Static and Dynamic Analysis of Multi-Storey Building with the Effect of Ground and Intermediate Soft Storey having Floating Columns

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Abstract— Generally the building is subjected to seismic loads the infill masonry wall are considered as nonstructural elements and their stiffness contribution are ignored during the analysis. RC frame building with open ground storey is called as soft storey, similarly soft storey effect can be observed when soft storey at different level of the structure are constructed. In recent earthquake it is observed that a building with discontinuous in stiffness and mass subjected to concentration of forces and the point of discontinuity which may leads to failure of members at the junction and collapse of building. One of the most economical ways to eliminate failure of soft storey is by adding shear walls to tall buildings. In this the study of 3D analytical model of fifteen storey building has been created. Eleven different building models (15 storey each). Analysis is carried out by “ETABS” software. The analytical model of the building include all important component that influence the strength, stiffness ,mass, and deformability of the structure. It is an attempt to study the performance of a building with open ground storey along with an intermediate soft storey with floating columns, type of shear wall in seismic porn areas. Fundamental time period, base shear, storey displacement, storey drift is calculated by equivalent static analysis (ESA) & response spectrum analysis (RSA) method and compared for all models.

Key words: ESA (Equivalent Static Analysis) & (RSA) Response Spectrum Analysis

I. INTRODUCTION

Earthquakes disasters had always been one of the natural hazards under which buildings are mainly caused by damage or collapse. Indian subcontinent has been experienced with some of the most severe earthquake in the world. Hence, it is necessary to take in to account the seismic analysis for the design of multistory buildings. The objective of seismic analysis started as the structure should be able to endure minor shaking intensity without sustaining any damage. High rise building is the most complex built structure since they are many conflicting requirements and complex building systems to integrate.

Nowadays many multistory buildings that are constructed have a special features that the ground storey are left open for the purpose of social and functional needs like vehicle parking, shops, reception etc. These type of building are often called soft first story or open ground storey building. Soft storey can form at any level of a high rise building to fulfill required functional necessity and serve various purposes. Soft storeys at different level of structure are constructed for the purpose of lobbies, conference hall and for the service storey. Soft storey is also known as weak storey because storey stiffness is lower compared to upper stories.. The Indian seismic code IS 1893 (part1): 2002 classifies a soft storey as “one in which the lateral stiffness is less than 70 percent of that in the storey above or less than 80 percent of the average lateral stiffness of the three storeys above”

II. DESCRIPTION OF STRUCTURAL MODEL

For the study of 11 different models of different fifteen 15 storey building are considered, the building has 5 bays of 10m in x-direction and 9 bays of 6m in y-direction with plan dimension of 50 x 54m and a storey height of 7m, 3.1m of storey1 and remaining all storey respectively considered following type of structure such as bare frame, both ground and intermediate floor as soft storey are considered, swastika, L, U, C, I, H, pattern shear wall at corner of the plan provided. The building is considered in zone 5 and medium strength soil. Response reduction factor is 5.

III. MODELS CONSIDERED FOR ANALYSIS

Following 11 Models are analyzed by equivalent static method and response spectrum method using ETAB software

A. Model 1

Building modeled as bare frame; however the masses of brick masonry infill walls (230mm thick) are included.

B. Model 2

Full infill masonry model, building model has full brick infill masonry wall of 230mm thick in all stories excluding the ground storey.

C. Model 3

Building has one full brick infill masonry wall in all storeys except ground storey and intermediate storey (9th storey).

D. Model 4

Building model is similar as model 3, further L shaped shear wall (200mm thick) is provided at corner (shear wall up to top storey)

E. Model 5

Building model is similar as model 3, further L shaped shear wall (200mm thick) is provided at corner i.e. till intermediate storey (shear wall up to 9th storey)

F. Model 6

Building model is similar as model 3, further C shaped shear wall (200mm thick) is provided at corner.

G. Model 7

Building model is similar as model 3, further U shaped shear wall (200mm thick) is provided at corner.

H. Model 8

Building model is similar as model 3, further H shaped shear wall (200mm thick) is provided at corner.

I. Model 9

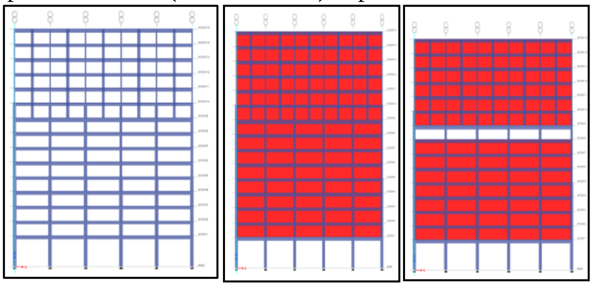
Building model is similar as model 3, further I shaped shear wall (200mm thick) is provided at corner.

J. Model 10

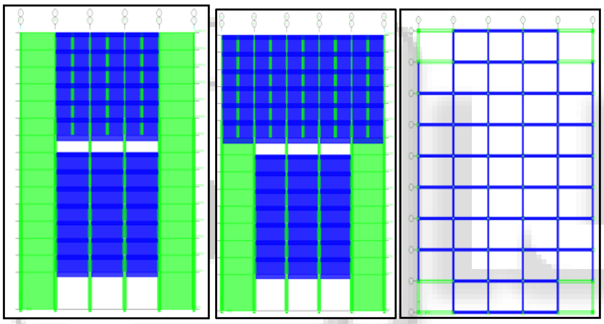
Building model is similar as model 3, further T shaped shear wall (200mm thick) is provided at corner.

K. Model 11

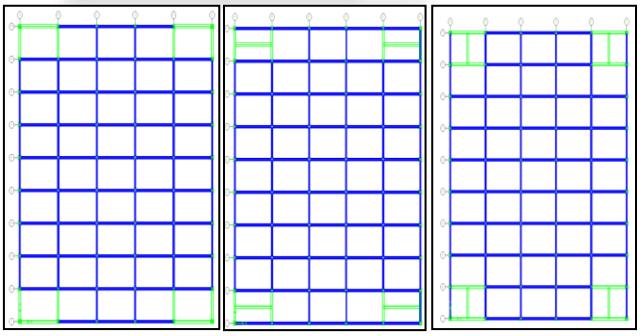
Building model is similar as model 3, further swastika shaped shear wall (200mm thick) is provided at corner.



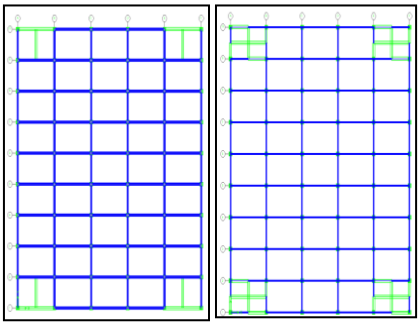
Model 1 Model 2 Model 3



Model 4 Model 5 Model 6



Model 7 Model 8 Model 9



Model 10 Model 11

IV. RESULTS AND DISCUSSION

Fundamental time period in sec	
Model No	Time in sec
1	2.43
2	2.37
3	2.34
4	1.584
5	1.603
6	1.493
7	1.425
8	1.503
9	1.508
10	1.716
11	1.469

Table 1: Fundamental Time Period for All Models

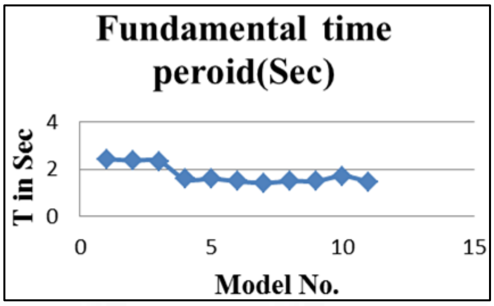


Fig. 1: Chart1: Model Vs. Time period for different models

Seismic base shear				
Model No	Equivalent Static Analysis		Response spectrum method	
	x-direction	y-direction	x-direction	y-direction
1	16876.64	19691.99	10518.15	11972.22
2	18797.74	21047.54	11777.85	12882.99
3	18622.18	20810.7	11662.3	12715.85
4	34192.65	27651.81	19817.71	16609.4
5	33698.56	27307.8	18869.81	15813.94
6	40121.74	29441.22	21194.29	16946.1
7	37057.56	30814.62	20360.59	17104.58
8	37534.7	29413.34	20633.84	16550.63
9	38655.54	29274.43	20540.87	16937.35
10	32228.54	25647.37	18077.7	15029.55
11	39800.61	30359.66	21131.12	17092.34

Table 2: Comparison of seismic base shear between equivalent static analysis and response spectrum method

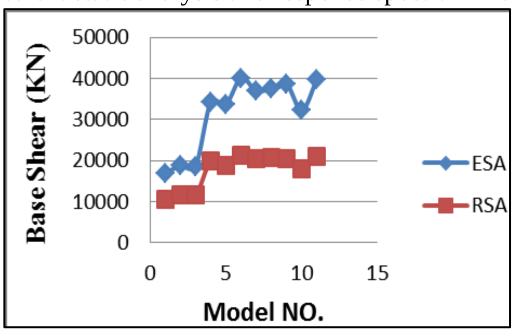


Fig. 2: Comparison of seismic base shear between ESA and RSA in x-direction

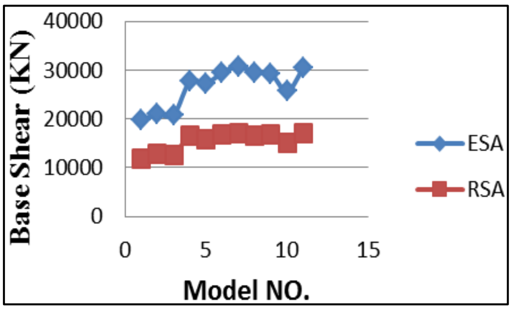


Fig. 3: Comparison of seismic base shear between ESA and RSA in y-direction

Model No	Maximum drift			
	Equivalent Static Analysis		Response spectrum method	
	X-direction	Y-direction	X-direction	Y-direction
1	9.31	10.57	6.23	5.67
2	9.66	10.52	6.58	5.95
3	9.52	10.92	6.51	5.88
4	3.43	4.76	1.96	2.52
5	3.86	6.07	2.15	2.81
6	4.55	6.50	2.44	2.97
7	5.21	6.77	2.31	3.04
8	4.26	6.60	2.34	2.97
9	4.46	6.44	2.41	2.97
10	3.73	5.68	2.05	2.67
11	4.52	6.70	2.44	3.04

Table 3: comparison of storey drift between ESA and RSA for all models in x and y directions

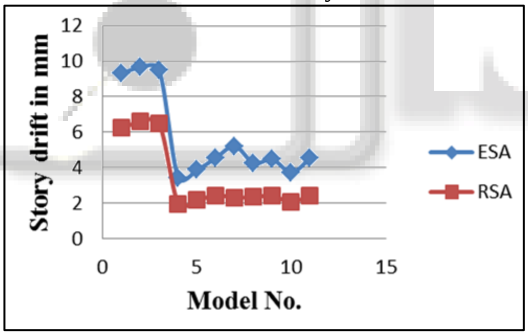


Fig. 4: Storey drifts Vs. Model for different models along x-direction by ESA and RSA

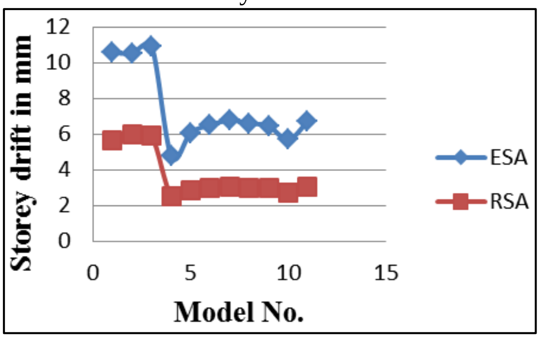


Fig. 5: Storey drifts Vs. Model for different models along y-direction by ESA and RSA

Model No	Maximum displacement			
	ESA		RSA	
	x-direction	y-direction	x-direction	y-direction
1	64.11	76.38	36.55	33.87
2	61.34	75.98	35.73	34.27
3	61.27	75.93	35.51	33.99
4	43.95	62.20	22.33	27.66
5	43.92	63.52	22.51	27.65
6	39.59	61.30	19.85	26.44
7	41.35	60.38	20.94	25.34
8	40.17	63.01	20.94	26.57
9	40.15	61.98	20.48	26.89
10	44.79	65.97	23.14	29.08
11	40.23	62.08	20.25	26.12

Table 4: Comparison of storey displacement between ESA and RSA for all models in x and y-direction

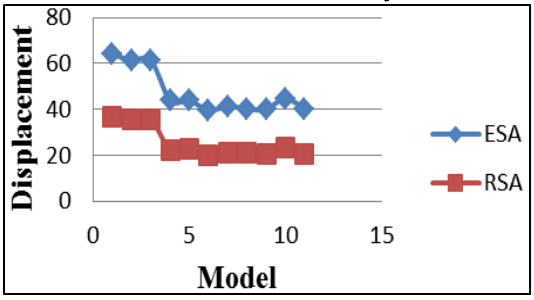


Fig. 6: Storey Displacement vs. Model for different models along x-direction by ESA and RSA

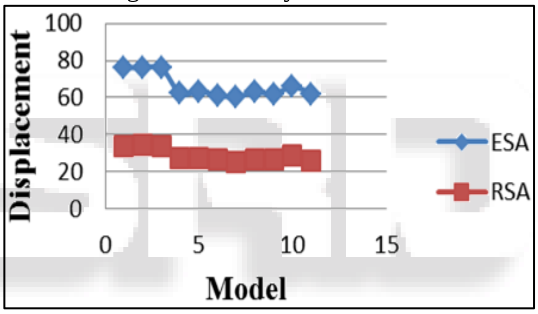


Fig. 7: Storey Displacement vs. Model for different models along y-direction by ESA and RSA

Maximum Acceleration		
Model No	Response specturm analysis	
	x-direction	y-direction
1	442.67	533.52
2	429.67	507.33
3	430.75	508.44
4	840.87	805.81
5	864.90	815.61
6	1009.2	865.9
7	923.69	912.03
8	923.69	887.08
9	985.34	841.82
10	835.26	722.62
11	997.8	890.56

Table 5: Maximum storey acceleration for RSA between all models in x-direction and y-direction

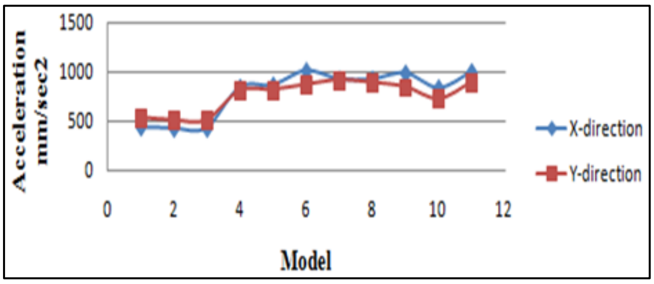


Fig 8: Maximum Storey Acceleration vs. Model for different models by RSA

From above table 1 it is observed that the time period is obtained by ETABS analysis. The table shows time period for model 2 reduce by 2.46% as compared to bare frame model 1. For model with intermediate soft storey i.e. model 3 reduce by 1.26% is less than that obtained from model 2. For models with shear walls i.e. model 4,5,6,7,8,9,10 and 11time period reduced by 32.30%, 31.49%, 36.19%, 39.10%, 35.76%, 35.55%, 26.66% and 37.22% respectively compared to model 3

Table 2 shows comparison of seismic base shear between equivalent static analysis and response spectrum method in which equivalent static analysis results show higher values compare to response specturm method. From fig, 3,4. It is clearly evident that the base shear obtained from RSA procedure is least as compared with ESA. Model 6 (corner C shaped shear wall) yields the highest base shear value from all models in case of ESA (in x-direction and y-direction) and also in case of RSA along x-direction.

Table 3 shows comparison of the highest drift values of all the model by both method of analysis, from that it can be seen that the storey drift in all storey for models (with shear wall) has lower value as compare to that for models (without shear wall) in both the -direction and -directions.

Table 4 shows the comparison of the highest displacement values of all the model by both method of analysis, The average percentage reduction in maximum storey displacement of all the models (from model 4 to 11) is 28.27%, 35.38%, 26.89% (in x-direction) and 18.08%, 20.47%, 13.11% (in y-direction) as compare with model 3 by ESA and RSA respectively.

Table 5 shows the comparison of the highest acceleration values of all the model by response spectrum analysis, Therefore it shows that, model 6 with C type of shear wall yield considerable greater acceleration than other types of shear walls in x-direction and model 7 with U type of shear wall yield considerable greater acceleration than other types of shear wall in y-direction

V. Conclusion

1) Fundamental time peroid reduces when the effect of infill masonry wall and concerte shear wall is considerd.
2) The time peroid of bare frame model having higher value as compared to model 3 having masonry infill with soft storey.
3) By RSA method the base shear value for models with shear walls are higher as compared with model 3
4) Model with U type of shear wall has got least value as compare with bare frame model
5) As per the code IS 1893(part -1) 2002 the storey drift values are found within the limits.
6) In the upper storeys the presences of floating column reduces storey drift because of increase in stiffness.
7) It is observed that by introducing any type of shear wall the storey displacement is reduce by 50%.
8) At intermediate location of a building the effect of soft storey is less, hence providing a service storey in tall building of lesser height is safe.
9) The effect of floating column is less when we provide at upper storey level, so providing floating column is advantageous in the upper floor.
10) It is observed that by introducing any type of shear wall the storey displacement is reduce by 50%.

References

[1] Sukumar behera "Seismic analysis of multistorey building with floating column" department of civil engineering national institute of technology Rourkela, odisha-769008, May 2012.
[2] WakchaureM R,Ped S. P "Earthquake Analysis of High Rise Building with and without In filled Walls" International Journal Of Engineering and Innovative Technology (IJEIT) Volume 2,Issue 2,Agust 2012.
[3] Manju G "Dynamic Analysis of Infills on RC Framed Structures" International Journal Of Innovative Research in Science, Engineering and Technology,Vol.3,Issue 9, September 2014.
[4] Suchitra Hirde and ganga Tepugade "Seismic performance of Multistorey Building with Soft Storey at Different Level with RC Shear wall", International journal of current engineering and technology Accepted 30 May 2014, Available online 01 June 2014, Vol.4,No.3,June 2014.
[5] Jaswant N. Arlekar, Sudhir K. Jain and C.V.R Murty "Seismic Response of RC Frame Buildings with Soft First Storeys" Proceedings of the CBRI Golden Jublee Conference on Natural Hazards in Urban Habitat, New Delhi, 1997.
[6] Amit.V.Khande, "Study on Seismic Response of RC Frame Buildings with Soft Storeys", International Journal of Engineering Resaerch and Applications (IJERA), ISSN: 2248-9622,www.ijera.com Vol.2, Issue3, May-Jun 2012,pp.2100-2108.
[7] C.V.R Murthy "Earthquake Tips" Learning Earthquake Design and Construction Depertent of Civil Engineering, Indian Institute Of Technology Kanpur,Kanpur 2005.
[8] P.V.Sumanth Chowdary, Senthil Pandain. M "A Comparative Study On RC Structure with and without Shear wall" International Journal for Science Research & Development Vol.2, Issue 02, 2014.

