The Study of Mass Irregularities With Floating Column

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Abstract- *This paper is concerned with the effects of various vertical irregularities with floating column on the seismic response of a structure. The objective of the project is to carry out Response spectrum analysis (RSA) of vertically irregular RC building frames.*

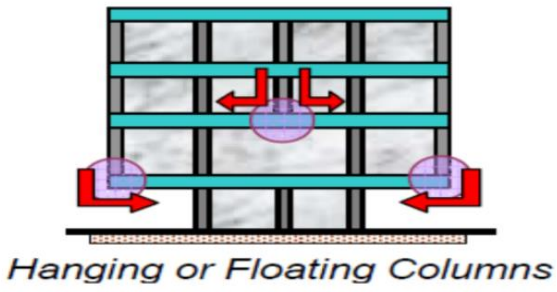
Keywords- Responce Spectrum Analysis, Seismic Static Analysis.

I. INTRODUCTION

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.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.

FLOATING COLUMN CONCEPT

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.



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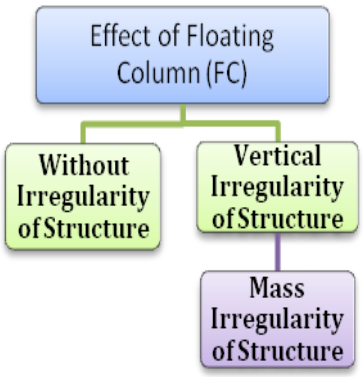
II. METHODOLOGY

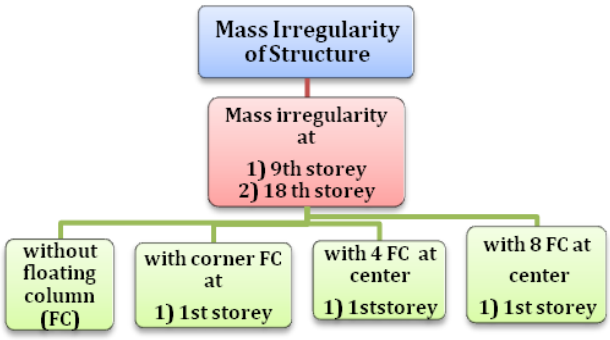
1. Review of existing literatures by different researchers.
2. Selection of types of structures.
3. Modeling of the selected structures.
4. Performing dynamic analysis on selected building models and comparison of the analysis results.

Table -1: The building following specifications are adopted for study.

Specification of Building Modeling			
Live Load	2KN/m^2	**Height of swimming pool**	1.8 m
Density of RCC considered	25KN/m^3	**Weight of swimming tank(Mass irregularity)**	18 KN/m^2
Steel	HYSD 500	**Earthquake Zone**	IV
Thickness of slab	125mm	**Damping Ratio**	5%
Width of beam	230mm	**Type of Soil**	Medium
Dimension of column	400x500mm	**Type of structure**	Special Moment Resisting Frame
Density of brick masonry	20 kN/m^3	**Response reduction Factor**	5
Thickness of outside wall	230mm	**Number of floor**	18 floor
Thickness of inner partition wall	150mm	**Number of modes**	Each floor 3 no of modes
Height of each floor	3m	**Type of diaphragms**	Rigid
Plinth height	1 m	**Type of irregularity**	mass irregularity
Depth of foundation	1.5m	**Location of soft storey**	9thstorey and 18thstorey
Depth of footing	0.6	**Location of swimming tank**	9thstorey and 18thstorey
Weight of wall on external plinth beam (0.23m thick)	16.33 KN/m	**Direction of lateral force**	X direction
Weight of wall on internal plinth beam (0.15m thick)	7.65 KN/m	**Load combination**	All load combination are taken from IS 1893-2016
Weight of wall on internal plinth beam (0.15m thick)	7.65 KN/m	**Type of support at base**	Fixed
Weight of wall on soft story floor external (0.23 thick)	18.63 KN/m	**Modal combination**	SRSS
Weight of wall on soft storey floor internal wall (0.15 thick)	12.15 KN/m		

1.2Modelling





1.3Without Irregularity Case Overall Results

Case no	1	2	3	4
	Without FC(normal regular building)	Corner FC at 1st storey	4 FC at center of 1st storey	8 FC at center of 1st storey
Maximum Modal Displacement mm	0.01590	0.0165	0.015969	0.0163
Base Shear KN	1032.7	997.38	995.49	1010.18
Natural Period sec	0.016	0.014	0.013	0.013
Frequency	63.99	72.217	79.087	78.76

1.4 There are different types of earthquake analysis methods calculation.

Comparison of Displacement,Base shear,Frequancy, Time periods of without floating column.

	Displacement	Base Shear	Frequancy	Time Periods
Sr,no	1	1	1	1
Case no	1	1	1	1
Without FC regular	0.0159	1032	63.99	0.016
Case no	2	2	2	2
Corner F.C	0.0165	997.38	72.21	0.014
% Diff.	3.77	-3.48	12.85	-12.5
Case no	3	3	3	3
4FC regular	0.0159	995	79.08	0.013
% Diff.	0.43	-3.60	23.59	-18.75
Case no	4	4	4	4
8FC regular	0.0163	1010	78.76	0.013
% Diff.	2.51	-2.18	23.08	-18.75
Location of F.C	FC at 1st storey	FC at 1st storey	FC at 1st storey	FC at 1st storey

Observation

From the table percentage difference of without irregularity G+ 18 stories building following points are observed.

DISPLACEMENT –

1. The modal displacement is increased up to **3.77%** when floating column are considered at corner of 1st storey, **0.43%** when 4 floating column are considered at center of 1st storey, to **2.51%** when 8 floating column are considered at center of 1st storey
2. The modal displacement is increased when corner column are considered as compared to 4floating column at center,8 floating column at center and without floating column normal regular building.

Base Shear –

1. The base shear is decreased up to **3.48%** when floating column are considered at corner of 1st storey, The base shear is decreased up to **3.6%**when 4 floating column are considered at center of 1st storey, The base shear is shear is decreased up to **2.18%**when 8 floating column are considered at center of 1st storey.
2. The base shear is decreased when 8 floating column are considered at center as compared to corner floating column, 4 floating column at center and without floating column normal regular building

Frequency –

1. The frequency is increased up to **12.85%** when floating column are considered at corner of 1st storey, The frequency is increased up to **23.59%**wh The frequency is shear is increased up to 23.08% when 8 floating column are considered at center of 1st storey en 4 floating column are considered at center of 1st storey.
2. The frequency is increased when 4 floating column are considered at center as compared to corner floating column, 8 floating column at center and without floating column normal regular building.

Time Periods –

1. The time period is decreased up to **12.5%** when floating column are considered at corner of 1st storey, The time period is decreased up to **18.75%** when 4 floating column are considered at center of 1st storey, The time period is decreased up to to**18.75%** when 8 floating column are considered at center of 1st storey.

2. The time period is decrease when 8 FC are consider at center as compare to corner FC,4 FC at center and without FC normal building.

1.5 Mass Irregularity at 9thStorey Overall Case Result

Case no	1	2	3	4
	Without FC(normal regular building)	**Corner FC at 1st storey**	**4 FC at center of 1st storey**	**8 FC at center of 1st storey**
Maximum Displacement mm	0.0153	0.0159	0.0153	0.0153
Base Shear KN	1069.41	1042.70	1052.39	1051.448
Natural Period sec	0.016	0.014	0.013	0.013
Frequency Cycle/sec	64.01	72.21	79.042	74.31

Comparison of Displacement,Base shear,Frequancy, Time periods of mass irregularity.

	Displacement	**Base Shear**	**Frequancy**	**Time Periods**
Sr,no	1	1	1	1
Withouing F.C regular	0.0159	1032.7	63.99	0.016
Case no	1	1	1	1
Without 9thFC mass	0.0153	1069.4	64.00	0.015
% Diff.	-3.77	3.55	0.031	-6.25
Case no	2	2	2	2
Corner 9thF.C mass	0.01591	1042.7	72.21	0.014
% Diff.	0.0628	0.96	12.85	-12.5
Case no	3	3	3	3
4FC regular	0.0153	1052.3	79.08	0.013
% Diff.	-3.77	1.90	23.59	-18.75
Case no	4	4	4	4
8FC regular	0.0153	1051	74.31	0.013
% Diff.	-3.77	1.81	16.12	-18.75
Location of F.C	FC at 1st storey	FC at 1st storey	FC at 1st storey	FC at 1st storey

Observation

From the table percentage difference mass irregularities 9th stories building following points are observed.

DISPLACEMENT –

1. The modal displacement is increased up to **0.0628%** when floating column are considered at corner of 1ststorey, The modal displacement is decreased up to **3.77%** when 4 floating column are considered at center of 1ststorey, The modal displacement is decreased up to **3.77%** when 8 floating column are considered at center of 1ststorey.
2. The modal displacement is increased when corner floating column are considered as compared to 8 floating column at center, 4 floating column at center, without floating column with soft storey and without floating column normal regular building.

Base Shear –

1. The base shear is increased up to **0.96%** when floating column are considered at corner of 1ststorey, The base shear is increased up to **1.9%** when 4 floating column are considered at center of 1ststorey, The base shear is shear is is increased up to **1.81%** when 8 floating column are considered at center of 1ststorey.
2. The base shear is increased when 8 floating column are considered at center as compared to corner floating column, 4 floating column at center and without floating column normal regular building.

Frequency –

1. The frequency is increased up to **12.84%** when floating column are considered at corner of 1ststorey, The frequency is decreased up to **23.52**% when 4 floating column are considered at center of 1ststorey, **5.25%** at 2ndstorey, The frequency is decreased up to **16.12%** when 8 floating column are considered at center of 1ststorey,
2. The frequency is decreased when corner floating column are considered as compared to 8 floating column at center, 4 floating column at center and without floating column building.

Time Periods –

1. The time period is decreased up to **12.5%** when floating column are considered at corner of 1ststorey, The time period is decreased up to**18.75%** when 4 floating column are considered at center of 1ststorey, The time period is decreased up to**18.75%** when 8 floating column are considered at center of 1ststorey
2. The time period is increased when corner floating column are considered as compared to 8 floating column at center, 4 floating column at center and without floating column building but when 4 floating column considered at

2nd storey time period increased than corner floating column.

1.6 Mass Irregularity at 18th Storey Overall Case Result

Case no	1	2	3	4
	Without FC(normal regular building)	Corner FC at 1st storey	4 FC at center of 1st storey	8 FC at center of 1st storey
Maximum Displacement mm	0.0152	0.0156	0.0152	0.0155
Base Shear KN	1053.33	1042.70	1052.39	1050.35
Natural Period sec	0.015	0.014	0.013	0.013
Frequency Cycle/sec	64.079	72.21	79.055	78.59

	Displacement	Base Shear	Frequancy	Time Periods
Sr,no	1	1	1	1
Withouing F.C regular	0.0159	1032.7	63.99	0.016
Case no	1	1	1	1
Without 9thFC mass	0.0152	1053.3	64.00	0.015
% Diff.	-4.40	1.99	0.0139	-6.25
Case no	2	2	2	2
Corner 9thF.C mass	0.0156	1042.3	72.21	0.014
% Diff.	-1.88	0.96	12.85	-12.5
Case no	3	3	3	3
4FC regular	0.0152	1052.3	79.08	0.013
% Diff.	-4.40	1.90	23.59	-18.75
Case no	4	4	4	4
8FC regular	0.0155	1050	78.59	0.013
% Diff.	-2.51	1.70	22.81	-18.75
Location of F.C	FC at 1st storey	FC at 1st storey	FC at 1st storey	FC at 1st storey

Observation

From the table percentage difference mass irregularities 18th stories building following points are observed.

DISPLACEMENT –

1. The modal displacement is decreased up to **1.88 %** when floating column are considered at corner of 1st storey, The modal displacement is decreased up to **4.4 %** when 4 floating column are considered at center of 1st storey, The modal displacement is decreased up to **2.51 %** when 8 floating column are considered at center of 1st storey.
2. The modal displacement is decreased when without floating column with swimming pool at 18th and 4 floating column are considered at center as compared to corner floating column, 8 floating column at center, and without floating column normal regular building.

Base Shear –

1. The base shear is increased up to **0.96 %** when floating column are considered at corner of 1st storey, The base shear is increased up to **1.9 %** when 4 floating column are considered at center of 1st storey, The base shear is shear is increased up to **1.7 %** when 8 floating column are considered at center of 1st storey.
2. The base shear is decreased when corner floating column are considered as compared to 8 floating column at center, 4 floating column at center and without floating column normal regular building.

Frequency –

1. The frequency is increased up to **12.84 %** when floating column are considered at corner of 1st storey, The frequency is increased up to **23.53 %** when 4 floating column are considered at center of 1st storey, The frequency is increased up to **22.81%** when 8 floating column are considered at center of 1st storey.
2. The frequency is decreased when without floating column with mass at 18th storey is considered as compared to corner floating column, 4 floating column at center, 8 floating column at center.

Time Periods -

1. The time period is decreased up to **12.5 %** when floating column are considered at corner of 1st storey, The time period is decreased up to **18.75 %** when 4 floating column are considered at center of 1st storey, The time period is decreased up to **18.75%** when 8 floating column are considered at center of 1st storey.
2. The time period is decreased when 8th floating column at center considered as compared to corner floating column, 4 floating column at center, without floating column

III. CONCLUSIONS

DISPLACEMENT –

As per result obtained in that, displacement for the case of 4 floating column at center is less as compared to corner floating column and 8 floating column at center. However, highest displacement value is observed when corner floating column is considered because of cantilever beams large stiffness acting on building as compared to other cases.

Base Shear –

As per result obtained in that, Base Shear for the case of 8 floating column at center is less as compared to corner floating column and 4 floating column at center. However, highest base shear value is observed when 4 floating columns at center and corner floating column are considered.

Frequency –

As per result obtained in that frequency for the case of 4 floating column at center and 8 floating column at center is higher as compared to corner floating column.

Time Periods –

As per result obtained in that time period for the case of 8 floating column at center 4 floating column at center are less as compared to corner floating column.

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