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Analysis of Seismic Pounding Effect of Adjacent Buildings Using Etabs

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ABSTRACT:Pounding occurs when the adjacent buildings start vibration out of phase during the seismic activity which causes collision amongst the adjacent buildings. This paper deals with the linear dynamic analysis (response spectrum) pounding effect between adjacent buildings with regular square plan, L plan and C plan with same storey and different storeys. Comparison of maximum storey displacement, storey drift and storey shear of every plans are done and came to a conclusion of best plan. Two buildings (T1 and T2) are considered. Two building of G+16 and G+12 are considered with 100 mm gap and 50 mm gap. The analysis is done by using ETABS 18 software.

KEYWORDS: Pounding effect, linear dynamic analysis, response spectrum, ETABS 18.

I. INTRODUCTION

Earthquakes have always been a source of great devastation for mankind. It is evident from the past and recent earthquake damages records, that the building structures are subjected to severe damages/collapse during earthquakes. Nowadays with the fast growth of metropolitan cities, land limitation has become a critical issue, thereby resulting in construction of high rise buildings very close to each other. Earthquake is a principal threat to build up Civil Infrastructure in seismically active areas. A quake with a magnitude of six is capable of causing severe damage. Several destructive earthquakes have hit India in both historical and recent times.

The Seismic pounding is simply known as collision or hammering of two buildings which are adjacent to each other having different dynamic characteristics. The main reason for the seismic pounding is a lack of separation gap in between the adjacent buildings. Most of the time pounding between the structures is commonly observed in the old buildings that were constructed before the earthquake resistant design principles came into the picture. Even though many present codes specify a minimum seismic gap, it still fails to include the effect of all other parameters that effect the structural deformation. The simplest and effective way for pounding mitigation and reducing damage due to pounding is to provide enough separation gap, but it is sometimes difficult to be implemented due to the high cost of land. Pounding effect in building simply means collision between buildings due to earthquake load. Poundingis the result of irregular response of adjacent buildings of different heights and of different dynamic properties. It is the phenomenon, in which two buildings have little or no gap providing separation.

1.1 CAUSES OF POUNDING

Pounding damage is caused by hitting of two buildings constructed in close proximity with each other. Structural Pounding damage can arise due the following:

- When separation gap between adjacent buildings is insufficient or zero.
- When buildings have sufficient gap but they are connected by one or more members such as bridges.
- when adjacent buildings have different dynamic properties like mass, height, orientation, geometry.

II. RELATED WORK

The concept of seismic pounding is to analyse a structure. The response spectrum analysis procedures have been carried out for determining the various structural parameters of the model. Mainly concerned with the behavior of the structure under the effect of ground motion and dynamic excitations such as earthquakes and the displacement of the structure.1 Static Analysis is not sufficient for high rise buildings and it is necessary to provide Dynamic Analysis. For important structures Time History Analysis should be performed as itpredicts the structural response more accurately compared to other methods4. During pounding the smaller building experiences more damage as compared to the



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larger building 5. As pounding force decreases for greater separation, hence it reduces damage to the neighbouring building5.

III. METHODOLOGY



IV. MODELLING

Two buildings with M30 concrete and HYSD are designed in ETABS. The regular square plan has 7 number of bays in each axis with 5m spacing in both direction. L plan has 9 number of bays in X direction whereas 8 in Y direction. Spacing is same for every plans. Area of 900 m² is kept same for every plans. C plan has 7 number of bays in X direction and 11 in Y direction. Figures shows the plan, elevation and 3D view of the models. Column and beam is of 600x600 mm. storey height is 3m with GF 1.5 m. dead load, live load and super imposed load is taken as 12, 4 and 1.2 kN/m² respectively.Soil type is II, seismic zone IV, importance factor 1 and response reduction factor 5(SMRF). The building is supposed for commercial purpose. The wind speed is taken as 47 m/s. Support conditions are fixed. Diaphragms are taken as rigid.

1. SQUARE PLAN CONFIGURATION

- MODEL 1- Two adjacent 17 storey building with 50 mm gap
- MODEL 2- Two adjacent 17 storey building with 100 mm gap
- MODEL 3- 17 and 13 storey building adjacently with 50 mm gap
- MODEL 4- 17 and 13 storey building adjacently with 100 mm gap

2. C PLAN CONFIGURATION

- MODEL 5- Two adjacent 17 storey building with 50 mm gap
- MODEL 6- Two adjacent 17 storey building with 100 mm gap
- MODEL 7-17 and 13 storey building adjacently with 50 mm gap
- MODEL 8- 17 and 13 storey building adjacently with 100 mm gap

3. L PLAN CONFIGURATION

- MODEL 09- Two adjacent 17 storey building with 50 mm gap
- MODEL 10- Two adjacent 17 storey building with 100 mm gap
- MODEL 11- 17 and 13 storey building adjacently with 50 mm gap
- MODEL 12- 17 and 13 storey building adjacently with 100 mm gap

Figure a, b, c, d, e shows the plan, elevation and 3D view of square plan buildings with 50mm and 100 mm gap (model 1 and 2).values are taken as per DCon12 combinations of concrete frame work. Mass source combination is 1DL+0.5LL+1SIDL.



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Fig a) plan of model 1, 2, 3and 4



Fig (c) elevation of model 1 and model 2



fig b) 3 D view of model 1 and model 2



fig d) elevation of model 3 and model 4



Fig e) 3 D view of model 3 and model 4



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Figure f, g, h, i, and j shows the plan, elevation and 3D view of C plan.



Fig f) plan of model 5, 6, 7, and 8



Fig h) 3 D view of model 5 and model 6



fig g) elevation of model 5 and model 6







fig j) 3 D view of model 7 and model 8



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Figures k, l, m, n and o shows plan, and elevation and 3 D view of L configuration.



Fig k) plan of model 9, 10, 11 and 12



Fig m) 3 D view of model 9 and model 10



fig 1) elevation of model 9 and model 10



fig n) elevation of model 11 and 12 $\,$



Fig o) 3D view of model 11 and 12



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Maximum displacement of the models are tabulated in columns below with its bar charts.

Table 1 maximum storey displacement of same storey

	Maximum storey displacement (mm)				
MODELS WITH SAME GROUND LEVEL	at 50 mm gap		at 100 mm gap		
	T1	T2	T1	T2	
Two adjacent 17 storey buildings in square plan	20.6397	20.6397	10.3198	10.3198	
Two adjacent 17 storey buildings in C plan	35.16	30.637	33.847	30.85	
Two adjacent 17 storey buildings in L plan	22.38	15.66	34.41	16.57	



fig 1 bar chart of MSD in same storey



Fig 2 bar chart of MSD of different storey

Table 3 storey	drift	of same	storey
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	Maximum storey drift					
MODELS WITH SAME GROUND LEVEL	at 50 m	m gap	at 100 mm gap			
	T1	T2	T1	Т2		
Two adjacent 17 storey buildings in square plan	0.000682	0.000682	0.000341	0.000341		
Two adjacent 17 storey buildings in C plan	0.001072	0.001042	0.001044	0.001023		
Two adjacent 17 storey buildings in L plan	0.001045	0.001033	0.001069	0.001051		

L

Table 2 maximum storey displacement of different storey

	Maximum storey displacement (mm)				
MODELS WITH SAME GROUND LEVEL	at 50 mm gap		at 100 mm gap		
	T 1	T2	T1	T2	
17 and 13 storey adjacent buildings in square plan	20.836	10.917	10.3198	10.3198	
17 and 13 storey adjacent buildings in C plan	37.082	28.959	33.796	30.619	
17 and 13 storey adjacent buildings in L plan	33.459	31.66	34.406	31.726	



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Table 4 storey drift of different storey

	Maximum storey drift					
MODELS WITH SAME GROUND LEVEL	at 50 mr	n gap	at 100 mm gap			
	T1	T2	T1	T2		
17 and 13 storey adjacent buildings in square plan	0.000666	0.000466	0.00064	0.000466		
17 and 13 storey adjacent buildings in C plan	0.001107	0.00081	0.001032	0.000905		
17 and 13 storey adjacent buildings in L plan	0.000647	0.000672	0.00067	0.000638		



Fig 3 bar chart of storey drift of same storey



Fig 4 bar chart of storey drift of different storey



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Table 5 storey shear of same storey buildings

MODELS WITH SAME GROUND LEVEL	Maximum storey shear in kN				
	at 5	at 50 mm gap		at 100 mm gap	
	T1	T2	T1	T2	
Two adjacent 17 storey buildings in square plan	4470.37	4470.37	4470.37	4470.37	
Two adjacent 17 storey buildings in C plan	7450.63	7450.63	7450.623	7450.383	
Two adjacent 17 storey buildings in L plan	5215.44	5215.44	5215.44	5215.44	



Fig 5 bar chart of storey shear on same storey

MODELS WITH SAME GROUND LEVEL	Maximum storey shear in kN				
	at 50 mm gap		at 100 mm gap		
	T1	T2	T1	T2	
17 and 13 storey adjacent buildings in square plan	4221.01	3231.77	4007.4	3123.98	
17 and 13 storey adjacent buildings in C plan	7962.4	6095.85	7570.15	8057.385	
17 and 13 storey adjacent buildings in L plan	5199.78	3770.42	5215.44	3933.95	

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Table 6 maximum storey shear value on different storey

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Fig 7 bar chart of maximum storey shear in different storey

V. RESULT AND DISCUSSIONS

In the case of storey displacement in adjacent neighbouring buildings with same storey no drastic change in value is seen for square, C and L configuration plan.Neighbouring buildings with 100 mm gap between them are effective. Comparing displacement of all the configuration, square plan has the least storey displacement.On the other hand maximum storey displacement in buildings with different storey, T1 (Highest number of storey tower) has the larger value at 100 mm gap.

In the case of storey drift and storey shear in adjacent neighbouring buildings with same level have no sufficient change in value same as storey displacement for every plan configuration.Neighboring buildings with 100 mm gap between them has lesser storey drift and storey shear. So concluded that square plan configuration is more stable than I plan and C plan.

VI. CONCLUSION

Buildings in regular or same ground level is more resistible than buildings in irregular plain or different ground levels. Rather than different plan configurations regular or equal bays on four side plans are better. A larger gap between 2 buildings is safer. Neighbouring buildings with same storey is safer than neighbouring buildings with different storeys.

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