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COMPARATIVE STUDY OF SYMMETRIC AND ASYMMETRIC BUILDINGS WITH IRREGULARITIES UNDER LATERAL LOADS

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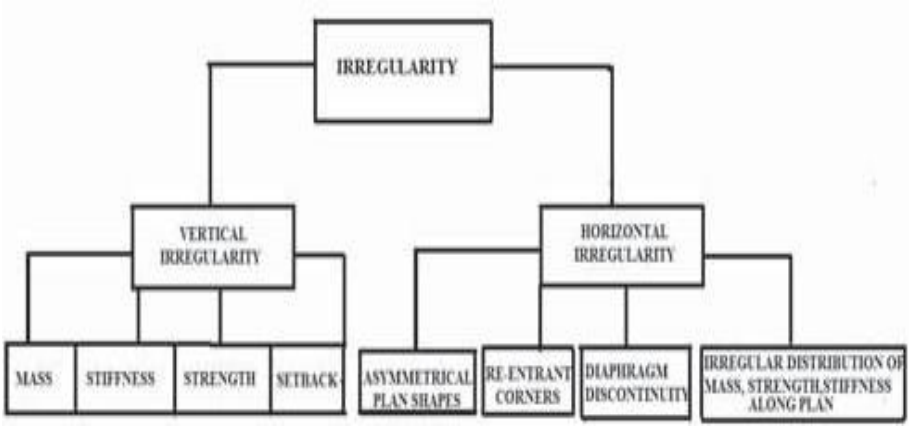
***Abstract*— In the present scenario many buildings are having irregular configurations. the irregularity in the configurations may be due to the necessity or it may be due to the architectural purpose. nowadays it is important to consider all the configurations of the building thoroughly before the analysis and design of the structure. structural irregularity is one of the major reason for the collapse of the building during severe earthquake. Our aim is to design the building as per the IS code provisions, by which the building can withstand against any earth quake and to prevent the damages in the building.**
In the present study (comparative study of symmetric and asymmetric buildings with irregularities under lateral loads) a regular building G+14,as well as asymmetric buildings having vertical and plan irregularities(c and l shape) are considered. these structures are analyzed by E-tabs software. In this study, comparison of seismic parameters such as displacement, drift, base shear and torsion has been done at each storey level between all the models considered.

***Keywords*— irregularity, plan irregularity, vertical irregularity, storey displacement, base shear, storey drift.**

I. INTRODUCTION

There are different weak zones or irregular configurations in the building which may cause the failure/damage to the building.these zones are generated due to the discontinuity or asymmetric configuration of the building.which cause the failure of the structure at the occurance of earthquake. If a building is having irregular dimensions such as variation in height/elevation or discontinuity in the plan or geometry it is called as irregular/assymetric building.there are different kinds of irregularties described by indian standard codes such as plan as well as vertical irregularities.below chart shows the types of irregularities..

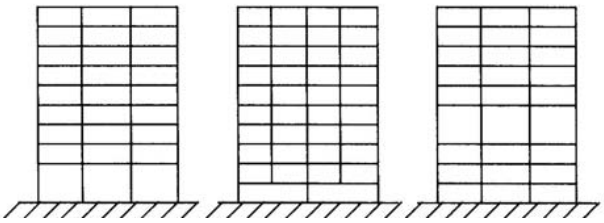


These irregularities are generated in the structure/building due to the improper distribuion of mass/weight, strength/stiffness, variation in the storey/floor heights .the above irregularities are described as
1) Stiffness irregularity:
Soft story: A soft story is one in which the horizontal stiffness is under 70 percent of that in the story above or under 80 percent of the normal sidelong stiffness of the three stories above
Extreme soft story: An extreme soft story is one in which the horizontal stiffness is under 60 percent of that in the story above or under 70 percent of the normal stiffness of the three stories above.

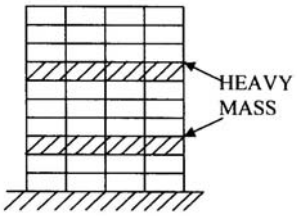
The main concept of a weak or soft storey consist of a discontinuity in the stiffness/strength which occurs at the second storey connections.this discontinuity is caused due to the lesser strength or increased flexibility.this causes the maximum deflections at the first storey.

2) Mass irregularity: Mass irregularity will be considered to exist where the seismic weight of any story is in excess of 200 percent of that of its nearby stories.

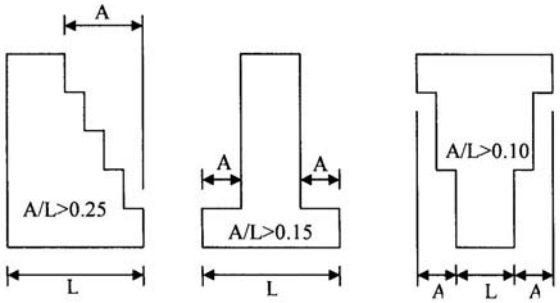
3) Vertical geometric irregularity: Vertical geometric irregularity will be considered to exist where the flat measurement of the parallel power resisting framework in any story is in excess of 150 percent of that in its adjoining story.



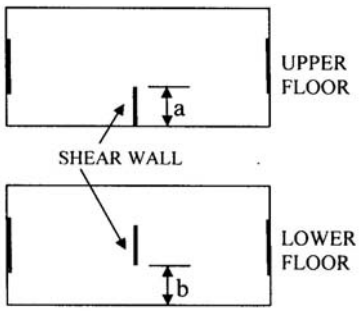
(Strength irregularity)



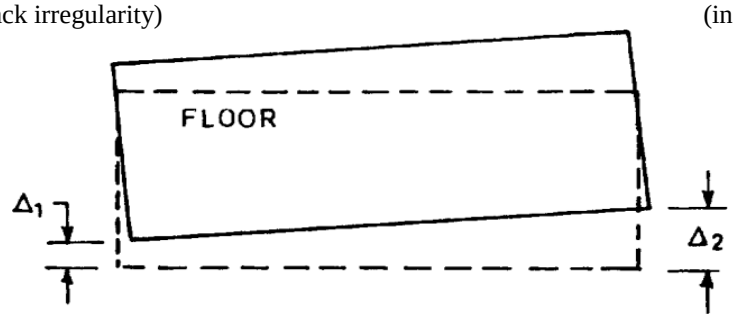
(mass irregularity)



(set.back irregularity)



(in plane discontinuity)



(torsional irregularity)

4) Re entrant corners irregularity
5) Diaphragm discontinuity
6) Torsional irregularity

II. LITERATURE REVIEW

*Dr. Mohd Hamraj, Mohammed Moiz khan:*they studied the seismic behaviour of RC buildings with vertical irregularities subjected to biaxial excitation. they have studied 4 models namely(1) Building A: Regular Shear Wall (Shear Wall up to top story both in core and elevation of the building) (2) Building B: Irregular Shear Wall (Shear wall interrupted at mid story in elevation of the Building A). (3) Building C: Irregular Shear Wall (Shear Wall located at mid story in core of the Building A).(4) Building D: Building having Soft First Story. seismic analysis is carried out for all the four models using time history analysis in E-tabs. buildings A,B,C and buildings A,D have been compared.then results comparison is done for storey drift, storey displacement and base shear.and their performance levels are reviewed.

Mohammed Irfan,Dr. Sunandan Reddy,K.Mythili: In this study a R C formed residential building resting on an isolated forting is considered. E-tabs software is used for analysis. This building is analyzed by pushover analysis as well as response spectrum analysis. In this study the effects of masonry infill and overall behaviour of the structure when subjected to lateral loads are observed. In this study three models is considered. First model is considering as bare frame which is having no walls in the first storey and one full brick infill masonry walls in upper stories. In the second model stiffness and mass of the walls are considered. In the third model infill masonry wall in bottom and top stores are provided. Same plan is considered for symmetric and asymmetric building models. The difference between the symmetric asymmetric building are symmetric building model is having equal height of columns is ground story. Where as asymmetric building model has variation in the ground story height such as 3to 5m. They have found that due to the

consideration of infill wall fundamental natural period of the structure,storey drift, joint displacements,ductility ratio are reduced.

Oman Sayyed, Suresh Singh Kushwah, Aruna Rawat: This study focuses on the behaviour and performance of regular and vertical irregular G+10 Reinforced concrete building under seismic loading. In this study two types of vertical irregularities are considered such as stiffness and setback irregularity .In this total 8 regular and irregular buildings are modelled and seismic analysis is done by the method of Response spectrum analysis is. By using these responses like storey shear, storey drift, story displacements ,overturning moments are obtained. by using these results a comparative study has been done between regular and irregular building. This study shows that a building structure with stiffness and set back irregularity gives instability during seismic loading. to counter the instability , a proper amount of stiffness is helpful in reinforced concrete building.

Pardeshi sameer, Prof. N. G. Gore: In this investigation, 3D analytical model of G+15 storied structures have been produced for symmetric and asymmetric building models are analyzed utilizing structural analysis software ETABS. Mass and stiffness are two fundamental parameters to assess the dynamic reaction of a structural system. Multi-storied structures are behaved differently relying on the different parameters like mass - stiffness distribution, foundation types and soil conditions. 2001 Bhoj earthquake in Gujarat, India showed the harm and collapse of the structures because of the irregularities in structural stiffness and floor mass. This paper is concerned about the impacts of different vertical irregularities on the seismic reaction of a structure

III. METHODOLOGY

3.1 MODEL DESCRIPTION

MODEL Ⅰ: regular/symmetric building
MODEL Ⅱ:soft storey @ s1
MODEL Ⅲ: soft storey @ s4
MODEL Ⅳ: soft storey @ s9
MODEL Ⅴ: soft storey @ s15
MODEL Ⅵ:C shape building
MODEL Ⅶ:L shape building

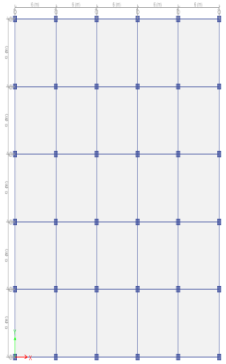


Fig 1.1 plan

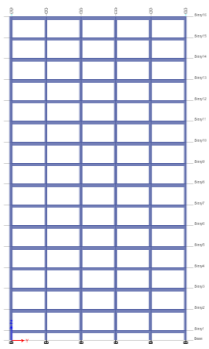


fig 1.2 elevation

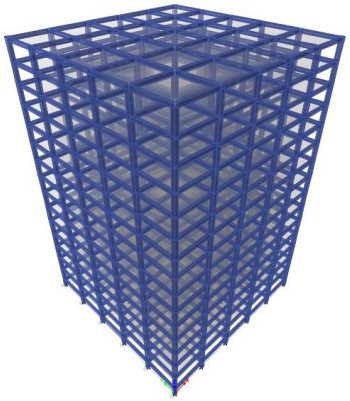


fig 1.3 3d view

MODEL Ⅰ: regular/symmetric building

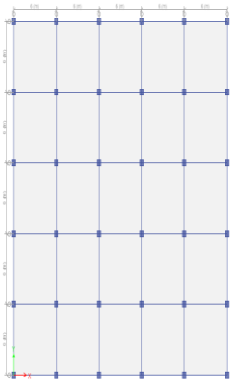


Fig 2.1 plan

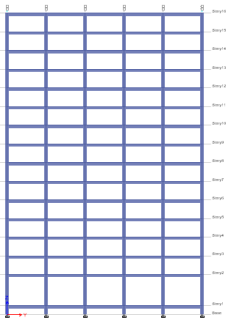


fig 2.2 elevation

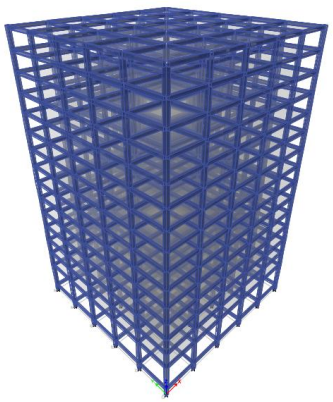


fig 2.3 3d view

MODEL Ⅱ:soft storey @ s1

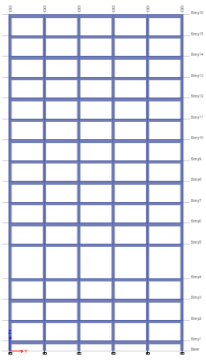


fig 2.4 elevation of MODEL Ⅲ

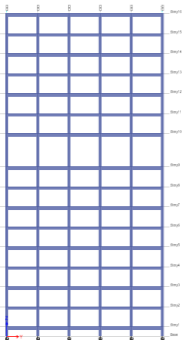


fig 2.6 elevation of MODEL Ⅳ

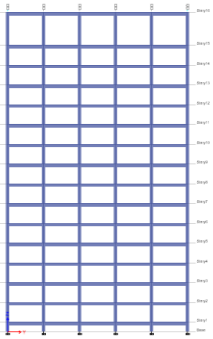


fig 2.5 elevation of MODEL Ⅴ

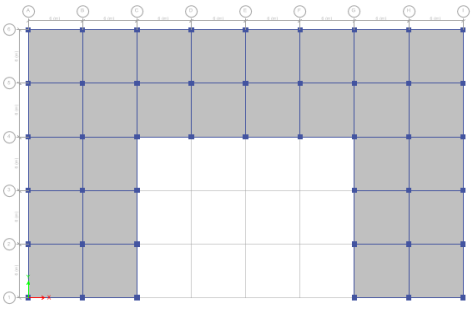


Fig 3.1 plan

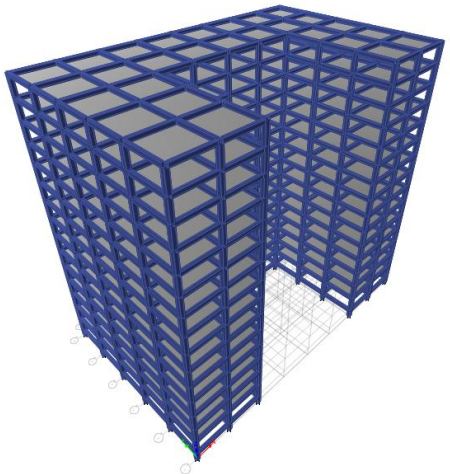


Fig 3.2 3d view

MODEL Ⅵ:C shape building

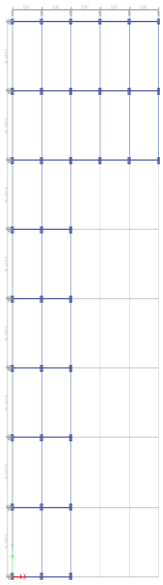
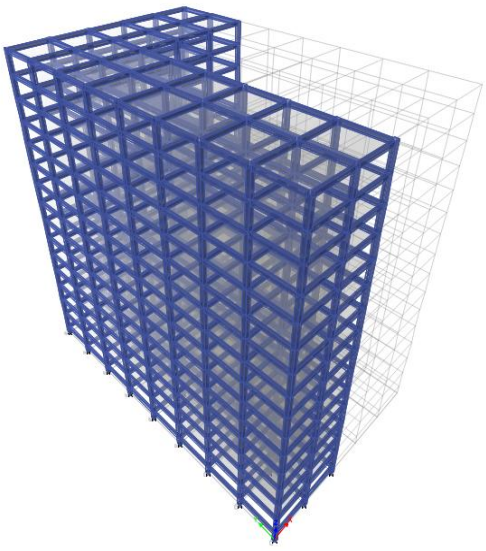


Fig4.1 plan



MODEL Ⅶ:L shape building

Fig 4.2 3d view

3.2 specifications and loads considered:

All the factors considered are as per IS 1893-2002 and IS875 part 1,2 and 3

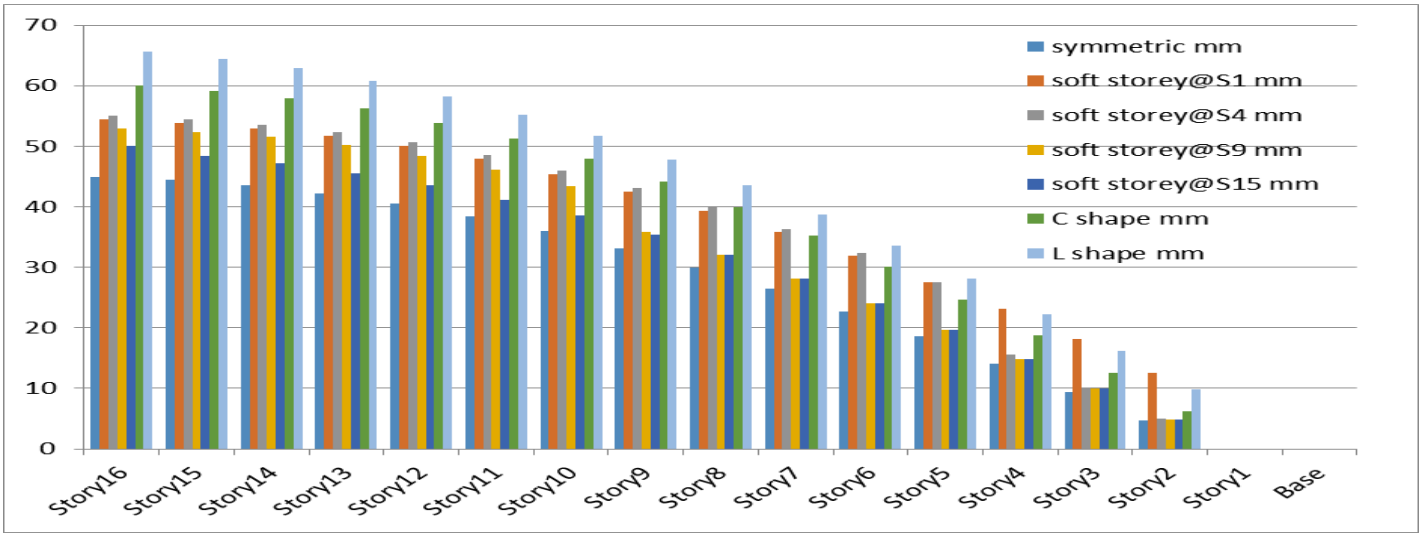
Grade of concrete	:	M30
Grade of steel	:	FE550
Size of beam	:	300mmx500mm
Size of column	:	500mmx500mm
Size of column for L shape	:	600mmx600mm
Storey height	:	3m
Soft storey height	:	5m
No of stories	:	G+14
wall load	:	5 kN/m
floor finish load	:	1 kN/m
wall road on roof	:	1.85 kN/m
live load	:	3 kN/m2
live load on roof	:	1.5 kN/m2
zone factor(z)	:	0.36
site type	:	Ⅱ
importance factor(I)	:	1.0
response reduction factor(R)	:	5
wind speed	:	44m/s
terrain category	:	Ⅱ
structure class	:	B
risk coefficient(k1)	:	1.0
topography factor(k2)	:	1.0

IV. RESULTS

Comparison between all models:

Storey	symmetric	soft storey@S1	soft storey@S4	soft storey@S9	soft storey@S15	C shape	L shape
	mm	mm	mm	mm	mm	mm	mm
Story16	44.9	54.5	55.1	53	50.1	60	65.7
Story15	44.4	53.9	54.5	52.4	48.4	59.2	64.5
Story14	43.5	53	53.6	51.5	47.2	58	62.9
Story13	42.2	51.7	52.3	50.2	45.6	56.2	60.8
Story12	40.5	50	50.6	48.4	43.6	53.9	58.3
Story11	38.4	47.9	48.5	46.2	41.2	51.2	55.2
Story10	36	45.4	46	43.4	38.5	47.9	51.8
Story9	33.2	42.5	43.1	35.9	35.4	44.1	47.8
Story8	30	39.3	39.9	32.1	32	39.9	43.5
Story7	26.5	35.8	36.3	28.2	28.2	35.2	38.7
Story6	22.7	31.9	32.3	24.1	24.1	30.1	33.6
Story5	18.6	27.6	27.5	19.6	19.6	24.6	28.1
Story4	14.1	23.1	15.6	14.9	14.9	18.7	22.3
Story3	9.4	18.1	10.1	10	10	12.5	16.2
Story2	4.7	12.5	5	4.9	4.9	6.2	9.9
Story1	0	0	0	0	0	0	0
Base	0	0	0	0	0	0	0

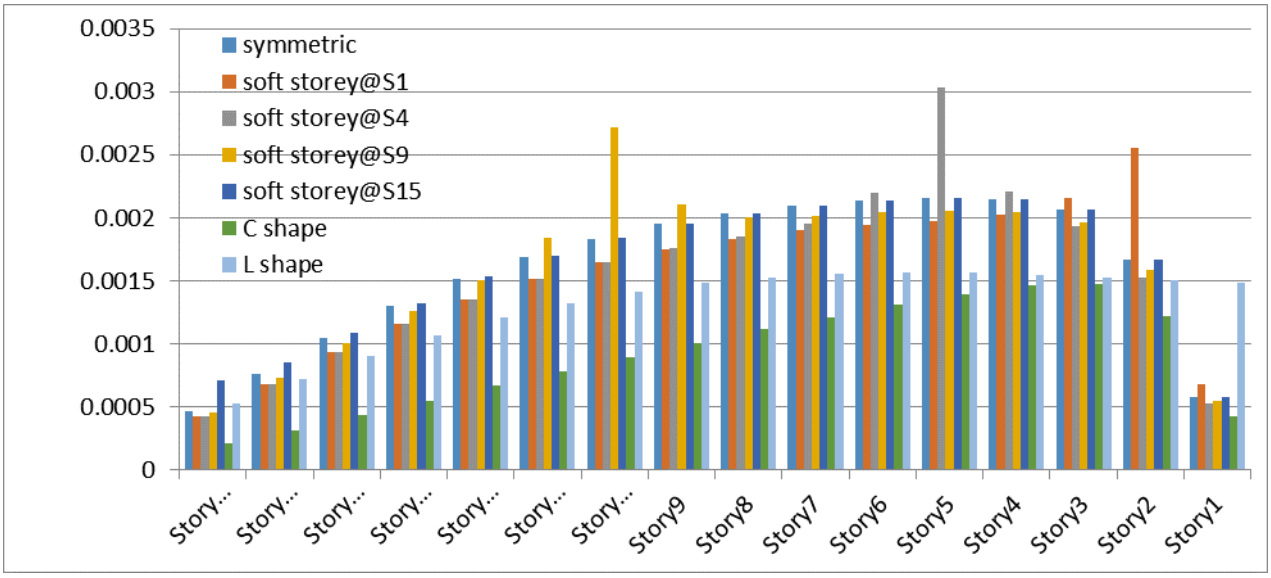
Table 4.1 showing displacement due to WX



Graph 4.1 showing displacement due to WX

Storey	symmetric	soft storey@S1	soft storey@S4	soft storey@S9	soft storey@S15	C shape	L shape
Story16	0.000472	0.000425	0.000427	0.000458	0.000713	0.000209	0.000529
Story15	0.00076	0.000679	0.000682	0.000733	0.000854	0.000315	0.000718
Story14	0.001046	0.000933	0.000936	0.001009	0.00109	0.000433	0.000906
Story13	0.001298	0.001158	0.001162	0.001259	0.001326	0.000553	0.001072
Story12	0.001512	0.001351	0.001355	0.001503	0.001532	0.000671	0.001211
Story11	0.00169	0.001513	0.001518	0.001846	0.001704	0.000788	0.001325
Story10	0.001835	0.001646	0.001652	0.002713	0.001844	0.0009	0.001414
Story9	0.001949	0.001753	0.001761	0.002103	0.001955	0.00101	0.001481
Story8	0.002036	0.001836	0.001853	0.002003	0.002039	0.001115	0.001527
Story7	0.002098	0.001898	0.001956	0.002019	0.0021	0.001215	0.001555
Story6	0.002139	0.001943	0.002193	0.002046	0.002139	0.00131	0.001567
Story5	0.00216	0.001977	0.003028	0.00206	0.002159	0.001397	0.001565
Story4	0.002152	0.00202	0.002204	0.00205	0.00215	0.001466	0.00155
Story3	0.002068	0.002162	0.001931	0.001968	0.002066	0.001474	0.001527
Story2	0.001668	0.002556	0.001525	0.001586	0.001665	0.001223	0.001501
Story1	0.000583	0.000681	0.000531	0.000554	0.000582	0.00043	0.001488

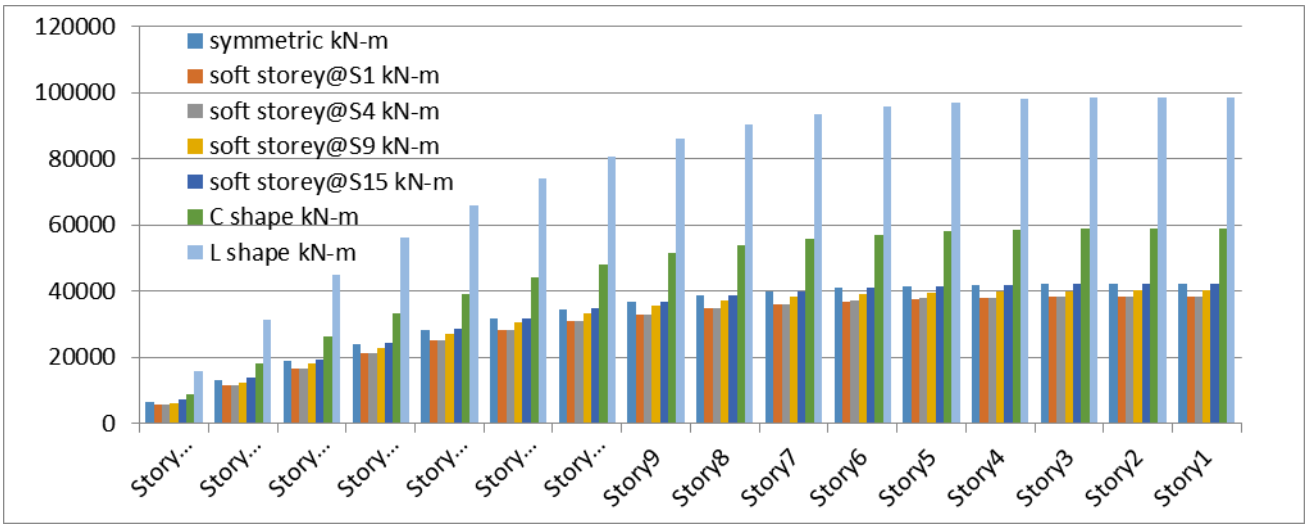
Table 4.2 showing drift due to EQX



Graph 4.2 showing drift due to EQX

Storey	symmetric	soft storey@S1	soft storey@S4	soft storey@S9	soft storey@S15	C shape	L shape
	kN-m	kN-m	kN-m	kN-m	kN-m	kN-m	kN-m
Story16	6376.311	5585.287	5604.333	6035.59	7036.162	8721.683	15750.18
Story15	13078.08	11489.09	11528.27	12415.38	13788.11	18114.22	31267.19
Story14	18887.34	16640.04	16696.78	17981.61	19442.46	26255.91	44717.72
Story13	23867.84	21089.46	21161.37	22789.75	24290.16	33236.09	56249.39
Story12	28083.34	24888.68	24973.55	26895.28	28393.25	39144.12	66009.79
Story11	31597.58	28089.04	28184.82	30353.66	31813.79	44069.33	74146.53
Story10	34474.32	30741.87	30846.7	33320.95	34613.82	48101.09	80807.22
Story9	36777.31	32898.49	33010.68	35395.11	36855.4	51328.73	86139.47
Story8	38570.29	34610.25	34728.27	36955.19	38600.57	53841.59	90290.87
Story7	39917.01	35928.46	36050.98	38126.99	39911.38	55729.03	93409.03
Story6	40881.24	36904.47	37030.31	38965.97	40849.9	57080.4	95641.56
Story5	41526.71	37589.6	37741.9	39527.6	41478.16	57985.03	97136.06
Story4	41917.19	38035.18	38068.44	39867.35	41858.22	58532.28	98040.15
Story3	42116.41	38292.55	38229.4	40040.69	42052.13	58811.48	98501.41
Story2	42188.12	38417.26	38287.34	40103.1	42121.94	58912	98667.47
Story1	42190.29	38419.23	38289.09	40104.98	42124.04	58914.98	98674.73

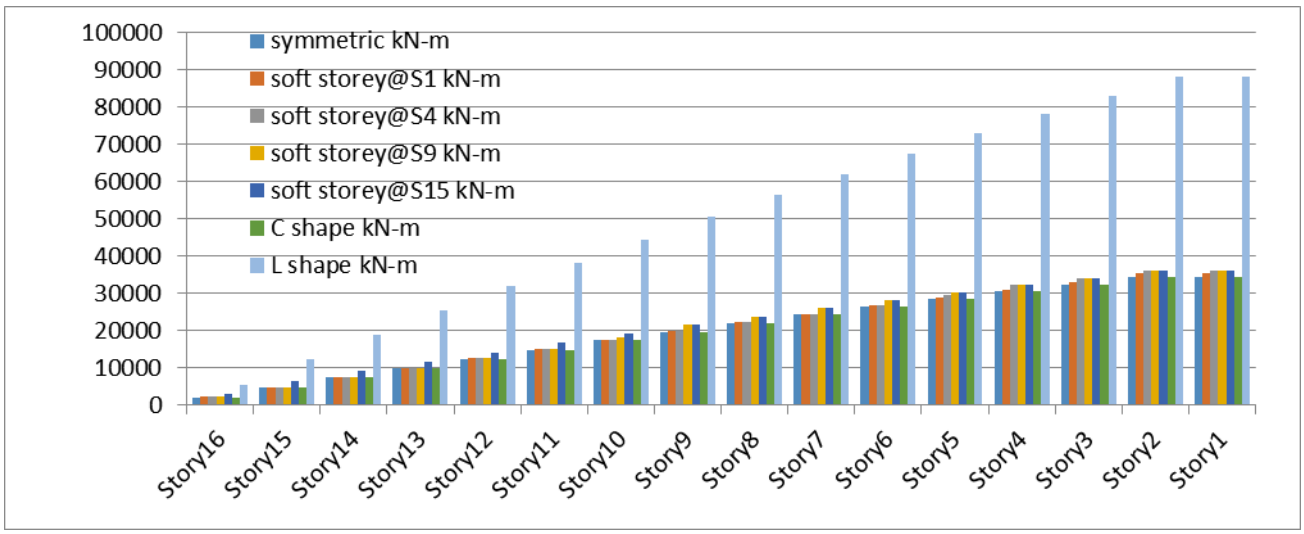
Table 4.3 showing torsion due to EQX



Graph 4.3 showing torsion due to EQX

Storey	symmetric	soft storey@S1	soft storey@S4	soft storey@S9	soft storey@S15	C shape	L shape
	kN-m	kN-m	kN-m	kN-m	kN-m	kN-m	kN-m
Story16	2208.783	2228.196	2228.196	2228.196	3110.668	2208.783	5654.484
Story15	4829.207	4871.784	4871.784	4871.784	6614.879	4829.207	12362.77
Story14	7415.076	7480.664	7480.664	7480.664	9200.748	7415.076	18982.59
Story13	9966.62	10055.07	10055.07	10055.07	11752.29	9966.62	25514.55
Story12	12484.07	12595.22	12595.22	12595.22	14269.74	12484.07	31959.21
Story11	14966.95	15101.35	15101.35	15101.35	16752.62	14966.95	38315.39
Story10	17399.51	17570.46	17570.46	18376.57	19185.18	17399.51	44542.75
Story9	19766.42	19981.49	19981.49	21552.1	21552.1	19766.42	50602.05
Story8	22067.89	22326.49	22326.49	23853.56	23853.56	22067.89	56493.79
Story7	24301.49	24606.08	24606.08	26087.16	26087.16	24301.49	62211.82
Story6	26459.64	26815.12	26815.12	28245.32	28245.32	26459.64	67736.69
Story5	28530.67	28946.31	29629.47	30316.34	30316.34	28530.67	73038.52
Story4	30513.97	30985.17	32299.64	32299.64	32299.64	30513.97	78115.76
Story3	32471.92	32952.35	34257.6	34257.6	34257.6	32471.92	83128.12
Story2	34429.8	35562.85	36215.48	36215.47	36215.47	34429.8	88140.29
Story1	34429.8	35562.85	36215.48	36215.47	36215.47	34429.8	88140.29

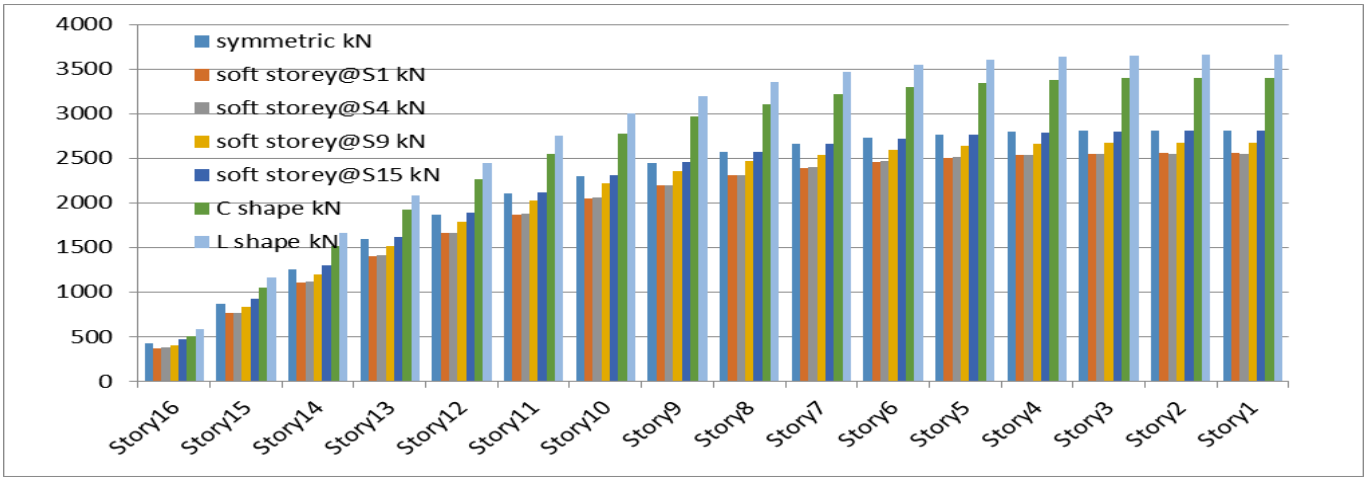
Table 4.4 showing torsion due to WX



Graph 4.4 showing torsion due to WX

Storey	symmetric	soft storey@S1	soft storey@S4	soft storey@S9	soft storey@S15	C shape	L shape
	kN	kN	kN	kN	kN	kN	kN
Story16	425.0874	372.3525	373.6222	402.3726	469.0775	502.7467	584.2115
Story15	871.8718	765.9395	768.5513	827.6917	919.207	1045.465	1160.274
Story14	1259.1558	1109.3359	1113.1187	1198.7738	1296.1641	1515.907	1659.619
Story13	1591.1893	1405.9639	1410.7581	1519.3168	1619.344	1919.235	2087.727
Story12	1872.2226	1659.2455	1664.9034	1793.0187	1892.8835	2260.612	2450.077
Story11	2106.5054	1872.6028	1878.9883	2023.5775	2120.9192	2545.2	2752.15
Story10	2298.288	2049.4579	2056.4464	2221.3969	2307.5879	2778.162	2999.425
Story9	2451.8204	2193.2328	2200.7117	2359.6738	2457.0263	2964.661	3197.382
Story8	2571.3525	2307.3498	2315.2177	2463.6795	2573.3711	3109.859	3351.501
Story7	2661.1343	2395.2307	2403.3984	2541.7993	2660.759	3218.919	3467.262
Story6	2725.416	2460.2978	2468.6873	2597.7313	2723.3266	3297.004	3550.143
Story5	2768.4476	2505.9731	2516.1265	2635.1733	2765.2107	3349.275	3605.626
Story4	2794.479	2535.6787	2537.8962	2657.8235	2790.548	3380.896	3639.19
Story3	2807.7604	2552.8366	2548.6266	2669.3797	2803.4752	3397.029	3656.314
Story2	2812.5416	2561.1509	2552.4896	2673.5399	2808.129	3402.837	3662.479
Story1	2812.6861	2561.2822	2552.6063	2673.6656	2808.2696	3403.012	3662.75

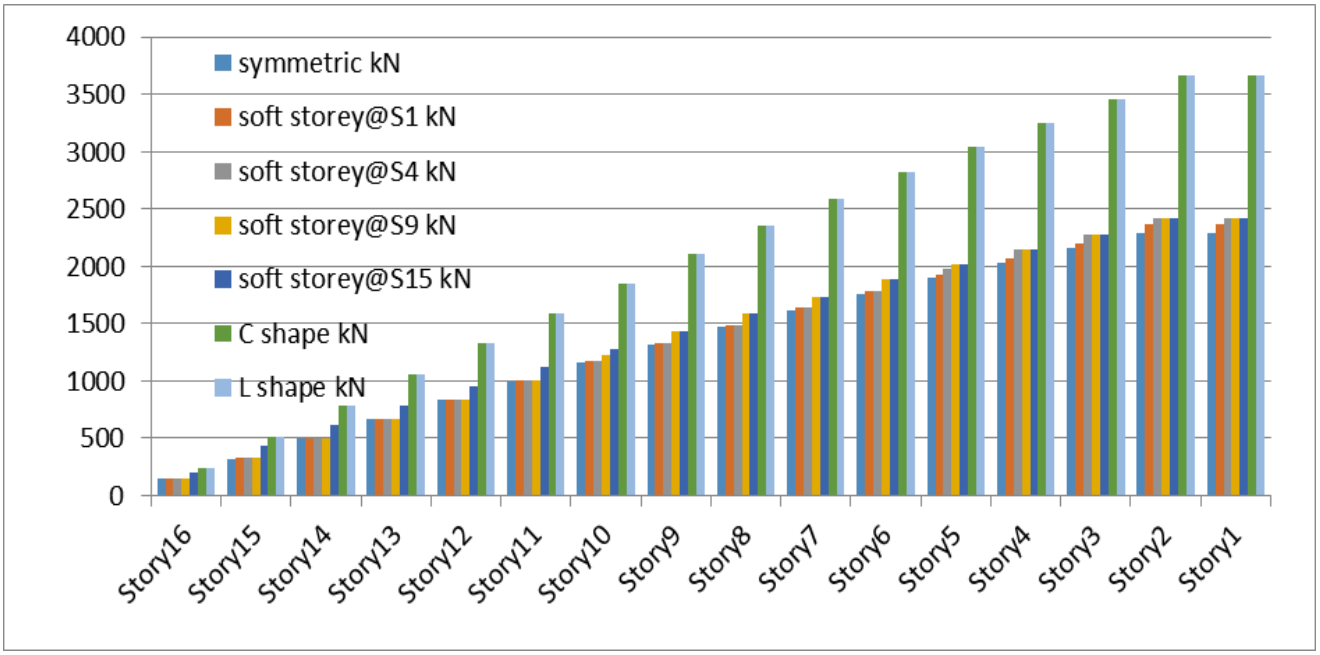
Table 4.5 showing base shear due to EQX



Graph 4.5 showing base shear due to EQX

Storey	symmetric	soft storey@S1	soft storey@S4	soft storey@S9	soft storey@S15	C shape	L shape
	kN	kN	kN	kN	kN	kN	kN
Story16	147.2522	148.5464	148.5464	148.5464	207.3778	235.6035	235.6035
Story15	321.9471	324.7856	324.7856	324.7856	440.9919	515.1154	515.1154
Story14	494.3384	498.7109	498.7109	498.7109	613.3832	790.9414	790.9414
Story13	664.4413	670.3377	670.3377	670.3377	783.4862	1063.106	1063.106
Story12	832.2712	839.6813	839.6813	839.6813	951.316	1331.634	1331.634
Story11	997.7965	1006.7569	1006.7569	1006.7569	1116.8413	1596.474	1596.474
Story10	1159.9674	1171.3643	1171.3643	1225.1045	1279.0123	1855.948	1855.948
Story9	1317.7616	1332.0992	1332.0992	1436.8065	1436.8065	2108.419	2108.419
Story8	1471.1926	1488.4324	1488.4324	1590.2374	1590.2374	2353.908	2353.908
Story7	1620.0994	1640.4055	1640.4055	1739.1443	1739.1443	2592.159	2592.159
Story6	1763.9762	1787.6749	1787.6749	1883.0211	1883.0211	2822.362	2822.362
Story5	1902.0447	1929.7539	1975.2982	2021.0895	2021.0896	3043.272	3043.272
Story4	2034.2646	2065.6779	2153.3096	2153.3094	2153.3094	3254.823	3254.823
Story3	2164.7949	2196.8233	2283.8398	2283.8397	2283.8397	3463.672	3463.672
Story2	2295.3201	2370.857	2414.3651	2414.365	2414.365	3672.512	3672.512
Story1	2295.3201	2370.857	2414.3651	2414.365	2414.365	3672.512	3672.512

Table 4.6 showing base shear due to WX



Graph 4.6showing base shear due to WX

V. CONCLUSIONS

From this study, comparison between all the models has been done and the values for displacement and drifts are within the permissible limits. The following are conclusions of the study

1. Model 4 is having maximum displacement at top storey due to EQX, which is 1.09 times higher than the model 1.
2. There is a sudden increment In the displacement in models 2,3,4,5 at soft stories.
3. Model 7 is having maximum displacement at top storey due to WX, which is 1.46 times higher than the model 1.
4. Model 3 is having maximum drift at storey5 due to EQX.
5. There is an increment in the drift in models 2,3,4,5 at soft stories.
6. Model 7 is having maximum torsion at first storey due to EQX, which is 2.34 times higher than the model 1.
7. Model 7 is having maximum torsion at first storey due to EQX, which is 2.8 times higher than the model 1.
8. Model 7 is having maximum base shear at first storey due to EQX.
9. Model 2, model 3 are having less base shear than model 1 at all stories.
10. Model 7 and model 6 are having same base shear due to WX.
11. Model 7 and model 6 are having maximum base shear due to WX.

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