

Earthquake Analysis of High Rise Building Using Combination of Chevron and Inverted V Bracings

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ABSTRACT: In structural engineering, bracings is a structural system composed to counter the effects of lateral load acting on a structure. Bracings are structural members used to augment the strength of RCC structures. These bracings will be built in each level of the structure, to form an effective box structure. The present work is an attempt to analyse and design a commercial building using ETABS. AG+17 storey building is considered for this study. Analysis is carried out by static method and design is done as per IS 456:2000 guidelines. For the analysis of the building for seismic loading with two different Zones (Zone-IV & Zone-V) is considered with all there soil types. Results of Displacement are compared in tabular forms and a remarkable conclusion is made.

KEYWORDS: Commercial Building, ETABS, Lateral load Resisting systems

I. INTRODUCTION

A new bracing system shaped like a diamond is incorporated in the main building frame and its applicability is evaluated by detailed calculations. It is also compared with the other known bracing system known as the cross bracing system. Both the bracing system has been shown below.

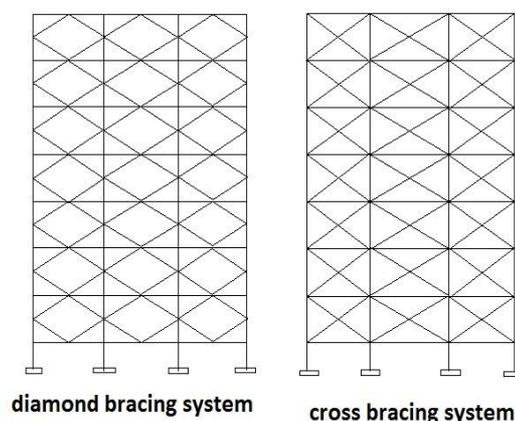


Fig-1.1 Showing different types of bracings

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Bracing is a very effective global upgrading strategy to enhance the global stiffness and strength of steel and composite frames. It can increase the energy absorption of structures and/or decrease the demand imposed by earthquake loads. Structures with augmented energy dissipation may safely resist forces and deformations caused by strong ground motions. Generally, global modifications to the structural system are conceived such that the design demands, often denoted by target displacement, on the existing structural and non-structural components, are less than their capacities (Figure 1). Lower demands may reduce the risk of brittle failures in the structure and/or avoid the interruption of its functionality. The attainment of global structural ductility is achieved within the design capacity by forcing inelasticity to occur within dissipative zones and ensuring that all other members and connections behave linearly

II. NUMERICAL MODELLING

Geometry Details

Length of building	:	72m
Width of building	:	72m
Height of building	:	54m
Height of floor	:	3m

Column sizes

Column size Base to Storey 9	=	600 mm x 450mm
Column size Storey 9 to Storey 18	=	450mm x 300mm
Clear Cover	=	40mm

Beam sizes

Beam Size Storey first storey to eighteenth storey	=	300 mm *450 mm
Cover	=	25mm
Slab thickness		110 mm

Materials

Concrete grade	:	M30
All Steel grades	:	Fe500 (HYSD)

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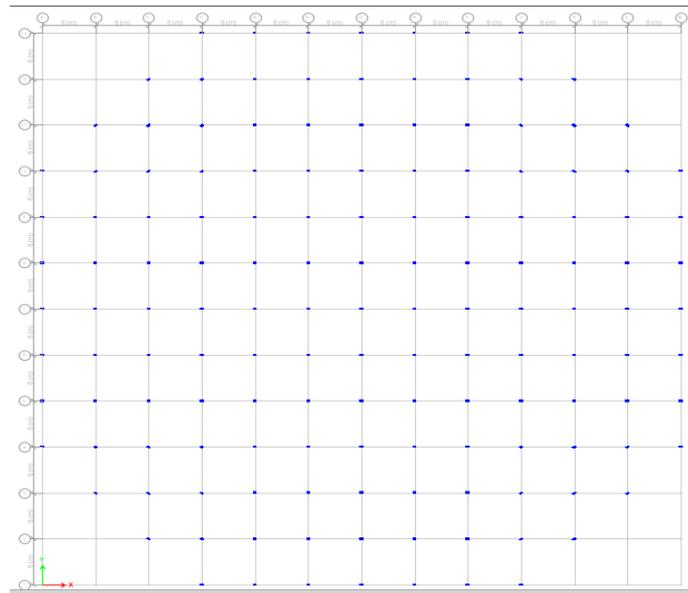
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Longitudinal bars : 20mm

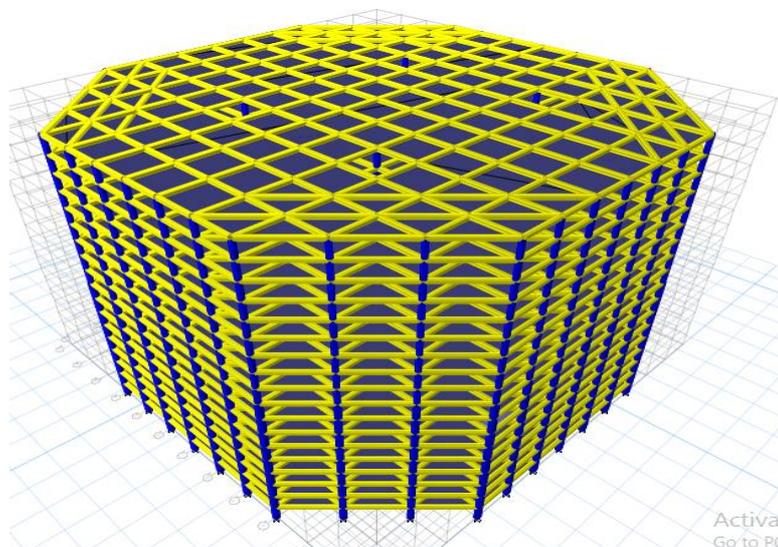
Confinement bars : 8mm

Chevron & Inverted V Bracings on each elevation

Grade of Concrete and Steel : M30; Fe500



Plan considered



3D View of Model Considered

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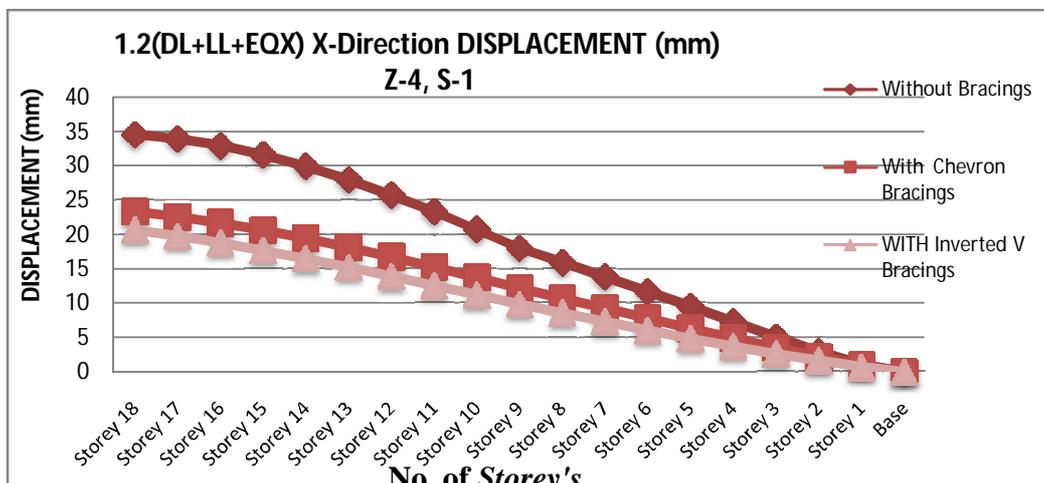
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III. EXPERIMENTAL RESULTS

CASE: 1 Comparison Of Displacement In Static Analysis For Zone-4 & Zone-5 In Soil-1, Soil-2 & Soil-3
Table 5.1 Displacement Comparison values along Z-4, S-1 in Static Analysis

1.2(DL+LL+EQX) X-Direction Displacement (mm) Z-4, S-1			
Storey's	Without Bracings	With Chevron Bracings	With Inverted V Bracings
Storey 18	34.625	23.393	20.713
Storey 17	33.988	22.635	19.851
Storey 16	33.019	21.730	18.847
Storey 15	31.681	20.680	17.747
Storey 14	30.007	19.505	16.554
Storey 13	28.041	18.203	15.285
Storey 12	25.824	16.797	13.961
Storey 11	23.393	15.314	12.606
Storey 10	20.790	13.773	11.243
Storey 9	18.056	12.188	9.876
Storey 8	15.991	10.734	8.600
Storey 7	13.883	9.279	7.338
Storey 6	11.729	7.818	6.098
Storey 5	9.541	6.367	4.894
Storey 4	7.333	4.941	3.739
Storey 3	5.127	3.551	2.648
Storey 2	2.978	2.245	1.636
Storey 1	1.075	1.037	0.712
Base	0	0	0



Graph 5.1 Variation of Displacement along Z-4,S-1 in Static Analysis

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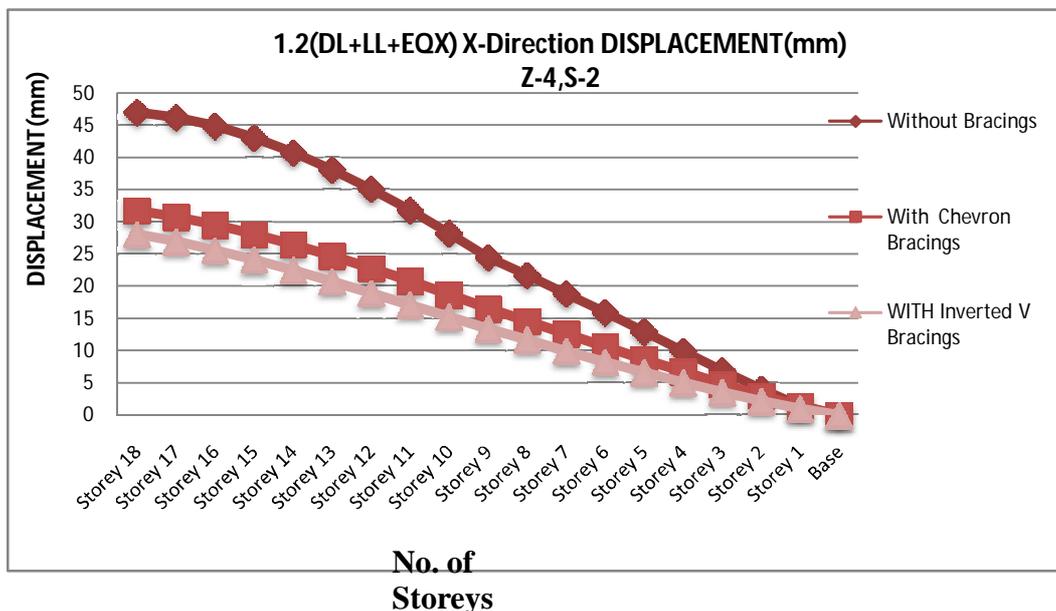
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Table 5.2 Displacement Comparison values along Z-4, S-2 in Static Analysis

1.2(DL+LL+EQX) X-Direction Displacement (mm) Z-4, S-2			
Storey's	Without Bracings	With Chevron Bracings	With Inverted V Bracings
Storey 18	47.042	31.755	28.111
Storey 17	46.225	30.773	26.984
Storey 16	44.911	29.553	25.629
Storey 15	43.091	28.123	24.133
Storey 14	40.814	26.526	22.509
Storey 13	38.14	24.755	20.783
Storey 12	35.123	22.844	18.982
Storey 11	31.818	20.826	17.134
Storey 10	28.274	18.73	15.272
Storey 9	24.552	16.575	13.415
Storey 8	21.748	14.597	11.68
Storey 7	18.882	12.619	9.963
Storey 6	15.952	10.633	8.276
Storey 5	12.976	8.659	6.638
Storey 4	9.973	6.719	5.067
Storey 3	6.973	4.826	3.58
Storey 2	4.049	3.017	2.203
Storey 1	1.453	1.368	0.968
Base	0	0	0



Graph 5.2 Variation of Displacement along Z-4,S-2 in Static Analysis

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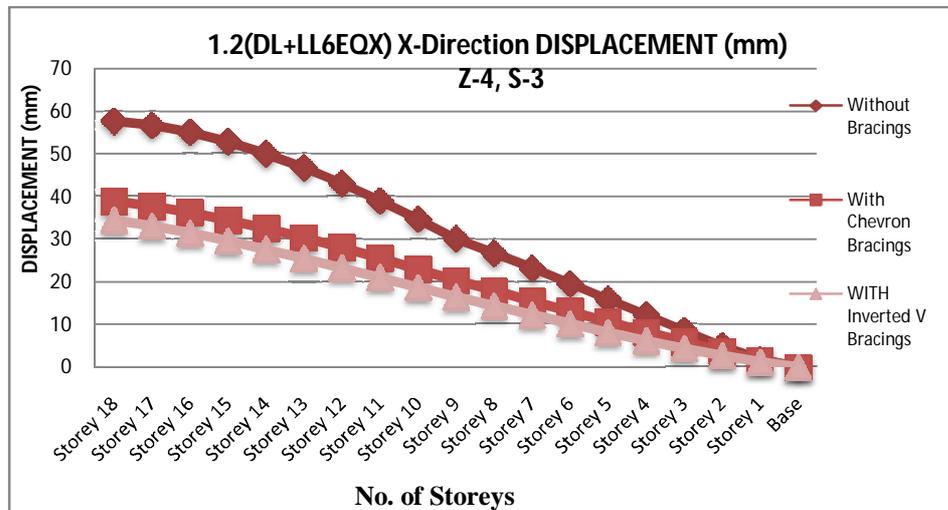
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Table 5.3 Displacement Comparison values along Z-4, S-3 in Static Analysis

1.2(DL+LL+EQX) X-Direction Displacement (mm) Z-4, S-3			
Storey's	Without Bracings	With Chevron Bracings	With Inverted V Bracings
Storey 18	57.734	38.957	34.482
Storey 17	56.763	37.781	33.127
Storey 16	55.152	36.289	31.47
Storey 15	52.916	34.533	29.632
Storey 14	50.12	32.572	27.637
Storey 13	46.835	30.398	25.518
Storey 12	43.131	28.052	23.306
Storey 11	39.072	25.572	21.036
Storey 10	34.719	22.999	18.744
Storey 9	30.146	20.353	16.463
Storey 8	26.705	17.924	14.332
Storey 7	23.187	15.494	12.223
Storey 6	19.589	13.056	10.151
Storey 5	15.934	10.633	8.139
Storey 4	12.246	8.25	6.21
Storey 3	8.562	5.925	4.385
Storey 2	4.971	3.695	2.698
Storey 1	1.78	1.652	1.189
Base	0	0	0



Graph 5.3 Variation of Displacement along Z-4,S-3 in Static Analysis

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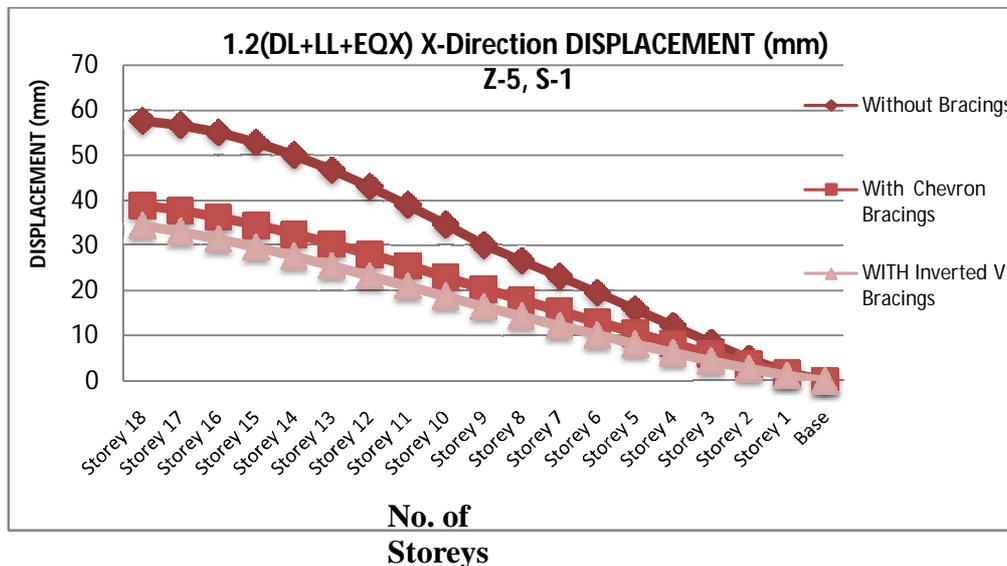
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Table 5.4 Displacement Comparison values along Z-5, S-1 in Static Analysis

1.2(DL+LL+EQX) X-Direction Displacement (mm) Z-5, S-1			
Storey's	Without Bracings	With Chevron Bracings	With Inverted V Bracings
Storey 18	51.870	35.008	30.988
Storey 17	50.984	33.938	29.759
Storey 16	49.536	32.595	28.267
Storey 15	47.528	31.018	26.616
Storey 14	45.017	29.256	24.825
Storey 13	42.067	27.304	22.921
Storey 12	38.740	25.196	20.935
Storey 11	35.094	22.969	18.896
Storey 10	31.185	20.658	16.839
Storey 9	27.078	18.282	14.791
Storey 8	23.987	16.100	12.877
Storey 7	20.826	13.917	10.983
Storey 6	17.595	11.727	9.123
Storey 5	14.312	9.550	7.316
Storey 4	10.999	7.410	5.583
Storey 3	7.691	5.322	3.943
Storey 2	4.465	3.320	2.424
Storey 1	1.600	1.496	1.068
Base	0	0	0



Graph 5.4 Variation of Displacement along Z-5,S-1 in Static Analysis

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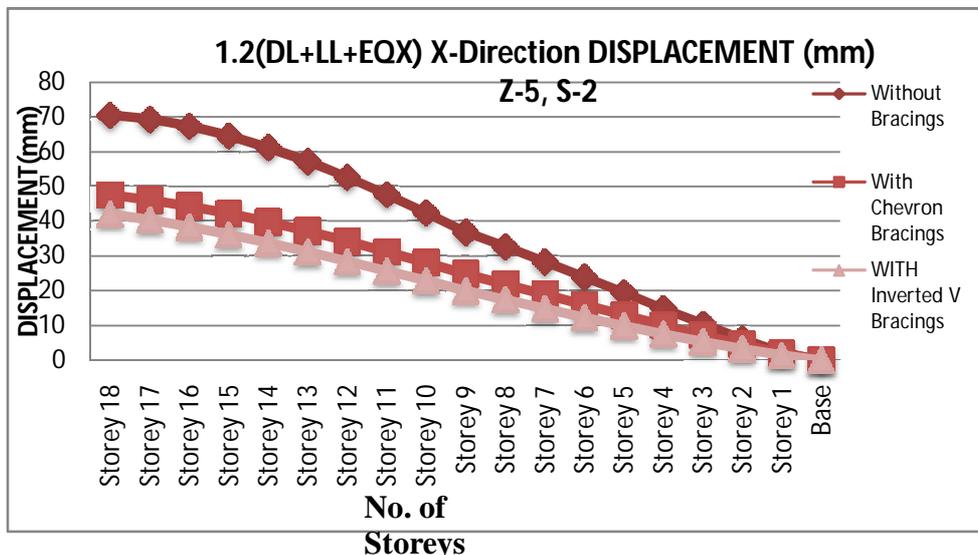
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Table 5.5 Displacement Comparison values along Z-5, S-2 in Static Analysis

1.2(DL+LL+EQX) X-Direction Displacement (mm) Z-5, S-2			
Storey's	Without Bracings	With Chevron Bracings	With Inverted V Bracings
Storey 18	70.501	47.552	42.085
Storey 17	69.34	46.145	40.458
Storey 16	67.374	44.329	38.441
Storey 15	64.643	42.184	36.195
Storey 14	61.226	39.788	33.758
Storey 13	57.214	37.133	31.169
Storey 12	52.689	34.267	28.466
Storey 11	47.73	31.238	25.694
Storey 10	42.411	28.093	22.891
Storey 9	36.822	24.863	20.105
Storey 8	32.622	21.895	17.497
Storey 7	28.325	18.926	14.921
Storey 6	23.929	15.948	12.391
Storey 5	19.464	12.988	9.936
Storey 4	14.959	10.077	7.582
Storey 3	10.459	7.236	5.356
Storey 2	6.072	4.51	3.296
Storey 1	2.17	1.993	1.452
Base	0	0	0



Graph 5.5 Variation of Displacement along Z-5, S-2 in Static Analysis

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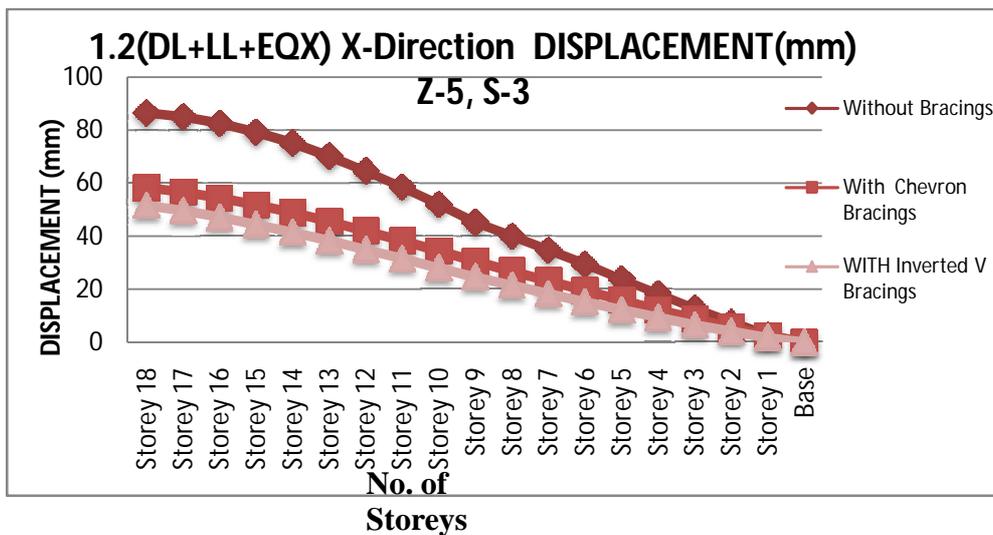
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Table 5.6 Displacement Comparison values along Z-5, S-3 in Static Analysis

1.2(DL+LL+EQX) X-Direction Displacement (mm) Z-5, S-3			
Storey's	Without Bracings	With Chevron Bracings	With Inverted V Bracings
Storey 18	86.563	58.354	51.641
Storey 17	85.146	56.657	49.672
Storey 16	82.735	54.433	47.202
Storey 15	79.381	51.798	44.444
Storey 14	75.185	48.857	41.451
Storey 13	70.258	45.597	38.271
Storey 12	64.701	42.077	34.952
Storey 11	58.611	38.358	31.547
Storey 10	52.079	34.496	28.102
Storey 9	45.213	30.53	24.688
Storey 8	40.057	26.885	21.484
Storey 7	34.782	23.24	18.32
Storey 6	29.384	19.583	15.215
Storey 5	23.901	15.949	12.201
Storey 4	18.369	12.372	9.31
Storey 3	12.843	8.883	6.577
Storey 2	7.456	5.535	4.048
Storey 1	2.66	2.433	1.783
Base	0	0	0



Graph 5.6 Variation of Displacement along Z-5, S-3 in Static Analysis

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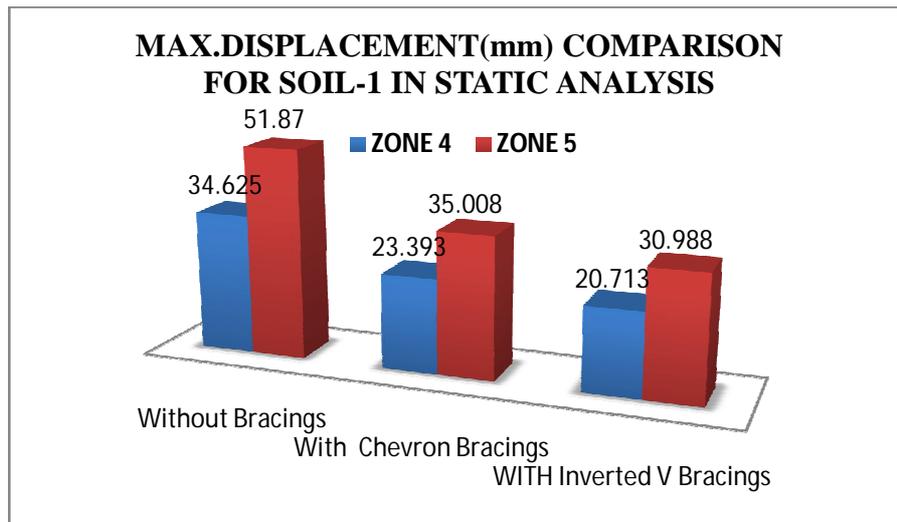
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CASE: 2 Zone Wise Comparison Of Displacement In Static Analysis For
Soil-1, Soil-2 & Soil-3

Table 5.7 Displacement Comparison values for S-1 along Z-4 & Z-5 in Static Analysis

SOIL-1			
Zones	Without Bracings	With Chevron Bracings	WITH Inverted V Bracings
ZONE 4	34.625	23.393	20.713
ZONE 5	51.87	35.008	30.988



Graph 5.7 Variation of Displacement for S-1 in Z-4 & Z-5 in static analysis

Table 5.8 Displacement Comparison values for S-2 along Z-4 & Z-5 in Static Analysis

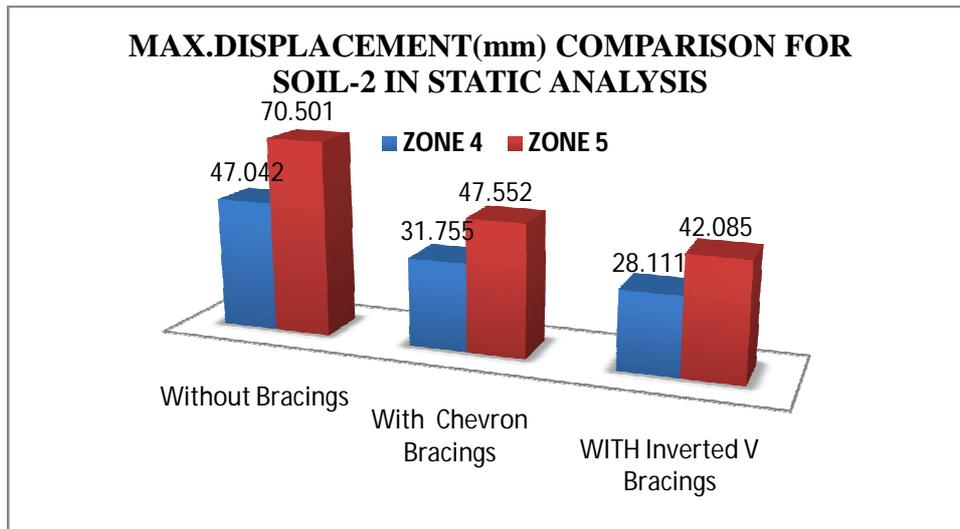
SOIL-2			
Zones	Without Bracings	With Chevron Bracings	WITH Inverted V Bracings
ZONE 4	47.042	31.755	28.111
ZONE 5	70.501	47.552	42.085

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Graph 5.8 Variation of Displacement for S-2 in Z-4 & Z-5 in static analysis

IV. CONCLUSION

1. The structural performance is analyzed. Without bracings, With X Bracing with chevron bracings, the displacement of 45% is reduced when lateral systems are provided.
2. By providing lateral systems in the framed structures the reduction in the displacement, shear, moment thereby increasing the stiffness of the structure for resisting lateral loads due to earth quakes.

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