Stability Analysis of Multi-Story Building with Underneath Satellite Bus Stand having Intermediate Soft-Story and Floating Columns

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Abstract— The masonry infill walls are considered as non-structural element and their stiffness contribution are ignored in the analysis when building is subjected to seismic loads, but it is considered while we studying stability analysis. RC frame building with open ground Story, and similar soft Story effect can be observed when soft Story at different levels of structure are constructed. The method used for stability analysis of columns, shear walls, coupled and coupled components, cores, single Story and multi-Story structures are studying. Buildings and structures are considering stable with lateral supports by using either bracing systems or shear system or both such as wall to ensure the stability of the building. One of the problems is affected from wind load. The calculation methods are computer assisted through the use of the software, ETAB. Comparisons of results are made between the methodologies, and different models with different parameters. This is how the soft Story effects are managed to overcome the future damages of the storied structures.

Key words: Floating Columns, Non-Linear Time History Analysis, P-Delta, Satellite Bus Stop, Soft-Story

I. Introduction

Satellite bus stop is the new term that has come in the recent years in cities like Bengaluru because, due to increasing population and the land value since the past few years' bus stands in populated cities is a matter of major problem. So that constructions of multi-Storyed buildings with open first Story. Hence it has been utilizing for the moment of the buses and people can use this as bus terminals. These type of buildings having no infill walls in ground Story, but all upper Storys infilled with masonry walls. Soft Storys at different levels of structure are constructed for other purposes like lobbies conference halls and for the service Storys. This Story is known as weak Story because Story stiffness is lower compare to above Storys. So, importance to be given for the earthquake resistant design. Consideration of infill and shear walls and correct shape can improve the performance of the building in analysis. [1]

II. Description of Structural Model

A. Geometry

For the study, four different models of a 12 Story building are considered. The building has four bays in X direction with spacing of 11m and seven bays in Y direction with spacing of 7m. The plan dimension 44 m × 49 m. Typical Story height is 3.65 m for each floor up to intermediate soft Story their after that 3.2 m for remaining Storys and bottom Soft-Story and intermediate soft-Storys are of height 7m and 3m respectively. Floating columns are used after intermediate soft story as shown in figure below. This geometry remains same throughout the study. The only influencing factor is change in the models and parameters, dimensions remains same. The column size decreases from Bottom to Top. [3]

Column size	
From Story 1 to Story 6	1.5m x 0.6m
Story 7 to Story 10	1.2m x 0.8m
Story 11 to Story 15	0.8m x 0.4m
Floating columns	0.8m x 0.4m
Beam size	
From Story 1to Story7	0.4m x 0.8 m
Story 7th in X direction	1m x 1m
Slab thickness	
Story 1 to 7	0.150m
Story 8 to 12	0.125m

Table 1: Column Beam Slab Size

Following 10 models are analyzed by equivalent static method, response spectrum method and Non-Linear Time History analysis using ETABS software. [1]

1) Model 1: Bare frame model, however masses of brick masonry infill walls are included in the model with P-Delta option for equivalent static method, response spectrum method and Time history nonlinear analysis.
2) Model 2: Bare frame model, however masses of brick masonry infill walls are included in the model without P-Delta option for equivalent static method, response spectrum method and Time history nonlinear analysis.
3) Model 3: Masonry frame model, however masses of brick masonry infill walls and stiffness are included in the model with P-Delta option for equivalent static method, response spectrum method and Time history nonlinear analysis.
4) Model 4: Masonry frame model, however masses of brick masonry infill walls and stiffness are included in the model without P-Delta option for equivalent static method, response spectrum method and Time history nonlinear analysis.
5) Model 5: Bare frame model, however masses of brick masonry infill walls are included in the model and 'L' Type Shear wall add with P-Delta option for equivalent static method, response spectrum method and Time history nonlinear analysis.
6) Model 6: Bare frame model, however masses of brick masonry infill walls are included in the model and 'L' Type Shear wall add without P-Delta option for equivalent static method, response spectrum method and Time history nonlinear analysis.
7) Model 7: Bare frame model, however masses of brick masonry infill walls are included in the model and 'Swastik' type shear wall adds with P-Delta option for equivalent static method, response spectrum method and Time history nonlinear analysis.
8) Model 8: Bare frame model, however masses of brick masonry infill walls are included in the model and

‘Swastik’ type shear wall adds without P-Delta option for equivalent static method, response spectrum method and Time history nonlinear analysis.

9) Model 9: Bare frame model, however masses of brick masonry infill walls are included in the model and ‘H’ Type shear wall add with P-Delta option for equivalent static method, response spectrum method and Time history nonlinear analysis.
10) Model 10: Bare frame model, however masses of brick masonry infill walls are included in the model and ‘H’ Type shear wall add without P-Delta option for equivalent static method, response spectrum method and Time history nonlinear analysis.

B. Analysis Data

Following data is used in the analysis of the RC frame building models for equivalent static method and Time History Non-Linear Analysis. [4]

1) Material Properties

E for (M20) concrete = 25.00×10^6 KN/m²
E for (M30) concrete = 29.58×10^6 KN/m²
Density of RCC = 25kN/m³
E for brick masonry = 3500×10^3kN/m²
Density of brick masonry = 20kN/m³
Floor finishes = 1.5kN/m²
Live load intensities: = 4.0KN/ m²

2) Seismic Data: (as per IS:1893-2002)

Zone factor (table 2) = 0.36(Zone–V)
Importance factor I (Table 6) = 1.5
Response reduction factor R (Table 7) = 5.0(SMRF)
Soil type (Figure 2) = Type II (Medium soil)

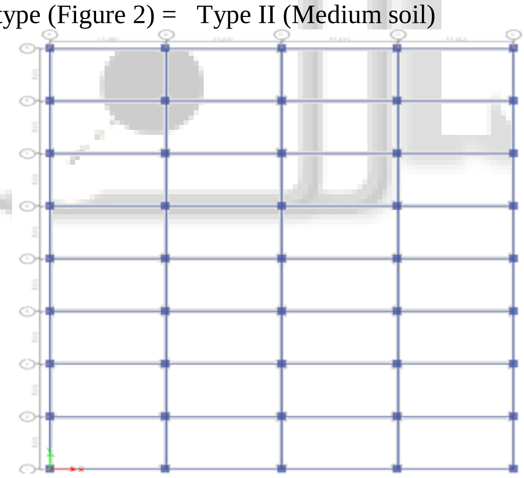
Fig. 1: Floor Plan up to intermediate soft-story

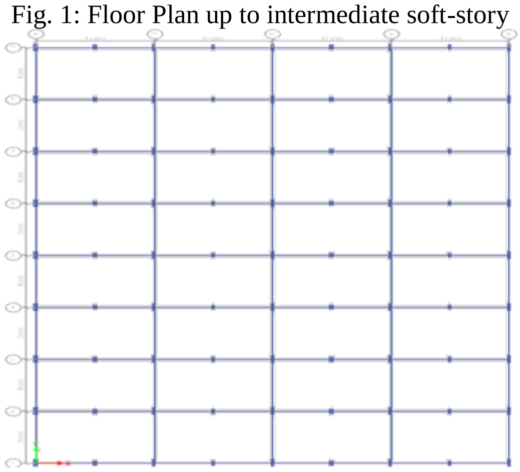
Fig. 2: Floor Plan after intermediate soft story [6]


Fig. 3: Elevation of Building Model-1and 2 along y-dir & x-dir.

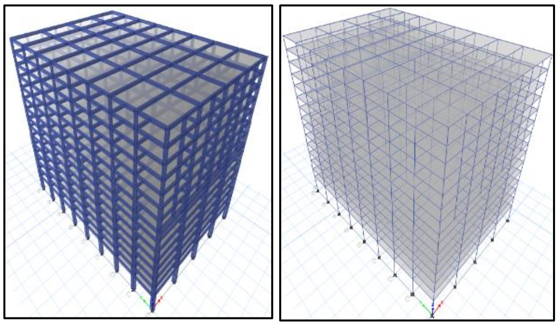
Fig. 4: 3D View of Model-1&2 [6]

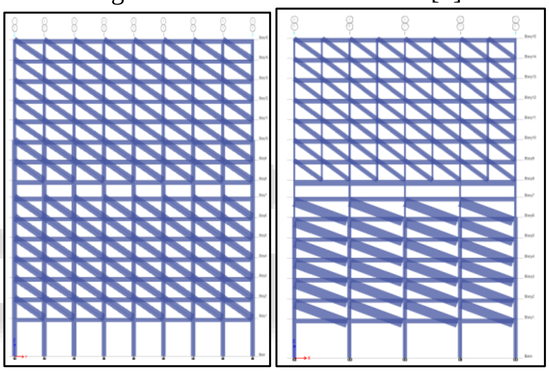
Fig. 5: Elevation of Building Model-3&4 along y-dir & x-dir.

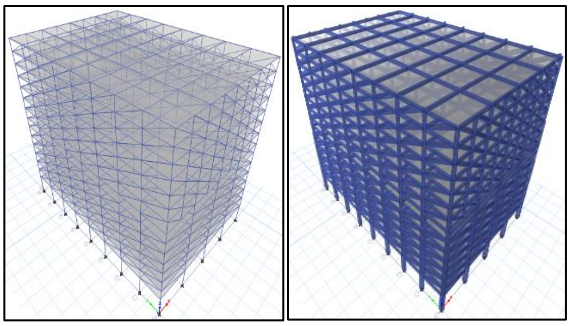
Fig. 6: 3D View of Model-3&4 [6]

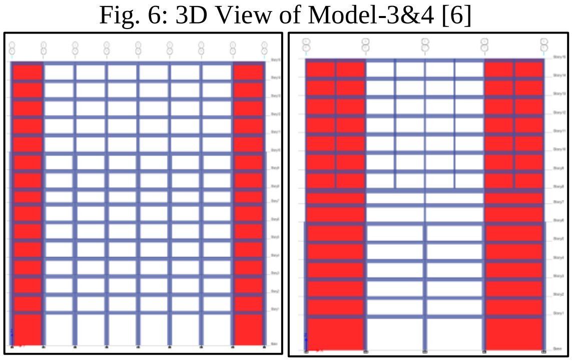
Fig. 7: Elevation of Building Model-5&6 along y-dir & x-dir.

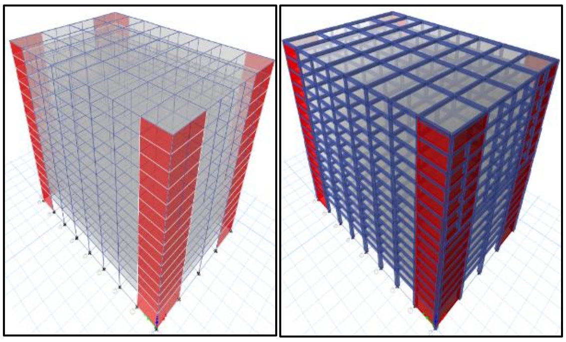

Fig. 8: 3D View of Model-5&6 [6]

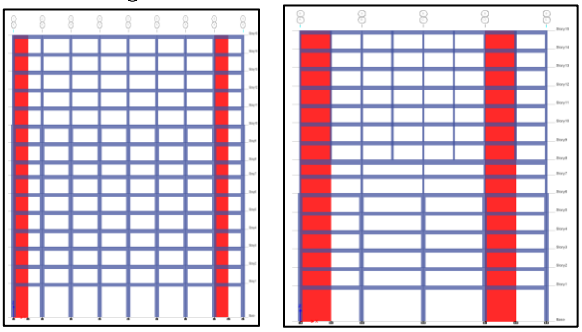

Fig. 9: Elevation of Building Model-7&8 along x-dir & y-dir.

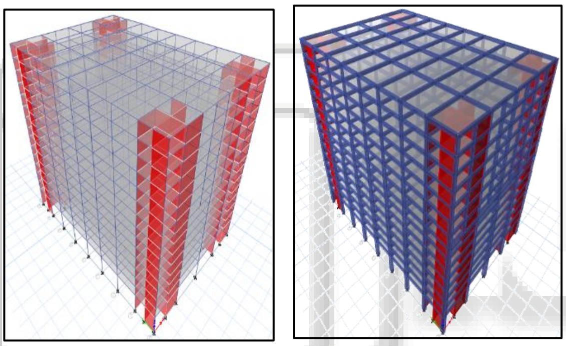

Fig. 10: 3D View of Model-7&8 [6]

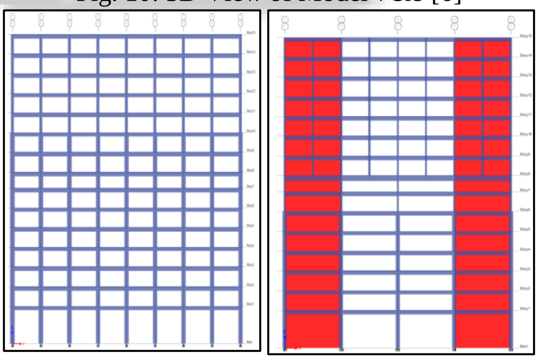

Fig. 11: Elevation of Building Model-9&10 along y-dir & x-dir.

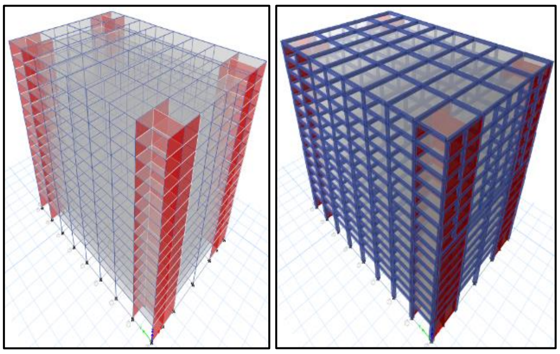

Fig. 12. 3D View of Model-9&10 [6]

III. RESULTS AND DISCUSSIONS

Most of the past studies on different buildings such symmetrical and unsymmetrical have adopted idealized structural systems without considering the effect of concrete shear and core walls. Although these systems are sufficient to understand the general behaviour and dynamic characteristics, it would be interesting to know how real building will respond to Earthquake forces and Wind forces. For this reason, a hypothetical building, located on a plane ground having similar ground floor plan have been taken as structural systems for the study. In this chapter, the results of natural period of vibration, base shear, lateral displacements, Story drifts of different building models are presented and compared. An effort has been made to study the effect of shear wall both at Centre and corners on exterior side in longitudinal & transverse direction respectively. [2]

A. Fundamental Natural Time Period

Table 1 shows the time period and frequency obtained by THNA. Time period for bare frame with P-Delta (model-2) increases by 5.17% as compared to bare frame without P-Delta (model-1). Model-3 reduces time period by 63.58% as compared to model-2. Similarly, for model-4, 5, 6, 7, 8, 9, and 10 are 62.60%, 52.24%, 51.74%, 55.37%, 55.05%, 56.91%, and 56.53% respectively. From that it can be clear that the presence of p-delta in the building will increases the time period and decreases the frequency of the structure. Thus it can be clearly understanding that, presence of brick infill wall stiffness and shear wall considerably reduces the time period of building. [3]

Model	Period in Sec	Frequency in CYC/Sec
1	3.266	0.306
2	3.444	0.290
3	1.257	0.796
4	1.288	0.776
5	1.645	0.608
6	1.662	0.602
7	1.537	0.651
8	1.548	0.646
9	1.484	0.674
10	1.497	0.668

Table 1: Fundamental natural time period and Frequency using ETABS software for various models.

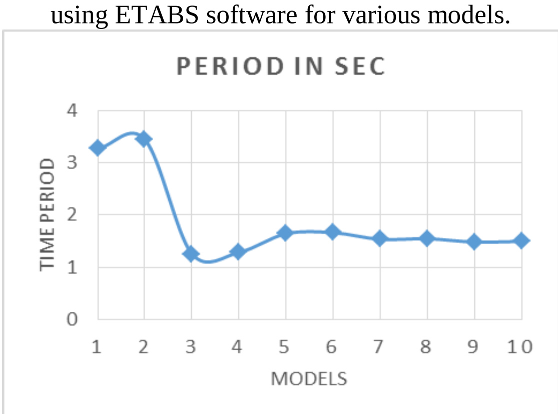

Fig. 13: Chart 1 Model Vs Time period for Different models.

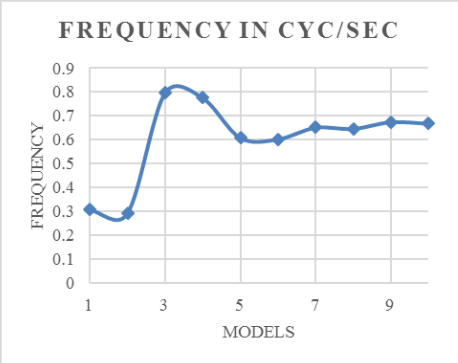

Fig. 14: Chart 2 Model Vs frequency for Different models.

B. Story Drifts

The maximum Story drifts for various building models along longitudinal and transverse direction obtained from Non-linear time history analysis from ETABS are shown in tables below, from the table 2 and 3 and chart 3 and 4. From that it can be seen that the Story drift in all Story for models without having Shear walls (model-1 to 4), the drift values gradually decrease from Story 1 to 15th Story in both directions and from model-5 to 10 with shear walls, the drift values gradually increasing from Story 1 to 15th Story in both directions. The effect of p-delta is reducing the drift values for all models of 4, 6, 8 and 10 but it is increasing in model-2. The permissible Story drift according to IS1893(part1)-2002 is limited to 0.004 times the Story height. All the values of drift are within the limit as per IS:1893-2002 i.e., 0.004x3.5=0.014m, 0.004x3=0.012m and 0.004x7=0.028m. [3]

Story No	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9	Model 10
1	0.002079	0.002235	0.008407	0.008102	0.000633	0.000626	0.000907	0.000871	0.000713	0.000708
2	0.002785	0.002998	0.000627	0.000545	0.000988	0.00098	0.001435	0.001433	0.001161	0.001165
3	0.002693	0.002931	0.000426	0.000369	0.00116	0.001155	0.001658	0.001665	0.001385	0.001395
4	0.002594	0.002735	0.000403	0.000358	0.001289	0.001286	0.001841	0.001852	0.001581	0.001597
5	0.002549	0.002413	0.000392	0.000374	0.001406	0.001363	0.001993	0.002009	0.001721	0.001742
6	0.002453	0.00227	0.000409	0.000387	0.001472	0.001429	0.002092	0.002113	0.001804	0.001827
7	0.003313	0.003099	0.000423	0.000416	0.001871	0.001825	0.0023	0.002329	0.002137	0.002174
8	0.002287	0.001945	0.006916	0.006683	0.001626	0.001583	0.002234	0.002262	0.001944	0.001977
9	0.001589	0.001347	0.000302	0.0003	0.001644	0.001603	0.002226	0.002257	0.001998	0.001996
10	0.001845	0.001574	0.000291	0.000288	0.00171	0.001672	0.002248	0.002282	0.002093	0.00203
11	0.001992	0.001709	0.000287	0.000284	0.001774	0.001736	0.002241	0.002277	0.00218	0.002119
12	0.001761	0.001563	0.000277	0.000274	0.001687	0.00165	0.002173	0.002207	0.002157	0.002099
13	0.001415	0.001355	0.000268	0.000266	0.001595	0.001559	0.002098	0.00213	0.00213	0.002075
14	0.00097	0.000971	0.000262	0.000259	0.001536	0.001501	0.002027	0.002057	0.002046	0.001992
15	0.000479	0.00048	0.000258	0.000255	0.001508	0.001473	0.001978	0.002006	0.002031	0.001977

Table 2: Comparison of Story Drifts with Story for different models of Non-Linear Time History analysis in X-direction.

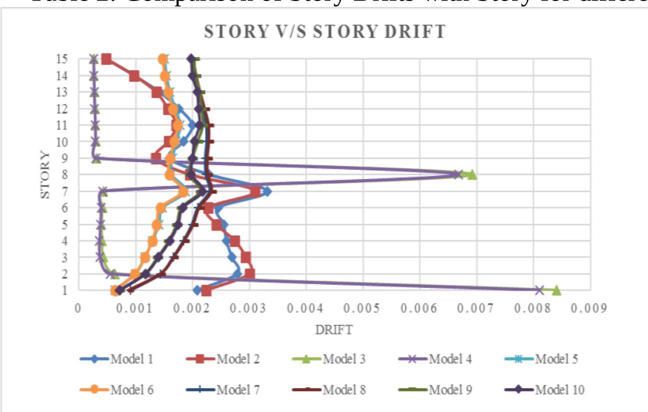

Fig. 15: Chart 3 Story drift Vs Story for different models along X-direction by THNA.

Story No	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9	Model 10
1	0.002257	0.002178	0.006174	0.006152	0.00073	0.000732	0.000625	0.00064	0.000589	0.000575
2	0.003316	0.00317	0.000691	0.000692	0.001157	0.00116	0.000953	0.000998	0.000951	0.000931
3	0.00327	0.003163	0.000368	0.000364	0.001273	0.001269	0.001094	0.001129	0.001085	0.001064
4	0.003062	0.003081	0.000348	0.000346	0.001363	0.001392	0.001254	0.001294	0.00119	0.001169
5	0.002919	0.002918	0.000311	0.000312	0.001536	0.001572	0.001403	0.001447	0.001258	0.001236
6	0.002727	0.002775	0.00031	0.000305	0.00167	0.00171	0.001507	0.001554	0.001326	0.001333

7	0.002822	0.00308	0.000341	0.000345	0.001842	0.001889	0.001703	0.001755	0.001479	0.001487
8	0.002867	0.003066	0.002136	0.002099	0.001872	0.00192	0.001729	0.001781	0.001469	0.001474
9	0.003098	0.003226	0.000436	0.000431	0.001923	0.001972	0.001808	0.00186	0.001501	0.001505
10	0.003254	0.003335	0.000318	0.000315	0.001952	0.002002	0.001817	0.001868	0.001489	0.00149
11	0.003723	0.003789	0.000295	0.000296	0.002039	0.00209	0.001918	0.001971	0.001564	0.001566
12	0.003498	0.003527	0.000265	0.000266	0.001943	0.001992	0.001865	0.001914	0.001467	0.001467
13	0.002968	0.002959	0.000247	0.000248	0.001849	0.001896	0.001822	0.001869	0.001383	0.001382
14	0.002189	0.002163	0.000233	0.000233	0.001762	0.001805	0.001744	0.001789	0.00128	0.001281
15	0.001366	0.00134	0.000228	0.000227	0.001717	0.001758	0.001661	0.001703	0.001206	0.001207

Table 3: Comparison of Story Drifts with story for different models of Non-Linear Time History analysis in Y-direction.

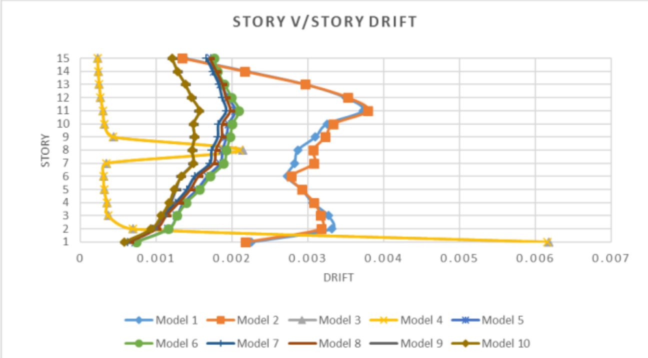

Fig. 16: Chart 4 Story drift Vs Story for different models along Y-direction by THNA.

C. Story Displacements

The maximum displacement at each Story with respective to ground level are presented in tables obtained from Non-Linear Time history analysis for different models. To understand in a better way, the displacements for each model along the longitudinal direction and transverse direction are plotted in charts below. Table 4 and 5, and chart 5 and 6 shows all Model Story displacements. The bare frame model-1 has highest Story displacement values as compared to all model-2. The effect of P-Delta in the models-2, 4, 6, 8 and 10 have the displacements values increasing little bit. The use of wall stiffness or shear wall in the models are reducing the displacement values.

Story No	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9	Model 10
1	211.299	210.505	210.424	210.477	209.458	209.462	209.352	209.351	209.329	209.329
2	213.074	212.040	210.447	210.500	209.661	209.672	209.469	209.470	209.438	209.439
3	214.846	213.667	210.474	210.527	209.890	209.909	209.603	209.607	209.572	209.572
4	216.568	215.255	210.500	210.553	210.140	210.166	209.751	209.758	209.724	209.724
5	218.209	216.752	210.525	210.578	210.399	210.434	209.910	209.920	209.890	209.889
6	219.773	218.161	210.550	210.603	210.651	210.694	210.070	210.082	210.058	210.057
7	221.785	219.941	210.576	210.628	210.959	211.013	210.270	210.285	210.264	210.262
8	222.715	220.714	211.137	211.206	211.164	211.225	210.417	210.434	210.418	210.413
9	223.346	221.183	211.161	211.231	211.394	211.461	210.594	210.613	210.600	210.595
10	224.002	221.641	211.184	211.254	211.633	211.709	210.786	210.807	210.796	210.788
11	224.650	222.064	211.209	211.279	211.868	211.955	210.982	211.006	210.995	210.985
12	225.186	222.387	211.233	211.303	212.087	212.183	211.173	211.200	211.189	211.176
13	225.597	222.621	211.258	211.328	212.293	212.401	211.357	211.387	211.378	211.363
14	225.872	222.772	211.282	211.352	212.485	212.606	211.532	211.565	211.561	211.544
15	226.011	222.851	211.306	211.376	212.639	212.771	211.676	211.712	211.717	211.698

Table 4: Comparison of Story Displacement with different models for Non-Linear Time History analysis in X-direction.

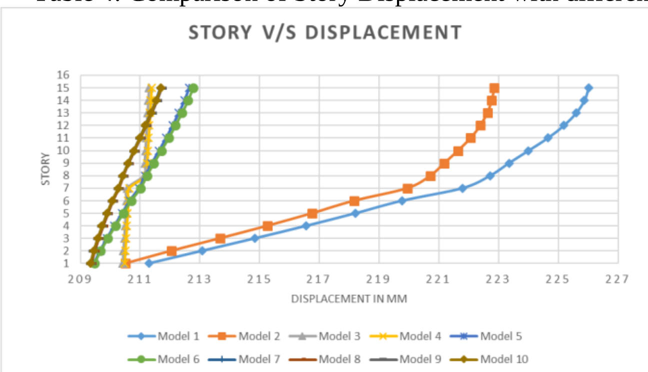

Fig. 17: Chart 5 Story Displacement Vs Story for different models along X-direction by THNA.

Story No	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9	Model 10
1	209.809	209.701	209.349	209.349	209.298	209.311	209.340	209.335	209.426	209.401
2	210.346	210.132	209.355	209.356	209.426	209.454	209.467	209.46	209.627	209.586

3	210.916	210.606	209.359	209.361	209.573	209.618	209.606	209.596	209.845	209.784
4	211.481	211.079	209.364	209.367	209.727	209.792	209.749	209.735	210.067	209.986
5	212.029	211.536	209.369	209.372	209.881	209.969	209.888	209.871	210.287	210.185
6	212.557	211.973	209.374	209.378	210.030	210.141	210.021	209.998	210.500	210.376
7	213.077	212.399	209.380	209.384	210.174	210.311	210.152	210.122	210.713	210.565
8	213.464	212.714	209.433	209.435	210.278	210.435	210.253	210.215	210.872	210.708
9	213.916	213.087	209.440	209.442	210.395	210.579	210.386	210.335	211.067	210.884
10	214.350	213.450	209.447	209.449	210.500	210.709	210.542	210.474	211.257	211.062
11	214.807	213.835	209.453	209.455	210.598	210.834	210.747	210.662	211.466	211.264
12	215.207	214.169	209.459	209.461	210.686	210.944	210.968	210.87	211.678	211.473
13	218.062	221.600	209.465	209.467	210.780	211.048	211.191	211.083	211.892	211.685
14	224.179	228.414	209.471	209.473	210.894	211.159	211.404	211.288	212.100	211.889
15	228.136	232.740	209.477	209.478	211.007	211.271	211.589	211.465	212.277	212.062

Table 5: Comparison of Story Displacement with different models for Non-Linear Time History analysis in Y-direction.

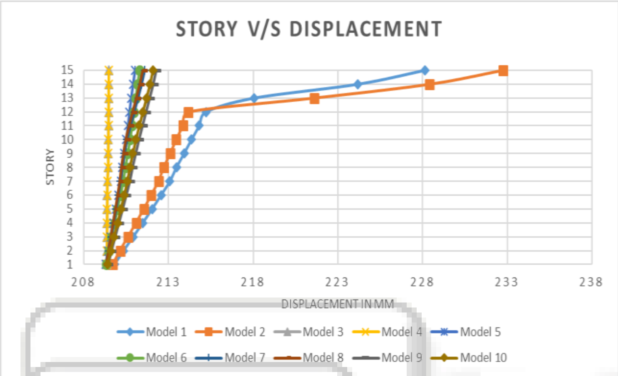

Fig. 18: Chart 6 Story Displacement Vs Story for different models along Y-direction by THNA.

D. *Story Acceleration*

The maximum acceleration at each floor level with respect to ground are presented in tables 6 and 7, Chart- 7 and 8, obtained from Non-Linear Time History Analysis along x-direction and y-direction. The acceleration value is lower for the bare frame model-2 as compare to the other models, when masonry infill stiffness taken into consideration, (full brick infill) model-3 and 4 shows considerable increase in Story acceleration than model-1 and 2. It is observed that, the models with wall stiffness and shear wall yields comparatively greater Story acceleration. Hence it can be concluded that by providing shear walls at corners in X and Y direction significantly increases the Story acceleration in the Storys. 'L' type shear wall reduces the Story acceleration compared to all other models. And consideration of P-delta will reduce the acceleration values in all the models. [3]

Story No	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9	Model 10
1	591.25	563.22	1705.3	1451.75	1065.07	1088.15	1065.73	1077.30	1107.20	1102.88
2	623.68	646.94	1749.62	1493.75	1184.81	1191.33	1058.29	1068.29	1263.00	1240.26
3	695.74	734.02	1775.21	1521.74	1162.58	1175.79	1113.43	1124.67	1605.12	1576.92
4	688.18	702.42	1799.42	1549.73	1222.07	1216.57	1270.90	1292.63	1853.08	1822.42
5	699.34	719.59	1821.37	1575.32	1317.28	1319.53	1311.66	1319.41	2047.66	2026.97
6	799.86	723.57	1843.62	1600.50	1318.90	1332.60	1450.70	1435.23	2206.70	2191.66
7	759.04	692.67	1874.31	1631.82	1304.49	1288.35	1576.24	1565.07	2206.34	2193.58
8	605.07	551.53	2385.78	2247.88	1316.69	1305.52	1658.21	1641.37	2044.42	2028.24
9	475.67	432.74	2405.16	2261.66	1268.78	1264.13	1737.39	1717.03	2126.95	2089.97
10	472.81	472.19	2422.11	2274.45	1150.91	1148.61	1819.32	1806.83	2198.86	2160.07
11	519.66	506.69	2438.54	2286.65	1022.31	996.13	1927.41	1921.05	2088.46	2038.52
12	569.96	517.35	2454.43	2299.27	1233.60	1187.13	2093.00	2095.96	2278.34	2295.84
13	707.94	672.51	2470.03	2312.38	1472.78	1421.42	2349.45	2372.75	2536.14	2568.99
14	894.47	850.5	2485.08	2325.79	1706.81	1654.99	2695.41	2739.93	3065.72	3029.34
15	997.43	944.24	2499.69	2339.96	1913.94	1862.17	3034.78	3093.37	3556.43	3497.62

Table 6: Comparison of Story Accelerations with different models for Non-Linear Time History analysis in X-direction.

Story No	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9	Model 10
1	821.52	812.32	2784.01	2799.85	1041.79	1042.48	1171.55	1177.18	1034.67	1030.33
2	888.62	862.64	2834.52	2850.21	1223.86	1216.71	1260.32	1269.72	1170.17	1158.06
3	878.00	879.84	2875.79	2891.19	1335.02	1329.45	1331.74	1343.82	1171.42	1156.23
4	1026.46	881.80	2912.84	2927.49	1188.54	1203.31	1402.28	1421.64	1149.09	1135.24
5	1046.07	860.88	2947.38	2960.62	1172.79	1177.17	1414.66	1440.58	1192.08	1186.60
6	996.86	893.27	2979.60	2990.64	1288.09	1297.25	1369.17	1398.39	1130.81	1131.24
7	1041.48	955.30	3010.75	3018.56	1281.50	1295.14	1216.89	1245.36	1137.61	1117.31

8	1011.93	955.94	3095.99	3047.87	1213.63	1248.73	1090.48	1111.18	1090.01	1071.44
9	960.95	937.52	3136.23	3068.28	1233.91	1271.86	1082.09	1099.38	920.78	916.69
10	939.36	885.99	3176.94	3091.10	1139.07	1169.23	1055.58	1077.44	961.30	979.06
11	848.07	887.96	3219.04	3116.98	993.78	989.93	987.27	1014.68	997.76	1017.99
12	1015.53	1004.21	3262.49	3146.06	1044.99	1031.87	1153.88	1186.62	1147.07	1125.61
13	958.89	917.23	3306.79	3177.88	1231.58	1224.74	1413.32	1451.92	1194.49	1188.06
14	1246.19	1114.32	3352.30	3211.99	1460.17	1509.05	1663.11	1705.93	1400.89	1390.31
15	1484.50	1340.36	3398.25	3248.22	1810.51	1859.71	1924.77	1971.16	1585.33	1571.64

Table 7: Comparison of Story Accelerations with different models for Non-Linear Time History analysis in Y-direction.

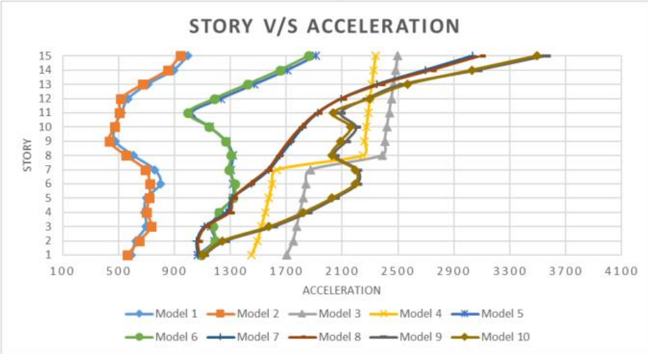

Fig. 19: Chart 7 Acceleration Vs Story for different models along X-direction by THNA.

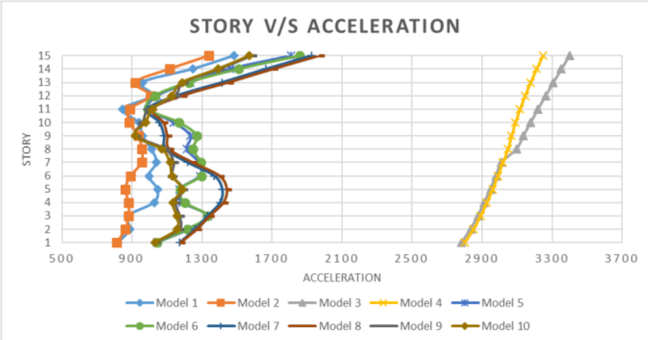

Fig. 20: Chart 8 Acceleration Vs Story for different models along Y-direction by THNA.

E. Seismic Base Shear

Table 8 shows comparison of highest values of seismic base shear of different models by Non-linear time history analysis using Bhuj Earthquake data. From the table it can be seen that the seismic base shear for all model-3 and 4 has larger values then all other models. The use of p-delta in the analysis decreasing the base shear value by 4.5% to 17% in longer direction and decreases 1.5% to 12% in shorter direction when compared without p-delta models-1, 3, 5, 7, 9 [3]

Model No	Base Shear along X	Base Shear along Y
1	13236	24997
2	12353	21449
3	93870	131205
4	84144	131828
5	29592	33064
6	29488	31581
7	60176	32496
8	58209	32810
9	78535	29978
10	77176	30939

Table 8: Seismic Base shear by Non-linear Time-History analysis.

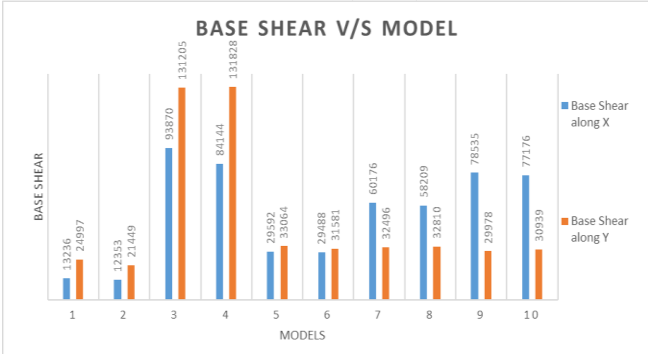

Fig. 21: Chart 9 Model Vs Base shear for different models along X & Y-direction by NTHA.

IV. CONCLUSIONS

1) Time period of the structure increases with use of p-delta in the analysis and frequency of the structure decreases.
2) Time period decreases when the stiffness of masonry infill wall stiffness and shear wall are considered.
3) Story drift of all the Stories found within the limit.
4) Story drift increases in longer direction and decreases in shorter direction when considered p-delta effect to the building. P-delta not effect more on drift, so it can be negligible.
5) Story displacement are decreases when infill wall stiffness and shear walls are considered in to the building.
6) Story acceleration are increases when infill wall stiffness and shear walls are added to the structure.
7) Base shear decreases when p-delta is considered in the building along shorter direction and increase in longer direction.
8) The soft story effect is less at intermediate location of the building. A service Story of lesser height can be safer for building at higher level.
9) Models with soft stories have got highest Story drift values at soft stories levels, which leads to dangerous sway mechanism. Therefore, providing shear wall is essential so as to avoid soft Story failure.
10) The use of P-delta can be included in the building for the analysis and design purposes.

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