear, bending moments and shear forces in different directions

Vertical Geometric Irregularities in Models

Type 1 Irregularity

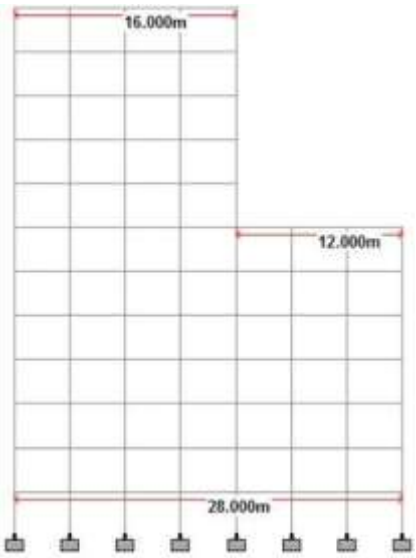

Fig.3.2- Type 1 irregularity

As per Is 1893 (part 1) : 2016

Here,

Width of top storey L1 – 16 m

Width of ground storey L2 – 28 m

A – 12 m , L - 28 m

L2 > 1.5L1 28 > 1.5 x 16

28 > 20

Hence the structure is vertically geometrical irregular structure.

A / L > 0.25

12/28 > 0.25

0.43 > 0.25

Type 2 Irregularity

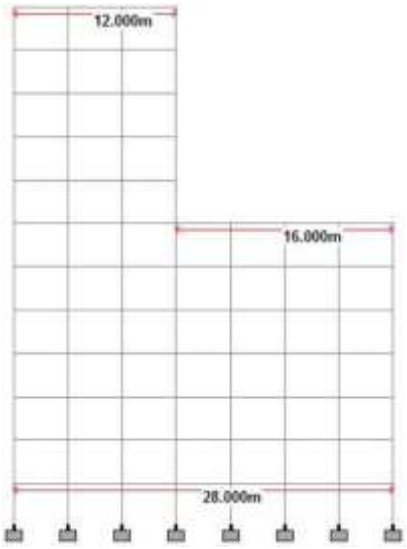

Fig.3.3- Type 2 irregularity

As per Is 1893 (part 1) : 2016

Here,

Width of top storey L1 – 12 m

Width of ground storey L2 – 28 m

A – 16 m, L - 28 m

L2 > 1.5L1

28 > 1.5 x 12

28 > 18

Type 3 Irregularity

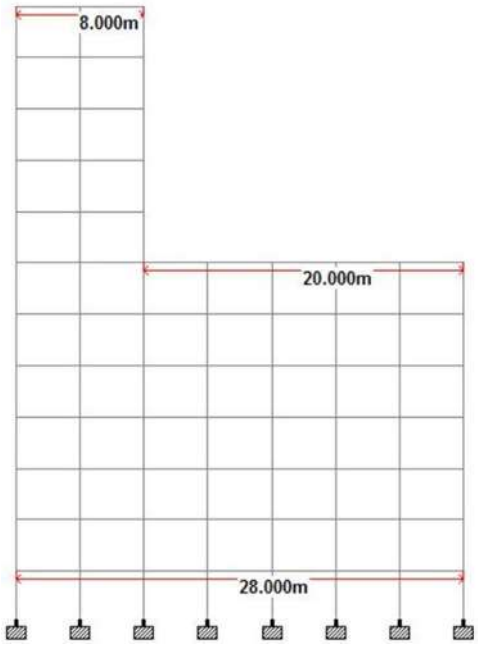

Fig.3.4- Type 3 irregularity

As per Is 1893 (part 1) : 2016

Here,

Width of top storey L1 – 8 m

Width of ground storey L2 – 28 m

A – 20 m , L - 28 m

L2 > 1.5L1

28 > 1.5 x 8

28 > 12

Hence the structure is vertically geometrical irregular structure.

A / L > 0.25

20/28 > 0.25

0.71 > 0.25

IV. ANALYSIS OF STRUCTURE

4.1 General

For the structure being analyzed, loading with applied loads includes dead load, live load and earthquake loads according to IS 875 Part I & II and IS 1893-(Part 1) : 2002. Total 16 models will be studied in the research to show the performance & behavior of RCC framed regular and vertical geometric irregular structure to calculate the various seismic responses like base shear, node displacement, storey drift, shear forces and bending moment.

Various input parameters have been used to evaluate the effect of irregularity and floating column in the structures. Detailed information of input parameters has been shown in table:

I) Material Data		
1	Grade of concrete	M25
2	Grade of Steel	FE 415
3	Unit weight of RCC	25 kn/m3
4	Unit weight of Brick	19.2 kn/m3 = 20 kn/m3
II) Structural Data		
1	Type of structure	SMRF
2	Support	Fixed
3	Type of soil	Medium soil Type II
4	Size of beam	400mm X 400mm
5	Size of column	
	Upto 6^{th} Floor	400mm X 900mm
	Above 6^{th} Floor	400mm X 500mm
6	Depth of slab	125mm
7	Thickness of wall	200 mm
III) Architectural Data		
1	Number of stories	G+10
2	Floor height	3.2 m
3	Height of structure	35.2 m
4	Dimension of plan	28m X 25m
5	Size of Bay	4M in X direction & 5M in Z direction
6	Number of bay	7 in X direction & 5 in Z direction
IV) Seismic Data		
1	Seismic Zone	V
2	Response reduction factor	5
3	Importance factor	1
4	Damping ratio	5%
5	Zone Factor	0.36 (Zone V)
V) Loads		
1	Live load	3 kn/m2
2	Floor finish	1 kn/m2
3	Wall load on storey	11.2 kn/m2
4	Parapet Wall load	4 kn/m2

V. RESULTS & DISCUSSIONS

5.1 General:

The position of floating column has been varied around the periphery in three different cases and also three different types of irregular structure has been analysed. Results have been compared in tabular way for each model and presented by plotting graphs which are as given.

Result of Storey Drift in X Direction

Storey Drift In X - Direction													
S.No	**Model/Story Number**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
	Storey Height	**0 M**	**3.2 M**	**6.4 M**	**9.6 M**	**12.8 M**	**16 M**	**19.2 M**	**22.4 M**	**25.6 M**	**28.8 M**	**32 M**	**35.2 M**
	Story Drift values in -	**MM**	**MM**	**MM**	**MM**	**MM**	**MM**	**MM**	**MM**	**MM**	**MM**	**MM**	**MM**
Case 1	1	6.5	12.32	13.35	13.35	13.01	12.4	11.55	12.30	10.46	8.13	5.31	2.40
	2	18.63	18.29	19.12	19.04	18.64	17.98	17.12	17.86	16.01	13.67	10.84	8.03
	3	9.76	12.57	13.32	13.29	12.94	12.33	11.49	12.23	10.40	8.09	5.28	2.39
	4	11.67	18.66	20.00	19.99	19.47	18.55	17.29	18.40	15.65	12.17	7.95	3.59
Case 2	5	5.55	10.50	11.41	11.35	10.96	10.26	9.38	13.89	12.99	10.30	6.82	3.22
	6	16.35	17.95	18.25	18.51	18.03	16.89	16.06	24.27	25.64	23.10	19.64	16.19
	7	8.35	10.76	11.43	11.37	10.93	10.30	9.38	15.34	15.27	12.13	9.16	5.65
	8	6.64	10.64	11.39	11.31	10.91	10.17	9.21	16.90	16.92	14.39	10.96	7.34
Case 3	9	5.26	9.95	10.74	10.65	10.21	9.41	8.52	15.18	14.59	11.75	7.89	3.90
	10	15.56	17.47	18.12	17.96	17.00	16.64	15.40	30.01	31.69	29.13	25.32	21.47
	11	7.89	10.16	10.76	10.66	10.22	9.47	8.56	17.62	17.72	14.91	10.39	7.16
	12	6.28	10.04	10.72	10.62	10.15	9.37	8.35	19.13	19.71	17.02	13.22	9.21
Case 4	13	4.94	9.36	10.09	9.96	9.43	8.57	7.57	17.07	17.39	14.23	9.79	5.20
	14	15.01	17.38	17.97	17.77	17.18	16.32	15.58	38.62	42.21	41.17	36.92	32.40
	15	7.41	9.55	10.08	9.94	9.42	8.53	7.58	20.70	22.1	19.16	14.79	10.23
	16	5.92	9.43	10.06	9.90	9.37	8.49	7.43	21.26	22.56	19.60	15.21	10.64

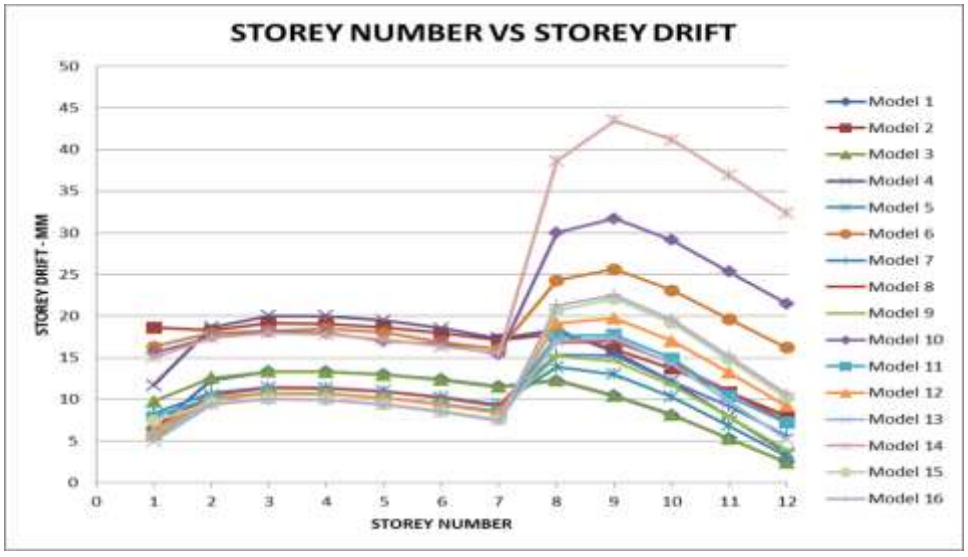

Fig. - Graph for storey drift in X direction

From the above graph it is concluded that the value of storey drift increases from 7th model to 9th model after that value of storey drift decreases.

Result of Storey Drift in Z Direction

Storey Drift In Z - Direction

S.No	Model/Storey Number	1	2	3	4	5	6	7	8	9	10	11	12
	Storey Height	**0 M**	**3.2 M**	**6.4 M**	**9.6 M**	**12.8 M**	**16 M**	**19.2 M**	**22.4 M**	**25.6 M**	**28.8 M**	**32 M**	**35.2 M**
	Story Drift values in-	**MM**	**MM**	**MM**	**MM**	**MM**	**MM**	**MM**	**MM**	**MM**	**MM**	**MM**	**MM**
Case 1	1	3.46	8.44	10.75	11.71	11.91	11.70	11.26	12.36	10.37	8.02	5.27	2.60
	2	9.29	15.95	18.18	19.09	19.25	19.01	18.57	19.69	17.73	15.37	12.64	10.07
	3	4.46	9.35	11.16	11.87	11.97	11.69	11.24	12.31	10.32	7.98	5.25	2.59
	4	3.87	8.87	10.95	11.78	11.94	11.69	11.25	12.33	10.34	8.00	5.26	2.60
Case 2	5	2.94	7.15	9.08	9.80	9.85	9.51	9.01	27.39	11.94	9.29	6.10	2.98
	6	7.96	13.69	15.58	16.27	16.30	15.95	15.46	38.71	18.96	16.31	13.14	10.13
	7	3.79	7.92	9.42	9.93	9.88	9.50	8.98	27.53	11.88	9.24	6.07	2.97
	8	3.30	7.53	9.24	9.86	9.86	9.50	8.99	27.37	11.91	9.26	6.08	2.97
Case 3	9	2.77	6.72	8.51	9.14	9.12	8.71	8.16	34.82	12.76	9.94	6.54	3.20
	10	7.51	12.93	14.67	15.29	15.25	14.84	14.31	49.51	19.96	17.18	13.80	10.58
	11	3.57	7.44	8.82	9.26	9.15	8.70	8.14	35.03	12.68	9.88	6.50	3.19
	12	3.10	7.07	8.66	9.19	9.13	8.71	8.15	34.77	12.72	9.91	6.52	3.19
Case 4	13	2.60	6.29	7.92	8.45	8.34	7.86	7.23	41.56	13.639	10.72	7.07	3.48
	14	7.04	12.14	13.74	14.26	14.14	13.65	13.05	59.46	21.13	18.21	14.60	11.12
	15	3.34	6.95	8.21	8.56	8.37	7.84	7.21	41.80	13.60	10.65	7.03	3.46
	16	2.90	6.60	8.06	8.50	8.35	7.85	7.22	41.47	13.65	10.68	7.05	3.47

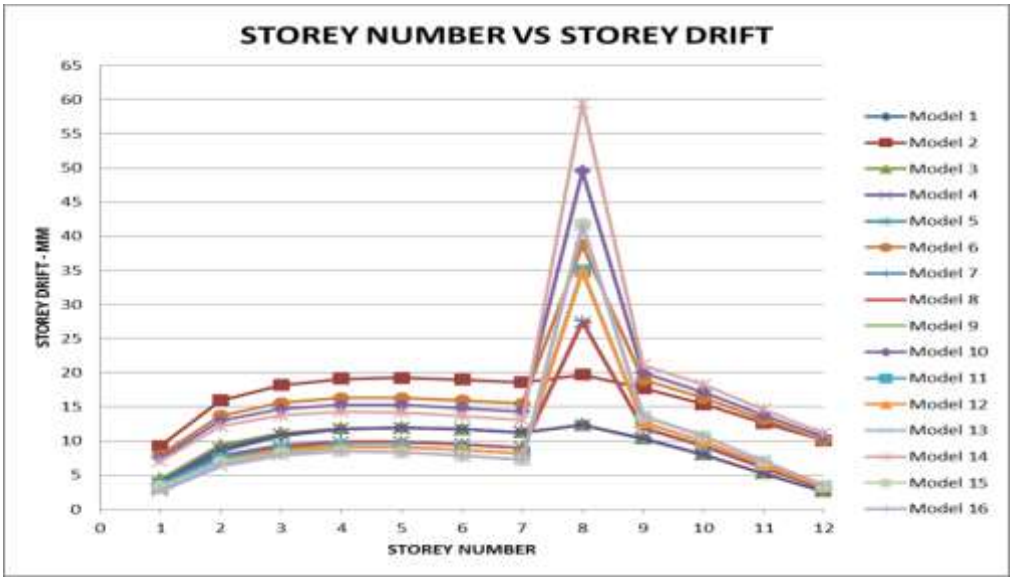

Fig. - Graph for storey drift in Z direction

From the above graph it is concluded that the value of storey drift increases from 7th model to 9th model after that value of storey drift decreases. So we can say that higher the vertical irregularity in the structure value of storey drift increases.

V. CONCLUSION

- After analyze the structure of G+10 it is concluded that the earthquake performance of regular structure is found enhanced than irregular structure for all the cases.
- After analysis the structure the various result were compared so it is concludes that storey drift is greater for regular structure for floating column. Therefore we can't provide floating column in high rise building in an earthquake zone area.

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