Seismic Behavior of Steel Frame Structure with and Without Bracing

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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 study model a G+21 with Square Shape building Plan 35mX35m, height of each floor is 3.2m and Structure in Etabs software by Response Spectrum Method and Analysis the Earthquake analysis of the Structure in seismic zones III with all soil (Soft, Medium and soil of India) conditions.*

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.

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

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

1.INTRODUCTION

A Braced Frame is a structural system which is designed primarily to resist wind and earthquake forces. Members in a braced frame are designed to work in tension and compression, similar to a truss. Braced frames are almost always composed of steel members. The commonly used lateral force resisting systems, moment resisting and concentrically braced frames, generally provide economic solutions to one or the other of the two requirements but not both; vis., moment resisting frames are ductile but often too flexible to economically meet drift control requirements, whereas concentrically braced frames are stiff but possess limited energy dissipation capability. Recently, eccentrically braced frames have been advanced as an economic solution to the seismic design problem. An eccentrically braced frame is a generalized framing system in which the axial forces induced in the braces are transferred either to a column or another brace through shear and bending in a segment of the beam. This critical beam segment is called an "active link" or simply "link" and will be designated herein by its length e. These links act to dissipate the large amounts of input energy of a severe seismic event via material yielding.

Bracing configuration: The selection of a bracing configuration is dependent on many factors. These include the height to width proportions of the bay and the size and location of required open areas in the framing elevation. These constraints may supersede structural optimization as design criteria. The introduction of the parameter, e/L, leads to a generalization of the concept of framing system. It has been shown that high elastic frame stiffness can be achieved by reducing the eccentricity, e. The reduction of e, however, is limited by the ductility that an active link can supply.

Objective of study

The objective of the study comprises of the following:

1. To study of the behavior of different type of steel braced and unbraced structure.

2. To perform the Response Spectrum Method of analysis on structures.

3. To compare the different bracing steel building structures such as with & without bracing.

Building Geometry:

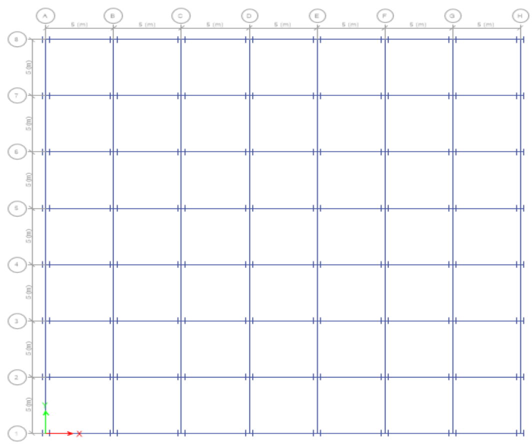

Fig1.1. Building Plan configuration

Fig.a without bracing

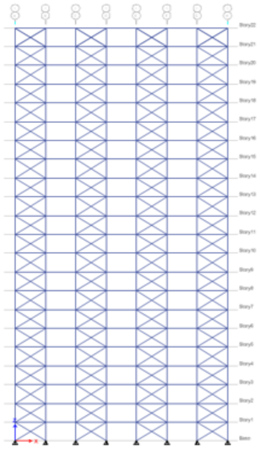

fig. b Cross Bracing

Fig. (c) V-Bracing

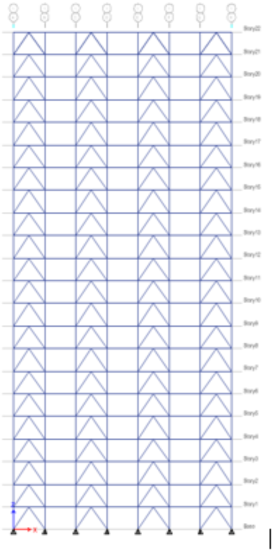

Fig. (d) Inverted V- Bracing

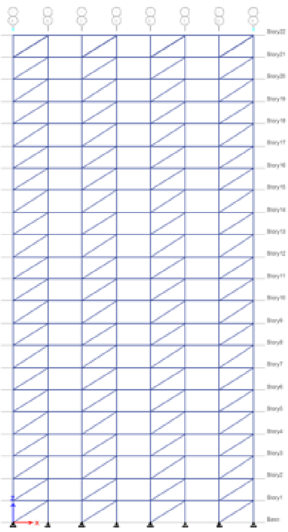

Fig. (e) Eccen Forward Bracing

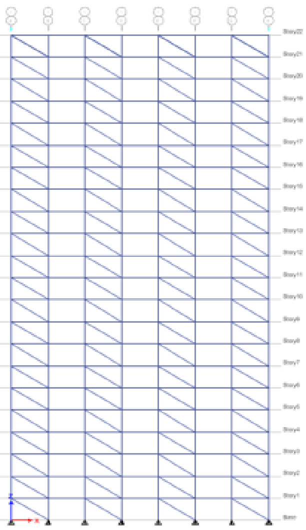

Fig. (f) Eccen Back Bracing

2. LITRETURE REVIEW

K. S. K. Karthik Reddy etc al{2015}- He studied that the comparative seismic behavior of multistory steel building G+15 plan of 25mX25m, six number of bays along to X and Z direction, member load 10kN/m, dead load 3kN/m2, live load 2 kN/m2, response reduction factor 3, importance factor 1, depth of foundation 3m, damping ratio five percent with different types and arrangement of racing**.** The tall steel building subjected to lateral or torsional effect under the action of the lateral load, lateral stiffness considered in the design of steel tall building frame**.** He used four different type bracing in the tall building in order to provide lateral stiffness and also provided a peripheral bracing in column in seismic zone II and wind speed 200kmph by equivalent static analysis as per Indian Standard Code IS**:** 1893-2002 and with IS 875 part-III-1987 using Staad Pro Software**.** He used various parameters in the term of story drift, column moment axial force x-type and x-type bracing compared with unbraced structure and compared with rc building frame with steel building frame**.** He observed that x-type bracing more efficient than that of reinforced concrete bracing and complete weight of the building structure increased by using concrete bracing**.**

Dr. Prakash M R, Jagdeesh B N (2016):- He studied that the seismic analysis of the steel framed structure with mega bracing system. The propping is a standout amongst other horizontal burden opposing frameworks and it will be the suitable answer for upgrading quake obstruction. A Supporting is a framework that is given to limit the sidelong avoidance of structure. The individuals from a propped outline are exposed to strain and pressure, with the goal that they are given to take these powers like a support. Supported edges are constantly structured of steel individuals. Utilization of the propped outlines has gotten extremely famous in skyscraper structure and furthermore in seismic plan of them. Demonstrating and investigation utilizing programming ETABS to decipher connection between supports outline and without support outline perspectives and concentrated to evaluate the seismic reaction of steel structure with concentric propping framework. Two basic setups were used; vertical unpredictable model (VIRM), vertical sporadic model with super supporting (VIRM_MB). A 15 story steel second opposing edge was broke down for all zones of soil type-II (medium). The examinations were done to evaluate the basic execution under quake ground movements. These models are looked at in changed angles, for example, story float, story uprooting and base shear. It presumes that the decrease of story floats in mega supported casing happens as for the without propped outline. The story relocation of the vertical unpredictable structure is decreased 77.64% by the utilization of user propping framework in contrast with without supporting framework. Subsequently, it very well may be said that propping framework has more effect on the limitation to comparative with floor removal. The most extreme base shear for mega (VIRM_MB) propping outline are diminished by 23.42% when contrasted with VIRM without supporting casing.

I. Anusha etc al (2016) - He studied the analysis of steel building frame G+5 structure against the seismic loads and different loading conditions. He selected the six story building fame structure with three bays in lateral and horizontal direction and height of each floor was 3m and spacing between bays 8m along to horizontal while 6m along the lateral direction. He also selected different seismic parameters like seismic zone III, response reduction factor 3, importance facto 5 and damping ratio five percent. He selected two methods for analysis the structure as Equivalent static load method and response spectrum method and also checked the P-delta analysis and connection design of exterior and interior joint. He observed different results like story drift, story shear more in lateral forced method as response spectrum method and Dynamic analysis values are smaller than the lateral force method.

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. MODELLING AND 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 AND ANALYSIS

5.1 STOREY LATERAL FORCE

5.1 MAXIMUM STOREY LATERAL FORCE IN MODEL-I

Table: 5.1 Storey Lateral force in MODEL-I

MODEL-I			
WITHOUT BRACING SYSTEM			
Maximum Lateral force in KN			
Story	Elevation (m)	X-Direction	Y-Direction
Story22	70.4	363.0019	363.0019
Story21	67.2	364.6932	364.6932
Story20	64	330.7875	330.7875
Story19	60.8	298.5357	298.5357
Story18	57.6	267.9379	267.9379
Story17	54.4	238.994	238.994
Story16	51.2	211.704	211.704
Story15	48	186.068	186.068
Story14	44.8	162.0859	162.0859
Story13	41.6	139.7577	139.7577
Story12	38.4	119.0835	119.0835
Story11	35.2	100.0632	100.0632
Story10	32	82.6969	82.6969
Story9	28.8	66.9845	66.9845
Story8	25.6	52.926	52.926
Story7	22.4	40.5215	40.5215
Story6	19.2	29.7709	29.7709
Story5	16	20.6742	20.6742
Story4	12.8	13.2315	13.2315
Story3	9.6	7.4427	7.4427
Story2	6.4	3.3079	3.3079
Story1	3.2	0.827	0.827
Base	0	0	0

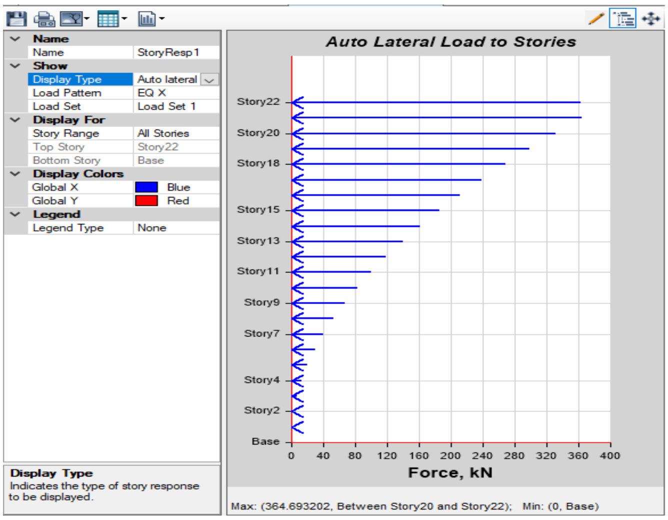

Fig. 5.1A Storey Lateral force in MODEL-I

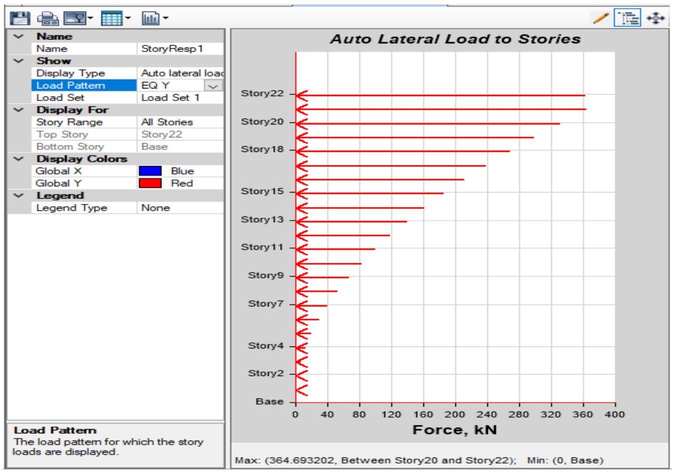

Fig. 5.1B Storey Lateral force in MODEL-I

5.2 MAXIMUM STOREY LATERAL FORCE IN MODEL-II

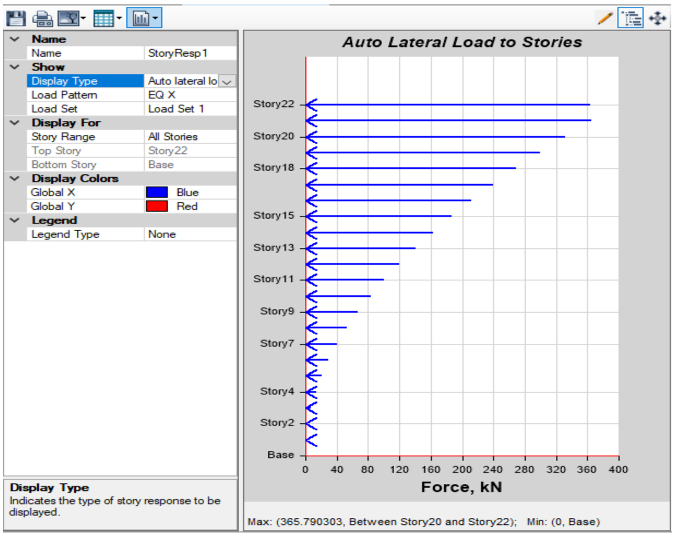

Fig. 5.2A Storey Lateral force in MODEL-II

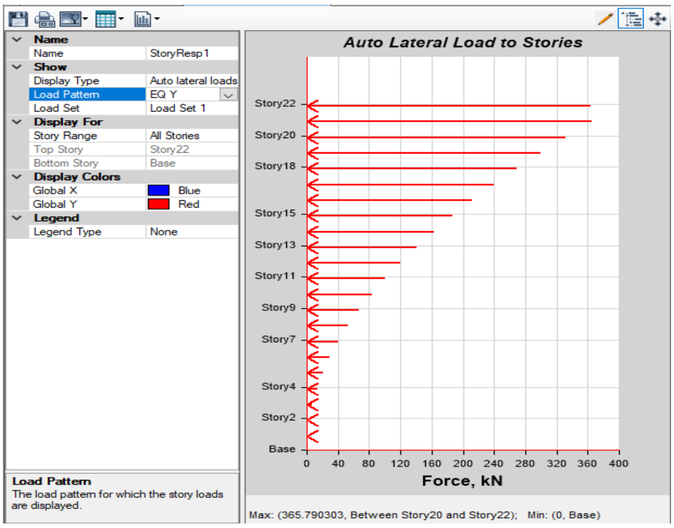

Fig. 5.2B Storey Lateral force in MODEL-II

Table: 5.2 Storey Lateral force in MODEL-II

MODEL-II			
WITH X- TYPE BRACING SYSTEM			
Maximum Lateral force in KN			
Story	Elevation (m)	X-Direction	Y-Direction
Story22	70.4	363.6572	363.6572
Story21	67.2	365.7903	365.7903
Story20	64	331.7826	331.7826
Story19	60.8	299.4338	299.4338
Story18	57.6	268.7439	268.7439
Story17	54.4	239.7129	239.7129
Story16	51.2	212.3409	212.3409
Story15	48	186.6277	186.6277
Story14	44.8	162.5735	162.5735
Story13	41.6	140.1781	140.1781
Story12	38.4	119.4417	119.4417
Story11	35.2	100.3642	100.3642
Story10	32	82.9456	82.9456
Story9	28.8	67.186	67.186
Story8	25.6	53.0852	53.0852
Story7	22.4	40.6434	40.6434
Story6	19.2	29.8604	29.8604
Story5	16	20.7364	20.7364
Story4	12.8	13.2713	13.2713
Story3	9.6	7.4651	7.4651
Story2	6.4	3.3178	3.3178
Story1	3.2	0.8295	0.8295
Base	0	0	0

5.3 MAXIMUM STOREY LATERAL FORCE IN MODEL-III

Table: 5.3 Storey Lateral force in MODEL-III

MODEL-III			
WITH V-TYPE BRACING SYSTEM			
Maximum Lateral force in KN			
Story	Elevation (m)	X-Direction	Y-Direction
Story22	70.4	363.3979	363.3979
Story21	67.2	365.3961	365.3961
Story20	64	331.425	331.425
Story19	60.8	299.1111	299.1111
Story18	57.6	268.4543	268.4543
Story17	54.4	239.4546	239.4546
Story16	51.2	212.112	212.112
Story15	48	186.4266	186.4266
Story14	44.8	162.3983	162.3983
Story13	41.6	140.0271	140.0271
Story12	38.4	119.313	119.313
Story11	35.2	100.2561	100.2561
Story10	32	82.8563	82.8563
Story9	28.8	67.1136	67.1136
Story8	25.6	53.028	53.028
Story7	22.4	40.5996	40.5996
Story6	19.2	29.8283	29.8283
Story5	16	20.7141	20.7141
Story4	12.8	13.257	13.257
Story3	9.6	7.4571	7.4571
Story2	6.4	3.3143	3.3143
Story1	3.2	0.8286	0.8286
Base	0	0	0

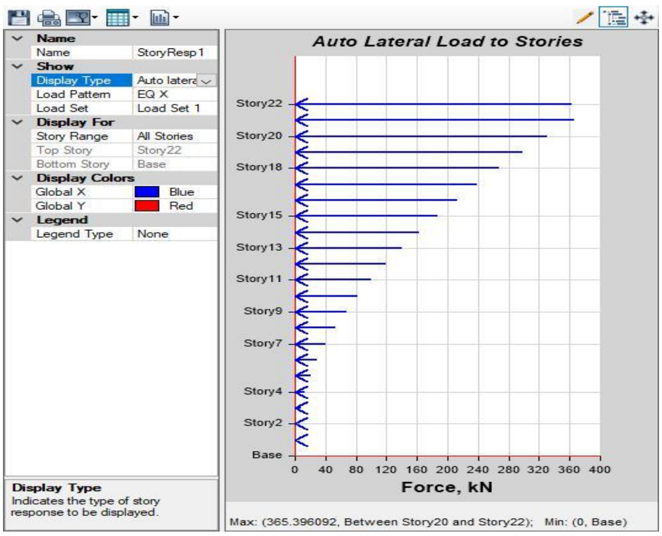

Fig. 5.3A Storey Lateral force in MODEL-III

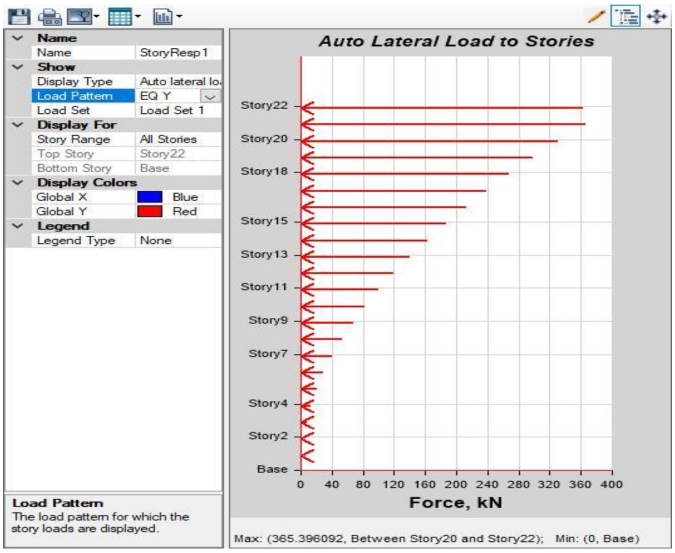

Fig. 5.3B Storey Lateral force in MODEL-III

5.4 MAXIMUM STOREY LATERAL FORCE IN MODEL-IV

Table: 5.4 Storey Lateral force in MODEL-IV

MODEL-IV			
WITH INVERTED V-TYPE BRACING SYSTEM			
Maximum Lateral force in KN			
Story	Elevation (m)	X-Direction	Y-Direction
Story22	70.4	363.3979	363.3979
Story21	67.2	365.3961	365.3961
Story20	64	331.425	331.425
Story19	60.8	299.1111	299.1111
Story18	57.6	268.4543	268.4543
Story17	54.4	239.4546	239.4546
Story16	51.2	212.112	212.112
Story15	48	186.4266	186.4266
Story14	44.8	162.3983	162.3983
Story13	41.6	140.0271	140.0271
Story12	38.4	119.313	119.313
Story11	35.2	100.2561	100.2561
Story10	32	82.8563	82.8563
Story9	28.8	67.1136	67.1136
Story8	25.6	53.028	53.028
Story7	22.4	40.5996	40.5996
Story6	19.2	29.8283	29.8283
Story5	16	20.7141	20.7141
Story4	12.8	13.257	13.257
Story3	9.6	7.4571	7.4571
Story2	6.4	3.3143	3.3143
Story1	3.2	0.8286	0.8286
Base	0	0	0

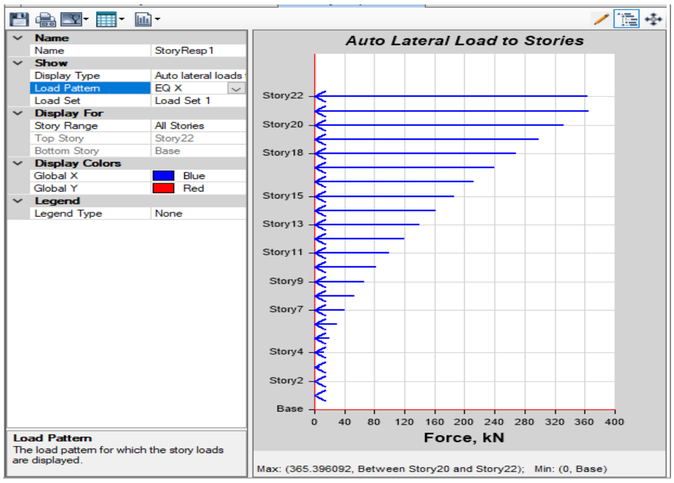

Fig. 5.4A Storey Lateral force in MODEL-IV

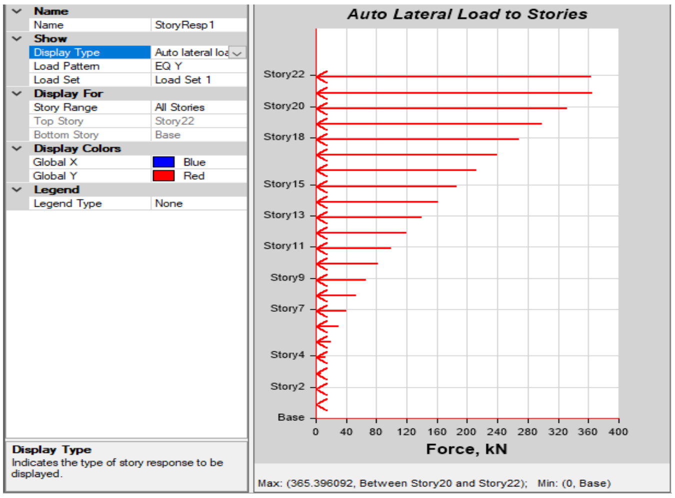

Fig. 5.4B Storey Lateral force in MODEL-IV

5.2.5 MAXIMUM STOREY LATERAL FORCE IN MODEL-V

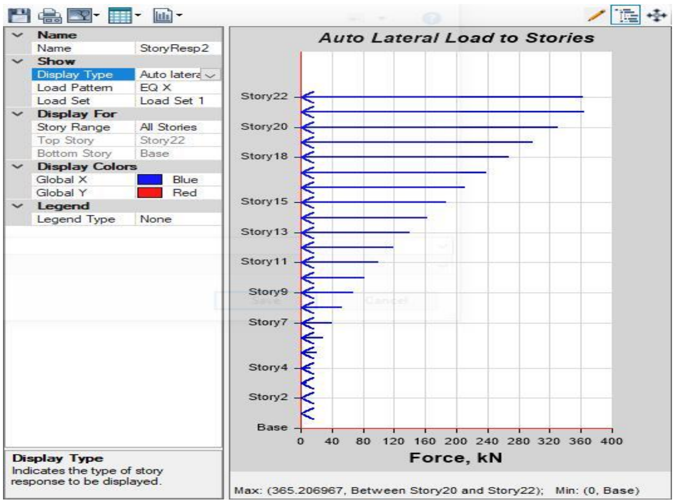

Fig. 5.5A Storey Lateral force in MODEL-V

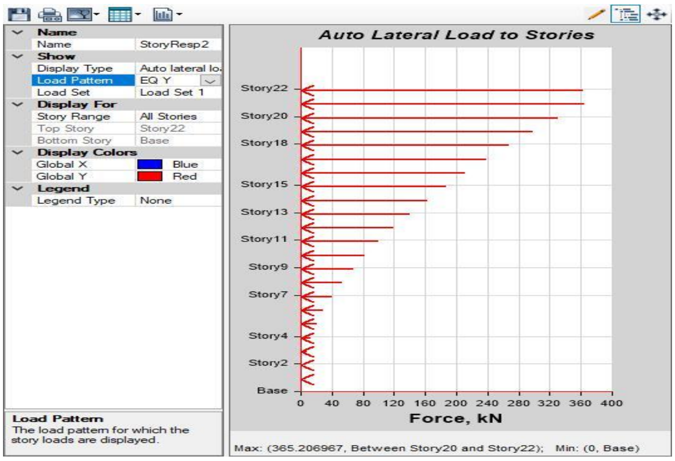

Fig. 5.5B Storey Lateral force in MODEL-V

Table: 5.5 Storey Lateral force in MODEL-V

MODEL-V			
WITH ECCEN. FORWORD TYPE BRACING SYSTEM			
Maximum Lateral force in KN			
Story	Elevation (m)	X-Direction	Y-Direction
Story22	70.4	363.2914	363.2914
Story21	67.2	365.207	365.207
Story20	64	331.2535	331.2535
Story19	60.8	298.9563	298.9563
Story18	57.6	268.3153	268.3153
Story17	54.4	239.3306	239.3306
Story16	51.2	212.0022	212.0022
Story15	48	186.3301	186.3301
Story14	44.8	162.3142	162.3142
Story13	41.6	139.9546	139.9546
Story12	38.4	119.2513	119.2513
Story11	35.2	100.2042	100.2042
Story10	32	82.8134	82.8134
Story9	28.8	67.0788	67.0788
Story8	25.6	53.0006	53.0006
Story7	22.4	40.5786	40.5786
Story6	19.2	29.8128	29.8128
Story5	16	20.7033	20.7033
Story4	12.8	13.2501	13.2501
Story3	9.6	7.4532	7.4532
Story2	6.4	3.3125	3.3125
Story1	3.2	0.8281	0.8281
Base	0	0	0

5.6 MAXIMUM STOREY LATERAL FORCE IN MODEL-VI

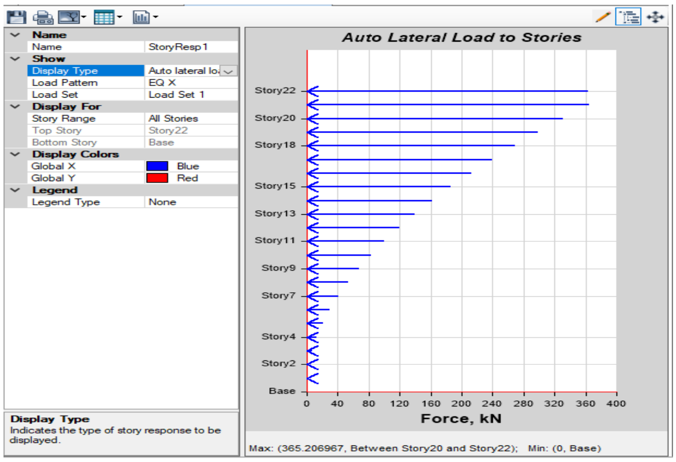

Fig. 5.6A Storey Lateral force in MODEL-VI

Table: 5.6 Storey Lateral force in MODEL-VI

MODEL-VI			
WITH ECCEN. BACK TYPE BRACING SYSTEM			
Maximum Lateral force in KN			
Story	Elevation (m)	X-Direction	Y-Direction
Story22	70.4	363.2914	363.2914
Story21	67.2	365.207	365.207
Story20	64	331.2535	331.2535
Story19	60.8	298.9563	298.9563
Story18	57.6	268.3153	268.3153
Story17	54.4	239.3306	239.3306
Story16	51.2	212.0022	212.0022
Story15	48	186.3301	186.3301
Story14	44.8	162.3142	162.3142
Story13	41.6	139.9546	139.9546
Story12	38.4	119.2513	119.2513
Story11	35.2	100.2042	100.2042
Story10	32	82.8134	82.8134
Story9	28.8	67.0788	67.0788
Story8	25.6	53.0006	53.0006
Story7	22.4	40.5786	40.5786
Story6	19.2	29.8128	29.8128
Story5	16	20.7033	20.7033
Story4	12.8	13.2501	13.2501
Story3	9.6	7.4532	7.4532
Story2	6.4	3.3125	3.3125
Story1	3.2	0.8281	0.8281
Base	0	0	0

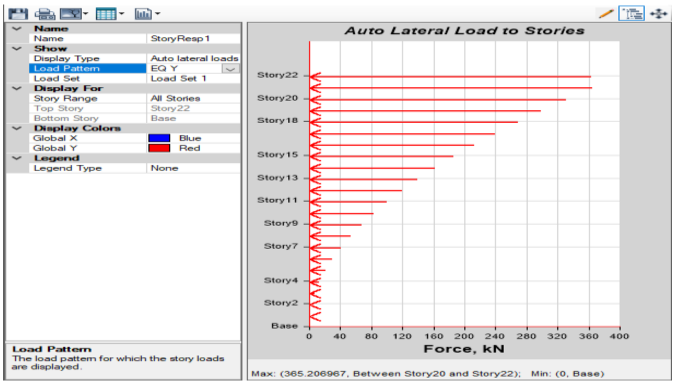

Fig. 5.6B Storey Lateral force in MODEL-VI

6. CONCLUSIONS

After the analysis is completed, the following outcome is found:

It is found that the storey lateral force maximum taken as 963.0019 KN at top storey of the building while minimum at first storey taken as 0.827 KN but zero at base in both the direction of x and y respectively.

It is found that the storey lateral force maximum taken as 363.65 KN at top storey of the building while minimum at first storey taken as 0.8295 KN but zero at base in both the direction of x and y respectively.

It is found that the storey lateral force maximum taken as 363.2914 KN at top storey of the building, zero at base but minimum value at first storey taken as 0.8281 KN in both the direction of x and y respectively.

Also observed that the lateral force of the cross bracing system of structure gradually increased when increased the height of structures. It means that the effect the lateral force varies with height of the structure. In the braced structure found minimum lateral force means that the braced structure is more effective and safe other the unbraced structure.

REFERENCES

[1] K. S. K. Karthik Reddy, Sai Kala Kondepudi: A Comparative Study on Behavior of Multistoried Building with Different Types and Arrangements of Bracing Systems- IJSTE - International Journal of Science Technology & Engineering | Volume 2 | Issue 2 | August 2015 ISSN (online): 2349-784X.M. Young, The Technical Writer's Handbook. Mill Valley, CA: University Science, 1989.

[2] Jagadeesh B N, Dr. Prakash M R: Seismic Response Of Steel Structure With Mega Bracing System- International Journal Of Engineering Sciences & Research Technology, ISSN: 2277-9655, Jagadeesh B N* et al., 5(9): September, 2016.

[3] Umesh. R .Biradar, Shivraj Mangalgi —Seismic Response of Reinforced Concrete by using different Bracing Systems International Journal of Research in Engineering and Technology (IJRET) Vol. 3, Issue 09 Sept. 2014 ISSN: 2319-1163 ISSN: 2321-7308.

[4] Ajay Mapari1 , Prof. Y. M. Ghugal: Seismic Evaluation Of High Rise Steel Structures With And Without Bracing- International Journal of Advanced Research in Science and Engineering, Volume 6, Issue 3, ISSN (O) 2313-8354, ISSN (P) 2319-8346, March 2017.

[5] Zasiah Tafheem, Shovona Khusru "Structural behaviour of steel building with concentric and eccentric bracing: A comparative study", international journal of civil and structural engineering, Volume 4, No 1, 2013.

[6] IS: 875 (Part 1) - 1987, "Indian Standard Code of Practice for design loads for building and structures, Dead Loads" Bureau of Indian Standards, New Delhi.

[7] IS 456:2000, "Indian Standard plain and reinforced concreteCode of Practice", Bureau of Indian Standards, New Delhi, 2000.

[8] IS 800(2007), "Indian Standards Code of Practice for General Construction in Steel", Bureau of Indian Standards, New Delhi.

[9] Ashiru Muhammad, Chhavi Gupta, Ibrahim B. Mahmoud: Comparative analysis of Seismic Behaviour of Multi-storey Composite Steel and Conventional Reinforced Concrete Framed Structures- International Journal of Scientific & Engineering Research, Volume 6, Issue 10, October-2015 ISSN 2229-5518.

[10] Kuldeep Kumar Chaudhary., Sabih Ahmad., Syed Aqeel Ahmad., Anwar Ahmad and Rajiv Banerjee: Analytical Study On The Structure Behaviour Of Regular And Irregular Space Frame By STAAD.PRO V8i- International Journal of Recent Scientific Research Vol. 9, Issue, 5(D), pp. 26749-26754, May, 2018.