

Different Types of Bracing System in Multi Story RCC Building

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Abstract

The aim of this research is to investigate the structural performance of steel buildings with various bracing systems. The structural efficacy of different forms of bracing systems was also studied. Different types of bracing systems, such as Without Bracing, X Bracing, Diagonal Bracing, and V-type bracing, were used to examine the structural strength of the steel building. In this study, the analysis of a Different Shape of building for 10Storey with different Bracing system (Without bracings, X – bracings, Diagonal bracings, V – bracings, In.V – bracings) have been analysed and comparison of Different parameter like, Story Displacement, Story Drift, Story Stiffness, Lateral Load and Story Shear are modeled of this problem using ETABS software. In addition, to compare and contrast various bracing options.

Keywords- Steel Bracing Systems, Story Displacements, Story Drift, Story Stiffness, Lateral Load, Story Shear

I. INTRODUCTION

Bracings are important structural component of these building systems which resist lateral loads. Different types of concentric bracings widely adopted in practice are shown in Figure. The lateral loads are transferred as axial forces to the bracing thereby reduction in the beam and column sections are achieved. Hence, it is proven to be cost effective in comparison to moment resisting frames apart from simple connection details that makes construction easy. Many studies are conducted to assess the seismic performance of concentric braced frames. (1)

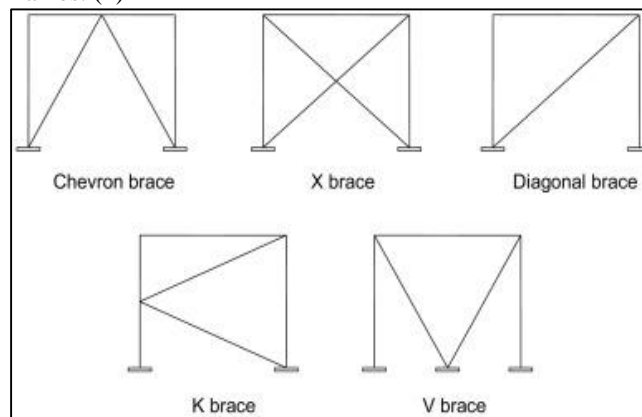


Fig. 1: Bracings of various styles

A. Bracings

- The bracing action of the braced frame provides resistance to lateral force.
- The braces act as a force simulator for the associated beams and columns, allowing them to function as a single truss member.
- By increasing the stiffness and capacity of the frame, a bracing device increases its seismic efficiency.
- Steel bracing systems are currently being used because they are simple to erect and allow for openings. (6)

1) Objectives

- The aim is to assess the response of a braced structure that has been exposed to loads and to determine the best bracing method for effectively resisting the seismic load.
- To critically examine essential structural response parameters such as story displacements, drift, stiffness, lateral load, and shear for the configurations examined, such as bare frame and various bracing systems.

II. MODELLING & ANALYSIS OF BUILDING

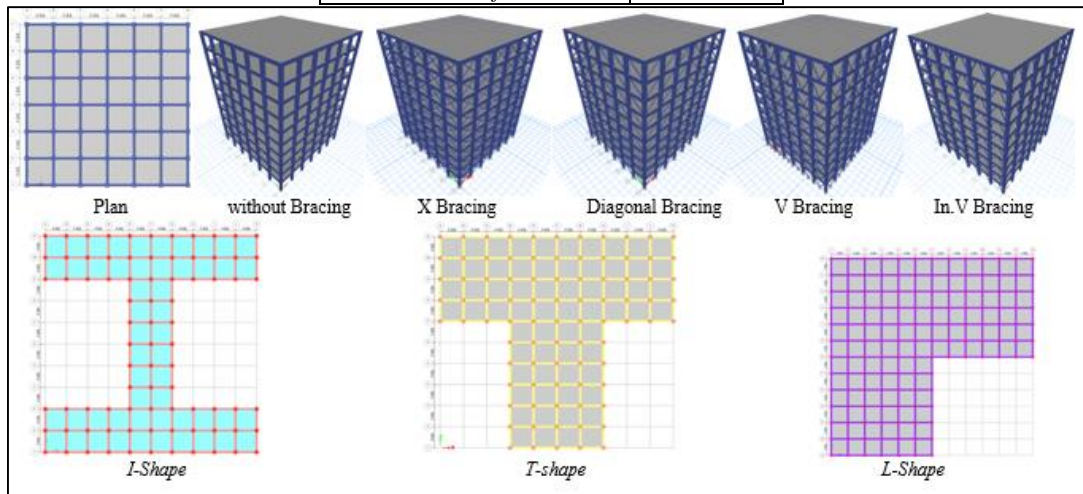
The Following are the specification of buildings located in seismic zone IV. The following is a full description of the structure, including modelling concepts: The first step in modelling any structure in ETABS is to define the nodal co-ordinate data, which is followed by selecting elements from the element library. To model the structure for the time being, beam elements have been chosen. The element selected for modeling is then assigned the properties if the element is beam the cross section of beam is assigned. For plate elements thickness is assigned. After assigning the sectional property to the member it is important to assign it with member properties.

Table 1: Square Shape- Story Displacement

Types of Building	Commercial
Storey	G+9 = 10 Storey
Width of bay	4 m
Size of Beam	600x300 mm
Size of column	600x600 mm
Thickness of Slab	150 mm
Wall Thickness	230 mm
Each storey height	3 m
Zone of building	V
Soil type	Medium Soil

Table 2: Square Shape- Story Drifts

Types of model	No. of model
No. of square shape of model	5
No. of I- shape of model	5
No. of T- shape of model	5
No. of L- shape of model	5
Total no. Of model	25



III. RESULTS

From the output of ETABS, various results are obtained. And these results are evaluated by preparing various graphs. It is to compare and find which bracing is more effective against Story Displacement, Story Drifts, Story Stiffness, Lateral Load, Story Shears and Base reaction.

Table 3: Square Shape- Story Displacement

Story	Elevation (m)	Without Bracing (mm)	X Bracing (mm)	Diagonal Bracing (mm)	V Bracing (mm)	In.V Bracing (mm)
Story10	35	19.866	13.004	15.402	14.731	14.579
Story9	31.5	19.091	12.345	14.762	14.04	13.907
Story8	28	17.837	11.396	13.763	13.008	12.892
Story7	24.5	16.159	10.204	12.444	11.684	11.583
Story6	21	14.151	8.833	10.881	10.141	10.053
Story5	17.5	11.904	7.34	9.146	8.446	8.371
Story4	14	9.498	5.778	7.3	6.657	6.595
Story3	10.5	6.999	4.191	5.396	4.828	4.777
Story2	7	4.469	2.618	3.481	3	2.961
Story1	3.5	2.073	1.108	1.652	1.24	1.22
Base	0	0	0	0	0	0

Table 4: Square Shape- Story Drifts

Story	Elevation (m)	Without Bracing	X Bracing	Diagonal Bracing	V Bracing	In.V Bracing
Story10	35	0.000222	0.000188	0.000186	0.000198	0.000194
Story9	31.5	0.000358	0.000271	0.000293	0.000295	0.000292
Story8	28	0.00048	0.00034	0.000382	0.000378	0.000375
Story7	24.5	0.000574	0.000392	0.000451	0.000441	0.000438
Story6	21	0.000642	0.000427	0.000499	0.000484	0.000481
Story5	17.5	0.000688	0.000447	0.00053	0.000511	0.000508
Story4	14	0.000714	0.000454	0.000546	0.000523	0.00052
Story3	10.5	0.000723	0.00045	0.00055	0.000524	0.00052
Story2	7	0.000704	0.00044	0.000545	0.00051	0.000505
Story1	3.5	0.000592	0.000317	0.000472	0.000352	0.000348
Base	0	0	0	0	0	0

Table 5: Square Shape- Story Stiffness

Story	Elevation (m)	Without Bracing kN/m	X Bracing kN/m	Diagonal Bracing kN/m	V Bracing kN/m	In.V Bracing kN/m
Story10	35	744267.672	982804.506	1148918.758	814562.006	846511.755
Story9	31.5	906544.682	1346604.544	1449282.006	1076765.943	1104576.281
Story8	28	940471.645	1489935.196	1532636.126	1167217.457	1190660.822
Story7	24.5	954781.092	1572786.444	1575748.576	1216892.25	1238299.873
Story6	21	963949.466	1631718.509	1605631.632	1251247.325	1271892.836
Story5	17.5	971815.438	1682754.845	1631666.056	1280164.543	1301018.921
Story4	14	980612.399	1734699.025	1658598.461	1308741.874	1330695.622
Story3	10.5	995843.777	1793430.754	1688654.24	1341207.523	1365239.885
Story2	7	1056569.69	1871086.373	1755125.182	1400586.076	1428791.546
Story1	3.5	1414966.37	2621046.063	2216840.031	2038452.599	2086102.995
Base	0	0	0	0	0	0

Table 6: Square Shape- Lateral Load

Story	Elevation (m)	Without Bracing kN/m	X Bracing kN/m	Diagonal Bracing kN/m	V Bracing kN/m	In.V Bracing kN/m
Story10	35	576.0213	640.9148	742.2008	558.9061	563.9892
Story9	31.5	559.9362	630.3087	723.2457	548.9156	553.9079
Story8	28	442.4188	498.0217	571.4534	433.7111	437.6556
Story7	24.5	338.7269	381.2978	437.519	332.0601	335.0801
Story6	21	248.8606	280.1372	321.4425	243.9625	246.1813
Story5	17.5	172.8198	194.5397	223.224	169.4184	170.9592
Story4	14	110.6047	124.5054	142.8634	108.4278	109.4139
Story3	10.5	62.2151	70.0343	80.3606	60.9906	61.5453
Story2	7	27.6512	31.1264	35.7158	27.1069	27.3535
Story1	3.5	6.9128	7.7816	8.929	6.7767	6.8384
Base	0	0	0	0	0	0

Table 7: Square Shape- Story Shears

Story	Elevation (m)	Without Bracing kN/m	X Bracing kN/m	Diagonal Bracing kN/m	V Bracing kN/m	In.V Bracing kN/m
Story10	35	576.0213	640.9148	742.2008	558.9061	563.9892
Story9	31.5	1135.9575	630.3087	1465.4465	548.9156	553.9079
Story8	28	1578.3763	498.0217	2036.8999	433.7111	437.6556
Story7	24.5	1917.1032	381.2978	2474.4189	332.0601	335.0801
Story6	21	2165.9637	280.1372	2795.8615	243.9625	246.1813
Story5	17.5	2338.7836	194.5397	3019.0855	169.4184	170.9592
Story4	14	2449.3883	124.5054	3161.9488	108.4278	109.4139
Story3	10.5	2511.6034	70.0343	3242.3094	60.9906	61.5453
Story2	7	2539.2546	31.1264	3278.0253	27.1069	27.3535
Story1	3.5	2546.1674	7.7816	3286.9542	6.7767	6.8384
Base	0	0	0	0	0	0

Table 8: Square Shape- Base Reaction

Output Case	Without Bracing (kN)	X Bracing (kN)	Diagonal Bracing (kN)	V Bracing (kN)	In.V Bracing (kN)
1.5 DL	137142.72	138001.6308	137570.3	137791.3	137791.3
1.5 DL + 1.5 LL	163062.72	163921.6308	163490.3	163711.3	163711.3
1.2 DL + 1.2 LL + 1.2 EQ X	130450.176	131137.3046	130792.2	130969	130969

1.2 DL + 1.2 LL - 1.2 EQ X	130450.176	131137.3046	130792.2	130969	130969
1.2 DL + 1.2 LL + 1.2 EQ Y	130450.176	131137.3046	130792.2	130969	130969
1.2 DL + 1.2 LL - 1.2 EQ Y	130450.176	131137.3046	130792.2	130969	130969
1.5 DL + 1.5 EQX	137142.72	138001.6308	137570.3	137791.3	137791.3
1.5 DL - 1.5 EQX	137142.72	138001.6308	137570.3	137791.3	137791.3
1.5 DL + 1.5 EQY	137142.72	138001.6308	137570.3	137791.3	137791.3
1.5 DL - 1.5 EQY	137142.72	138001.6308	137570.3	137791.3	137791.3
0.9 DL + 1.5 EQX	82285.632	82800.9785	82542.17	82674.76	82674.76
0.9 DL - 1.5 EQX	82285.632	82800.9785	82542.17	82674.76	82674.76
0.9 DL + 1.5 EQY	82285.632	82800.9785	82542.17	82674.76	82674.76
0.9 DL - 1.5 EQY	82285.632	82800.9785	82542.17	82674.76	82674.76

Table 9: I Shape- Story Displacement

Story	Elevation (m)	Without Bracing (mm)	X Bracing (mm)	Diagonal Bracing (mm)	V Bracing (mm)	In.V Bracing (mm)
Story10	35	18.823	9.322	12.987	12.748	12.55
Story9	31.5	18.029	8.923	12.445	12.215	12.027
Story8	28	16.806	8.267	11.57	11.353	11.184
Story7	24.5	15.165	7.417	10.414	10.219	10.07
Story6	21	13.2	6.435	9.054	8.891	8.761
Story5	17.5	11	5.364	7.555	7.428	7.318
Story4	14	8.644	4.243	5.979	5.881	5.792
Story3	10.5	6.201	3.1	4.379	4.29	4.222
Story2	7	3.751	1.945	2.772	2.678	2.628
Story1	3.5	1.441	0.843	1.187	1.145	1.12
Base	0	0	0	0	0	0

Table 10: I Shape- Story Drifts

Story	Elevation (m)	Without Bracing (mm)	X Bracing (mm)	Diagonal Bracing (mm)	V Bracing (mm)	In.V Bracing (mm)
Story10	35	0.000227	0.000121	0.000155	0.000154	0.000166
Story9	31.5	0.00035	0.000188	0.00025	0.000246	0.000254
Story8	28	0.000469	0.000243	0.00033	0.000324	0.000325
Story7	24.5	0.000561	0.000281	0.000388	0.00038	0.000379
Story6	21	0.000629	0.000306	0.000428	0.000418	0.000415
Story5	17.5	0.000673	0.00032	0.000453	0.000442	0.000438
Story4	14	0.000699	0.000327	0.000466	0.000455	0.000449
Story3	10.5	0.000705	0.00033	0.000473	0.000462	0.000456
Story2	7	0.000665	0.000331	0.000465	0.00046	0.000453
Story1	3.5	0.000412	0.000241	0.000339	0.000326	0.00032
Base	0	0	0	0	0	0

Table 11: I Shape- Story Stiffness

Story	Elevation (m)	Without Bracing (mm)	X Bracing (mm)	Diagonal Bracing (mm)	V Bracing (mm)	In.V Bracing (mm)
Story10	35	1231745.0	3623166.64	2665851.79	2781369.62	2874738.01
Story9	31.5	1523976.21	4584373.18	3276395.36	3430703.54	3504614.79
Story8	28	1576850.77	4930180.96	3430222.91	3629902.84	3691647.60
Story7	24.5	1597943.53	5154517.13	3522266.37	3748677.43	3803936.64
Story6	21	1611628.19	5317197.54	3588905.86	3832291.36	3885162.34
Story5	17.5	1623511.04	5455786.86	3646218.88	3901471.37	3954809.03
Story4	14	1637361.25	5588128.88	3699986.55	3964233.27	4020496.56
Story3	10.5	1665145.35	5700516.31	3748473.83	4015178.39	4076083.54
Story2	7	1783975.78	5805414.22	3871639.19	4103938.65	4172771.93
Story1	3.5	2920644.90	7922195.80	5499817.28	5826332.25	5943543.88
Base	0	0	0	0	0	0

Table 12: I Shape- Lateral Load

Story	Elevation (m)	Without Bracing (mm)	X Bracing (mm)	Diagonal Bracing (mm)	V Bracing (mm)	In.V Bracing (mm)
Story10	35	928.947	1436.2246	1374.265	1432.011	1432.011
Story9	31.5	915.2761	1425.2609	1358.9347	1418.6501	1418.6501
Story8	28	723.1811	1126.1321	1073.7262	1120.9088	1120.9088
Story7	24.5	553.6855	862.1949	822.0716	858.1958	858.1958
Story6	21	406.7894	633.4493	603.971	630.5112	630.5112
Story5	17.5	282.4926	439.8953	419.4243	437.855	437.855
Story4	14	180.7953	281.533	268.4315	280.2272	280.2272

Story3	10.5	101.6973	158.3623	150.9927	157.6278	157.6278
Story2	7	45.1988	70.3833	67.1079	70.0568	70.0568
Story1	3.5	11.2997	17.5958	16.777	17.5142	17.5142
Base	0	0	0	0	0	0

Table 13: I Shape- Story Shears

Story	Elevation (m)	Without Bracing (mm)	X Bracing (mm)	Diagonal Bracing (mm)	V Bracing (mm)	In.V Bracing (mm)
Story10	35	928.947	1436.2246	1374.265	1432.011	1432.011
Story9	31.5	1844.2231	2861.4855	2733.1997	2850.6612	2850.6612
Story8	28	2567.4042	3987.6175	3806.9259	3971.5699	3971.5699
Story7	24.5	3121.0897	4849.8124	4628.9975	4829.7657	4829.7657
Story6	21	3527.8791	5483.2617	5232.9685	5460.2769	5460.2769
Story5	17.5	3810.3717	5923.157	5652.3927	5898.1318	5898.1319
Story4	14	3991.167	6204.69	5920.8243	6178.359	6178.359
Story3	10.5	4092.8643	6363.0523	6071.817	6335.9868	6335.9868
Story2	7	4138.0632	6433.4356	6138.9249	6406.0436	6406.0436
Story1	3.5	4149.3629	6451.0314	6155.7019	6423.5578	6423.5578
Base	0	0	0	0	0	0

Table 14: I Shape- Base Reaction

Output Case	Without Bracing (kN)	X Bracing (kN)	Diagonal Bracing (kN)	V Bracing (kN)	In.V Bracing (kN)
1.5 DL	235797.9363	237793.2133	236795.6	237311.2	237311.2
1.5 DL + 1.5 LL	273237.9363	275233.2133	274235.6	274751.2	274751.2
1.2 DL + 1.2 LL + 1.2 EQ X	218590.349	220186.5706	219388.5	219801	219801
1.2 DL + 1.2 LL - 1.2 EQ X	218590.349	220186.5706	219388.5	219801	219801
1.2 DL + 1.2 LL + 1.2 EQ Y	218590.349	220186.5706	219388.5	219801	219801
1.2 DL + 1.2 LL - 1.2 EQ Y	218590.349	220186.5706	219388.5	219801	219801
1.5 DL + 1.5 EQX	235797.9363	237793.2133	236795.6	237311.2	237311.2
1.5 DL - 1.5 EQX	235797.9363	237793.2133	236795.6	237311.2	237311.2
1.5 DL + 1.5 EQY	235797.9363	237793.2133	236795.6	237311.2	237311.2
1.5 DL - 1.5 EQY	235797.9363	237793.2133	236795.6	237311.2	237311.2
0.9 DL + 1.5 EQX	141478.7618	142675.928	142077.3	142386.7	142386.7
0.9 DL - 1.5 EQX	141478.7618	142675.928	142077.3	142386.7	142386.7
0.9 DL + 1.5 EQY	141478.7618	142675.928	142077.3	142386.7	142386.7
0.9 DL - 1.5 EQY	141478.7618	142675.928	142077.3	142386.7	142386.7

Table 15: T Shape- Story Displacement

Story	Elevation (m)	Without Bracing (mm)	X Bracing (mm)	Diagonal Bracing (mm)	V Bracing (mm)	In.V Bracing (mm)
Story10	35	20.316	14.925	16.961	16.642	7.42
Story9	31.5	19.45	14.228	16.228	15.9	7.045
Story8	28	18.1	13.193	15.104	14.774	6.551
Story7	24.5	16.311	11.861	13.622	13.306	5.97
Story6	21	14.179	10.305	11.865	11.576	5.313
Story5	17.5	11.8	8.593	9.912	9.659	4.608
Story4	14	9.256	6.785	7.832	7.625	3.88
Story3	10.5	6.621	4.933	5.686	5.529	3.151
Story2	7	3.976	3.086	3.532	3.428	2.449
Story1	3.5	1.501	1.302	1.452	1.409	1.741
Base	0	0	0	0	0	0

Table 16: T Shape- Story Drifts

Story	Elevation (m)	Without Bracing (mm)	X Bracing (mm)	Diagonal Bracing (mm)	V Bracing (mm)	In.V Bracing (mm)
Story10	35	0.000248	0.0002	0.000213	0.000213	0.000115
Story9	31.5	0.000386	0.000296	0.000327	0.000322	0.000153
Story8	28	0.000511	0.00038	0.000428	0.00042	0.000179
Story7	24.5	0.000609	0.000445	0.000506	0.000495	0.000197
Story6	21	0.00068	0.000489	0.000561	0.000548	0.000208
Story5	17.5	0.000727	0.000517	0.000596	0.000582	0.000213
Story4	14	0.000753	0.000529	0.000614	0.000599	0.000211
Story3	10.5	0.000756	0.000528	0.000616	0.0006	0.000211
Story2	7	0.000708	0.00051	0.000594	0.000578	0.000283
Story1	3.5	0.000429	0.000372	0.000415	0.0004	0.000498

Base	0	0	0	0	0	0
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Table 17: T Shape- Story Stiffness

Story	Elevation (m)	Without Bracing (mm)	X Bracing (mm)	Diagonal Bracing (mm)	V Bracing (mm)	In.V Bracing (mm)
Story10	35	1307035.30	2458650.29	1975526.95	2029082.77	4996067.47
Story9	31.5	1592400.75	3174091.73	2479387.66	2558562.40	7337875.27
Story8	28	1650533.21	3413716.06	2606740.80	2711749.36	8657235.63
Story7	24.5	1673747.23	3543927.92	2670739.84	2790176.05	9488881.30
Story6	21	1688304.35	3634170.30	2714392.85	2842847.39	10106703.6
Story5	17.5	1700900.09	3712292.17	2752500.76	2887271.13	10672039.0
Story4	14	1715783.44	3793172.35	2792981.04	2932758.39	11295079.8
Story3	10.5	1746423.81	3895313.41	2849374.05	2993319.81	11897986.6
Story2	7	1873705.29	4074933.43	2995694.57	3134572.35	10325948.1
Story1	3.5	3060736.13	5535946.72	4351913.19	4464563.47	5388445.97
Base	0	0	0	0	0	0

Table 18: T Shape- Lateral Load

Story	Elevation (m)	Without Bracing (mm)	X Bracing (mm)	Diagonal Bracing (mm)	V Bracing (mm)	In.V Bracing (mm)
Story10	35	1024.5798	1498.7592	1294.3406	1324.0898	1726.5956
Story9	31.5	993.2224	1459.6534	1257.6581	1288.1056	1733.2108
Story8	28	784.7683	1153.3064	993.7052	1017.7625	1369.4505
Story7	24.5	600.8383	883.0002	760.8055	779.2244	1048.4855
Story6	21	441.4322	648.7349	558.9592	572.4914	770.3159
Story5	17.5	306.5501	450.5103	388.1661	397.5635	534.9416
Story4	14	196.1921	288.3266	248.4263	254.4406	342.3626
Story3	10.5	110.358	162.1837	139.7398	143.1228	192.579
Story2	7	49.048	72.0817	62.1066	63.6102	85.5907
Story1	3.5	12.262	18.0204	15.5266	15.9025	20.5704
Base	0	0	0	0	0	0

Table 19: T Shape- Story Shears

Story	Elevation (m)	Without Bracing (mm)	X Bracing (mm)	Diagonal Bracing (mm)	V Bracing (mm)	In.V Bracing (mm)
Story10	35	1024.5798	1498.7592	1294.3406	1324.0898	1726.5956
Story9	31.5	2017.8022	2958.4126	2551.9987	2612.1954	3459.8064
Story8	28	2802.5705	4111.719	3545.7039	3629.9578	4829.2569
Story7	24.5	3403.4088	4994.7192	4306.5094	4409.1822	5877.7424
Story6	21	3844.841	5643.454	4865.4686	4981.6736	6648.0584
Story5	17.5	4151.3911	6093.9643	5253.6346	5379.237	7183
Story4	14	4347.5832	6382.2909	5502.0609	5633.6777	7525.3626
Story3	10.5	4457.9412	6544.4747	5641.8007	5776.8005	7717.9416
Story2	7	4506.9892	6616.5563	5703.9073	5840.4107	7803.5322
Story1	3.5	4519.2512	6634.5767	5719.4339	5856.3132	7824.1026
Base	0	0	0	0	0	0

Table 20: T Shape- Base Reaction

Output Case	Without Bracing (kN)	X Bracing (kN)	Diagonal Bracing (kN)	V Bracing (kN)	In.V Bracing (kN)
1.5 DL	261554.0362	262979.2341	262266.6	262635	271924.9
1.5 DL + 1.5 LL	307634.0362	309059.2341	308346.6	308715	318004.9
1.2 DL + 1.2 LL + 1.2 EQ X	246107.229	247247.3873	246677.3	246972	254403.9
1.2 DL + 1.2 LL - 1.2 EQ X	246107.229	247247.3873	246677.3	246972	254403.9
1.2 DL + 1.2 LL + 1.2 EQ Y	246107.229	247247.3873	246677.3	246972	254403.9
1.2 DL + 1.2 LL - 1.2 EQ Y	246107.229	247247.3873	246677.3	246972	254403.9
1.5 DL + 1.5 EQX	261554.0362	262979.2341	262266.6	262635	271924.9
1.5 DL - 1.5 EQX	261554.0362	262979.2341	262266.6	262635	271924.9
1.5 DL + 1.5 EQY	261554.0362	262979.2341	262266.6	262635	271924.9
1.5 DL - 1.5 EQY	261554.0362	262979.2341	262266.6	262635	271924.9
0.9 DL + 1.5 EQX	156932.4217	157787.5404	157360	157581	163154.9
0.9 DL - 1.5 EQX	156932.4217	157787.5404	157360	157581	163154.9
0.9 DL + 1.5 EQY	156932.4217	157787.5404	157360	157581	163154.9
0.9 DL - 1.5 EQY	156932.4217	157787.5404	157360	157581	163154.9

IV. CONCLUSIONS

The steel bracing system has not only improved displacement capacity of reinforced concrete structures, but also the lateral stiffness and strength capacity of the structures by increasing its shear capacity.

- In Square Shape of building the parameters are more efficient in Diagonal type of bracing system.
- In I-Shape of building the parameters are more efficient in X-type of bracing system.
- In T-Shape of building the parameters are more efficient in Inverted V type of bracing system.
- In L-Shape of building the parameters are more efficient in X-type of bracing system.

In base reaction, provide the bracings to increase the value of base reaction.

V. FUTURE SCOPE

Further studies can be carried out using different sections and arrangements of bracings.

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