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Engineering

Analysis of the Behaviour of Soft Storey Building Using E Tab Software

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ABSTRACT

Soft storey buildings are multi-story buildings which have one or more floors "soft" due to its structural design. Soft storeys are much unsafe in earthquakes, because they cannot survive due to lateral forces and thrust developed by the shaking action of the earthquake. As a result, the soft storey may fail, causing what is known as a soft storey collapse. After a major earthquake, there was lot of collapse of buildings structures, which we have shown soft storey collapse, as it is the one of the common leading causes of damage to structures. To analyze the effect of earthquake on soft storey building, a building model of twelve storeys with different soft storey were analyzed. Analysis is also done for a full infill & bare frame. Analysis was carried out using E-tab analysis. E-TABS is a software that helps in analysis and design of multi-story building. Basic or advanced systems under static or dynamic conditions may be evaluated using E-TABS. As a result of this analysis, we found that soft storey at lower level is much vulnerable in comparison of upper soft storeys.

KEYWORDS :Earthquakes, Soft storey buildings, E tab

INTRODUCTION

In India, soft storey at first floor level is an unavoidable feature due to unavailability of space as in multi storied buildings, first storey is used for parking or reception lobbies. The storeys above stilt floor is used for residential or commercial purpose which comprises of brick wall panels, due to which they possess small storey drift. According to "The Indian seismic code", a soft storey is defined as a building whose lateral stiffness is less than 50% of the storey above or below [IS: 1893, 2002]. Dynamic analysis of such buildings is compulsory. The analysis suggested that the vulnerability of building at lower soft storey is comparatively much higher.

PRELIMINARIES

Soft storey is defined by vertical stiffness discontinuity in vertical direction. When any individual storey in a multistoried building (generally stilt floor) is made full open (without wall) in construction is termed as soft storey. The structural elements of soft storey are so designed so that they can bear 2.5 times the storey shears and moments calculated for specified earthquake loads. In the case of soft stilt floor, this arrangement should be provided to minimize the vulnerability of earthquake to such building.

1) Unnecessary openings should be closed.

2) The number and size of columns at stilt floor level should be increased.

3) As per requirement the interior side of building should be braced.

4) If the stilt floor is used for parking, then minimize the openings by using modern techniques.

DESCRIPTION OF STRUCTURAL MODELS

The analysis is focused on the behaviour of soft storey building. From bare frame to infill different models are prepared with different soft storey. Every model is analyzed on E-tab. The frame elements are modelled as beam column elements. The infill is modelled as plane stiffness of uniform thickness of 0.23mm. The non linear properties for columns are assumed to be a plastic hinge and for the beams as plastic moment hinge. Structures overall behaviour at different soft storey level are compared. Rigid slab is modelled .

BUILDING DESCRIPTION

For analysis twelve storey m r f building models are used the building is considered in seismic zone 5, importance factor 1, Soil type 2, the dimensions of building (plan) is 20m x15m. The length of each bay is 5m in length and width side both. In the analysis the floor height is taken 3.2m. The modelling of structure is carried out using E-tabs.1 bare frame(mass considered but stiffness neglected) ,1 full infill and 12 models of 12 storied building having soft storey at different levels(in first building first storey soft and in 12th building 12th storey soft.) are prepared..The *size of column used are 600mmX600mm, Size of Beam 300mmX600mm* and *thickness of slab is 125mm. live load given to the building is 3.5KN/m²*.

Material	Grade	Poisson's Ratio	Modulus of Elasticity
Masonry	-	0.2	3500 MPa
Concrete	M 25	0.2	2.85X10^4 MPa
Steel	Fe 415	0.3	2.1X10^5 MPa

Table 1: Material Properties

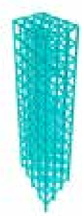

Figure I: Bare Frame

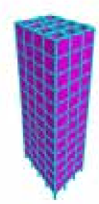

Figure II: Full Infill

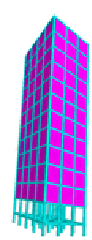

Figure III: 1st storey soft

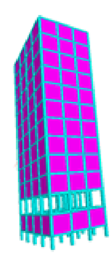

Figure IV: 2nd storey soft

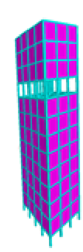

Figure V: 9th storey soft

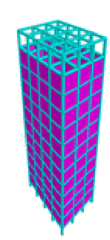

Figure VI: 12th storey soft

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ANALYSIS AND RESULTS

Table II: Lateral Forces (KN) At The Storey Level

Storey	Bare Frame	Infill	Different storey level											
			1	2	3	4	5	6	7	8	9	10	11	12
12	402	824	788	790	794	799	805	812	821	832	844	858	874	446
11	373	857	820	823	826	831	838	845	855	866	878	892	540	793
10	311	716	686	687	690	695	700	706	714	723	734	423	648	775
9	255	288	262	264	267	270	274	280	286	293	557	522	624	636
8	205	472	451	453	455	458	461	465	470	283	413	491	500	511
7	161	368	353	354	356	358	360	364	219	318	378	384	391	399
6	121	278	266	267	268	270	272	163	237	281	285	290	295	301
5	87	201	193	193	194	195	116	169	200	203	206	209	213	217
4	59	136	130	130	131	78	113	134	135	137	139	141	144	147
3	36	83	80	80	48	69	81	82	83	84	85	87	88	90
2	19	44	42	25	36	42	43	43	44	44	45	46	46	47
1	7	17	10	14	16	16	16	17	17	17	17	17	18	18

Storey	Bare Frame	Infill	Different storey level											
			1	2	3	4	5	6	7	8	9	10	11	12
12	38.33	11.91	13.31	13.27	12.56	12.3	12.2	12.05	12	12	11.9	12	11.66	11.36
11	37.32	11.07	12.69	12.61	11.95	11.7	11.6	11.43	11	11	11.3	11	10.91	10.18
10	35.38	10.14	12.01	11.87	11.27	11.1	10.9	10.73	11	11	10.5	10	9.27	9.41
9	33.89	9.13	11.27	11.08	10.52	10.3	10.1	9.95	9.8	9.8	9.37	8.1	8.38	8.37
8	31.21	8.07	10.47	10.25	9.72	9.49	9.3	9.12	8.9	8.8	6.96	7.3	7.48	7.66
7	28.16	6.97	9.64	9.37	8.88	8.65	8.44	8.26	8	5.9	5.96	6.2	6.52	6.69
6	24.66	5.85	8.77	8.48	8	7.77	7.57	7.22	4.9	4.9	5.05	5.3	5.52	5.68
5	20.75	4.73	7.89	7.58	7.11	6.89	6.51	3.94	3.9	3.9	4.12	4.3	4.51	4.65
4	16.46	3.64	7.02	6.68	6.24	5.84	3.07	2.95	3	3.1	3.2	3.4	3.51	3.62
3	11.88	2.61	6.15	5.83	5.21	2.27	2.1	2.14	2.2	2.2	2.32	2.4	2.54	2.62
2	7.17	1.65	5.34	4.86	1.33	1.35	1.35	1.37	1.4	1.4	1.48	1.6	1.62	1.68
1	2.83	0.79	4.35	0.79	0.64	0.66	0.65	0.66	0.7	0.7	0.72	0.8	0.87	0.81

Table III: Lateral Displacement (Mm) At The Storey Level

Storey	Bare Frame	Infill	Different Soft storey level											
			1	2	3	4	5	6	7	8	9	10	11	12
12	42.23	6.7	4.2	3.12	4.63	4.76	5.2	5.4	5.34	5.89	6.29	6.37	11.40	28.3
11	70	18.3	12.28	9.02	13.03	13.1	14.4	14.92	15.03	16.36	17.04	21.28	308.3	4.8
10	84.35	25.64	18.08	13.37	18.9	19.4	20.44	21.24	22	22.9	28.02	466.7	10.76	34.3
9	85.52	32	23.18	17.14	24.03	24.5	25.58	26.82	27.08	32.94	578.1	20.9	32.22	29.6
8	100	37.44	27.7	20.54	28.77	29.9	30.27	30.82	36.42	440.4	28.97	38.24	34.62	35.7
7	106	41.99	31.71	23.41	32.9	33.5	33.6	39.22	482.1	34.89	2.6	2.44	2.49	40.8
6	113.3	2.39	35.21	25.93	36.7	36.5	42.02	516.7	39.43	2.33	2.37	2.41	2.43	2.41
5	119.7	48.86	38.2	28.97	38.96	44.5	554.3	1.83	46.81	40.33	42.27	44.44	46.81	48.7
4	122.4	51.24	41.86	29.73	1.89	587	1.7	48.94	41.33	42.83	44.51	46.65	49.21	51.1
3	117.7	52.81	1.5	53.26	618	1.44	50.24	42.31	43.48	44.5	46	48.85	50.14	52.8
2	88.9	1.69	0.88	585.5	1.08	51.8	42.22	43.63	44.71	45.5	46.95	49	51.56	53.6
1	332.5	0.89	798	22.61	53.3	45.3	44.94	46.32	47.39	48.17	0.78	0.84	0.39	0.39
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table IV: Maximum Bending Moment (Knm) At The Storey Level

VI. GRAPHICAL REPRESENTATION OF RESULTS OBTAINED FROM E-TAB ANALYSIS

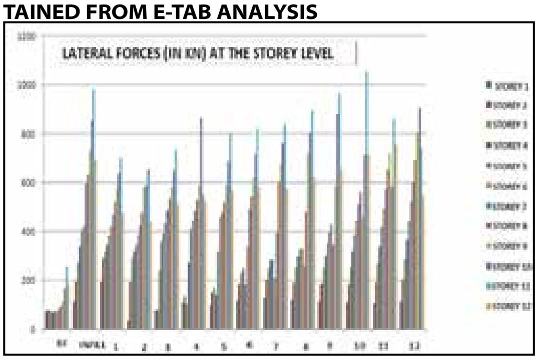

Figure VII: Lateral Forces (KN) At The Storey Level

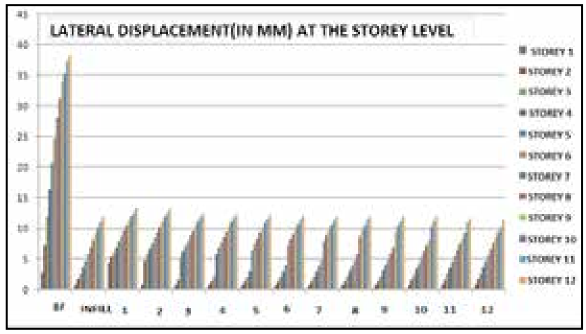

Figure VIII: Lateral Displacement (Mm) At The Storey Level

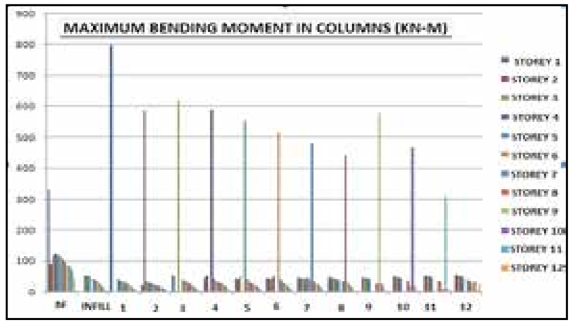

Figure IX: Maximum Bending Moment (KNm) At The Storey Level

VII. CONCLUSION

1. The soft storey present at the top level of multistoried building does not give any significant effect on the structural performance of building with other stories with full infill. But the presence of soft storey at the lower level of multi-storeyed building (mainly at first floor level) adversely affects the structural performance of that building.
2. At the time of earthquake, the multi-storey building structures, mainly soft storey building having only frames as lateral load resisting systems are vulnerable during the earthquakes.
3. The analysis shows that the main cause of failure of building with soft storey is ground storey mechanism at a relatively low base shear and low lateral displacement. .

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