Comparative Study on Conventional Slab & Flat Slab System Using Overhanging Column For Seismic Zone-3 Using Staad Pro Software

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Abstract - A reinforced concrete flat slab, also called as beamless slab, is a slab supported directly by columns without beams. A part of the slab bound on each of the four sides by centre lines of columns is called a panel. The flat slab is often thickened near to supporting columns to provide adequate strength in shear and to reduce the quantity of negative reinforcement in the support regions. The main difference between flat slab & conventional slab-beam system is that the one is directly supported on the column while another system has a beam for support. This study on conventional slab & flat slab system using overhanging column for seismic zone-3 using staad pro software. For this analysis we used STAAD. Pro software and prepare model for same height, same plan and same loading condition. We are taking a G+8 -story building for analysis having 28.8 m height from ground level and 19 x 20 m is plan.

I. INTRODUCTION

- The economic growth and rapid urbanization in hilly region has accelerated the real estate development and resulted in increase in population density in the hilly region enormously. Therefore, there is popular and pressing demand for the construction of multi-storey The main objective of the analysis is to study the behaviour against different forces acting on components of a multistoried building .
- With rapid growth in population along with development of industrial and commercial activities rapid urbanization has taken place which has resulted into continues influx of rural people to metro cities. So obviously the horizontal space constraint is reaching an alarming situation for metros.
- To cope with the situation maximum utilization of space vertically calls for the construction of multi-storey buildings in large numbers but the question of affordability of the target customers mainly the middle income group of our country necessitates efficient and cost effect design of such buildings.

II. OBJECTIVES

- **Comparative study on conventional slab & flat slab system using overhanging column for seismic zone-3 using staad pro software.**

III. METHODOLOGY

4.1 General :

study on conventional slab & flat slab system using overhanging column for seismic zone-3 using staad pro software are modeled and analyzed for the different combinations of static loading. The comparison is made between the conventional slab & flat slab system structure situated in seismic zone III. Different cases of building considered are as given below :

Case-1: analysis of Building without overhanging columns with conventional slab

Case-2: analysis of Building having Overhanging Columns with conventional Slab.

Case-3: analysis of Building without overhanging columns With Flat slab.

Case-4: analysis of Building having Overhanging Columns with Flat Slab

In this study the behavior of building frame with and without overhanging columnis studied under static load, Dynamic load and seismic loading condition. The Response Spectrum method is adopted for dynamic analysis in the STAAD. Pro. Four G+8 Storey two bay 3D building frame with and without overhanging columns are analyzed for static loading using the present FEM code and for dynamic loading using Response Spectrum method. For analysis of the commercial software *STAAD Pro*. For this study we design a G+8 Storey building tower with all columns supporting to the ground and another same building is design with overhanging columns. These columns are supported by a shear wall provided in place of brick masonry wall.

IV. RESULT ANALYSIS

In this example two concrete frames with and without overhanging column having same material property and dimension are analyzed under same loading condition.

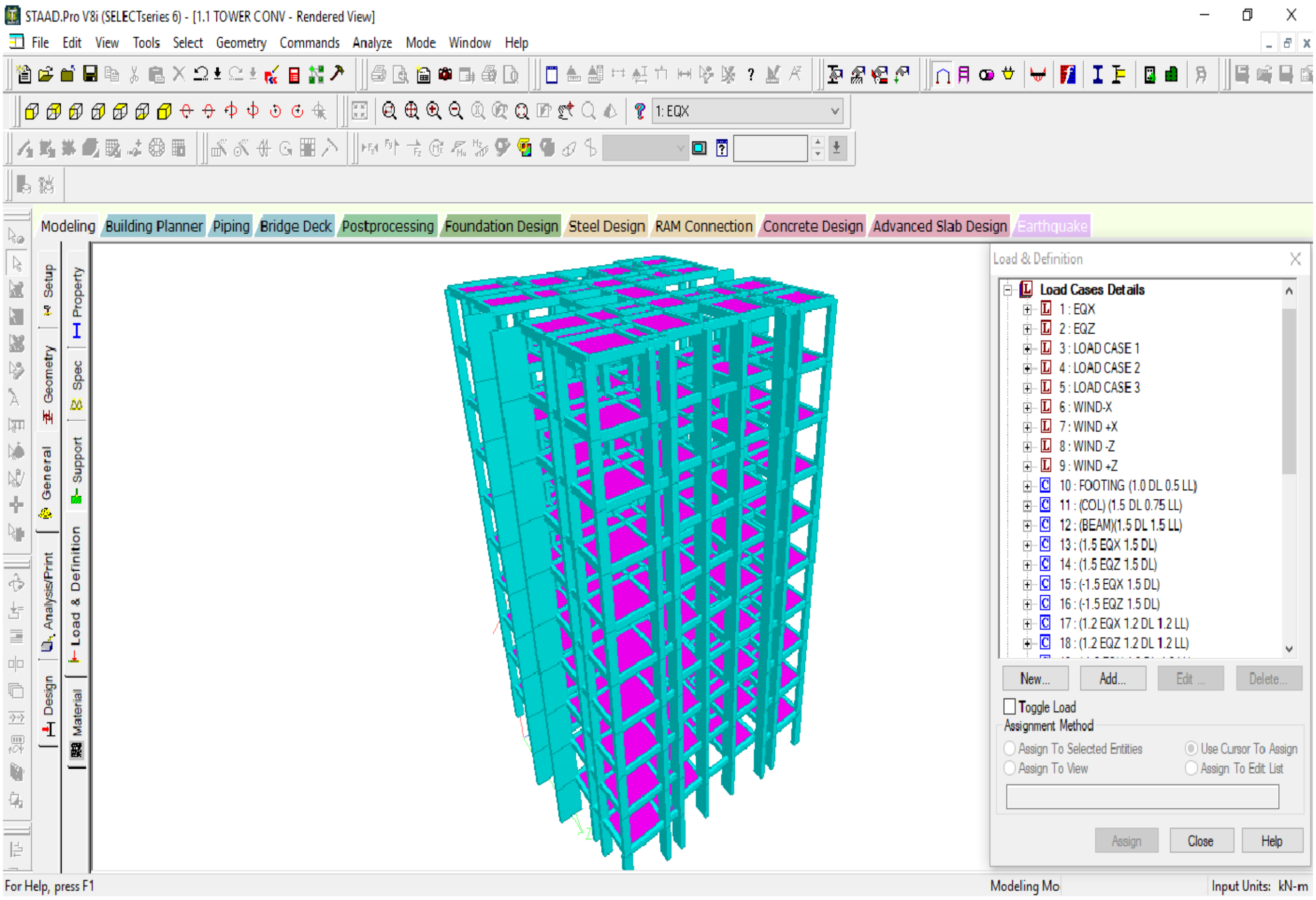

Fig. 4.2 –STAAD Generated 3D Rendered model of building having conventional slab.

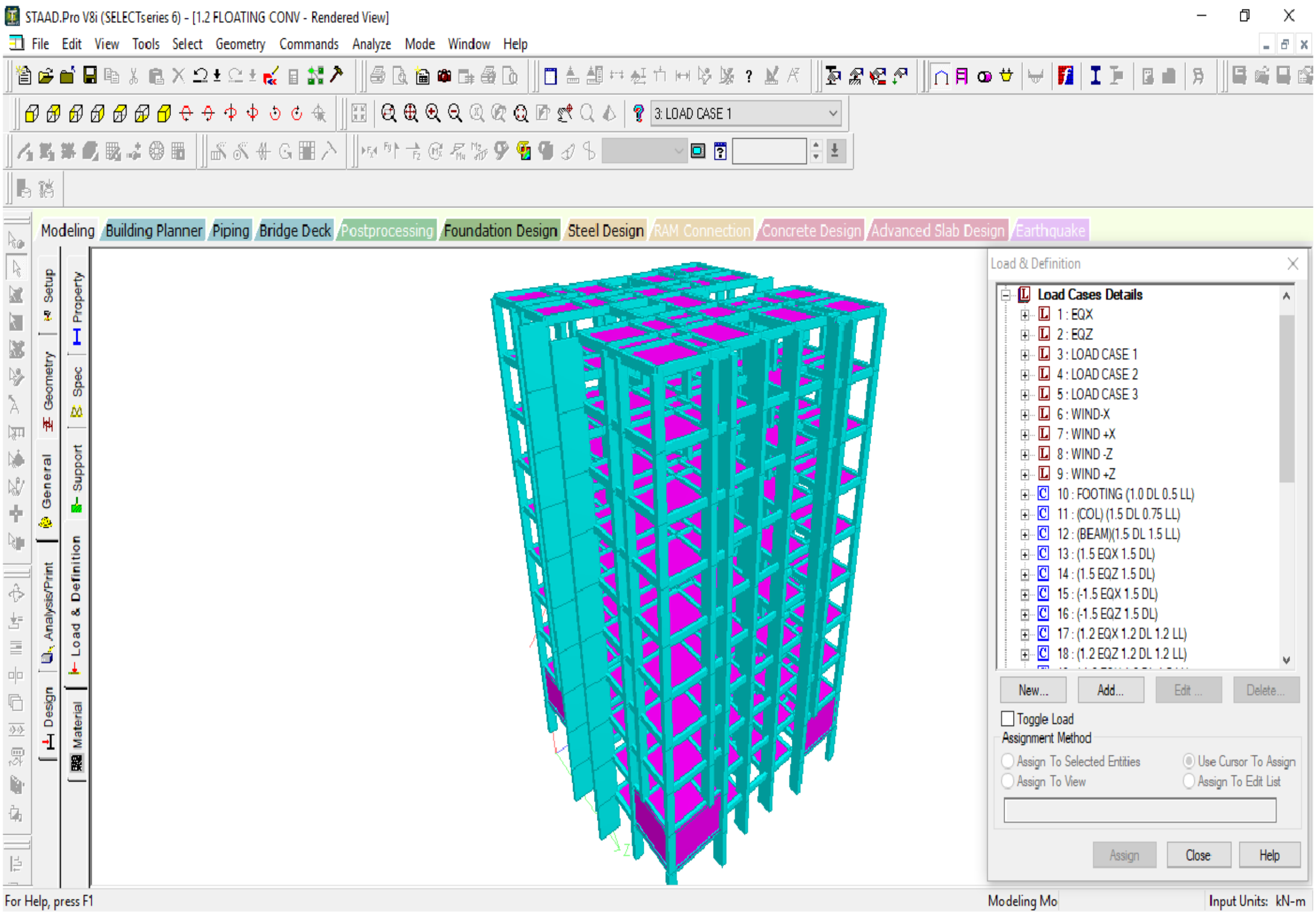

Fig. 4.3 –STAAD Generated 3D Rendered model of building having conventional slab and overhanging columns.

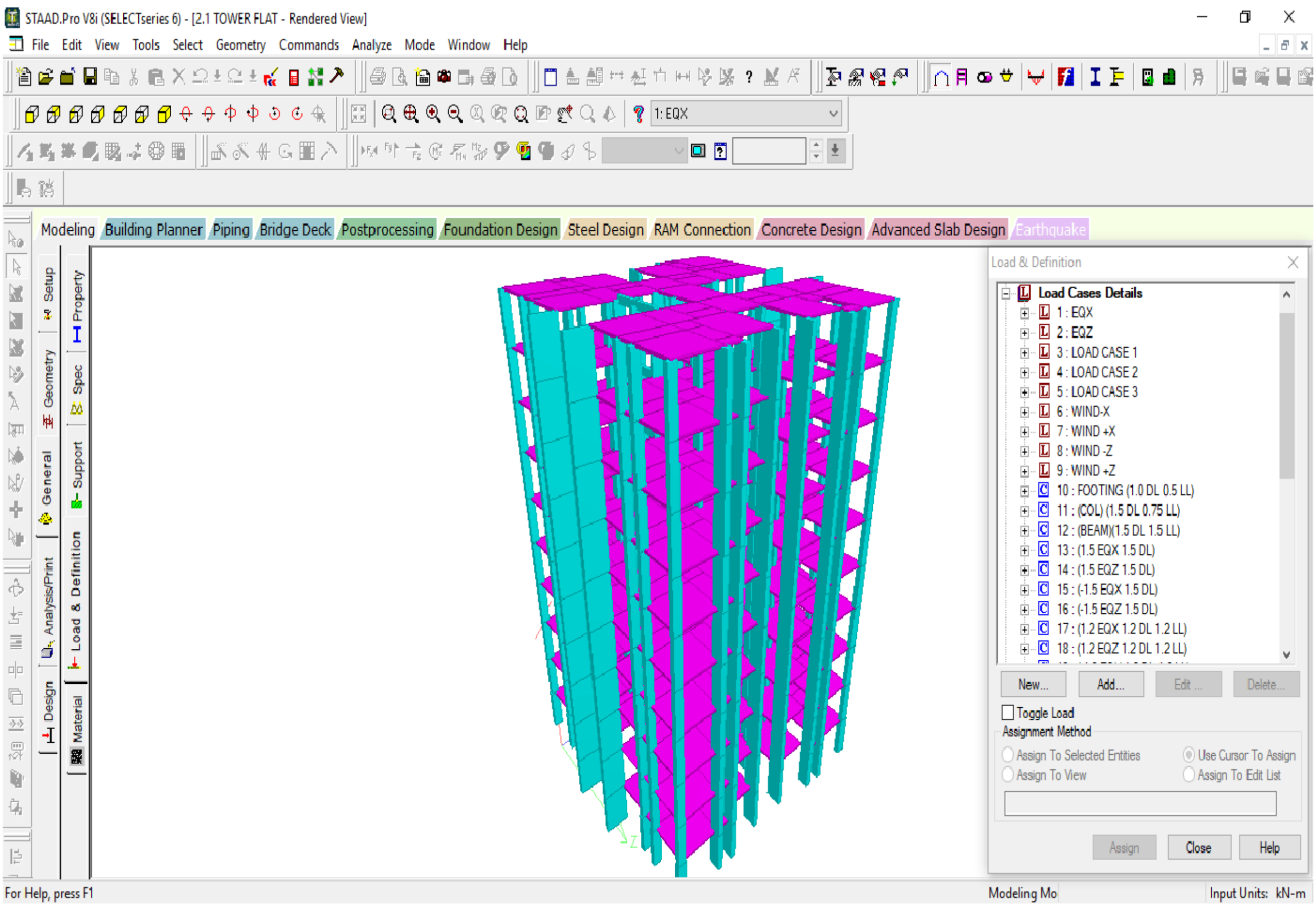

Fig. 4.4 –STAAD Generated 3D Rendered model of building having flat slab.

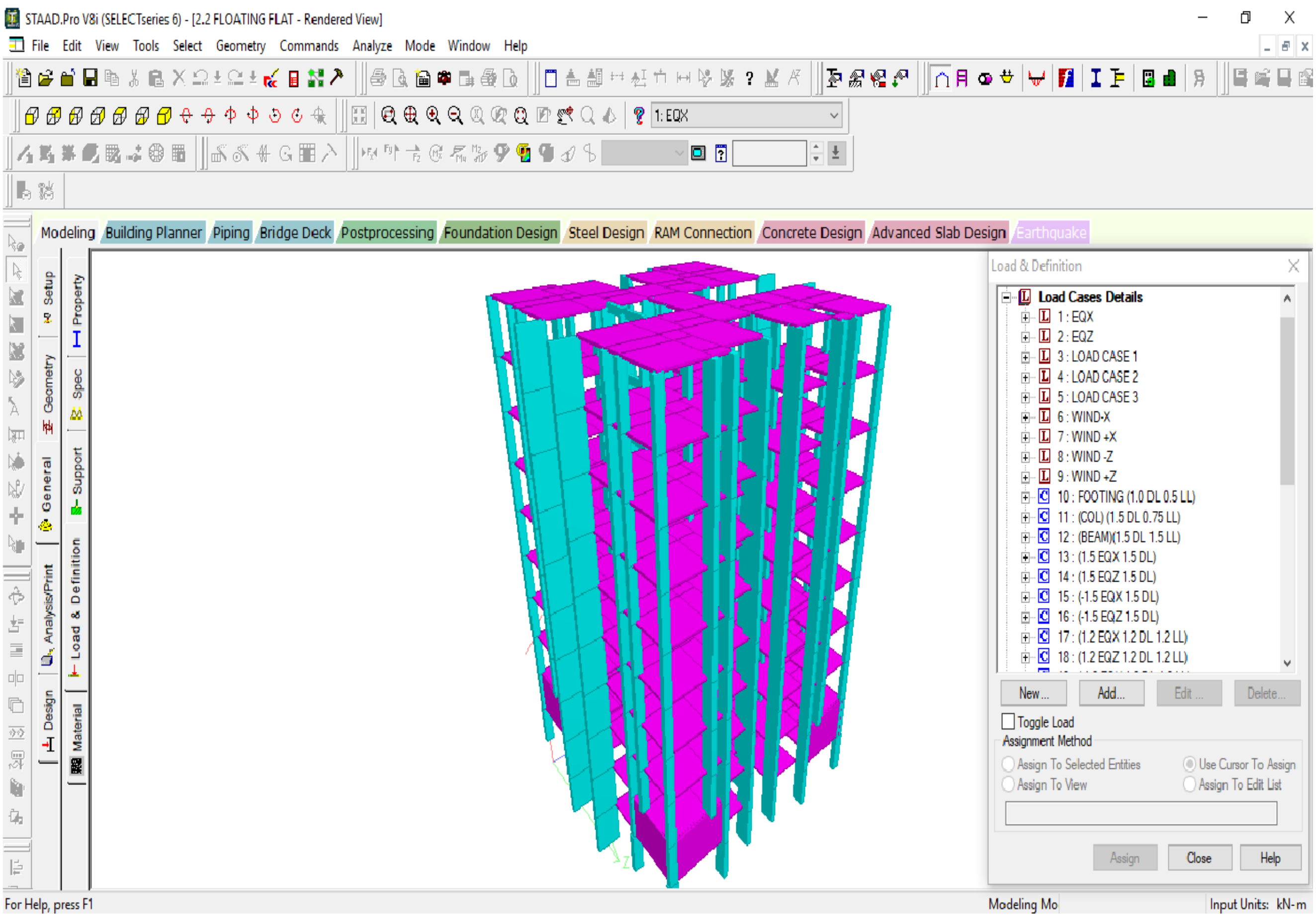

Fig. 4.5 –STAAD Generated 3D Rendered model of building having flat slab and overhanging columns.

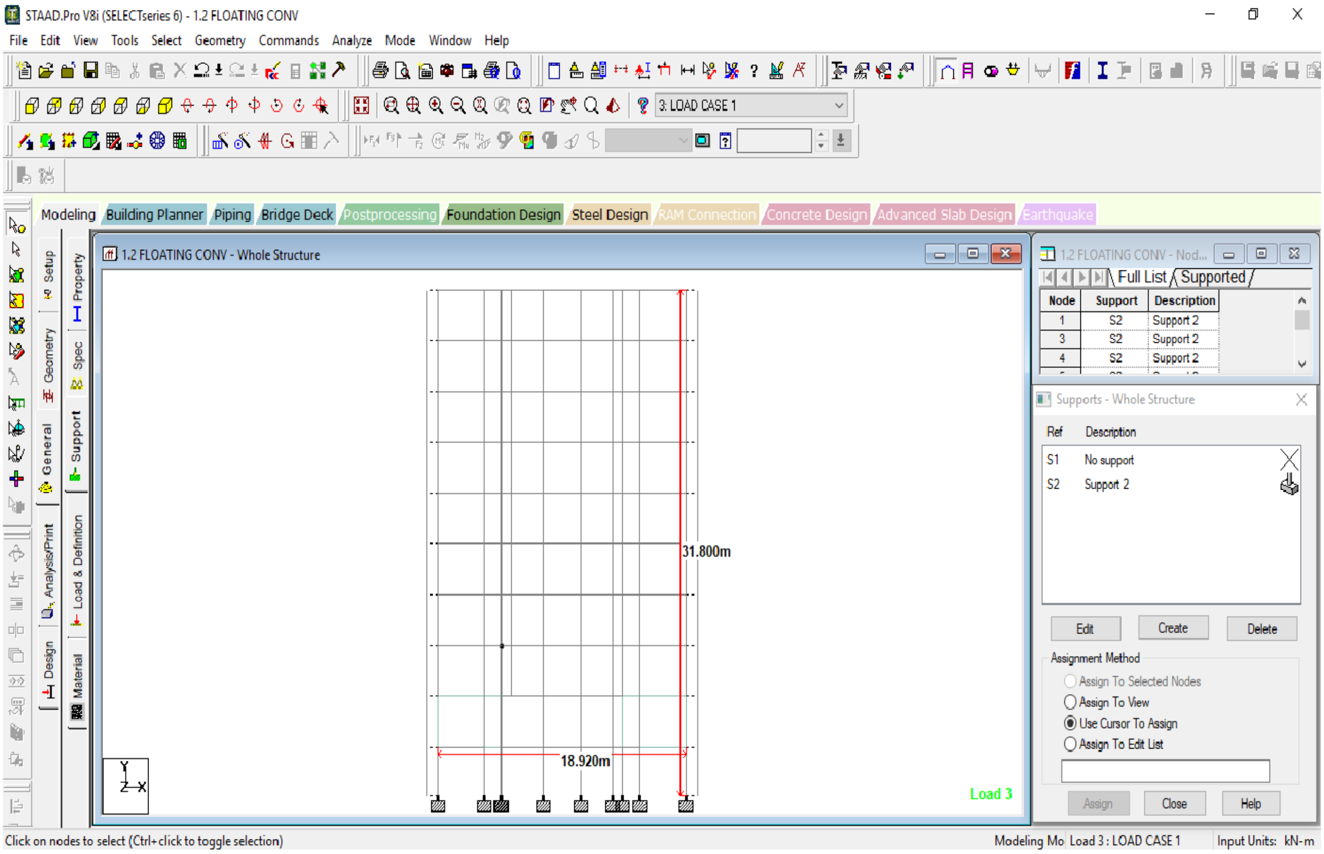

Fig. 4.11 – Basic Elevation of the building having shear wall and overhanging columns.

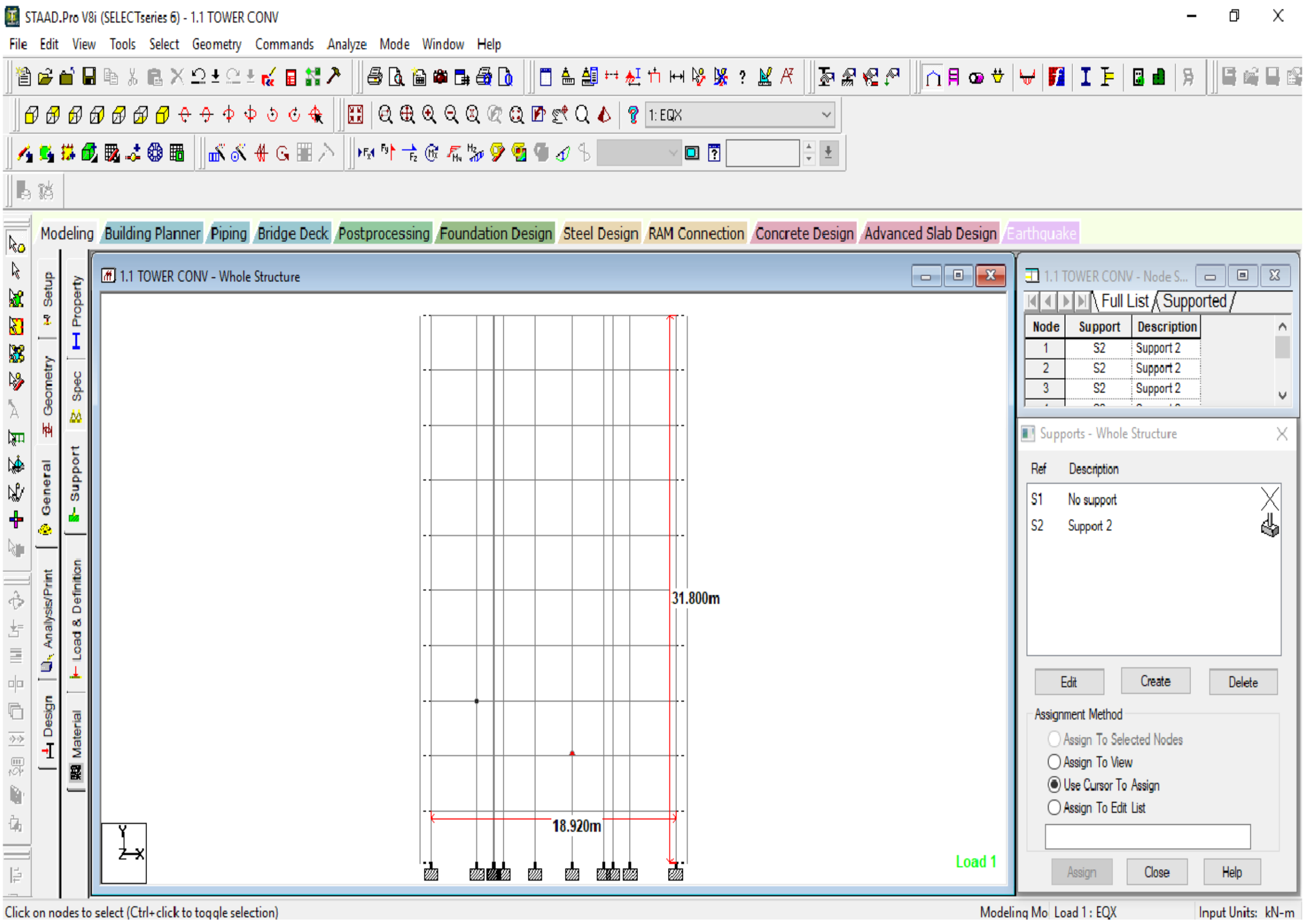

Fig. 4.12 – Basic Elevation of the building without shear wall and overhanging columns.

After finishing comparative study of the building's towers Analysis of G+8 storied buildings with Conventional slab & flat slab system using with & without overhanging column system in zone III a comparison is made on the basis of following points given bellow. Then final result is obtained by reading these tables.

(1) MAXIMUM & MINIMUM SHARE FORCE

(2) MAXIMUM & MINIMUM AXIAL LOAD ON COLUMNS FOOTING

(3) MAXIMUM & MINIMUM BENDING MOMENT

(4) MAXIMUM & MINIMUM DISPLACEMENT OF BEAMS

Table 5.11 Axial load on columns of building having flat slab without overhanging columns.

Node	*L/C*	*Force-X kN*	*Force-Y kN*	*Force-Z kN*	*Moment-X N-m*	*Moment-Y N-m*	*Moment-Z N-m*
10	5	2.459	359.44	-0.068	63.15	-6.84	-2286.819
11	5	2.463	359.321	0.06	-98.993	0.947	-2295.21
40	5	-1.78	298.289	-3.906	-3728.97	20.008	1885.87
41	5	-1.626	284.211	3.829	3609.91	-22.57	1728.973
22	5	-2.225	273.996	-0.775	-771.238	-1.968	2513.617
24	5	-2.218	273.835	0.775	768.281	0.911	2499.43
28	5	1.602	243.374	0.222	191.645	1.063	-1438.926
31	5	1.355	237.424	-0.446	-446.941	-4.221	-1200.897
29	5	0.173	226.669	-0.319	-319.979	0.365	234.514
19	5	0.089	226.275	-5.023	-4847.172	-40.573	43.376
18	5	0.088	226.26	5.019	4811.044	34.222	49.28
30	5	0.177	225.748	0.31	296.54	-3.224	223.192
25	5	-1.782	218.733	-0.282	-313.815	-5.307	1882.333
21	5	-1.792	218.593	0.273	266.121	1.148	1896.582
34	5	1.92	201.94	-1.466	-1450.502	16.373	-1413.983
35	5	1.915	200.054	1.454	1423.787	-19.506	-1419.167
39	5	-0.461	177.406	1.646	1470.02	16.102	639.547
12	5	0.287	177.143	-1.757	-2035.469	-14.052	-56.997
9	5	0.288	176.977	1.759	1966.157	3.511	-46.07
33	5	0.426	164.84	2.054	1918.849	6.788	-282.446
36	5	0.421	162.04	-2.046	-1957.141	-11.937	-282.003
4	5	4.349	157.076	-0.759	-650.723	-661.637	-1.30E+05
5	5	4.356	156.912	0.756	634.9	646.018	-1.30E+05
3	5	2.341	149.791	1.356	1412.735	-15.78	-1827.204
6	5	2.343	149.715	-1.36	-1423.129	9.842	-1843.481
42	5	-0.163	148.392	-1.152	-1121.051	-28.264	324.789
45	5	-1.948	146.77	0.725	706.202	26.929	2265.902
46	5	-4.486	137.422	-0.522	-546.252	497.875	1.25E+05
48	5	-1.749	136.924	-0.814	-813.254	-28.503	2060.464
47	5	-4.484	135.683	0.531	527.262	-506.999	1.23E+05
44	5	0.704	127.211	0.034	27.29	5.612	-249.526
49	5	0.74	125.976	-0.414	-421.795	-15.093	-308.673
7	5	-1.123	121.876	-0.059	-145.854	-12.454	1482.837
2	5	-1.126	121.598	0.056	136.211	6.089	1504.724
26	5	-0.799	115.844	-0.527	-673.496	-21.598	949.559
20	5	-0.797	115.764	0.534	483.409	16.593	955.705
27	5	0.71	115.441	0.519	341.91	-6.752	-583.728
32	5	0.592	113.168	-0.602	-701.625	-34.141	-478.945
16	5	-0.461	110.155	1.411	1580.131	-11.782	696.324
17	5	-0.463	110.09	-1.408	-1657.22	-0.23	686.4
37	5	0.35	107.645	1.329	1205.321	13.09	-164.024

50	5	-0.621	98.887	-0.487	-493.535	-16.476	967.241
43	5	-0.461	94.625	0.334	321.31	8.728	861.797
8	5	0.153	92.137	-0.36	-436.303	-0.013	346.915
1	5	0.15	91.943	0.357	427.483	-5.836	377.096
38	5	0.115	72.794	-0.791	-849.389	163.541	39.097
13	5	0	0	0	0	0	0
14	5	0	0	0	0	0	0
15	5	0	0	0	0	0	0
23	5	0	0	0	0	0	0

Table 5.12 Axial load on columns of building having flat slab with overhanging columns.

Node	***L/C***	***Force-X kN***	***Force-Y kN***	***Force-Z kN***	***Moment-X N-m***	***Moment-Y N-m***	***Moment-Z N-m***
11	5	6.307	468.381	-1.012	-848.675	90.043	-6846.64
10	5	6.263	467.806	0.875	525.439	-77.817	-6773.629
40	5	-4.972	373.804	-3.559	-4123.977	-81.04	5526.265
41	5	-4.922	361.031	2.98	3179.741	58.336	5487.956
21	5	-5.647	328.082	2.073	2592.642	661.946	6058.239
25	5	-5.625	327.668	-2.157	-2869.348	-618.139	6011.963
28	5	5.09	321.334	1.869	2021.175	-572.134	-5286.039
31	5	5.133	315.39	-1.966	-2289.148	621.87	-5348.491
22	5	-3.159	300.597	-1.271	-1269.244	-71.879	2681.071
24	5	-3.105	300.244	1.25	1233.694	83.165	2590.504
37	5	2.138	248.462	0.578	-2781.077	-1224.546	-1543.83
34	5	1.331	245.537	-1.921	-1792.746	603.778	-1038.582
16	5	-2.192	244.513	1.413	-1350.44	1207.86	1572.896
17	5	-2.125	243.105	-1.648	681.501	-1171.513	1432.054
35	5	1.254	242.863	1.84	1609.491	-571.332	-934.419
45	5	-3.411	233.474	-3.34	-3989.011	161.867	4992.083
3	5	3.743	233.391	-2.706	-3186.004	-317.808	-5291.995
6	5	3.856	232.451	2.646	3069.701	314.195	-5491.971
29	5	0.06	228.584	-0.568	-637.167	294.061	176.799
30	5	0.07	227.692	0.512	511.255	-253.269	153.579
48	5	-3.2	223.443	3.113	3709.694	-121.64	4944.647
38	5	1.504	188.38	0.863	4169.154	514.151	-816.29
4	5	7.152	156.921	-0.819	-1544.92	-619.592	-1.45E+05
5	5	7.472	156.762	0.792	1471.663	651.71	-1.46E+05
8	5	7.767	153.907	-2.476	-2492.082	-99.329	-10288.039
1	5	7.61	150.686	2.401	2360.355	112.396	-9972.07
43	5	-7.61	143.517	1.869	1678.321	-129.341	9890.191
50	5	-7.479	140.619	-1.967	-1831.737	285.568	9859.716
46	5	-6.715	136.005	-0.885	-1901.546	672.374	1.24E+05
47	5	-6.036	133.601	0.804	1759.478	-640.404	1.19E+05
26	5	-0.749	115.849	0.746	3758.586	-3478.339	594.588
20	5	-0.767	115.745	-0.887	-4749.222	3483.513	641.367
27	5	0.422	114.593	-1.523	-5632.045	-2805.962	-170.008
32	5	0.541	111.971	2.082	5941.83	3307.035	-448.196

13	5	0	0	0	0	0	0
15	5	0	0	0	0	0	0
23	5	0	0	0	0	0	0

NODAL DISPLACEMENT OF BEAMS

Table 5.13 Maximum Nodal displacement in building having conventional slab without overhanging columns.

			Horizontal	*Vertical*	*Horizontal*	*Resultant*	*Rotational*		
	Node	***L/C***	***X mm***	***Y mm***	***Z mm***	***mm***	***rX rad***	***rY rad***	***rZ rad***
Max X	846	4 LOAD CASE 2	0.149	-0.635	0.016	0.652	0	0	0
Min X	887	3 LOAD CASE 1	-0.485	-1.861	0.002	1.923	0	0	0
Max Y	1	3 LOAD CASE 1	0	0	0	0	0	0	0
Min Y	793	3 LOAD CASE 1	-0.366	-5.032	0.045	5.045	0	0	0
Max Z	883	3 LOAD CASE 1	-0.385	-3.08	0.122	3.106	0	0	0
Min Z	814	3 LOAD CASE 1	-0.468	-3.095	-0.068	3.131	0	0	0
Max rX	745	3 LOAD CASE 1	-0.355	-2.639	0.025	2.663	0.001	0	0
Min rX	750	3 LOAD CASE 1	-0.386	-2.638	0.021	2.666	-0.001	0	0
Max rY	886	3 LOAD CASE 1	-0.477	-1.864	0.106	1.927	0	0	0
Min rY	887	3 LOAD CASE 1	-0.485	-1.861	0.002	1.923	0	0	0
Max rZ	857	3 LOAD CASE 1	-0.441	-4.339	0.025	4.361	0	0	0
Min rZ	206	3 LOAD CASE 1	-0.04	-3.059	-0.003	3.059	-0.001	0	-0.001
Max Rst	793	3 LOAD CASE 1	-0.366	-5.032	0.045	5.045	0	0	0

Table 5.14 Maximum Nodal displacement in building having conventional slab with overhanging columns.

			Horizontal	*Vertical*	*Horizontal*	*Resultant*	*Rotational*		
	Node	***L/C***	***X mm***	***Y mm***	***Z mm***	***mm***	***rX rad***	***rY rad***	***rZ rad***
Max X	198	3 LOAD CASE 1	0.248	-3.835	-0.002	3.843	0	0	0.001
Min X	846	3 LOAD CASE 1	-1.848	-4.095	0.019	4.493	0	0	0
Max Y	1	3 LOAD CASE 1	0	0	0	0	0	0	0
Min Y	826	3 LOAD CASE 1	-1.836	-7.515	0.016	7.736	0	0	0
Max Z	137	3 LOAD CASE 1	-0.209	-1.678	0.286	1.715	0	0	0
Min Z	140	3 LOAD CASE 1	-0.219	-1.678	-0.306	1.719	0	0	0
Max rX	191	3 LOAD CASE 1	0.001	-3.594	-0.02	3.594	0.001	0	-0.001
Min rX	188	3 LOAD CASE 1	-0.004	-3.616	0.034	3.617	-0.001	0	-0.001
Max rY	179	3 LOAD CASE 1	-0.016	-0.942	0.101	0.948	0	0	0
Min rY	170	3 LOAD CASE 1	-0.08	-0.948	0.106	0.957	0	0	0
Max rZ	196	3 LOAD CASE 1	0.104	-3.879	0.083	3.882	0	0	0.002
Min rZ	159	3 LOAD CASE 1	-0.172	-4.154	0.11	4.159	0	0	-0.002
Max Rst	826	3 LOAD CASE 1	-1.836	-7.515	0.016	7.736	0	0	0

Table 5.15 Maximum Nodal displacement in building having flat slab without overhanging columns.

			Horizontal	*Vertical*	*Horizontal*	*Resultant*	*Rotational*		
	Node	***L/C***	***X mm***	***Y mm***	***Z mm***	***mm***	***rX rad***	***rY rad***	***rZ rad***
Max X	810	3 LOAD CASE 1	0.658	-0.895	0.31	1.154	0	0	0
Min X	1	3 LOAD CASE 1	0	0	0	0	0	0	0
Max Y	1	3 LOAD CASE 1	0	0	0	0	0	0	0
Min Y	819	3 LOAD CASE 1	0.651	-7.056	0.207	7.089	0.003	0	-0.001
Max Z	808	3 LOAD CASE 1	0.519	-1.141	0.314	1.293	0	0	0
Min Z	813	3 LOAD CASE 1	0.48	-1.143	-0.271	1.269	0	0	0
Max rX	63	3 LOAD CASE 1	0.009	-5.488	-0.004	5.488	0.003	0	0
Min rX	64	3 LOAD CASE 1	0.009	-5.487	0.005	5.487	-0.003	0	0
Max rY	836	3 LOAD CASE 1	0.549	-1.701	0.143	1.793	0	0	0
Min rY	881	3 LOAD CASE 1	0.518	-0.956	0.142	1.097	0	0	0
Max rZ	838	3 LOAD CASE 1	0.64	-6.044	0.146	6.08	0.002	0	0.001
Min rZ	833	3 LOAD CASE 1	0.48	-3.122	-0.096	3.16	0	0	-0.001
Max Rst	819	3 LOAD CASE 1	0.651	-7.056	0.207	7.089	0.003	0	-0.001

Table 5.16 Maximum Nodal displacement in building having flat slab with overhanging columns.

			Horizontal	*Vertical*	*Horizontal*	*Resultant*	*Rotational*		
	Node	***L/C***	***X mm***	***Y mm***	***Z mm***	***mm***	***rX rad***	***rY rad***	***rZ rad***
Max X	810	3 LOAD CASE 1	0.363	-0.901	0.289	1.013	0	0	0
Min X	161	3 LOAD CASE 1	-0.184	-2.015	-0.074	2.024	0.001	0	0
Max Y	1	3 LOAD CASE 1	0	0	0	0	0	0	0
Min Y	819	3 LOAD CASE 1	0.351	-8.062	0.267	8.074	0.002	0	-0.001
Max Z	888	3 LOAD CASE 1	0.124	-1.808	0.685	1.938	0	0	0
Min Z	153	3 LOAD CASE 1	0	-0.357	-0.542	0.649	0	0	0
Max rX	63	3 LOAD CASE 1	-0.008	-6.581	0.014	6.581	0.003	0	-0.001
Min rX	64	3 LOAD CASE 1	-0.012	-6.577	-0.006	6.577	-0.003	0	-0.001
Max rY	94	3 LOAD CASE 1	-0.027	-0.153	-0.038	0.16	0	0	0
Min rY	881	3 LOAD CASE 1	0.073	-3.671	0.581	3.717	0.001	0	-0.003
Max rZ	151	3 LOAD CASE 1	-0.103	-3.523	-0.048	3.525	0	0	0.003
Min rZ	209	3 LOAD CASE 1	0.043	-3.455	-0.125	3.457	0.001	0	-0.004
Max Rst	819	3 LOAD CASE 1	0.351	-8.062	0.267	8.074	0.002	0	-0.001

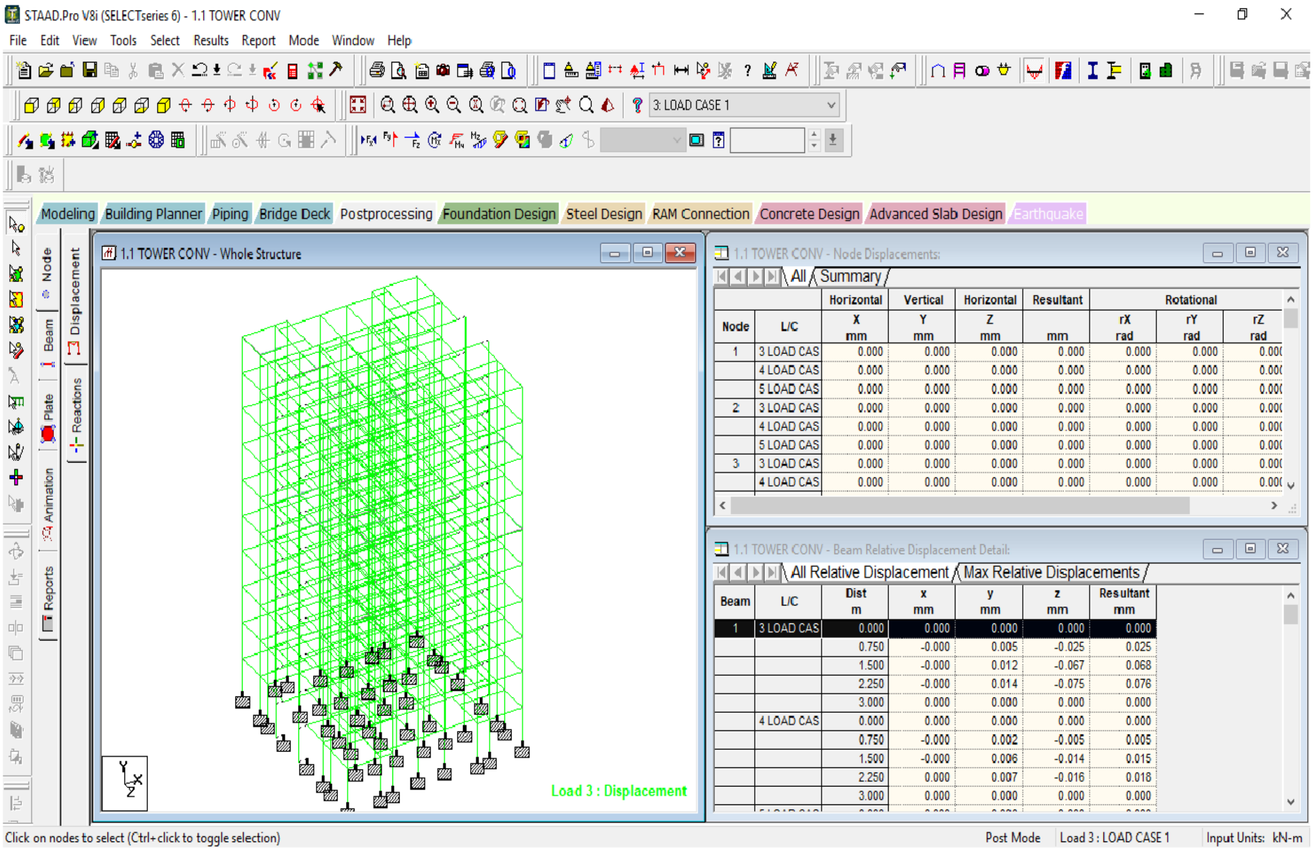

Fig. 5.9 – STAAD. Pro Model showingNodal displacement in Building having conventional slab without overhanging columns

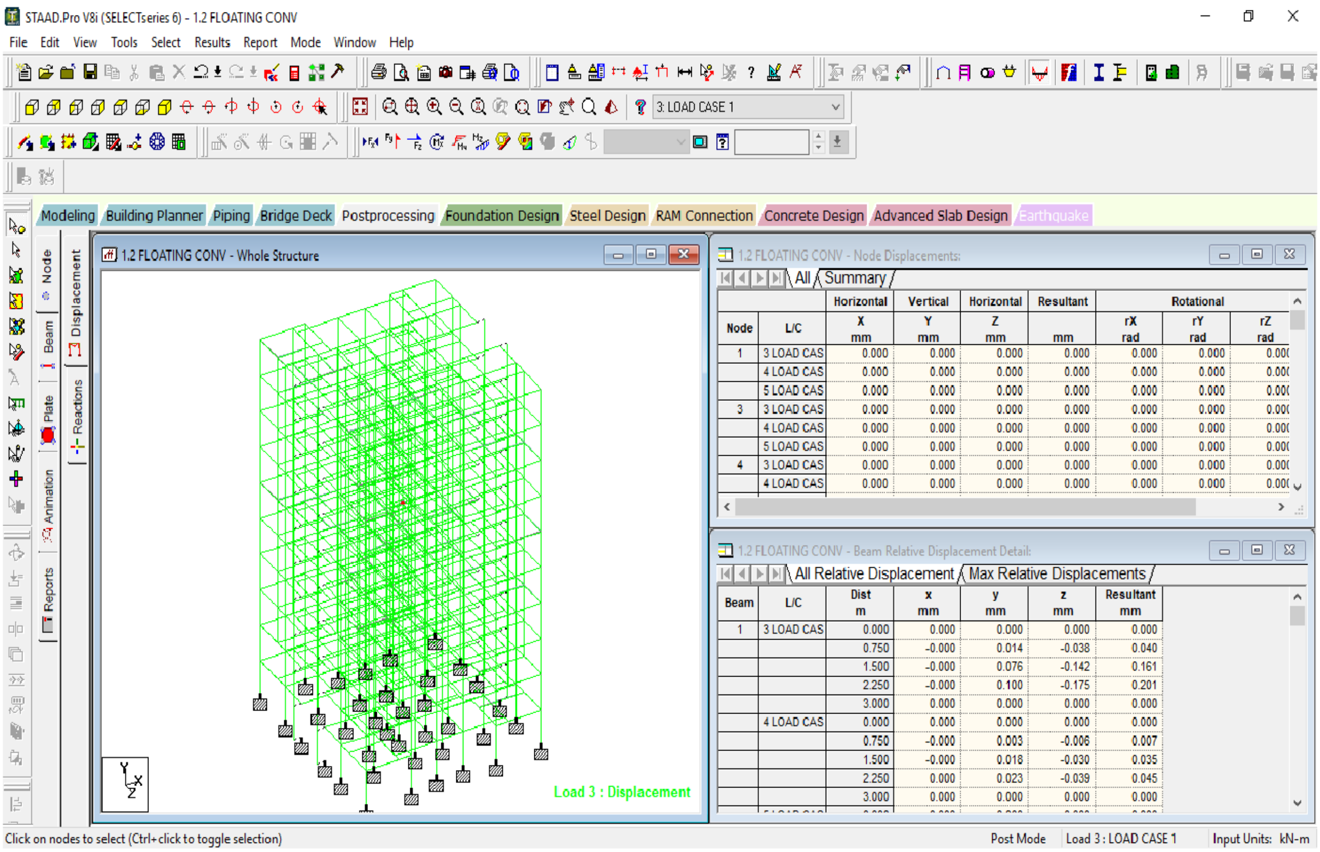

Fig. 5.10 – STAAD. Pro Model showing Nodal displacement in Building having conventional slab with overhanging columns

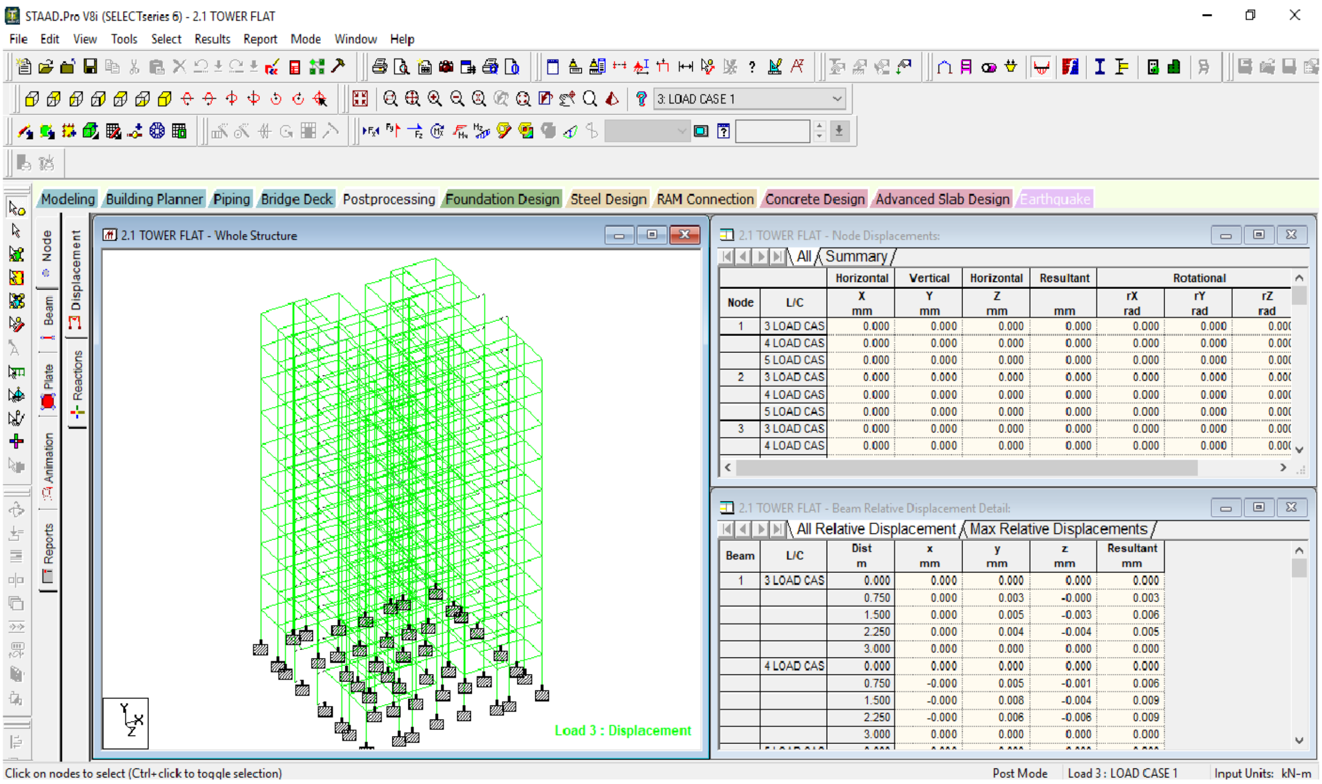

Fig. 5.11– STAAD. Pro Model showing Nodal displacement in Building having conventional slab without overhanging columns

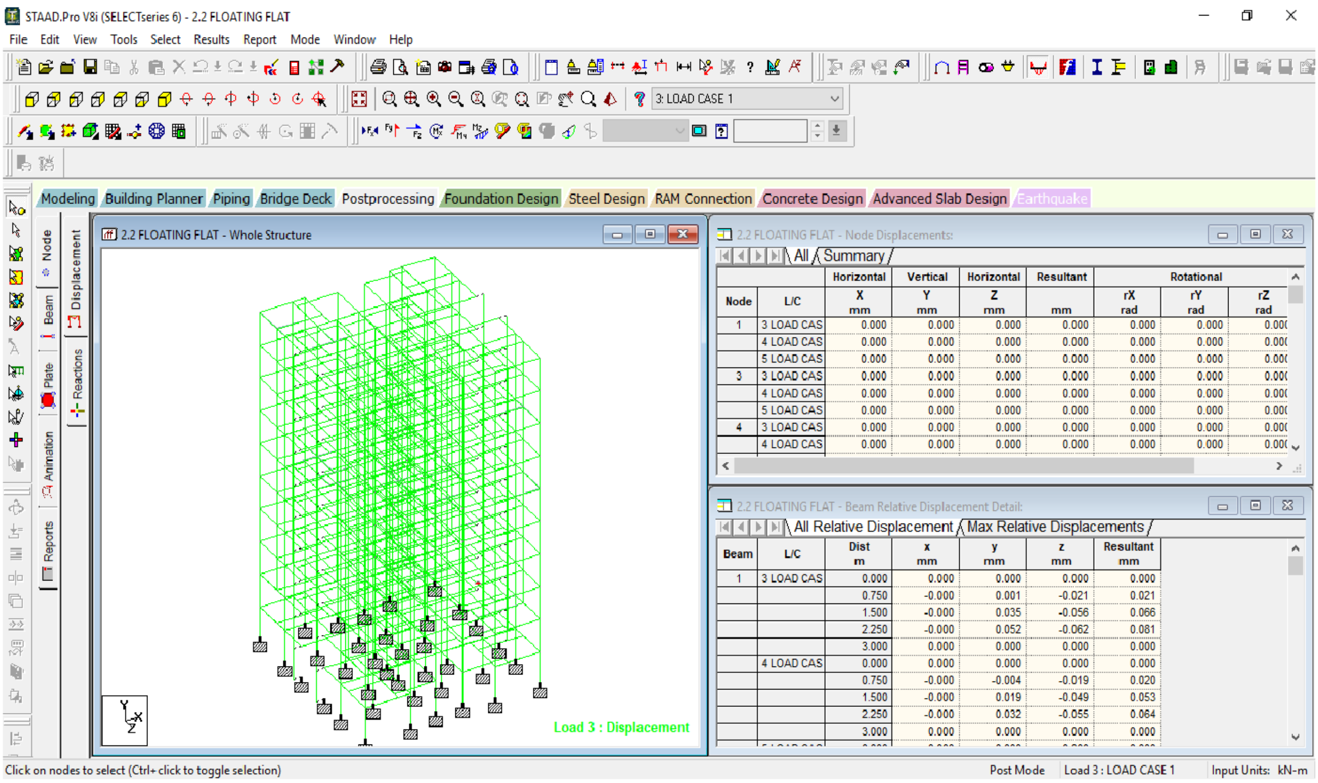

Fig. 5.12– STAAD. Pro Model showing Nodal displacement in Building having conventional slab with overhanging columns

V. CONCLUSIONS

Based on Analysis of Flat slab building and Conventional R.C. framed buildings using overhanging column, the following conclusions are drawn:

- In two building the conventional slab is provided and those of one building all the columns are supported directly to the ground and in other second building some columns are supported in shear wall in first floor not to the ground. These columns are termed as overhanging columns.

- In other remaining two building the flat slab is provided and those of one building all the columns are supported directly to the ground and in other second building some columns are supported in shear wall in first floor not to the ground. These columns are termed as overhanging columns.
- The vertical load and moment are more in columns supporting the shear walls. Hence there are need to increase the sizes of these columns.
- Hence there are more chances of settlement of these columns carrying heavy load or need to greater strength in footing.
- The maximum +Vemoment in the building having conventional slab without overhanging columns is 4323.771N-m and for the building with overhanging columns is 23119.341N-m. and maximum -Ve moment in the building having conventional slab without overhanging columns is -9134.434N-m and for the building with overhanging columns is -22586.825N-m. The detail comparison is given in Table No.-5.1 & 5.2.
- The maximum +Ve moment in the building having flat slab without overhanging columns is 6039.581 N-m and for the building with overhanging columns is 12351.728N-m. and maximum -Ve moment in the building having flat slab without overhanging columns is -6083.226 N-m and for the building with overhanging columns is -10496.261N-m. The detail comparison is given in Table No.-5.3& 5.4.
- The maximum shear force in the building having conventional slab without overhanging columns is 1419.943KN and for the building with overhanging columns is 1859.406KN. The detail comparison is given in Table No.-5.5& 5.6.
- The maximum shear force in the building having flat slab without overhanging columns is 678.561 KN and for the building with overhanging columns is 876.671 KN. The detail comparison is given in Table No.-5.7 & 5.8.
- The maximum axial load in the column building having conventional slab without overhanging columns is 175.291KN and for the building with overhanging columns is 233.911KN. The detail comparison is given in Table No.-5.9 &5.10.

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