Analysis of A Steel Structure With Knee Bracings By Response Spectrum Method

Ambati Supraja, P.Prasanthi

Abstract:;In this study the seismic impact of distinctive sorts of steel bracings was examined. A comparison of knee braced steel outline with other sorts of bracings had been done. Execution of each outline had been considered utilizing non-linear static analysis investigation and non linear time history analysis investigation. Different parameters such as displacement and stiffness were considered. Advance optimization think about was carried out to choose the appropriate sort of the bracing design by keeping the inter-story float, add up to horizontal relocation and stretch level inside passable restrain. Point of consider was to compare comes about of seismic examination of tall rise steel building with distinctive design of bracing framework and without bracing system.

Index Terms: Knee bracing, X-bracing, V-bracing, inverted V-bracing, Response Spectrum Analysis.

I. INTRODUCTION

Steel has ended up the prevail fabric for the development of bridges, buildings, towers and other structures. Bracing component in basic framework plays imperative part in auxiliary behavior amid seismic tremor. Steel bracing is a compelling and conservative arrangement for standing up to horizontal strengths in a surrounded structure. Knee bracings (KBFs) give a compelling bracing arrangement. It can be gotten by giving a modern component called "knee" in between the pillar and column along with bracings.

A. Function of Bracing

- Control Buckling of the main beams
- Load distribution
- Dimensional control

B. Objectives

- To know about the seismic impact on the steel bracing frames.
- To study the dynamic behavior of Steel structure with bracing system.
- Comparative study on structure with X, V and inverted V bracing.
- To study the mode shapes and response of steel Structure subjected to seismic loads by Response spectrum analysis.
- To compare seismic execution of knee braced steel outline with diverse sorts of bracings and finding which is the productive one for the seismic response.
- To observe the structural performance of different building models through response spectrum analysis.
- To discover the story displacement and comparing the percentile displacement with distinctive sorts of bracings (X, V, inverted V).

Model

MODEL NAME	SHAPE OF BRACING	STOREY HEIGHT	GRADE OF STEEL	GRADE OF CONCRETE	GRADE OF REBAR
SM01NBS06	None	19.5	Fe250	M25	Fe345
SM02NBS11	None	34.5	Fe250	M25	Fe345
SM03NBS21	None	64.5	Fe250	M25	Fe345
SM04XBS06	X	19.5	Fe250	M25	Fe345
SM05XBS11	X	34.5	Fe250	M25	Fe345
SM06XBS21	X	64.5	Fe250	M25	Fe345
SM07VBS06	V	19.5	Fe250	M25	Fe345
SM08VBS11	V	34.5	Fe250	M25	Fe345
SM09VBS21	V	64.5	Fe250	M25	Fe345
SM10IVBS06	IV	19.5	Fe250	M25	Fe345
SM11IVBS11	IV	34.5	Fe250	M25	Fe345
SM12IVBS21	IV	64.5	Fe250	M25	Fe345

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Ambati Supraja, Assistant Professor, Dept. of Civil Engineering, BVRIT, Narsapur, Medak. Telangana.
P.Prasanthi , Assistant Professor, Dept. of Civil Engineering, BVRIT, Narsapur, Medak. Telangana.

RESULTS AND DISCUSSIONS

NO BRACING CASE

Table 1: Storey Response of M1NBS06

Storey	X-dir	Y-dir
0	0	0
1	19.211	21.225
2	19.43	21.443
3	19.649	21.661
4	19.867	21.88
5	20.086	22.098
6	20.304	22.315

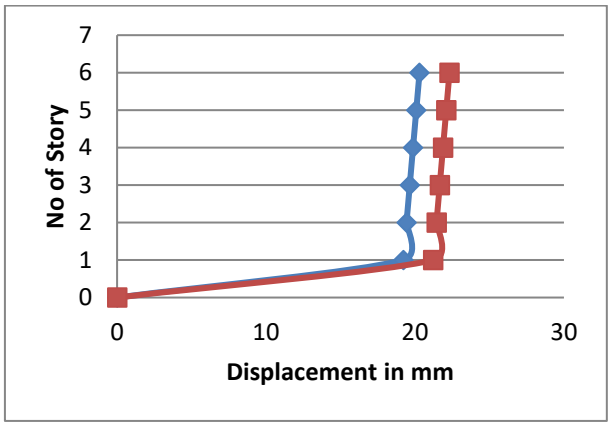

Figure 1 : Displacemnt graph of M1NBS06

A. Observations:

1. Displacement in Y- direction is more when compared to displacement in X- direction.
2. There is no sudden change in both directions of displacement that means there is no gradual increase in displacement values.
3. With the increase in number of storeys, displacement also increases.

Table 2: Storey Response of M1NBS11

Storey	X-dir	Y-dir
0	0	0
1	40.179	40.179
2	41.048	41.048
3	41.919	41.92
4	42.791	42.792
5	43.664	43.664
6	44.536	44.536
7	45.409	45.409
8	46.282	46.282
9	47.154	47.154
10	48.027	48.027
11	48.899	48.9

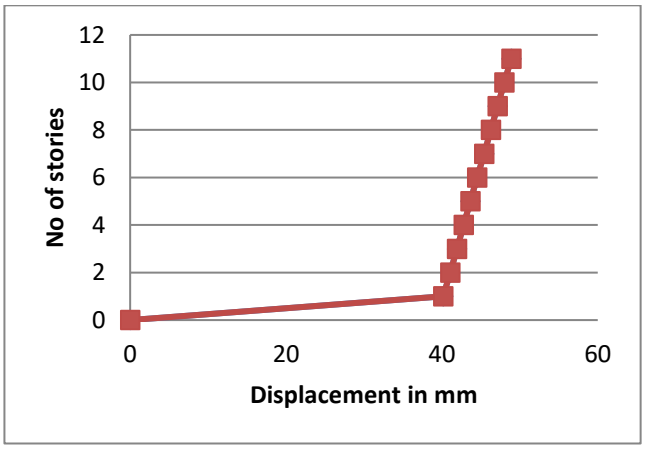

Figure 2: Displacement Graph of M2NBS11

B. Observations:

1. Displacement in Y- direction and displacement in X- direction is same.
2. There is sudden change in both directions for displacement that means there is gradual increase in displacement values.
3. With the increase in number of storeys, displacement also increases.

Table 3: Storey Response of M3NBS21

Storey	X-dir	Y-dir
0	0	0
1	60.376	60.376
2	63.212	63.212
3	66.054	66.054
4	68.9	68.9
5	71.75	71.75
6	74.603	74.603
7	77.459	77.459
8	80.317	80.317
9	83.176	83.176
10	86.038	86.038
11	88.901	88.901
12	91.765	91.765
13	94.631	94.631
14	97.497	97.497
15	100.364	100.364
16	103.231	103.231
17	106.099	106.099
18	108.968	108.968
19	111.836	111.836
20	114.705	114.705
21	117.573	117.574

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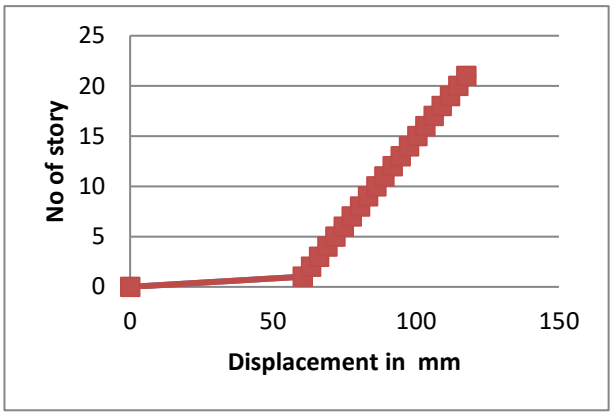

Figure 3: Displacement graph of M3NBS21

C. Observations:

1. Displacement in Y- direction and displacement in X- direction is same.
2. There is sudden change in both directions for displacement that means there is gradual increase in displacement values.
3. With the increase in number of storeys, displacement also increases.

II.MODELS WITH X- BRACINGS IN STEEL STRUCTURES

Table 4: Storey Response of M4XBS06

Storey	X-dir	Y-dir
0	0	0
1	6.635	40.565
2	7.575	41.132
3	7.773	41.332
4	7.971	41.531
5	8.168	41.729
6	8.366	41.927

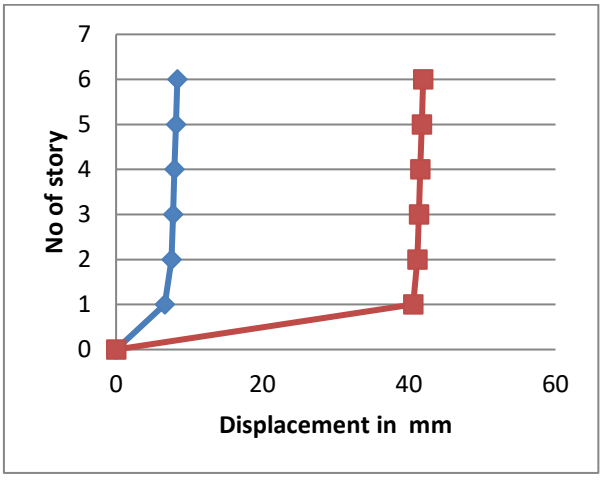

Figure 4: Displacement graph of M4XBS06

D. Observations:

1. Displacement in Y- direction is more when compared to displacement in X- direction.
2. There is no sudden change in both directions for displacement that means there is gradual increase in displacement values.
3. With the increase in number of storeys, displacement also increases.

Table 5: Storey Response of M5XBS11

Storey	X-dir	Y-dir
0	0	0
1	15.569	53.615
2	19.928	56.386
3	21.599	57.767
4	23.287	59.19
5	24.929	60.596
6	26.502	61.962
7	27.982	63.265
8	29.353	64.49
9	30.603	65.627
10	31.725	66.673
11	32.723	67.628

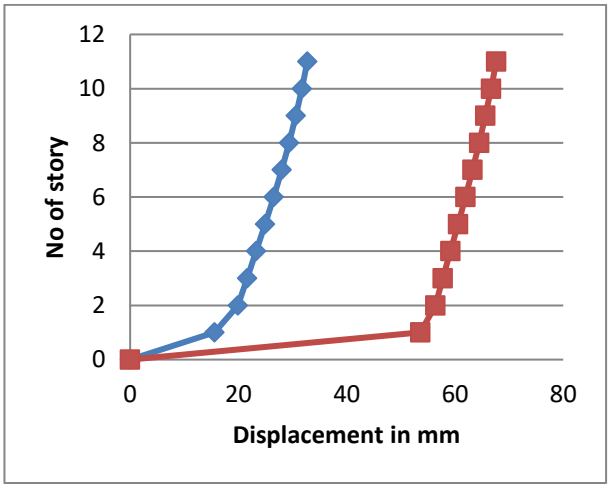

Figure 5: Displacement graph of M5XBS11

E. Observations:

1. Displacement in Y- direction is more when compared to displacement in X- direction.
2. There is sudden change in both direction displacements that means there is gradual increase in displacement values.
3. With the increase in number of storeys, displacement also increases.

Table 6: Storey Response of M6XBS21

Storey	X-dir	Y-dir
0	0	0
1	23.508	94.364
2	29.037	96.914
3	32.273	98.794
4	35.523	100.679
5	38.783	102.566
6	42.05	104.456
7	45.324	106.347
8	48.603	108.239
9	51.885	110.133
10	55.171	112.027
11	58.459	113.922
12	61.75	115.818
13	65.041	117.714
14	68.334	119.61
15	71.627	121.506
16	74.92	123.402
17	78.213	125.298
18	81.506	127.193
19	84.798	129.089
20	88.09	130.984
21	91.382	132.878

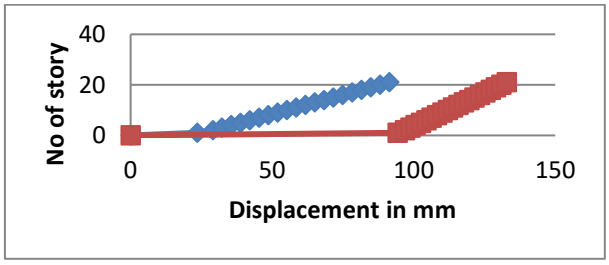

Figure 6: Displacement graph of M6XBS21

F. Observations:

1. Displacement in Y- direction is more when compared to displacement in X- direction.
2. There is sudden change in both directions for displacement that means there is gradual increase in displacement values.
3. With the increase in number of storeys, displacement also increases.

III.MODELS WITH INVERTED V-BRACING IN STEEL STRUCTURES

Table 7: Storey response of M7IVS06

Storey	X-dir	Y-dir
0	0	0
1	16.435	16.435
2	18.132	18.132
3	18.347	18.347
4	18.562	18.562
5	18.775	18.775
6	18.988	18.988

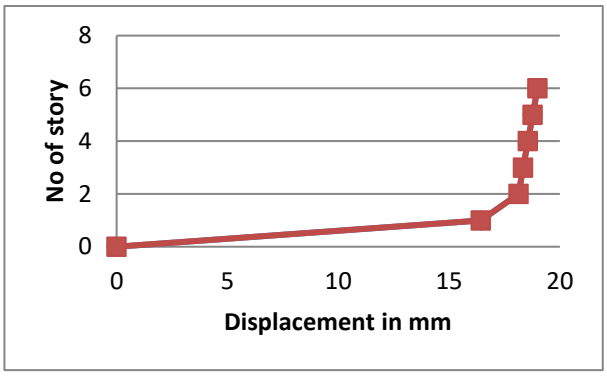

Figure 7: Response of M7IVS06

A. Observations:

1. Displacement in Y- direction and displacement in X- direction is same.
2. There is no sudden change in both directions for displacement that means there is no gradual increase in displacement values.
3. With the increase in number of storeys, displacement also increases.

Table 8: Storey response of M8IVBS11

Storey	X-dir	Y-dir
0	0	0
1	32.769	32.769
2	35.158	35.158
3	36.841	36.842
4	37.946	37.946
5	38.893	38.893
6	39.788	39.788
7	40.659	40.659
8	41.52	41.521
9	42.377	42.377
10	43.228	43.229
11	44.069	44.069

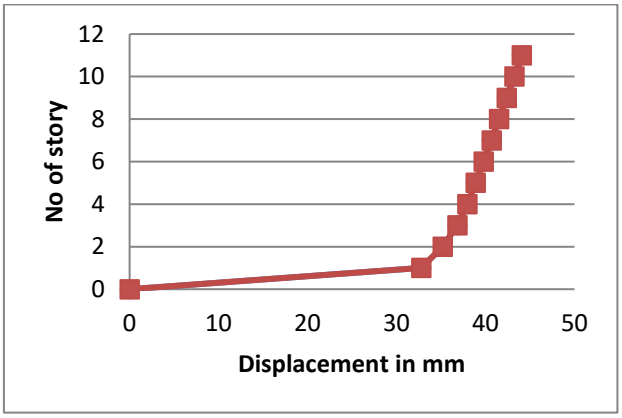

Figure 8: Displacement graph of M8IVBS11

B. Observations:

1. Displacement in Y-direction and displacement in X- direction is same.
2. There is no sudden change in both directions for displacement that means there is no gradual increase in displacement values.
3. With the increase in number of storeys, displacement also increases.

Storey	X-dir	Y-dir
0	0	0
1	51.38	51.38
2	56.513	56.513
3	59.517	59.517
4	62.53	62.53
5	65.549	65.549
6	68.573	68.573
7	71.601	71.602
8	74.633	74.634
9	77.668	77.669
10	80.706	80.706
11	83.745	83.746
12	86.786	86.787
13	89.828	89.829
14	92.872	92.872
15	95.915	95.916
16	98.96	98.96
17	102.004	102.005
18	105.048	105.049
19	108.093	108.093
20	111.137	111.137
21	114.18	114.181

Table 9: Storey response data of M9IVBS2

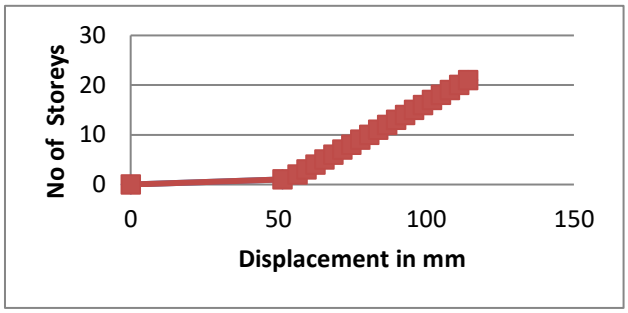

Figure 9: Displacement graph of M9IVBS21

C. Observations:

1. Displacement in Y- direction and displacement in X- direction is same.
2. There is no sudden change in both directions for displacement that means there is no gradual increase in displacement values.
3. With the increase in number of storeys, displacement also increases.

IV. MODELS WITH V- BRACING IN STEEL STRUCTURES

Table 10: Storey Response of M10VBS06

Storey	X-dir	Y-dir
0	0	0
1	16.802	16.802
2	18.432	18.432
3	18.66	18.66
4	18.888	18.888
5	19.114	19.115
6	19.341	19.341

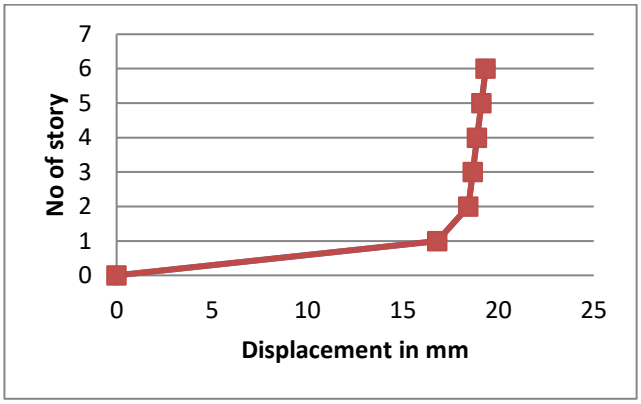

Figure 10: Displacement graph of M10VBS06

Observations:

1. Displacement in Y- direction and displacement in X- direction is same.
2. There is no sudden change in both directions for displacement that means there is no gradual increase in displacement values.
3. With the increase in number of storeys, displacement also increases.

Table 11: Storey Response data M11VBS11

Storey	X-dir	Y-dir
0	0	0
1	32.618	32.618
2	35.911	35.911
3	36.814	36.814
4	37.719	37.719
5	38.623	38.623
6	39.528	39.528
7	40.433	40.433
8	41.337	41.337
9	42.24	42.241
10	43.144	43.144
11	44.046	44.046

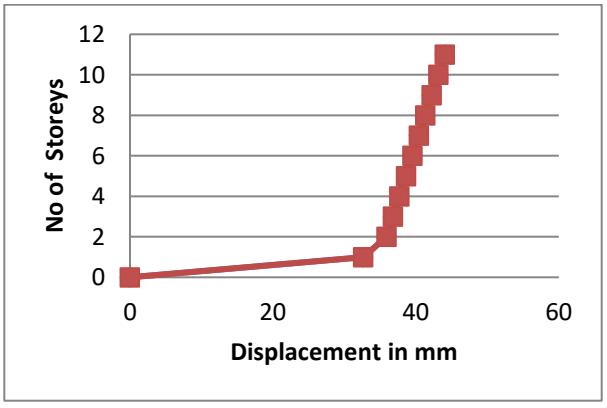

Figure 11: Displacement Graph of model M11VBS11

A. Observations:

1. Displacement in Y- direction and displacement in X- direction is same.
2. There is no sudden change in both directions for displacement that means there is no gradual increase in displacement values.
3. With the increase in number of storeys, displacement also increases.

Table 12: Storey Response data M12VBS21

Storey	X-dir	Y-dir
0	0	0
1	54.023	54.023
2	59.627	59.627
3	62.871	62.871
4	66.124	66.124
5	69.385	69.385
6	72.651	72.651
7	75.923	75.923
8	79.198	79.198
9	82.477	82.477
10	85.758	85.758
11	89.042	89.042
12	92.328	92.328
13	95.615	95.615
14	98.904	98.904
15	102.193	102.193
16	105.483	105.483
17	108.773	108.773
18	112.063	112.063
19	115.353	115.353
20	118.643	118.643
21	121.933	121.933

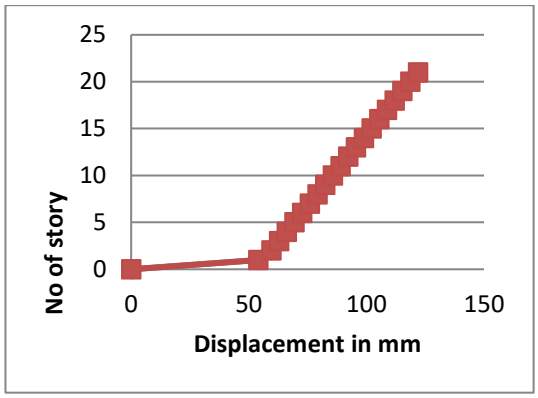

Figure 12: Displacement graph of M12VBS21

B. Observations:

1. Displacement in Y- direction and displacement in X- direction is same.
2. There is no sudden change in both directions for displacement that means there is no gradual increase in displacement values.
3. With the increase in number of storeys, displacement also increases.

V. RESPONSE SPECTRUM NO BRACING

Table 13: Response spectrum of M1NBS06

Period	Frequency

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0.001	841.981
0.001	844.996
0.001	867.84
0.001	890.983
0.001	899.991
0.001	909.311
0.001	918.306
0.001	920.84
0.001	936.379
0.002	505.093
0.027	37
0.028	35.747
0.248	4.04
0.278	3.594
0.29	3.448

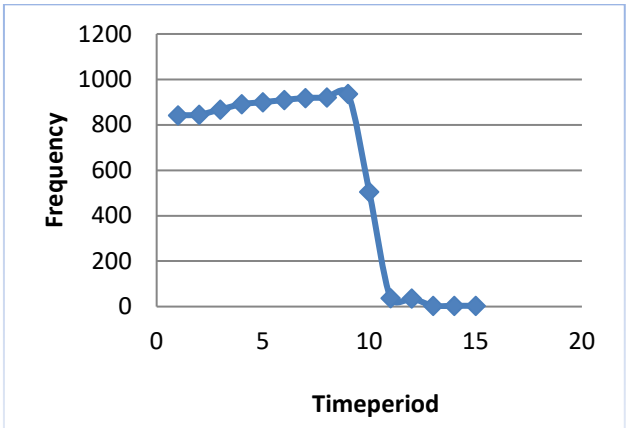

Figure 13: Response of M1NBS06

Observations:

Steel building with no of storey 06 (no. of bracings) response for a seismic loads at a frequency of 841.981cyc/sec in a short period of 0.001sec.

Table 14: Response spectrum of M2NBS11

Period	Frequency
0.043	23.06
0.044	22.862
0.051	19.742
0.054	18.673
0.054	18.677
0.055	18.15
0.059	16.811
0.061	16.346
0.061	16.348
0.065	15.281
0.186	5.362
0.186	5.368
0.475	2.106

0.714	1.401
0.714	1.401

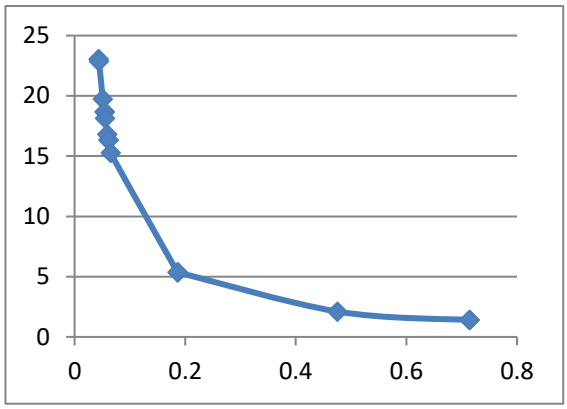

Figure 14: Response of M2NBS11

Observations:

Steel building with no of storeys 11(no. of bracings) response for a seismic loads at a frequency of 23.06cyc/sec in a short period of 0.043sec.

Table 15: Response spectrum of M3NBS21

Period	Frequency
0.003	300.832
0.003	388.627
0.004	259.417
0.006	172.238
0.006	172.248
0.008	129.693
0.03	300.327
0.176	5.671
0.176	5.671
0.509	1.964
0.697	1.434
0.699	1.431

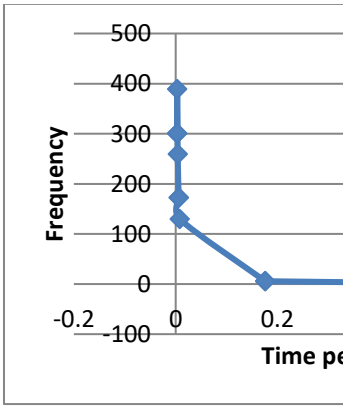

Figure 15: Response of M3NBS21

Observations:

Steel building with no of storeys 21 (no. of bracings) response for seismic loads at a frequency of 300.832cyc/sec in a short period of 0.003sec.

Table 16: Response spectrum of M4XBS06

Period	Frequency
0.012	80.011
0.012	82.272
0.013	76.645
0.014	69.278
0.014	72.536
0.015	65.919
0.017	59.76
0.026	38.174
0.027	36.482
0.171	5.854
0.199	5.029
0.427	2.34

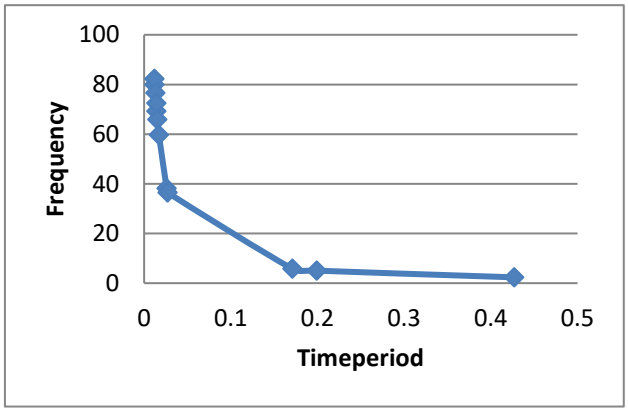

Figure 16: Response of M4XBS06

Observations:

Steel building with X bracing response for seismic loads at a frequency of 80.011 cyc/sec in a short period of 0.012sec.

Table 17: Storey Response of M5XBS11

Period	Frequency
0.017	59.673
0.018	55.394
0.019	51.476
0.021	47.438
0.022	46.188
0.025	39.334
0.033	30.479
0.034	29.429
0.039	25.939
0.074	13.536
0.096	10.432
0.116	8.609
0.309	3.239
0.325	3.082
0.645	1.551

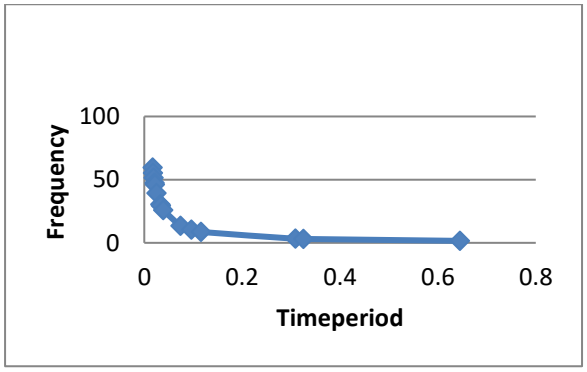

Figure 17: Response of M5XBS06

Observations:

Steel building with X bracing response for seismic loads at a frequency of 59.673cyc/sec in a short period of 0.017sec.

Table 18: Response spectrum of M6XBS21

Period	Frequency
0.011	90.832
0.011	95.059
0.012	82.234
0.013	76.311
0.013	79.927
0.014	69.018
0.014	72.496
0.015	65.542
0.017	59.857
0.018	55.107
0.133	7.509
0.195	5.135
0.396	2.527
0.526	1.902
0.928	1.077

Period	Frequency
0.01	98.529
0.012	82.849
0.012	83.953
0.013	75.015
0.013	76.08
0.014	69.952
0.015	68.329
0.016	61.685
0.016	63.129
0.018	55.408
0.175	5.699
0.175	5.707
0.458	2.183
0.667	1.499
0.667	1.499

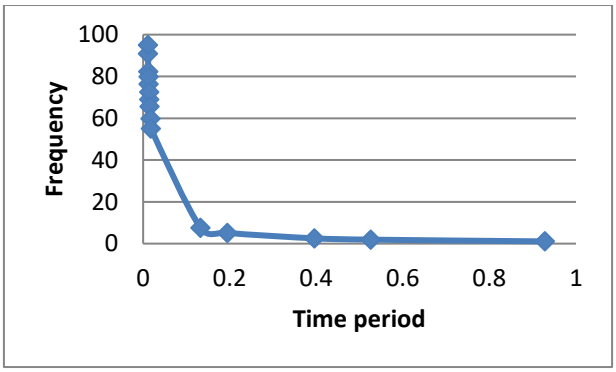

Figure 18: Response graph of M6XBS21

Observations:

Steel building with X bracing response for seismic loads at a frequency of 90.832cyc/sec in a short period of 0.011sec.

Table 19: Response spectrum of M7IVBS06

Period	Frequency
0.01	98.528
0.01	98.772
0.012	82.922
0.012	83.979
0.013	75.052
0.013	76.195
0.014	70.008
0.015	68.782
0.016	62.103
0.016	63.056
0.028	35.306
0.028	35.39
0.228	4.377
0.268	3.731
0.269	3.712

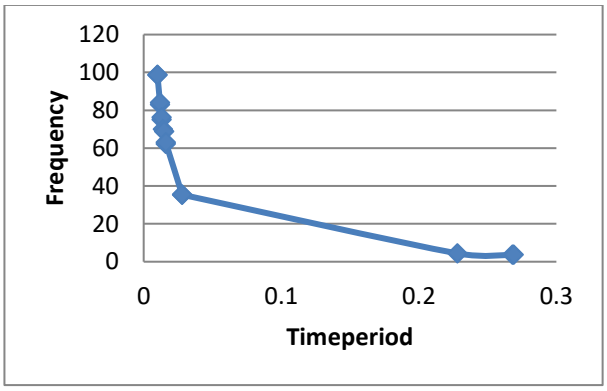

Figure 19: Response spectrum graph of M7IVS06

Observations:

Steel building with Inverted V bracing response for seismic loads at a frequency of 98.538cyc/sec in a short period of 0.01sec.

Table 20: Response spectrum of M8IVBS11

Period	Frequency
0.023	42.716
0.023	43.503
0.024	41.004
0.024	41.239

0.024	41.922
0.024	42.442
0.025	40.473
0.026	38.159
0.027	36.923
0.029	34.651
0.075	13.404
0.075	13.422
0.328	3.047
0.399	2.505
0.401	2.495

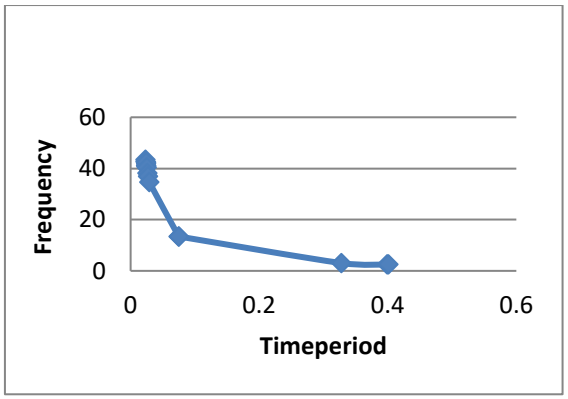

Figure 20: Response spectrum graph of M8IVBS11.

Observations:

Steel building with Inverted V bracing response for seismic loads at a frequency of 42.716cyc/sec in a short period of 0.023sec.

Table 21: Response spectrum of M9IVBS21

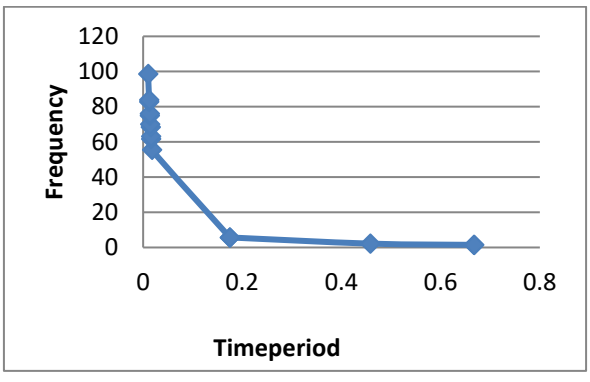

Figure 21: Response spectrum graph of model

Observations:

Steel building with Inverted V bracing response for seismic loads at a frequency of 98.529cyc/sec in a short period of 0.01sec.

Table 22: Response spectrum of M10VBS06

Period	Frequency
0.043	23.057
0.043	23.064
0.043	23.382
0.044	22.858
0.051	19.74
0.054	18.673
0.054	18.674
0.055	18.149
0.059	16.811
0.061	16.346
0.061	16.348
0.065	15.281
0.23	4.34
0.27	3.709
0.271	3.688

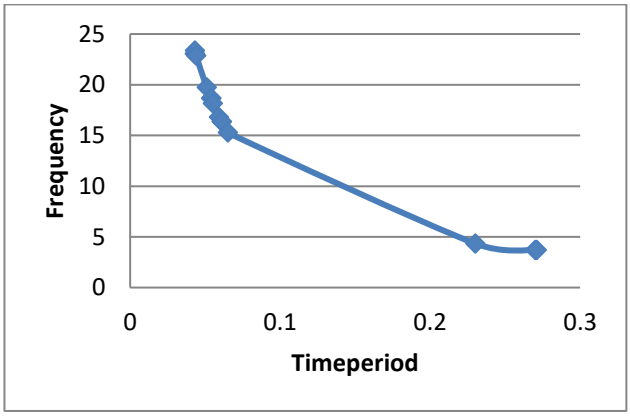

Figure 22: Response spectrum graph of M10VBS06

Observations:

Steel building with V bracing response for seismic loads at a frequency of 23.057cyc/sec in a short period of 0.043sec.

Table 23: Response spectrum of M11VBS11

Period	Frequency
0.043	23.063
0.044	22.866
0.051	19.745
0.054	18.68
0.054	18.684
0.055	18.155
0.059	16.812
0.061	16.346
0.061	16.348
0.065	15.282

0.075	13.305
0.075	13.326
0.326	3.068
0.401	2.496
0.402	2.487

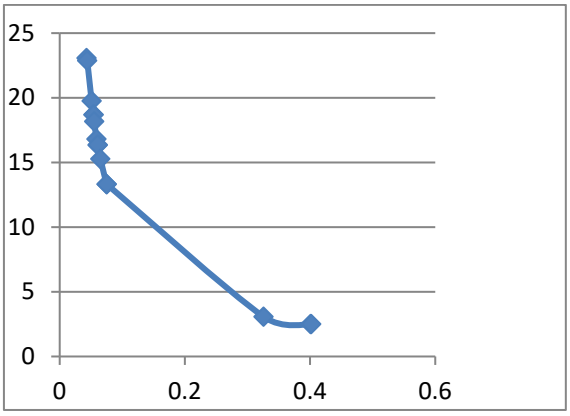

Figure 23: Response spectrum graph of M11VBS11

Observations:

Steel building with V bracing response for seismic loads at a frequency of 23.063cyc/sec in a short period of 0.043sec.

Table 24: Response spectrum of M12VBS21

Period	Frequency
0.043	23.06
0.044	22.862
0.051	19.742
0.054	18.673
0.054	18.677
0.055	18.15
0.059	16.811
0.061	16.346
0.061	16.348
0.065	15.281
0.186	5.362
0.186	5.368
0.475	2.106
0.714	1.401
0.714	1.401

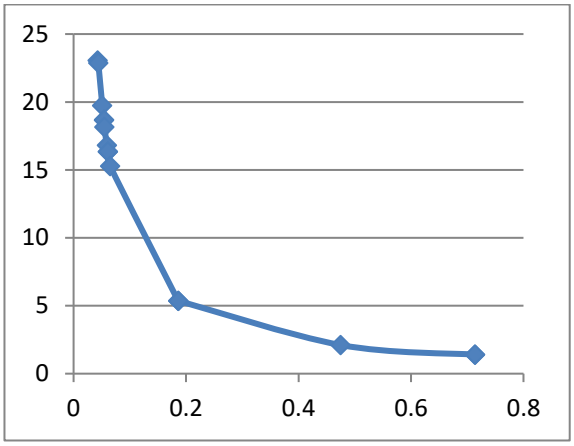

Figure 24: Response spectrum graph of M12VBS21

Observations:

Steel building with V bracing response for seismic loads at a frequency of 23.063cyc/sec in a short period of 0.043sec.

VI. CONCLUSIONS

1. Dynamic Seismic behavior of steel structure is better.
2. Structures with X-Bracing systems exhibits more lateral resistance followed by V and inverted V bracing systems.
3. Lateral Displacement of the structure using X-Bracing in Steel Structure is less.
4. Reaction time period for Steel building for seismic loads is 0.01 sec with an excitation frequency of 98.53 cyc/sec.
5. From analytical results obtained, we can conclude that overall Seismic performance of steel structures are better.