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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), Sa/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) X 0.23X20= 12.88 KN/m

Dead Load for Slab = 0.12 X 25 = 3 KN/m2.

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

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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.2 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

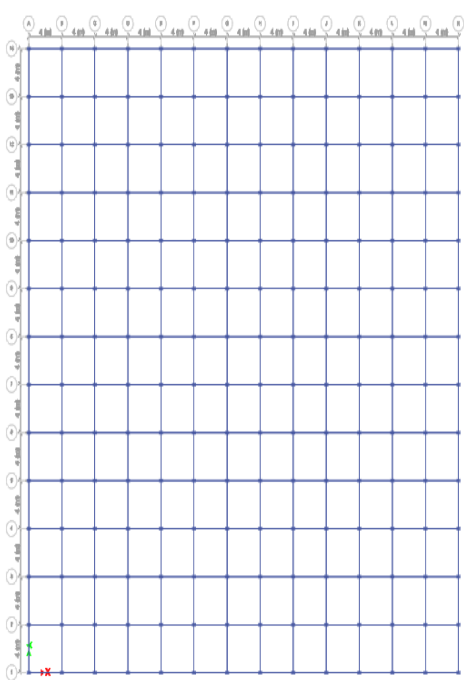
Fig.1a: Building Plan

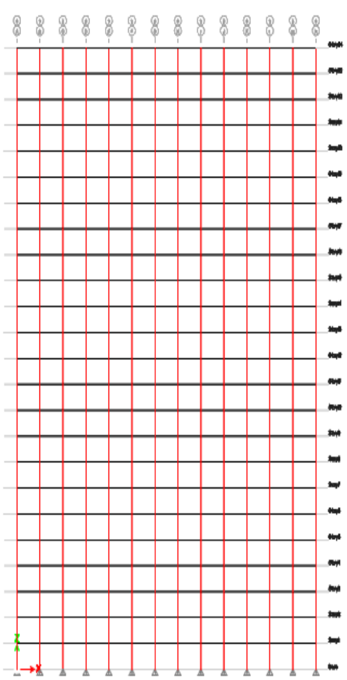
Fig.1b: Elevation without Bracing

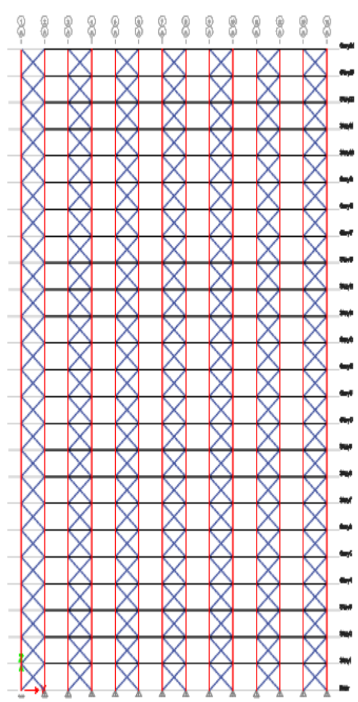
Fig.1c: Elevation with X Bracing

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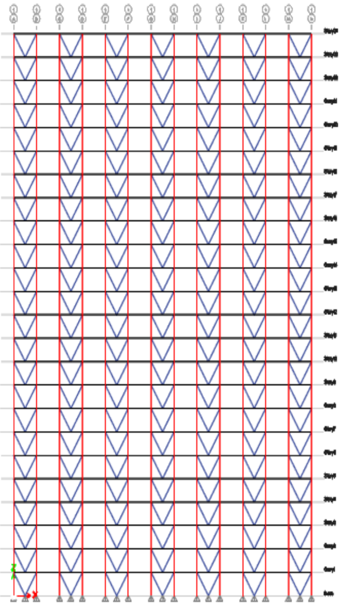

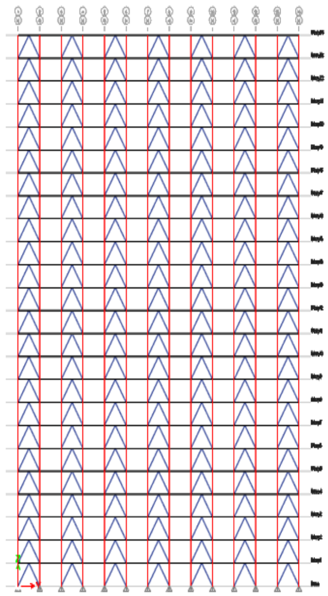

Fig.1d: Elevation with V Bracing   Fig.1e: Elevation with inverted V Bracing

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 2 for all floors while the floor while the floor finish load is taken as 1 kN/m2 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.

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The unit weight of reinforced concrete is 25kN/m3 and brick masonry is taken as 20 kN/m3. The compressive strength of concrete is 25 N/mm2 and yield strength of steel reinforcements is 415 N/mm2. The modulus of elasticity of concrete and steel are 25000 N/mm2 and 2×105 N/mm2 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

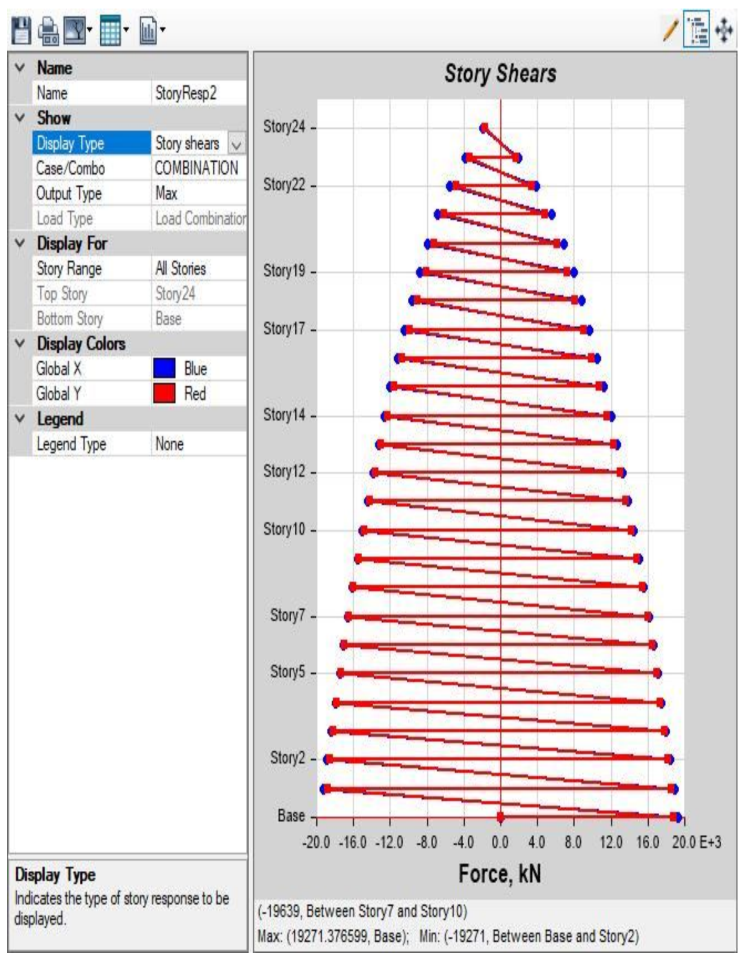

Fig 7.1**:** Storey Shear in Model-I

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

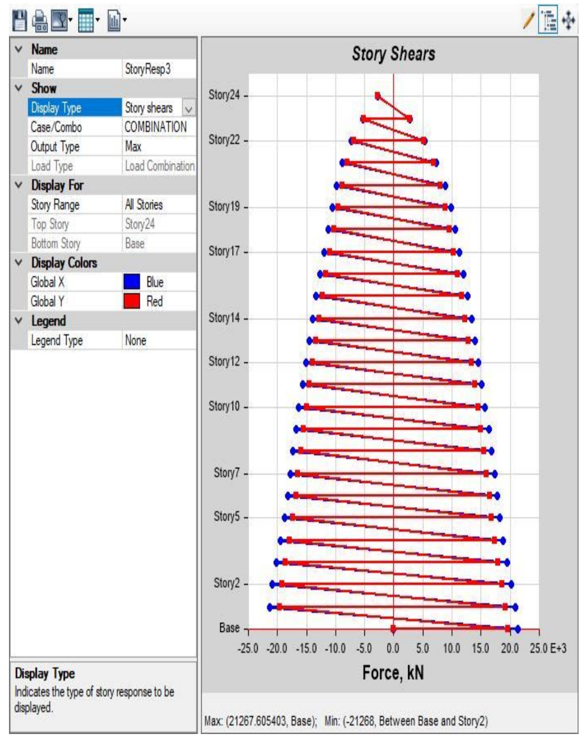

Fig 7.2**:** Storey Shear in Model-II

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

STOREY SHEAR IN KN			
MODEL-III WITHV-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

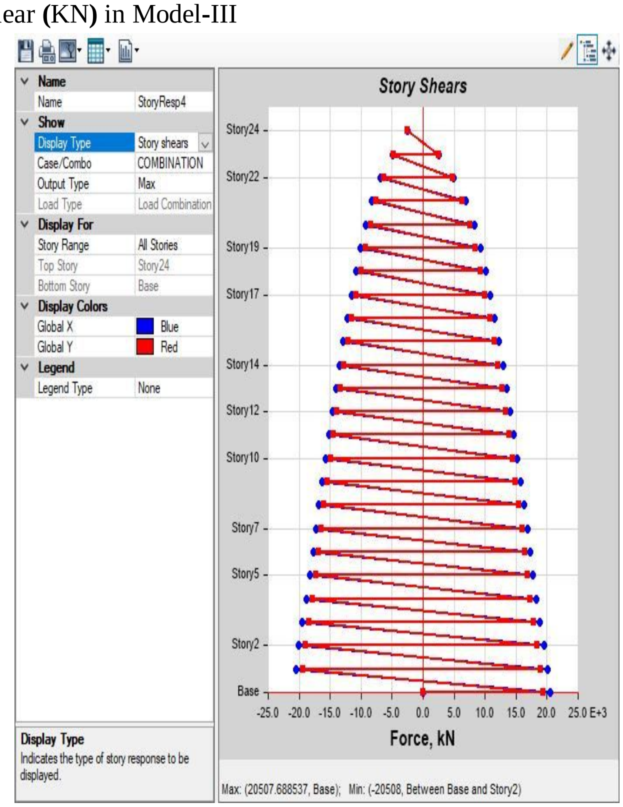

Fig 7.3**:** Storey Shear in Model-III

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

STOREY SHEAR IN KN			
MODEL-1V 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

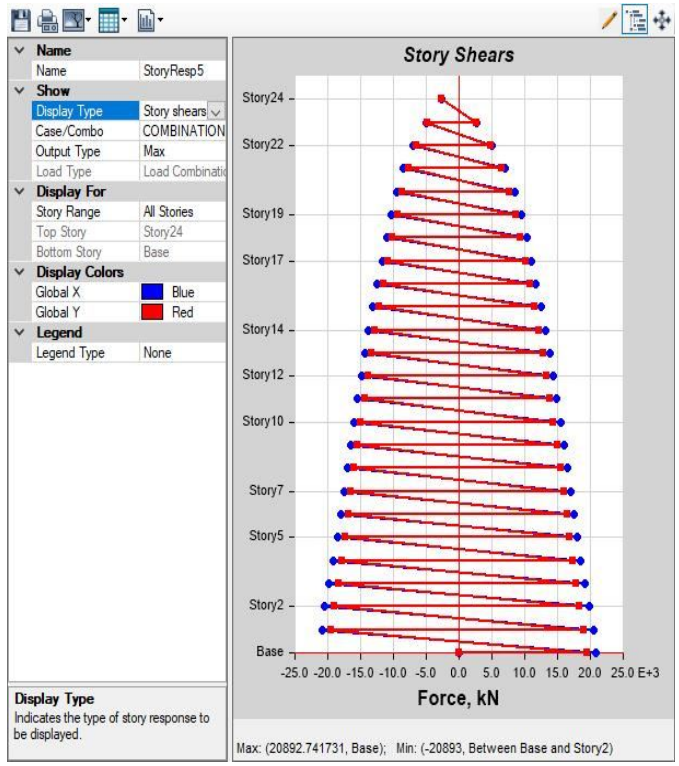

Fig 7.4: Storey Shear in Model-IV

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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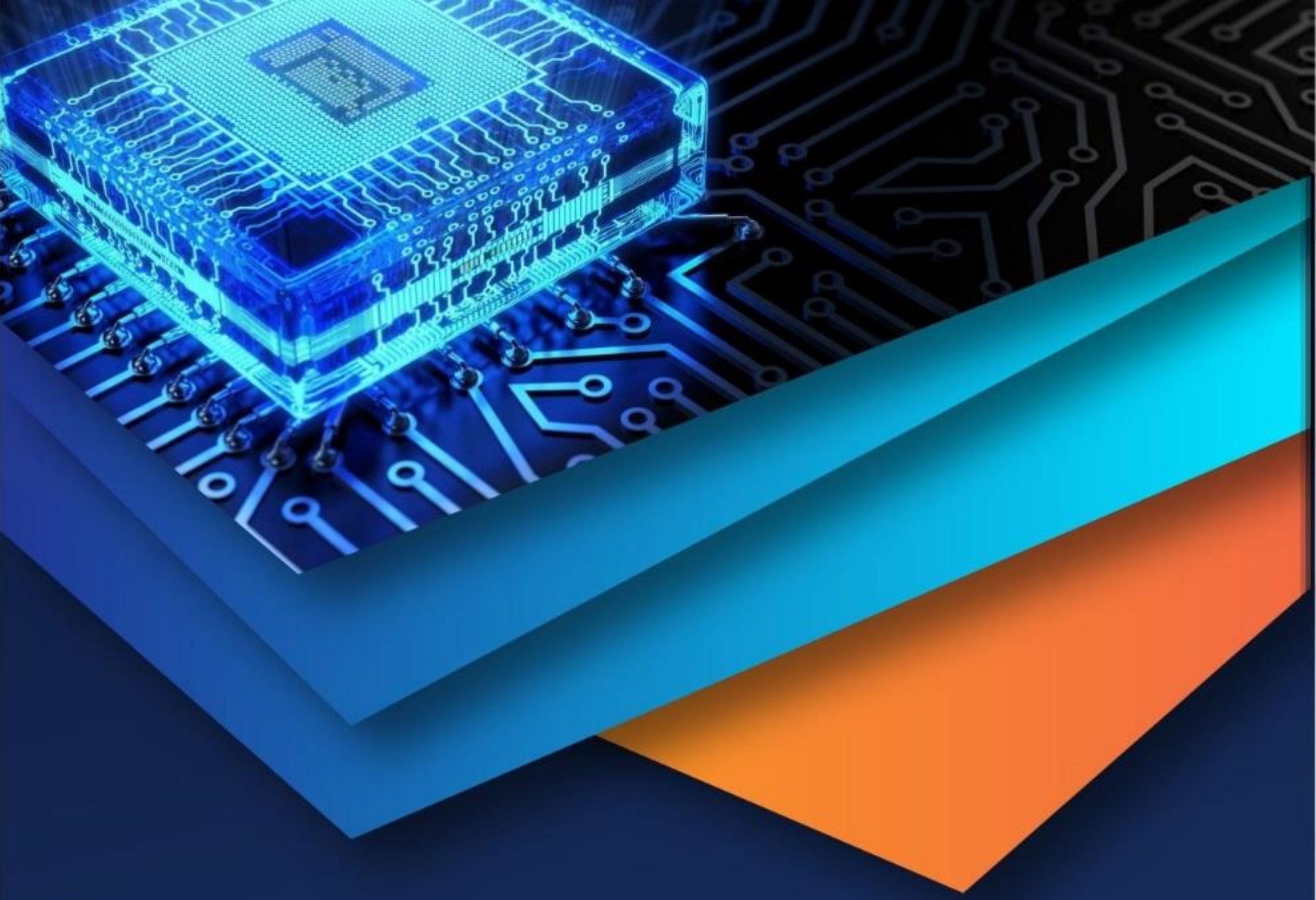

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