DYNAMIC ANALYSIS OF TEN STORIED BUILDING WITH DIFFERENT LIFT WALL LOCATIONS

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Abstract- *The main objective of earthquake engineering is to design and build a structure in such a way that the damage to the structure and its structural component during an earthquake is minimized. This paper aims towards the dynamic analysis of reinforced concrete building with different locations of lift wall. In the present study 10 storey building is considered for investigation of structure. The analysis of building with different locations of lift wall is assumed to be located in seismic zone II. Estimation of parameters such as Base Shear, Lateral displacements, Bending moment, Shear force, Axial force. Dynamic responses under prominent earthquake, related to IS 1893–2002(part1) have been carried out. In dynamic analysis, Response Spectrum method and Time History methods are used.*

Key Words: *Sap2000 v15.0.0, Lift Wall, Different Locations, response spectrum analysis, time history analysis.*

1. INTRODUCTION

Structural design of buildings for seismic loading is primarily relate with structural safety against major earthquakes, but serviceability and the potential for economic loss are also of concern. Seismic loading requires an understanding of the structural behavior under large inelastic deformations. Behavior under this loading is fundamentally different from wind or gravity loading, requiring much more detailed analysis to assure acceptable seismic performance beyond the elastic range. Some structural damage can be expected when the building experiences design ground motions because almost all building codes allow inelastic energy dissipation in structural systems.

1.1 Methods of Dynamic Analysis

The methods of dynamic analysis used here are Time History Method and Response Spectrum Method.

Time History Method- Time-history analysis is a step-by-step analysis of the dynamical response of a structure to a Specified loading that may vary with time. The analysis may be linear or non linear. Time History analysis is used to determine the dynamic response of a structure to arbitrary loading.

Response Spectrum Method- Response Spectrum is a method of estimation of maximum responses (acceleration, velocity and displacement) of a family of SDOF systems subjected to a prescribed ground motion. The RSM utilizes the response spectra to give the structural designer a set of possible forces and deformations a real structure would experience under earthquake loads. In this approach, the multiple modes of response of a building to an earthquake are taken into account. For each mode, a response is read from the design spectrum, based on the modal frequency and the modal mass. The responses of different modes are combined to provide an estimate of total response of the structure using modal combination methods such as complete quadratic combination (CQC), square root of sum of squares (SRSS), or absolute sum (ABS) method.

1.2 Seismic Base Shear

The seismic base shear V_B, in a given direction shall be determined in accordance with the following equation.

$$V_B = A_h W$$

A_h = Design horizontal seismic coefficient

W = Seismic weight of the building

Calculation of Seismic Response Coefficient-The Design horizontal seismic coefficient A_h for a structure shall be determined by the following expression.

$$A_h = \frac{Z\ I\ Sa}{2\ R\ g}$$

Z =Zone factor given in
Sa/g = average response acceleration coefficient
R = the response reduction factor
I = the importance factor depending upon the
Functional use of structure

Period Determination- The fundamental period of the building, T, in the direction under consideration shall be established using the structural properties and deformational characteristics of the resisting elements in a properly substantiated analysis or, alternatively, it is permitted to be taken as the approximate fundamental period, T, determined in accordance with the requirements of Sec. The fundamental period, T, shall not exceed the product of the coefficient for upper limit on calculated period from and the approximate fundamental period T.

T= 0.075h ¾ for R.C. frame building
h=Height of building in meter

1.3 Model Participation Factor

This is a function of mode shape, mass distribution of the structure and the direction of the earthquake excitation. If the vibration components of the mode shape are orthogonal to the direction of the ground excitation. The participation factor for that mode is zero. Negative participation factors may also be observed. In general, the magnitudes of the participation factors diminish with increasing mode number and at the same point it may be considered that the remaining higher modes do not significantly affect the displacements.

2. METHODOLOGY

To determine the basic components like displacements, Base shear and member forces this analysis has been carried using the software sap2000 v15.0.0 for the analysis purpose. Response spectrum method and time history methods are adopted.

2.1 Building Modeling

In this 10 storied Reinforced concrete building model is considered with different lift wall locations like exterior corner, interior portion and centre of the frame and plan area is 25x25m. The bottom storey height is 1.5m and the rest of stories means upper stories height is kept constant as 3.2m for the building models, properties of the considered building models are detailed below here.

2.2 Material Properties

The materials used for analysis of building models construction is reinforced concrete with M25grade of concrete and Fe-500 grade of steel and the stress-strain relationship is used as per IS 456:2000. The basic material properties are in given table 1.

Material Properties	values
Characteristic strength of concrete, f_{ck}	25 MPa
Yield stress for steel, f_y	500 MPa
Modulus of Elasticity of steel, E_s	20,0000 MPa
Modulus of Elasticity of concrete, E_c	25000 MPa

2.3 Section Properties

The section properties of ten storied building model are given in table 2.

Plan area	25x25m
Thickness of slab	0.15m
Beam Size	0.3x0.45m
Column Size	0.45x0.45m
Thickness of External Wall	0.23m
Thickness of Internal Wall	0.15m
Floor Finish	1KN/m2
Live Load	3KN/m2
Importance Factor	0.1
Response Reduction Factor	5
Type of Soil	Medium

2.4 Plans and models

Three models are considered for Analysis.

Model A- Building with lift wall 5m far from corner

Model B- Building with lift wall at Centre

Model C- Building with lift wall at Exterior corner

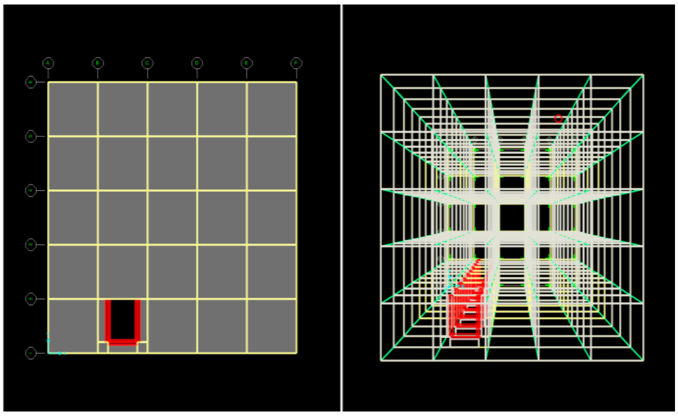

Fig 1: The plan and 3d model of G+9 building with lift wall 5m far from bottom corner (model A)

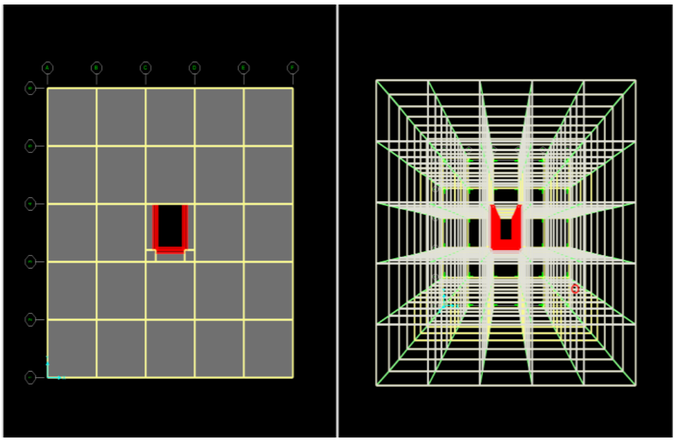

Fig 2: The plan and 3d model of G+9 building with lift wall at centre (model B)

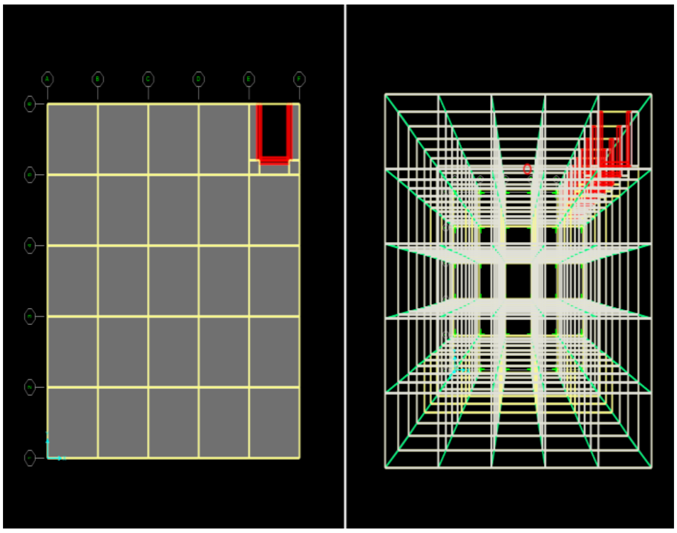

Fig 3: The plan and 3d model of G+9 building with lift wall at exterior corner (model C)

2.5 LOAD COMBINATIONS CONSIDERED FOR THE BUILDING ANALYSIS

The following are the load combinations are adopted for the analysis & design of building as per IS 1893(Part1):2002, as shown in table no 3.

SI No	Load Combination
1	1.5(DL+LL)
2	1.2(DL+LL+EQX)
3	1.2(DL+LL-EQX)
4	1.2(DL+LL+EQY)
5	1.2(DL+LL-EQY)
6	1.5(DL+EQX)
7	1.5(DL-EQX)
8	1.5(DL+EQY)
9	1.5(DL-EQY)
10	0.9DL+1.5EQX
11	0.9DL-1.5EQX
12	0.9DL+1.5EQY
13	0.9DL-1.5EQY

Where,

DL= Dead load,
LL= Live load,
EQX= Earth quake load in X-direction,
EQY= Earth quake load in Y-direction.

3. RESULTS AND DISSCUSSIONS

3.1 MODAL MASS PARTICIPATION FACTOR

Modal mass participation factor for different model in first 3 modes of vibration in Y- Direction is shown in table no.4 and fig 4.

Model	Mode 1	Mode 2	Mode 3
Model A	79.4	13.04	2.7
Model B	76.14	17.17	9.3
Model C	82.3	12.71	4.33

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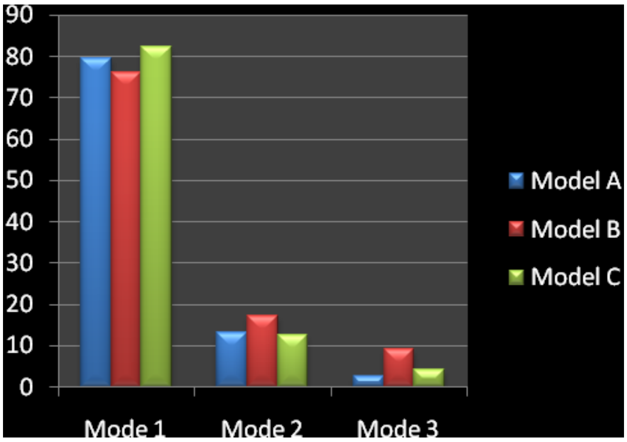

Fig 4: Model participation mass factor for different models (%)

Modal Mass participation Factor is found to be higher for model C in 1st mode. For 2nd and 3rd mode modal mass Participation Factor was higher in case of Model B.

3.2 CALCULATION OF BASE SHEAR

Design Seismic Base Shear in **X**-direction,

V_{BX} = 1311.73KN

Design Seismic Base Shear in **Y**-direction,

V_{BY} = 1310.93KN

SCALE FACTOR = 0.13

3 .3 LATERAL DISPLACEMENT FOR G+9 BUILDING BY RESPONSE SPECTRUM ANALYSIS

Lateral displacement along X-direction & Y-direction (Response spectrum analysis) as showed in table no 5.

Storey	**Model A**		**Model B**		**Model C**	
	x-axis	**y-axis**	**x-axis**	**y-axis**	**x-axis**	**y-axis**
10	30.95	30.99	27.89	28.04	33.03	33.02
9	30.28	30.3	27.26	27.35	30.03	30.02
8	29.6	29.03	26.07	26.08	28.34	27.32
7	27.03	27.19	24.27	24.52	27.72	27.89
6	26.04	26.03	21.89	21.91	26.07	26.05
5	24.19	24.19	18.99	19.13	24.23	24.22
4	21.85	21.88	15.64	15.93	21.89	21.88
3	19.07	19.08	11.93	12.33	15.91	15.91
2	12.27	12.36	7.96	8.38	12.32	12.32
1	8.3	8.36	6.22	6.24	8.37	8.37
0	0	0	0	0	0	0

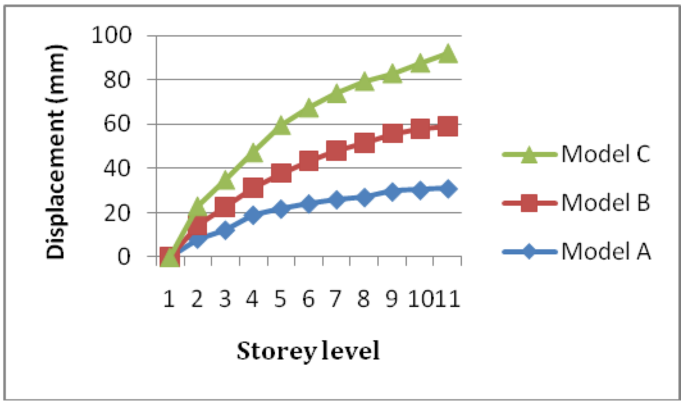

Fig 5: Lateral Displacements of G+9 building by Response spectrum analysis

3 .4 LATERAL DISPLACEMENT FOR G+9 BUILDING BY TIME HISTORY ANALYSIS

Lateral displacement along X-direction & Y-direction (Time History analysis) as showed in table no 6.

Storey	**Model A**		**Model B**		**Model C**	
	x-axis	**y-axis**	**x-axis**	**y-axis**	**x-axis**	**y-axis**
10	47.6	47.6	45.62	45.62	50.16	50.16
9	45.38	45.38	44.45	44.45	47.93	47.93
8	42.23	42.23	42.65	42.65	45.21	45.21
7	39.65	39.65	39.7	39.7	42.63	42.63
6	36.15	36.15	35.81	35.81	37.2	37.2
5	31.76	31.76	31.06	31.06	32.22	32.22
4	27.09	27.09	25.58	25.58	30.61	30.61
3	21.30	21.30	19.51	19.51	25.73	25.73
2	14.56	14.56	13.03	13.03	16.85	16.85
1	7.23	7.23	6.4	6.4	8.46	8.46
0	0	0	0	0	0	0

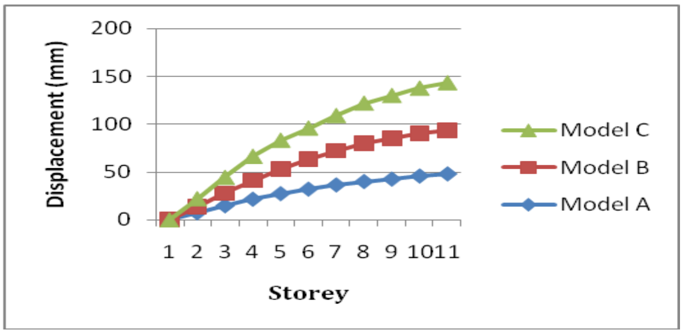

Fig 6: Lateral Displacements of G+9 building by Time History analysis

3.5 COMPARISON OF RESPONSE SPECTRUM AND TIME HISTORY ANALYSIS

Comparison of Lateral displacement of top storey when building is only subjected to Lateral forces as obtained in Response Spectrum and Time History Analysis is shown in chart below

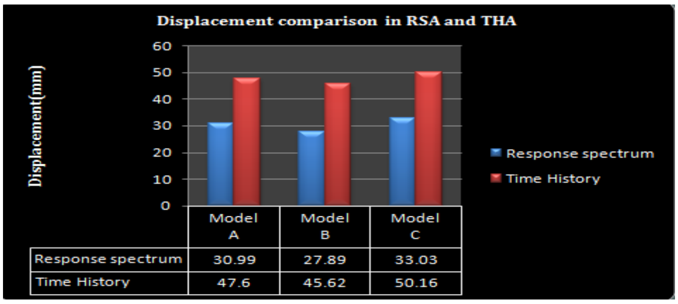

Fig 7: Lateral displacements of top storey by Response spectrum and time history analysis

3.6 BENDING MOMENT IN BEAM (B732) IN DIFFERENT MODELS

Maximum Bending moment in B732 as showed in table no.7

Storey	Model A	Model B	Model C
6	120.94	118.34	138.58
5	157.21	147.04	170.21
4	158.09	148.3	172.44
3	160.63	148.3	173.44
2	159.71	147.04	170.97
1	120.07	119.34	132.12

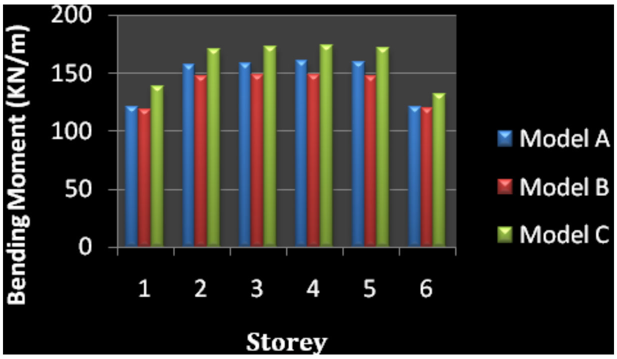

Fig 8: Bending moment (KN/m) in Beam

3.7 SHEAR FORCE IN BEAM (B732) IN DIFFERENT MODELS

Maximum Bending moment in B732 as showed in table no.8

Storey	Model A	Model B	Model C
6	120.22	118.79	135.25
5	154.37	144.55	164.99
4	160.97	145.08	166.51
3	156.76	146.08	166.94
2	154.91	144.55	164.9
1	119.07	118.79	129.09

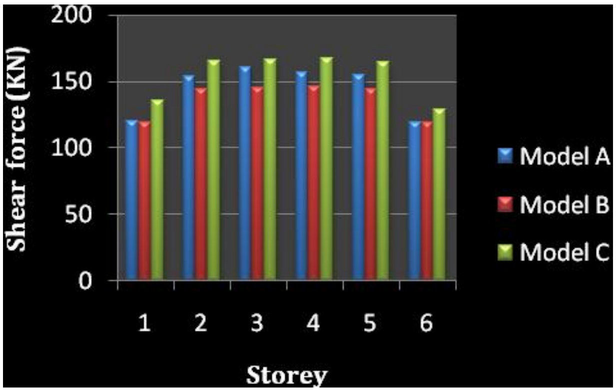

Fig 9: Shear force (KN) in beam

3.8 AXIAL FORCE IN COLUMN (C32) IN DIFFERENT MODELS

Axial force in column C32 as showed in table no.9

Storey	Model A	Model B	Model C
10	337.33	251.13	348.53
9	807.54	624.94	831.24
8	1279.35	997.24	1335.82
7	1751.84	1368.75	1841.19
6	2225.43	1738.91	2348
5	2700.29	2107.39	2856.58
4	3176.65	2473.78	3367.33
3	3654.79	2837.66	3880.69
2	4134.71	3198.78	4396.89
1	4618.42	3555.77	4917.34
Base	4861.23	3754.57	5147.17

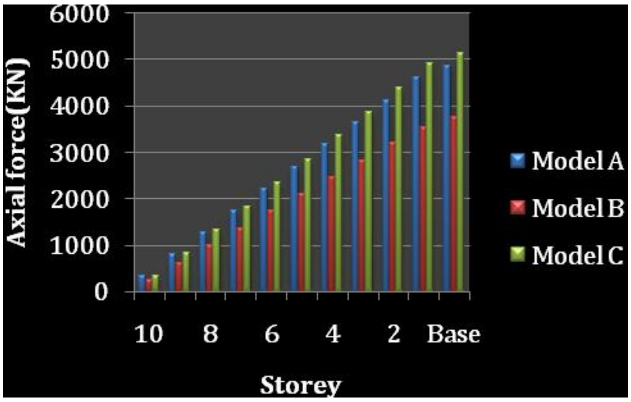

Fig 10: Axial force (KN) in column

4. CONCLUSIONS

The analysis has been completed on G+9 building with different locations of lift wall. The following specific conclusions are drawn from the present work.

- Modal Mass participation Factor is found to be higher for model C in 1st mode and lower for model B.
- In dynamic analysis, response spectrum and time history analysis have been completed in that it can be seen that minimum displacement is seen in model B (lift wall at centre) and maximum is seen in model C (lift wall at exterior corner) means model C is critical case in displacement and it should be avoided.
- When compared Time history Analysis and Response spectrum analysis for all three models the results of time history analysis approximately uneconomical because values of displacements is higher than response spectrum analysis.
- In bending moment it can be seen that minimum bending moment is seen in model B (lift wall at centre) and maximum is seen in model C (lift wall at exterior corner) means model C is critical and uneconomical because as a moment increases reinforcement is also increases.
- In shear force it can be seen that minimum shear force is seen in model B (lift at centre) and maximum is seen in model C (lift wall at exterior corner) means model C is critical and uneconomical because as a shear force increases shear reinforcement also increases.
- In axial force it can seen that minimum axial force is seen in model B (lift wall at centre) and maximum is seen in model C (lift at exterior corner) means model C is critical in axial forces in column.
- Base Shear is calculated by using IS 1893-2002 code.

By providing lift walls at adequate locations subsequently reduces the displacements, member forces. From above listed results and graphs it is observed that model B (lift wall at centre) is best.

REFERENCES

1) IS 456:2000, “Code of Practice for Plain and Reinforced Concrete”, Bureau of Indian Standards, New Delhi, India.
2) IS 1893 (Part 1): (2002), “Criteria for Earthquake Resistant Design of Structures”, Bureau of Indian Standards, New Delhi 110002.
3) Agarwal, P. and Shrikhande, M. (2006), “Earthquake Design of Structures” Prentice Hall of India Private Limited New Delhi India.
4) Dohare Devendra and Maru Savita (2014) 'Seismic Behavior of soft Storey Building, A Critical Review' International Journal of Engineering Research and General Science. Volume 2, Issue 6, October-November, 2014 ISSN 2091-2730.
5) Dr. Sudhir K Jain and Dr. Sudhir K Jain, “Design Example of a Six Storey Building”, Department of Applied Mechanics M. S. University of Baroda, Department of Civil Engineering, Indian Institute of Technology Kanpur.
6) Mohammed yousuf[1] P.M. shimpale [2] “ Dynamic Analysis of Reinforced Concrete Building with Plan Irregularities” International Journal of Emerging Technology and Advanced Engineering(ISSN 2250-

2459, ISO 9001:2008 Certified Journal, Volume 3, Issue 9, September 2013).

7) Sachin.P.Dyavappanavar[1], Dr. K.Manjunatha[2], Kavya N[3] "seismic analysis of rc multi-storied structures with shear walls at different locations" International Research Journal of Engineering and Technology (IRJET). Volume: 02 Issue: 06 | Aug-2015.
8) P. Chandurkar, Dr. P. Pajgade (2013) "Seismic analysis of RCC Buildings with and without shear wall" – International journal of modern engineering Research, Volume 3, PP-1805-1810.
9) Ashish S. Agrawal, S.D. charkha."Effect of Change in shear wall location on storey drift of multi storey building subjected to Lateral Load."(IJERA) www.ijera.comvol .2, Issue 3, pp1789-1793, May-Jun 2012.