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# “Analysis of Seismic Behaviours of RC Frame Structure With Bracing System and Without Bracing System”

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**Abstract:** This work time history analysis is carried out for G+23 storey steel frame building with different pattern of bracing system. The member property of beams 300mm X 400mm and columns 300mm X 500mm and ISLB250 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 IS 456:2016 and 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 as per IS:1893:2016. In this study model a G+23 with Square Shape building Plan 52m X 52m, 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 soil Medium conditions. Parameter Using: Type of Building: RC buildings with and without Steel Bracing System Number of Floors: G+23 (Square Shape Building) Section Property: Beam size 300X400mm, Column size 300X500mm, and ISLB250 sections. Seismic Zone- III, Soil Site factor 2 for Medium Soil, Damping = 5% (as per table-3 clause 6.4.2), Zone factor for zone III,  $Z=0.16$ , Importance Factor  $I=1.5$  (Important structure as per Table-6), Response Reduction Factor  $R=5$  for Special steel moment resisting frame Table-7),  $S_a/g$ = Average acceleration coefficient (depend on Natural fundamental period) Grade of concrete is considered M25, Grade of Rebar is considered Fe-415, Grade of Steel -Fe-345, Dead Load for Wall =  $(3.2-0.4) \times 0.23 \times 20 = 12.88 \text{ KN/m}$

Dead Load for Slab =  $0.12 \times 25 = 3 \text{ KN/m}^2$ .

In this study, the comparative analysis of Steel multi-storey building with and without bracing framed structure in the term of Maximum Overturning Moment, Maximum Story Shears, Maximum Story Displacement, Maximum Story drift etc.

**Keywords:** Retrofit, Seismic analysis, braced RC structures, Seismic Zone, types of Soil, Steel Brace, RC Structure, Etab Software's etc.

## I. INTRODUCTION

The concrete structure with Steel braced frame is one amongst the structural system accustomed resist the earthquake masses within the multi-storey buildings, several existing bolstered cement concrete buildings must be retrofitting to beat deficiencies to resist seismic masses. the employment of steel bracing systems for strengthening or retrofitting seismically light concrete frames could be a viable answer for enhancing tremor confrontation.

The primary purpose of every kind of structural systems employed in the building form of structures is to transfer gravity masses effectively. the foremost common masses ensuing from the result of gravity are loading, load and snow load. Besides these vertical masses, buildings also are subjected to lateral masses caused by wind, blasting or earthquake. Lateral masses will develop high stresses, turn out sway movement or cause vibration. Therefore, it's important for the structure to own ample strength against vertical masses along with adequate stiffness to resist lateral forces. Strengthening of structures proves to be a more robust choice business to the economic issues and immediate shelter issues instead of replacement of buildings. Hence, we all know this retrofitting and while not retrofitting structure within which economical as compared to every different structure. Therefore, seismic retrofitting or strengthening of building structures is one amongst the foremost vital aspects for mitigating seismic hazards particularly in earthquake prone areas.

Strengthening of RC Structures for Earthquake Resistance

Steel bracing is a highly efficient and economical method of resisting horizontal forces in a frame structure. Bracing has been used to stabilize laterally the majority of the world's tallest building structures as well as one of the major retrofit measures. Bracing is efficient because the diagonals work in axial stress and therefore call for minimum member sizes in providing stiffness and strength against horizontal shear. A number of researchers have investigated various techniques such as infilling walls, adding walls to existing columns, encasing columns, and adding steel bracing to improve the strength and/or ductility of existing buildings. A bracing system improves the seismic performance of the frame by increasing its lateral stiffness and capacity. Through the addition of the bracing system, load could be transferred out of the frame and into the braces, bypassing the weak columns while increasing strength.<sup>2</sup> Steel braced frames are efficient structural systems for buildings subjected to seismic or wind lateral loadings. Therefore, the use of steel bracing systems for retrofitting reinforced concrete frames with inadequate lateral resistance is attractive. 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

**Bracing System:** 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

## II. BUILDING CONFIGURATIONS

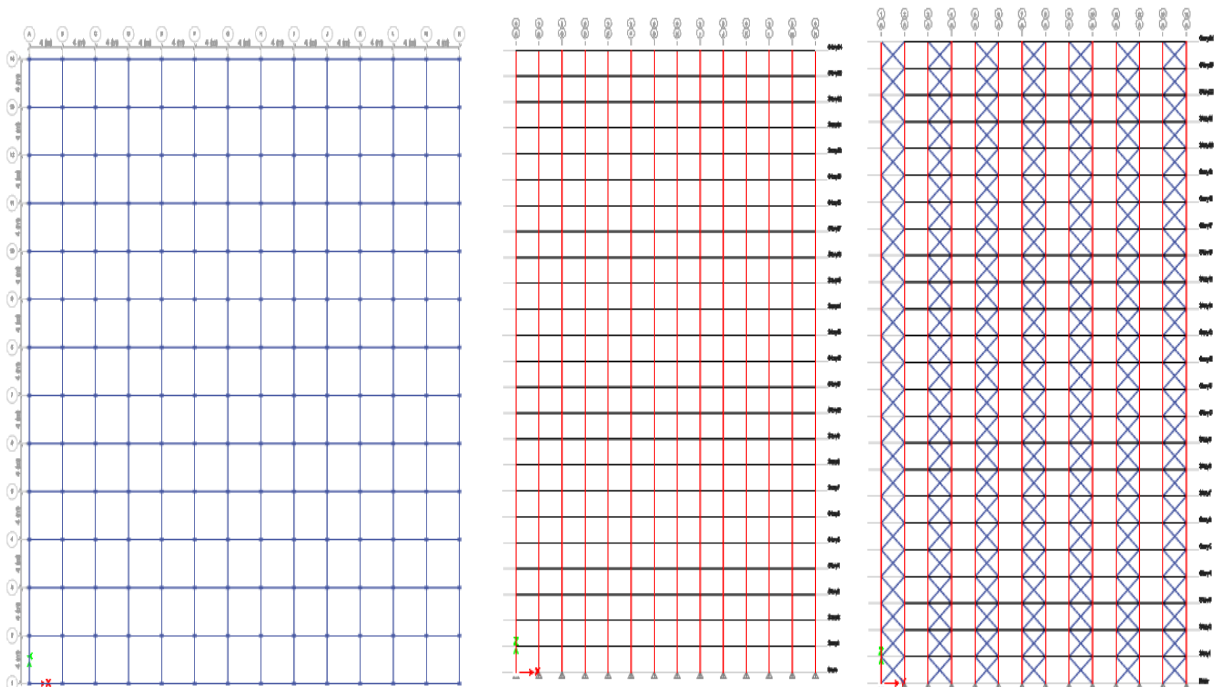


Fig.1a: Building Plan

Fig.1b: Elevation without Bracing

Fig.1c: Elevation with X Bracing

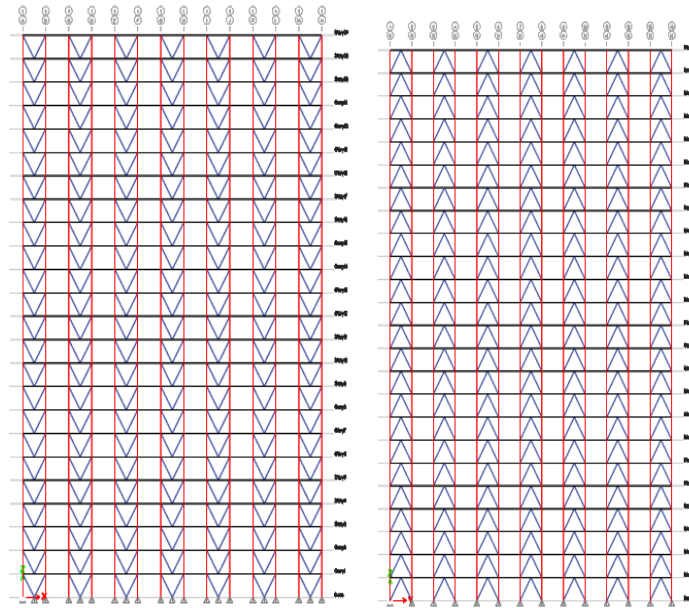


Fig.1d: Elevation with V Bracing Fig.1e: Elevation with inverted V Bracing

### III. OBJECTIVE OF WORK

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, X, V and inverted V-braced in RC Buildings.
- 2) To perform the Response Spectrum Method of analysis on RC structures.
- 3) To compare the different model of RC structures with & without steel bracing system.

### IV. LITERATURE SURVEY

Abhijeet Baikerika, Kanchan Kanagali (2014)- They analyzed the RC structure using steel bracing system of G+9 storey building in seismic zone V with soft soil as per IS code. They are used square grid of 20 meters with 5-meter bay in each direction and results compared RC bare framed structure without and with braced (ISHB 500) system by using Etabs software. He found that the bare framed structure and braced structure significantly lower the lateral displacements and also drifts as compared to bare framed structure.

Birendra Kumar Bohara, Kafeel Hussain et.al. (2021)- They analyzed existing G+3 storey RC structure with V type bracing system and provided the different thickness 2.5mm, 4mm, 6mm, 8mm, 10mm, 14mm and 20mm of steel bracing. They worked that seismic effect of the structure in the term of storey displacements, inter storey drift, base shear, fundamental time periods, capacity curve and also the failure of the structure by dynamic analysis and nonlinear static analysis in Etabs software. He observed that V bracing system improved the seismic performance of the RC structure as well as improved the strength capacity and stiffness of the buildings and when using bracing in RC frames decreased the top storey displacements and inter storey drift of the buildings.

Rishi Mishra, Dr. Abhay Sharma, Dr. Vivek Garg (2014)- They are worked on the G+10 storey RC building framed structure with different bracing system like X bracing, K bracing, V and inverted V bracing system and compared the these structures output to the RC bared frame structures and they work done all these models on Staad Pro software to evaluate the structure of a particular type braced system in order to control the lateral displacement , forces and also observed that inverted V braced system is more economical as compared to the other braced structures.

Krishnaraj R. Chavan, H.S. Jadhav (2014)- The analyzed the G+6 storey RC building with different bracing system in Staad pro software in third earthquake region with medium soil.

They provided different parameters such as storey height is 3m for all the stories. The live load taken has 3 KN/m<sup>2</sup> for all floors while the floor while the floor finish load is taken as 1 kN/m<sup>2</sup> on all other floors. Thickness of brick wall over all floor beams is taken as 0.230 m. Thickness of slab is taken as 0.125 m.

The unit weight of reinforced concrete is 25kN/m<sup>3</sup> and brick masonry is taken as 20 kN/m<sup>3</sup>. The compressive strength of concrete is 25 N/mm<sup>2</sup> and yield strength of steel reinforcements is 415 N/mm<sup>2</sup>. The modulus of elasticity of concrete and steel are 25000 N/mm<sup>2</sup> and 2×10<sup>5</sup> N/mm<sup>2</sup> respectively. The steel bracing used is ISA 110X110X10. They found that the X type of steel bracing significantly contributes to the structural stiffness and reduces the maximum interstorey drift of R.C.C building than other bracing system.

### V. METHODOLOGY

#### A. Using Etabs Software

- 1) Open Etab Software
- 2) Creating Modelling of RC building without and with steel bracing system.
- 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 Discussion & Future Scope.

### VI. RESULTS AND ANALYSIS

Table 7.1: Storey Shear (KN) in Model-I

| STOREY SHEAR IN KN             |               |             |             |
|--------------------------------|---------------|-------------|-------------|
| MODEL-I WITHOUT BRACING SYSTEM |               |             |             |
| STOREY                         | ELEVATION (m) | X-DIRECTION | Y-DIRECTION |
| Story24                        | 76.8          | 1984.6977   | 1707.4301   |
| Story23                        | 73.6          | 3882.232    | 3368.7997   |
| Story22                        | 70.4          | 5520.4513   | 4843.3248   |
| Story21                        | 67.2          | 6862.6733   | 6104.1526   |
| Story20                        | 64            | 7941.7605   | 7175.877    |
| Story19                        | 60.8          | 8842.603    | 8119.1374   |
| Story18                        | 57.6          | 9660.9164   | 8999.8811   |
| Story17                        | 54.4          | 10458.558   | 9858.9859   |
| Story16                        | 51.2          | 11244.1904  | 10700.9459  |
| Story15                        | 48            | 11990.8106  | 11506.7404  |
| Story14                        | 44.8          | 12671.9622  | 12257.8565  |
| Story13                        | 41.6          | 13288.115   | 12953.1822  |
| Story12                        | 38.4          | 13867.1524  | 13608.9163  |
| Story11                        | 35.2          | 14442.2832  | 14244.3092  |
| Story10                        | 32            | 15025.9243  | 14865.4601  |
| Story9                         | 28.8          | 15600.9031  | 15460.2467  |
| Story8                         | 25.6          | 16136.2734  | 16008.4279  |
| Story7                         | 22.4          | 16615.0404  | 16498.9489  |
| Story6                         | 19.2          | 17052.1631  | 16941.0198  |
| Story5                         | 16            | 17487.8847  | 17359.6419  |
| Story4                         | 12.8          | 17957.7402  | 17776.6619  |
| Story3                         | 9.6           | 18458.0967  | 18189.2348  |
| Story2                         | 6.4           | 18931.2843  | 18560.9233  |
| Story1                         | 3.2           | 19271.3766  | 18827.5275  |
| Base                           | 0             | 0           | 0           |

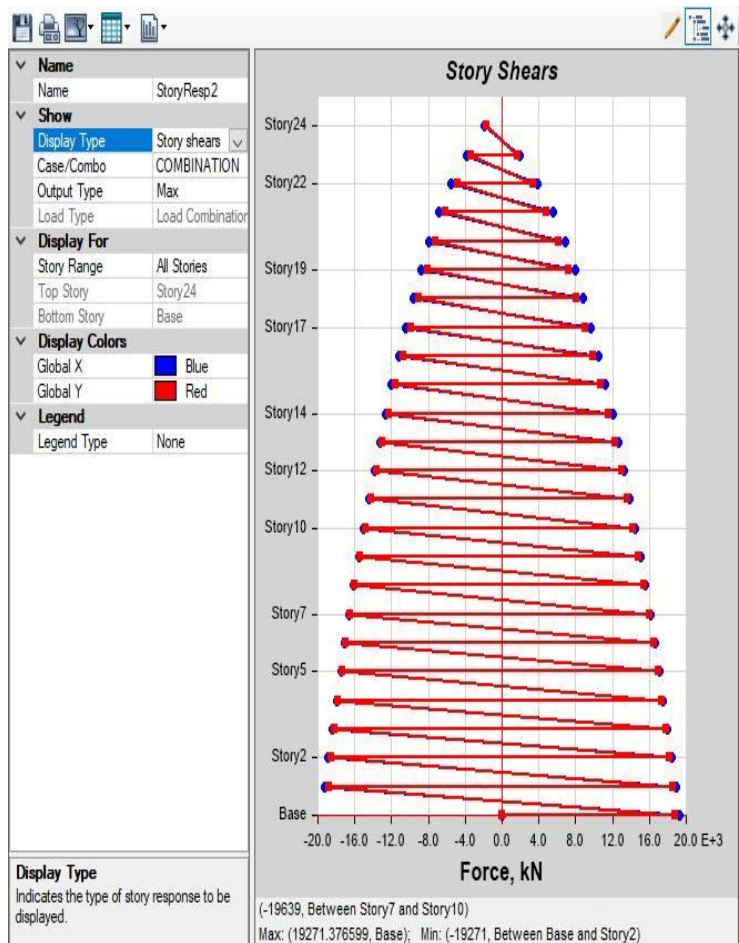


Fig 7.1: Storey Shear in Model-I

Table 7.2: Storey Shear (KN) in Model-II

| STOREY SHEAR IN KN             |               |             |             |
|--------------------------------|---------------|-------------|-------------|
| MODEL-II WITH X-BRACING SYSTEM |               |             |             |
| STOREY                         | ELEVATION (m) | X-DIRECTION | Y-DIRECTION |
| Story24                        | 76.8          | 2813.3553   | 2797.1483   |
| Story23                        | 73.6          | 5336.9847   | 5163.0754   |
| Story22                        | 70.4          | 7330.4851   | 6874.9336   |
| Story21                        | 67.2          | 8788.6354   | 8028.4283   |
| Story20                        | 64            | 9812.8365   | 8849.4369   |
| Story19                        | 60.8          | 10575.2065  | 9564.4725   |
| Story18                        | 57.6          | 11249.4708  | 10281.5985  |
| Story17                        | 54.4          | 11939.0808  | 10989.2593  |
| Story16                        | 51.2          | 12653.5655  | 11649.5044  |
| Story15                        | 48            | 13348.5006  | 12263.7593  |
| Story14                        | 44.8          | 13987.3237  | 12858.1185  |
| Story13                        | 41.6          | 14574.4462  | 13439.1942  |
| Story12                        | 38.4          | 15143.2802  | 13988.7538  |
| Story11                        | 35.2          | 15718.6098  | 14498.5851  |
| Story10                        | 32            | 16290.0599  | 14990.1572  |
| Story9                         | 28.8          | 16822.0177  | 15487.5245  |
| Story8                         | 25.6          | 17292.3801  | 15980.2029  |
| Story7                         | 22.4          | 17727.1906  | 16434.74    |
| Story6                         | 19.2          | 18199.1634  | 16853.04    |
| Story5                         | 16            | 18781.6435  | 17305.625   |
| Story4                         | 12.8          | 19485.4352  | 17877.8834  |
| Story3                         | 9.6           | 20228.6621  | 18562.2708  |
| Story2                         | 6.4           | 20868.1237  | 19214.2558  |
| Story1                         | 3.2           | 21267.6054  | 19639.8693  |
| Base                           | 0             | 0           | 0           |

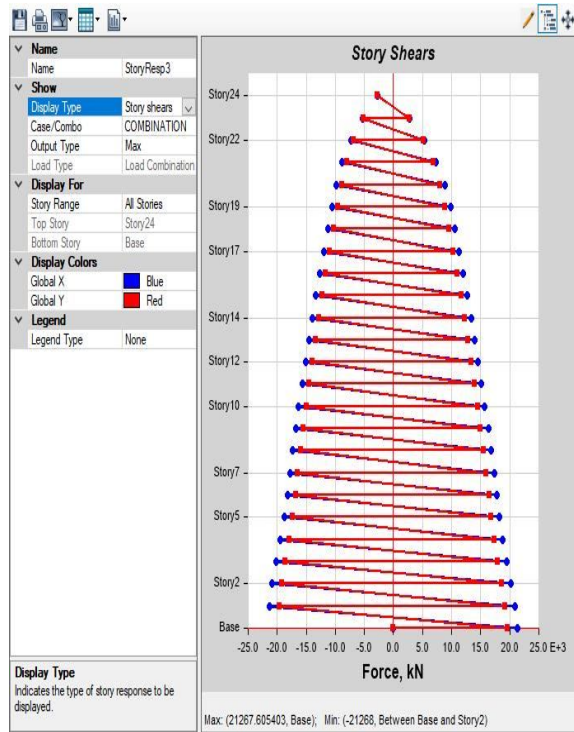


Fig 7.2: Storey Shear in Model-II

Table 7.3: Storey Shear (KN) in Model-III

| STOREY SHEAR IN KN              |               |             |             |
|---------------------------------|---------------|-------------|-------------|
| MODEL-III WITH X-BRACING SYSTEM |               |             |             |
| STOREY                          | ELEVATION (m) | X-DIRECTION | Y-DIRECTION |
| Story24                         | 76.8          | 2566.8369   | 2521.3606   |
| Story23                         | 73.6          | 4913.9502   | 4720.0141   |
| Story22                         | 70.4          | 6816.6367   | 6378.0957   |
| Story21                         | 67.2          | 8253.9853   | 7556.6816   |
| Story20                         | 64            | 9301.9462   | 8440.3289   |
| Story19                         | 60.8          | 10103.5982  | 9224.0409   |
| Story18                         | 57.6          | 10809.1181  | 10004.4443  |
| Story17                         | 54.4          | 11511.9445  | 10770.9254  |
| Story16                         | 51.2          | 12224.6604  | 11483.7093  |
| Story15                         | 48            | 12910.2133  | 12136.6383  |
| Story14                         | 44.8          | 13535.9303  | 12752.1588  |
| Story13                         | 41.6          | 14106.1928  | 13344.1224  |
| Story12                         | 38.4          | 14655.4342  | 13906.6137  |
| Story11                         | 35.2          | 15214.3311  | 14437.9691  |
| Story10                         | 32            | 15780.7579  | 14957.6782  |
| Story9                          | 28.8          | 16322.0623  | 15485.3675  |
| Story8                          | 25.6          | 16807.6499  | 16007.6102  |
| Story7                          | 22.4          | 17244.952   | 16484.1849  |
| Story6                          | 19.2          | 17688.1886  | 16900.0186  |
| Story5                          | 16            | 18206.6672  | 17305.6587  |
| Story4                          | 12.8          | 18828.8383  | 17785.4543  |
| Story3                          | 9.6           | 19503.1576  | 18363.4223  |
| Story2                          | 6.4           | 20109.1822  | 18940.2576  |
| Story1                          | 3.2           | 20507.6885  | 19341.6205  |
| Base                            | 0             | 0           | 0           |

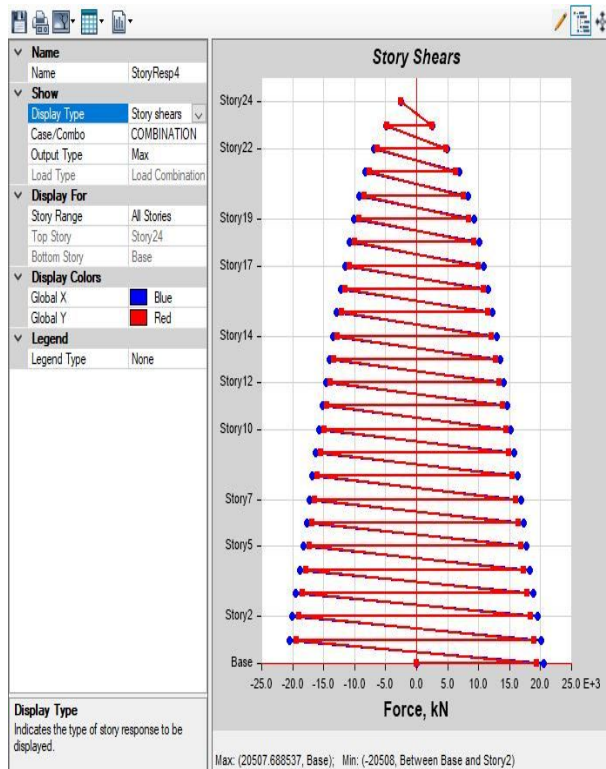


Fig 7.3: Storey Shear in Model-III

Table 7.4: Storey Shear (KN) in Model-IV

| STOREY SHEAR IN KN                      |               |             |             |
|---|---------------|-------------|-------------|
| MODEL-IV WITH INVERTED V-BRACING SYSTEM |               |             |             |
| STOREY                                  | ELEVATION (m) | X-DIRECTION | Y-DIRECTION |
| Story24                                 | 76.8          | 2636.0859   | 2588.1357   |
| Story23                                 | 73.6          | 5048.5055   | 4846.1927   |
| Story22                                 | 70.4          | 7001.4462   | 6539.7221   |
| Story21                                 | 67.2          | 8468.8317   | 7724.3376   |
| Story20                                 | 64            | 9527.1343   | 8590.6071   |
| Story19                                 | 60.8          | 10325.5088  | 9347.164    |
| Story18                                 | 57.6          | 11023.0896  | 10102.1516  |
| Story17                                 | 54.4          | 11720.6274  | 10847.8145  |
| Story16                                 | 51.2          | 12433.1379  | 11541.6751  |
| Story15                                 | 48            | 13121.8993  | 12175.5441  |
| Story14                                 | 44.8          | 13751.7864  | 12772.3321  |
| Story13                                 | 41.6          | 14326.28    | 13346.8738  |
| Story12                                 | 38.4          | 14880.3092  | 13893.4812  |
| Story11                                 | 35.2          | 15444.8011  | 14411.0001  |
| Story10                                 | 32            | 16016.6657  | 14920.3992  |
| Story9                                  | 28.8          | 16562.0611  | 15442.1015  |
| Story8                                  | 25.6          | 17051.0771  | 15961.2676  |
| Story7                                  | 22.4          | 17494.7763  | 16436.1602  |
| Story6                                  | 19.2          | 17952.387   | 16854.3182  |
| Story5                                  | 16            | 18495.7101  | 17273.4779  |
| Story4                                  | 12.8          | 19149.8989  | 17783.0896  |
| Story3                                  | 9.6           | 19855.2539  | 18401.92    |
| Story2                                  | 6.4           | 20483.4693  | 19016.2231  |
| Story1                                  | 3.2           | 20892.7417  | 19439.5926  |
| Base                                    | 0             | 0           | 0           |

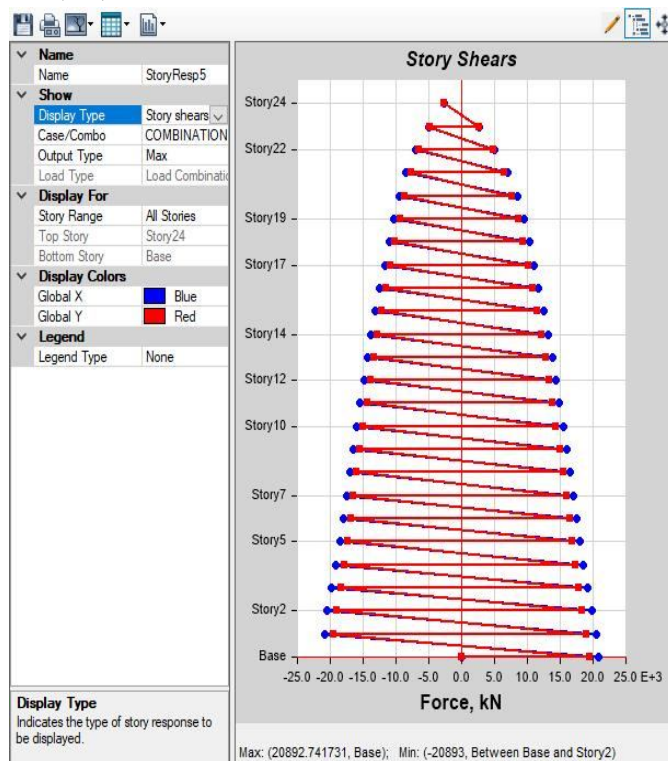


Fig 7.4: Storey Shear in Model-IV

### VII. CONCLUSIONS

It is observed that in Model-I the storey shear zero at base while maximum value of storey shear in x direction 19271.380 KN and y direction 18827.530 KN at first storey but top storey minimum shear value taken as 1984.698 KN in x direction and 1707.430 KN in y direction.

It is observed that in Model-II the storey shear zero at base while maximum value of storey shear in x direction 21267.61 KN and y direction 19639.870 KN at first storey while upper storey minimum shear value taken as 2813.355 KN in x direction and 2797.148 KN in y direction.

It is observed that in Model-III the storey shear zero at base while maximum value of storey shear in x direction 20507.690 KN and y direction 19341.620 KN at first storey but upper storey minimum shear value taken as 2566.837 KN in x direction and 2521.361 KN in y direction.

It is observed that in Model-IV the storey shear zero at base while maximum value of storey shear in x direction 20892.740 KN and y direction 19439.590 KN at first storey, in upper storey minimum shear value taken as 2636.086 KN in x direction and 2588.136 KN in y direction.

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