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Seismic Behavior of Steel Frame Structure with and without Bracing System

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Abstract - Steel Building in the world in the last decades, the steel structure for the building industry has played an important role in the most useful content. Providing the strength, stability and flexibility are the key purposes of seismic design. It is to design a structure under seismic load is required to perform. Structural bracing element in the system plays an important role in structural behavior during earthquakes. Bracing pattern of massive steel framed building can modify the behavior of the global seismic.

In this work Response Spectrum Analysis is carried out for G+21 storey steel frame building with different pattern of bracing system. Three types of sections i.e. ISMB, ISWB and ISB sections are used to compare for same patterns of beam, column and bracings. A software package ETABS SOFTWARE is using for the analysis of steel buildings and different parameters are compared. The property of the section is used as per IS 800:2007 which is analysis for various types of bracings like X, V, inverted V, Eccen Forward, Eccen Back and without bracing and Performance of each frame is carried out and studied the comparatively through Response Spectrum Method. India) conditions.

In this study, the comparative analysis of Steel multistory building with and without bracing framed structure in the term of Maximum Story Displacement.

Key Words: *Seismic zone, Soil type, G+21Multistory Steel Building, different type Bracing, Etabs Software etc.*

1.INTRODUCTION *(Size 11, Times New roman)*

The earthquake is a natural phenomenon, which is generated in the earth's crust. Earthquake period is generally rather low, more than a few seconds to a minute or permanent. But different parts of the world, thousands of people lose their lives in the earthquake. Building collapse or damage caused by the earthquake ground motion are a big loss. In an earthquake, the building based high frequency movements inertial forces on the building and its components is the result of experience. The building is created by the force of the tendency to remain at rest, and is in its original position, even if it is rising from the ground below. Assessment of seismic vulnerability of structures and seismic action levels beyond traditional linear behavior of the need for an accurate prediction of the seismic responses of non-deterministic characteristics is a very complex issue. The main factor influencing the choice of stable performance is bracing systems. Before destruction one more plastic deformation bracing system that can absorb more energy during the earthquake. Seismic analysis and structural analysis is a subset of the earthquake response of the structure of a building is calculated. The structural design, structural engineering or earthquake assessment and retrofit areas where earthquakes are prevalent in the part of the process. Providing strength, stability and flexibility are the key purposes of seismic design.

Objective of study

The objective of the study comprises of the following:

1. Comparative study of the behavior of different type of steel bracing structures such as with and without braced, inverted V-braced.
2. To perform the Response Spectrum Method of analysis on steel structures.
3. To compare the different bracing steel structures such as with & without bracing.

Building Geometry:

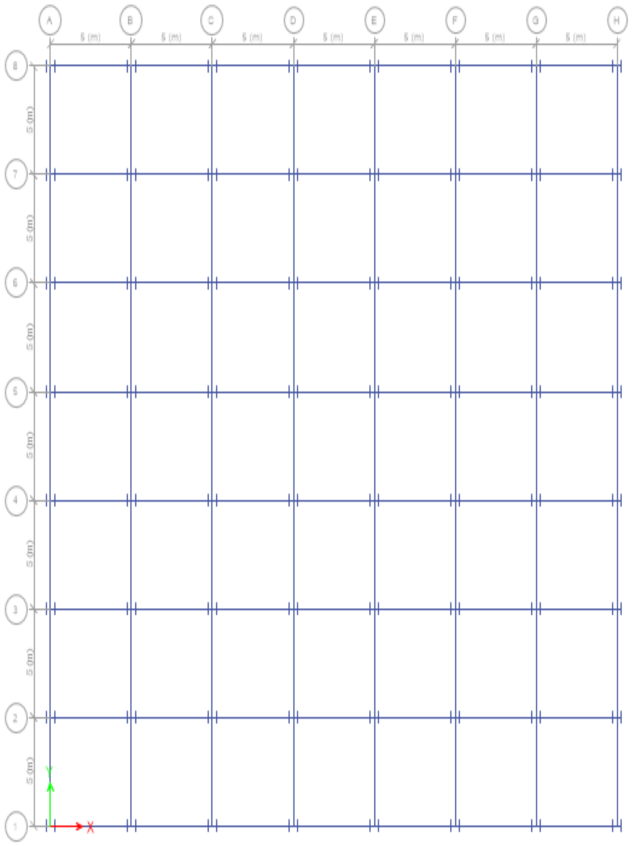

Fig1.1. Building Plan configuration

Fig.a without bracing

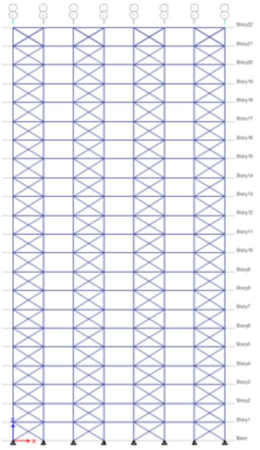

fig. b Cross Bracing

Fig. (c) V-Bracing

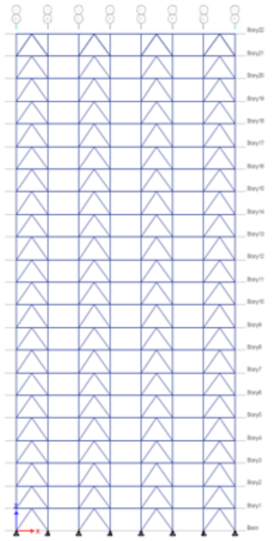

Fig. (d) Inverted V- Bracing

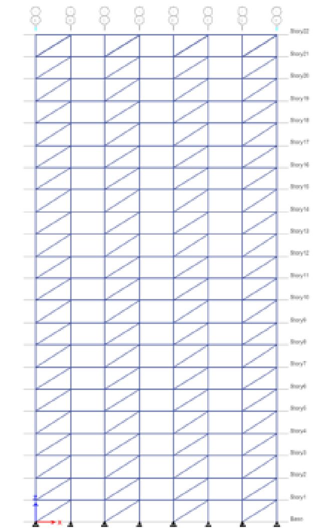

Fig. (e) Eccen Forward Bracing

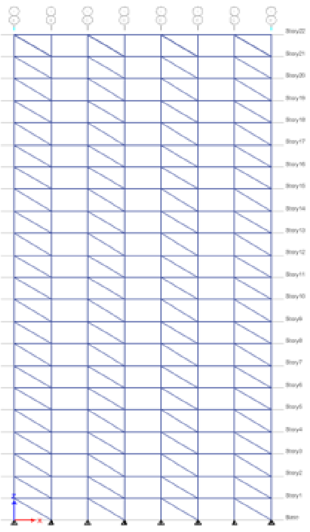

Fig. (f) Eccen Back Bracing

2. LITRETURE REVIEW

Anila S, Safvana P {9} (2018):- He analyzed the Steel structure with and without bracing system and RCC structure under the seismic loads by using Etabs software. He considered different type bracing system like X bracing, zipper bracing etc. The bracing is provided at each corner of different multistory building like G+6, G+12, G+18 storey with 6x3 bays along to X and Y direction and performed that the effectiveness of various type bracing system in steel and RCC structures. He observed that the percentage reduction in lateral displacement and deformation and base shear is less for SBS with double spring bracing system in the case of RCC structure and for steel structures deformation is less for zipper bracing system and base shear value is also less for SBS with double spring bracing system.

Chhavi Gupta, Ashiru Muhammad, etc al{41} [2015]- He studied the comparative seismic analysis of multistory G+5, G+8, G+11 story building framed of RCC and Steel structure by using Staad Pro. He selected the building geometry of three bays along to X direction and five bays along to Z direction with different height of 19.6m, 29.2m, 38.8m from the ground level, each floor height of 3.2m except ground floor because of ground floor heath of 3.6m. the section property of beam and column of RCC structure was 230mmX450mm with 150mm thickness of slab while column of steel building frame of ISWB 500 and steel beam ISHB 450with thickness of slab 150mm. The time period increase with increase the height of building it means that irrespective type of building frames like as composite and conventional type structure. He compared and observed that the time period was more in conventional structure with composite structure and also found that the average response reduction coefficient for conventional and composite frame decrease increase as per the building height.

Jagdeesh Bommisetty, Dr. G, Rajesh Kumar etc. al. {12} (2019):- Seismic analysis of steel framed building structure without bracing and with different bracing system of the structure in earthquake zone V with medium soil condition. They analyzed and compared the structure with two bracing system such as global bracing system and concentric bracing system along with moment resisting frame and considered various parameter such as fundamental time period of vibration, storey drift, storey displacement for different height 20m, 60, and 100m of the building structure by response spectrum method in SAP2000 V16 software and observed that every bracing system improved the earthquake performance but relatively global bracing system enhances significantly followed by the K bracing and X bracing frame.

K. M. Bajoria, K. K.Sangle, etc.al. {16} (2012):- They studied that the seismic analysis of the high rise steel framed building with bracing and without bracing system. Bracing element in structural system plays vital role in structural behavior during earthquake. The pattern of the bracing can extensively modify the global seismic behavior of the framed steel building. He include the linear time history analysis on high rise steel building with different pattern of bracing system for Northridge earthquake. Natural frequencies, fundamental time period, mode shapes, inter story drift and base shear are calculated with different pattern of bracing system. Further optimization studied to decide the suitable type of the bracing pattern by keeping the inter-story drift, total lateral displacement and stress level within permissible limit. He observed that bracing element will have very important effect on structural behavior under earthquake effect. From the tables it shows that due to bracings in both direction base shear increases up to 38%. The displacements at roof level of the building with different bracing style is reduces from 43% to 60%. Modal time period is also reduced up to 65%. The diagonal brace highly effective and economical design of bracing style.

Prof. G.D. Dhawale, Prof. N. P. Shende, Amol V. Gowardhan, {27} (2016):- They analyzed the residential steel building frame structure of G+15 without bracing and with different type bracing system such as diagonal, K, inverted V and K type bracing, along with gravity load structure by using SAP2000 software with section such as ISMB, ISMC and ISA section are used and compared for same pattern of the bracing system with different position in earthquake zone III. They found that steel bracing system reduced flexure and shear on beams and column, reduced the lateral displacement, storey drift, as compared to the without braced frame structure while axial force increased in braced structure as compared to the without braced building structure.

3. MATHEDOLOGY

The seismic performance i.e. analysis of steel structures is attempt in the current project. For this, the proposed methodology is as follows:

1. An extensive survey of the literature on the response of steel structures to seismic loading is performed.
2. Different type of steel structure are taken and analyzed by Dynamic Analysis.
3. Different type of bracing system of steel structures are taken and analyzed by different ground motion with the help of RSM analysis.
4. Calculate the different results of steel structure i.e. without bracing.
5. Plot different curves from RSM analysis for all types of steel structure i.e. without bracing.

1. Using Etabs Software.
2. Creating building plan of building structure.
3. Applying property like beam , column, slab dimension and support on structure.
4. Applying Load like Dead load, Live load, seismic load and load combination as per IS code.
5. Getting Results in the form of Max Overturning Moments, Max Story Shears. Max Story Displacement, Max. Story Drifts etc.
6. Results Analysis: Graphical analysis in the term of Max Overturning Moments, Max Story Shears. Max Story Displacement, Max. Story Drifts etc.
7. Conclusion

4. MODELING DESCRIPTIONS

Etabs is a general purpose program for doing the analysis the structure with different types soil condition and seismic zone III. The following three activities must be performed to achieve that goal

a. Model generation using Etabs.
b. The calculations to determine the analytical results
c. Result check is all encouraged by apparatuses contained in the system's graphical surroundings.

Parameter Using:

Type of Building : Steel Framed Structure
Number of Floor : G+21 (Square Shape Building)
Section Property: ISMB, ISWB and ISLB sections

Seismic Parameter:

Seismic Zone- III
Soil Type- Medium Soil
Damping = 5% (as per table-3 clause 6.4.2), Zone factor for zone V, Z=0.16)
Importance Factor I=1.5 (Important structure as per Table-6)
Response Reduction Factor R=5 for Special steel moment resisting frame Table-7)
Sa/g= Average acceleration coefficient (depend on Natural fundamental period)

Geometry And Modelling

Grade of concrete is considered M25
Grade of Rebar is considered Fe-415
Grade of Steel –Fe-345

5. RESULTS ANALYSIS

5.1 STOREY DISPLACEMENTS

5.1.1 MAXIMUM STOREY DISPLACEMENTS IN MODEL-I

Table: 5.1.1 Storey Displacements in MODEL-I

MODEL-I			
WITHOUT BRACING SYSTEM			
Maximum Storey Displacement in mm			
Story	Elevation (m)	X	Y
Story22	70.4	364.607	1966.074
Story21	67.2	360.223	1953.467
Story20	64	354.349	1931.455
Story19	60.8	346.82	1900.077
Story18	57.6	337.661	1859.539
Story17	54.4	326.947	1810.08
Story16	51.2	314.757	1751.98
Story15	48	301.165	1685.553
Story14	44.8	286.237	1611.14
Story13	41.6	270.043	1529.115
Story12	38.4	252.657	1439.884
Story11	35.2	234.166	1343.878
Story10	32	214.66	1241.551
Story9	28.8	194.228	1133.387
Story8	25.6	172.95	1019.903
Story7	22.4	150.891	901.629
Story6	19.2	128.113	779.113
Story5	16	104.689	652.939
Story4	12.8	80.745	523.718
Story3	9.6	56.555	392.046
Story2	6.4	32.82	258.493
Story1	3.2	11.646	123.818
Base	0	0	0

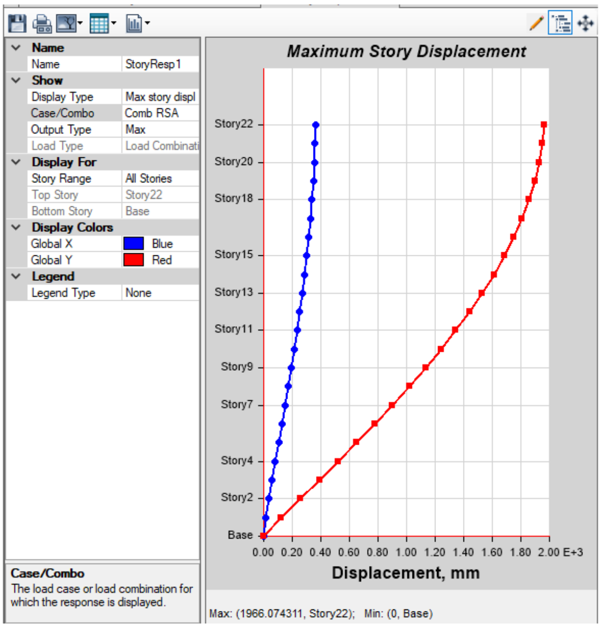

Fig. 5.1.1 Storey Displacements in MODEL-I

5.1.2 MAXIMUM STOREY DISPLACEMENTS IN MODEL-II

Table: 5.1.2 Storey Displacements in MODEL-II

MODEL-II			
WITH X- TYPE BRACING SYSTEM			
Maximum Storey Displacement in mm			
Story	Elevation (m)	X	Y
Story22	70.4	239.97	484.842
Story21	67.2	233.335	467.317
Story20	64	226.019	448.895
Story19	60.8	218.021	429.512
Story18	57.6	209.368	409.106
Story17	54.4	200.054	387.649
Story16	51.2	190.084	365.146
Story15	48	179.474	341.642
Story14	44.8	168.257	317.216
Story13	41.6	156.477	291.98
Story12	38.4	144.192	266.073
Story11	35.2	131.468	239.667
Story10	32	118.378	212.962
Story9	28.8	105.015	186.191
Story8	25.6	91.489	159.62
Story7	22.4	77.929	133.552
Story6	19.2	64.473	108.338
Story5	16	51.275	84.361
Story4	12.8	38.516	62.038
Story3	9.6	26.432	41.827
Story2	6.4	15.325	24.261
Story1	3.2	5.828	10.016
Base	0	0	0

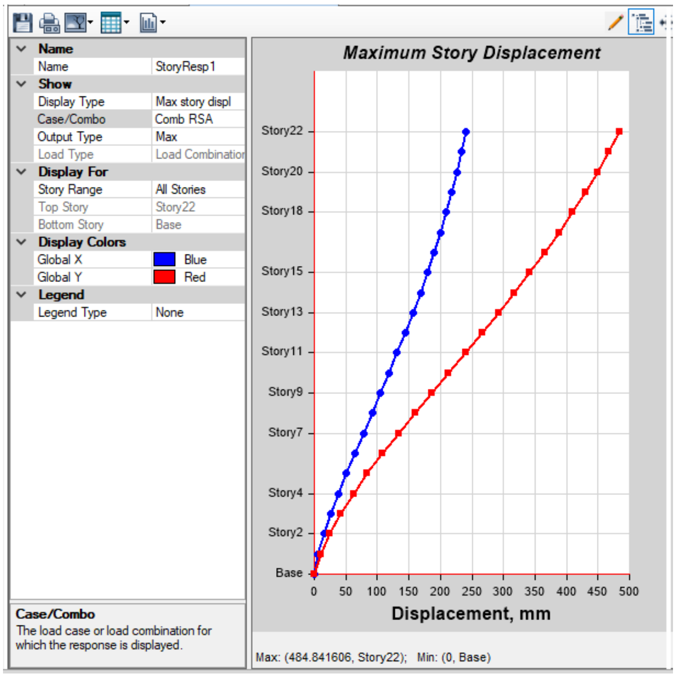

Fig. 5.1.2 Storey Displacements in MODEL-II

5.1.3 MAXIMUM STOREY DISPLACEMENTS IN MODEL-III

Table: 5.1.3 Storey Displacements in MODEL-III

MODEL-III			
WITH V-TYPE BRACING SYSTEM			
Maximum Storey Displacement in mm			
Story	Elevation (m)	X	Y
Story22	70.4	251.573	519.712
Story21	67.2	245.087	502.05
Story20	64	237.799	483.406
Story19	60.8	229.762	463.72
Story18	57.6	221.018	442.923
Story17	54.4	211.566	420.978
Story16	51.2	201.415	397.885
Story15	48	190.585	373.68
Story14	44.8	179.108	348.436
Story13	41.6	167.031	322.254
Story12	38.4	154.411	295.265
Story11	35.2	141.306	267.629
Story10	32	127.785	239.538
Story9	28.8	113.931	211.209
Story8	25.6	99.847	182.894
Story7	22.4	85.651	154.878
Story6	19.2	71.469	127.496
Story5	16	57.436	101.107
Story4	12.8	43.702	76.106
Story3	9.6	30.465	52.921
Story2	6.4	18.003	32.05
Story1	3.2	7.03	14.124
Base	0	0	0

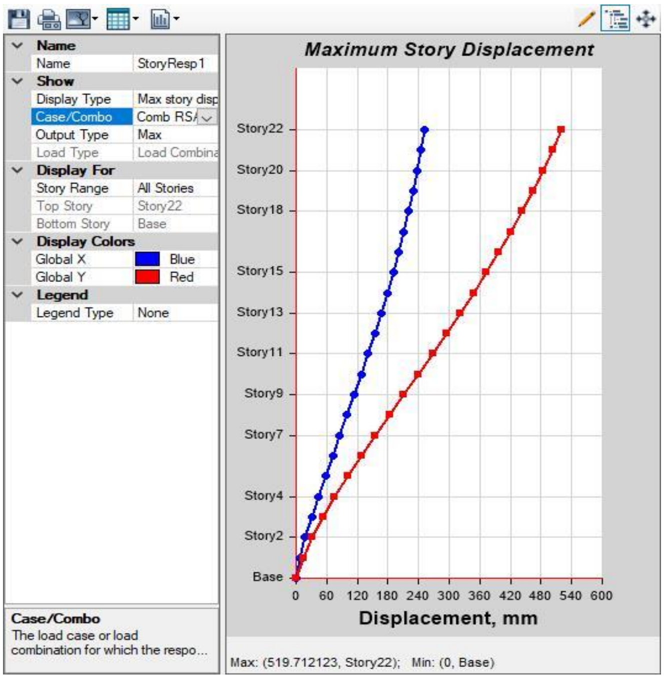

Fig. 5.1.3 Storey Displacements in MODEL-III

5.1.4 MAXIMUM STOREY DISPLACEMENTS IN MODEL-IV

Table: 5.1.4 Storey Displacements in MODEL-IV

MODEL-IV			
WITH INVERTED V-TYPE BRACING SYSTEM			
Maximum Storey Displacement in mm			
Story	Elevation (m)	X	Y
Story22	70.4	239.09	473.902
Story21	67.2	232.891	458.064
Story20	64	225.859	441.016
Story19	60.8	218.056	422.796
Story18	57.6	209.533	403.371
Story17	54.4	200.301	382.736
Story16	51.2	190.376	360.917
Story15	48	179.785	337.978
Story14	44.8	168.565	314.015
Story13	41.6	156.772	289.155
Story12	38.4	144.466	263.55
Story11	35.2	131.714	237.384
Story10	32	118.592	210.872
Story9	28.8	105.192	184.258
Story8	25.6	91.629	157.818
Story7	22.4	78.034	131.872
Story6	19.2	64.55	106.783
Story5	16	51.326	82.959
Story4	12.8	38.536	60.832
Story3	9.6	26.404	40.862
Story2	6.4	15.23	23.576
Story1	3.2	5.708	9.646
Base	0	0	0

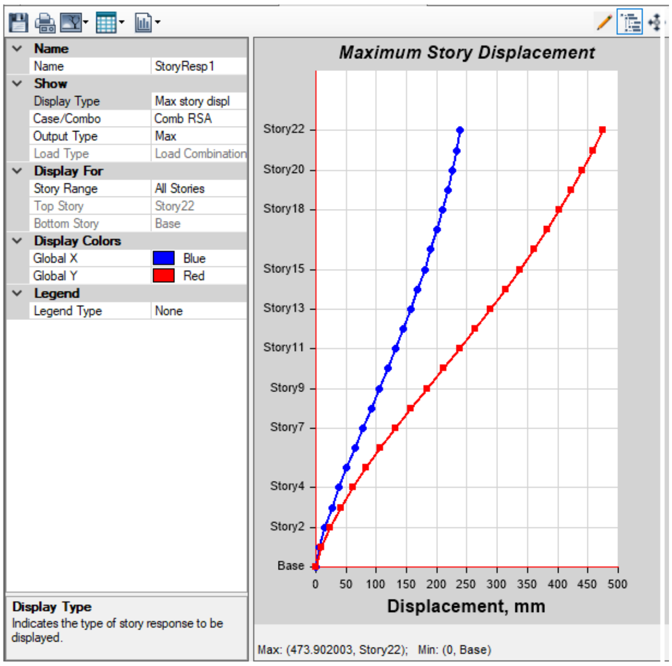

Fig. 5.1.4 Storey Displacements in MODEL-IV

5.1.5 MAXIMUM STOREY DISPLACEMENTS IN MODEL-V

Table: 5.1.5 Storey Displacements in MODEL-V

MODEL-V			
WITH ECCEN. FORWORD TYPE BRACING SYSTEM			
Maximum Storey Displacement in mm			
Story	Elevation (m)	X	Y
Story22	70.4	268.455	570.274
Story21	67.2	262.293	553.223
Story20	64	255.216	534.812
Story19	60.8	247.284	514.915
Story18	57.6	238.488	493.531
Story17	54.4	228.859	470.621
Story16	51.2	218.413	446.205
Story15	48	207.174	420.35
Story14	44.8	195.186	393.153
Story13	41.6	182.506	364.744
Story12	38.4	169.197	335.277
Story11	35.2	155.323	304.941
Story10	32	140.954	273.957
Story9	28.8	126.171	242.572
Story8	25.6	111.079	211.062
Story7	22.4	95.797	179.735
Story6	19.2	80.45	148.948
Story5	16	65.166	119.101
Story4	12.8	50.079	90.62
Story3	9.6	35.36	63.954
Story2	6.4	21.312	39.602
Story1	3.2	8.55	18.146
Base	0	0	0

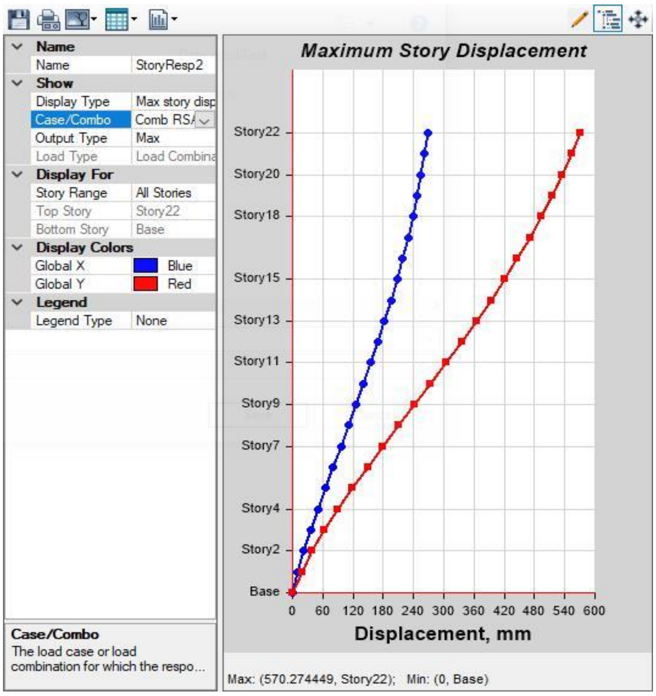

Fig. 5.1.5 Storey Displacements in MODEL-V

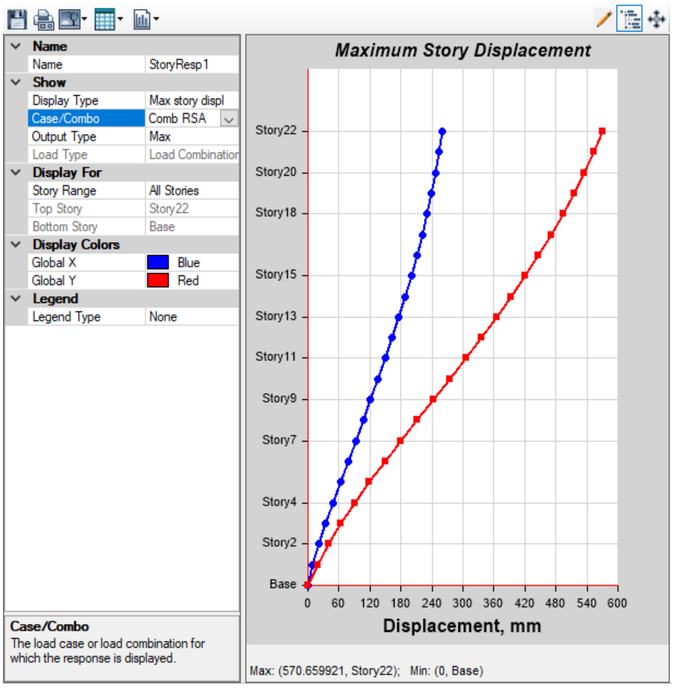

Fig. 5.1.6 Storey Displacements in MODEL-VI

5.1.6 MAXIMUM STOREY DISPLACEMENTS IN MODEL-VI

Table: 5.1.6 Storey Displacements in MODEL-VI

MODEL-VI			
WITH ECCEN. BACK TYPE BRACING SYSTEM			
Maximum Storey Displacement in mm			
Story	Elevation (m)	X	Y
Story22	70.4	260.049	570.66
Story21	67.2	254.021	553.608
Story20	64	247.081	535.204
Story19	60.8	239.307	515.31
Story18	57.6	230.687	493.935
Story17	54.4	221.261	471.024
Story16	51.2	211.05	446.605
Story15	48	200.076	420.744
Story14	44.8	188.386	393.541
Story13	41.6	176.037	365.122
Story12	38.4	163.092	335.645
Story11	35.2	149.613	305.296
Story10	32	135.668	274.298
Story9	28.8	121.339	242.897
Story8	25.6	106.724	211.368
Story7	22.4	91.943	180.022
Story6	19.2	77.117	149.213
Story5	16	62.369	119.342
Story4	12.8	47.83	90.835
Story3	9.6	33.671	64.139
Story2	6.4	20.194	39.753
Story1	3.2	8.036	18.244
Base	0	0	0

6. CONCLUSIONS

After the analysis the we get following putcomes in Model-, Model-II, Model-III, Model-IV, Model-V and Model-VI respectively.

It is seen that the maximum storey displacement 3604.607mm in X direction and 1966.074mm in Y direction at 22th storey top of the structure and something the displacement is in decreasing order with the decreasing the storey height of the structure while zero displacement at the base of the structure.

It is seen that the maximum storey displacement 239.97 mm in X direction and 484.97 mm in Y direction at 22th storey of the structure and as comparing both direction in which in y direction, the displacement is found maximum and also observed that the displacement is in decreasing order with the decreasing the storey height of the structure while zero displacement at the base of the structure.

It is seen that the maximum storey displacement 251.573 mm in X direction and 519.712 mm in Y direction at 22th storey top of the structure and something the displacement is in decreasing order with the decreasing the storey height of the structure while zero displacement at the base of the structure.

It is seen that the maximum storey displacement 239.09 mm in X direction and 473.902 mm in Y direction at 22th storey of the structure and as comparing both direction in which in y direction, the displacement is found maximum and also observed that the displacement is in decreasing order with the decreasing the storey height of the structure while zero displacement at the base of the structure.

It is seen that the maximum storey displacement 268.455 mm in X direction and 570.274 mm in Y direction at 22th storey top of the structure and something the displacement is in decreasing order with the decreasing the storey height of the structure while zero displacement at the base of the structure.

It is seen that the maximum storey displacement 260.049 mm in X direction and 570.66 mm in Y direction at 22th storey of the structure and as comparing both direction in which in y direction, the displacement is found maximum and also observed that the displacement is in decreasing order with the decreasing the storey height of the structure while zero displacement at the base of the structure.

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