IJNRD.ORG ISSN : 2456-4184
INTERNATIONAL JOURNAL OF NOVEL RESEARCH AND DEVELOPMENT (IJNRD) | IJNRD.ORG
An International Open Access, Peer-reviewed, Refereed Journal

Comparative study of dynamic analysis of multistorey building with and without shear wall and bracing system

Yogendra S Patil, Dr. Ravindra Desai

[1]P.G. Student of Civil Engineering Department of Sanjay Ghodawat university, Kolhapur, India
[2] Assistant Professor of Civil Engineering Department Sanjay Ghodawat university, Kolhapur, India

Abstract: rigid frames, shear walls, diagrid structural systems, bracing systems, wall frames, and outrigger systems are lateral load-resisting systems that have been employed universally. The most widely employed lateral load-resisting technologies recently are shear wall systems and bracing systems. Because shear wall systems have significant levels of stiffness and strength, they can resist lateral loads and support gravity loads. The key benefit is that the weight of the bracing system is lower than that of a concrete shear wall, even though it has less stiffness than a shear wall system. As expected, it is seen that the lower self-weight of the bracing system results in fewer story shears and better performance.

Keywords – Rigid frames, lateral load resisting system

1.0 INTRODUCTION

Strong structural systems that can withstand these loads and provide acceptable safety and serviceability must be used when developing high-rise structures. The main objective of seismic design is to withstand lateral stresses during an earthquake, hence lowering the risk of injury to persons nearby. In high-rise projects, structural engineers commonly advise using a bracing system for lateral resistance. It provides significant resistance to seismic waves and lateral pressures.

Shear Wall- In structural engineering a shear wall, is a vertical structural component of a lateral resisting system meant to counteract horizontal stresses including wind and seismic forces. Tall buildings or buildings in areas with strong wind or seismic activity frequently have shear walls. Shear walls are used to resist the lateral loads that an earthquake, wind, or occasionally hydrostatic or horizontal ground pressure, exert on a structure. Shear walls provide structural support for lateral and gravitational loads as well as partitions. They are ideal for high-rise buildings because they combine strength and effective stiffness. Due to wind and seismic occurrences, the walls of a shear wall structure fully support lateral loads. Shear walls can be both non-planar assemblies of connected walls and independent planar walls. Shear wall structures are cost effective up to around 35 stories because they are significantly more rigid horizontally than rigid frames. When shear walls and frames are coupled in low to medium-rise structures, it is fair to assume that the shear walls draw all lateral loading, allowing the frame to just be designed for gravity loading. It has been demonstrated that shear wall structures function effectively during an earthquake, making ductility a crucial factor in their design.

2.0 FUTURE SCOPE

The following are the future scope of the research which can be carried out further. The effect of bracing system on retrofitting structure.

Parametric study of shear wall and bracing structure multistorey building on sloping ground with respect to dynamic loading.

3.0 METHODOLOGY

3.1 To accomplish the research objectives, the following steps were undertaken:

This contains the software work carried out for the dissertation work. This study is carried out to investigate the behaviour effect of boundary elements of special shear walls on the response of tall RCC buildings under dynamic loading. The modeling is done using finite element software ETABS.

The software is based on the finite element method.

3.2 Linear dynamic method

For a building whose response is dominated by more than one mode, the Linear Dynamic Method is used to estimate the demand of the structure.

3.3 Response spectrum method

There are computational benefits in using the response spectrum method of seismic evaluation for the prediction of displacements and member forces in the structural method. The technique includes the calculation of big values of the displacements and member forces in every mode of vibration and the use of smooth design spectra that are common to numerous earthquake motions. Response spectra are curves plotted among the max response of a single degree of freedom (SDOF) system subjected to certain earthquake ground movement and its period (or frequency). Response spectrum can be interpreted as the locus of the extreme response of an SDOF system for a given damping ratio. Response spectra, as a result, enables in the acquisition of the peak structural responses below the linear range, which may be used for acquiring lateral forces created in structure because of earthquake hence facilitating earthquake-resistant planning of structures. Usually, the reaction of a single degree of freedom is determined by frequency area analysis, and for a given frequency of the system, the maximum response is taken. This system is continued for all ranges of feasible time durations of the SDOF machine. The final plot with method period on X-axis and reaction quantity on Y-axis is the specified response spectra bearing on damping ratio and input floor motion. The same system is completed with various damping ratios to acquire typical reaction spectra. The succeeding approach is adopted for this thesis to accomplish the objective. The adopted approach has been represented in the form of a flowchart as shown in Figure 3.1.

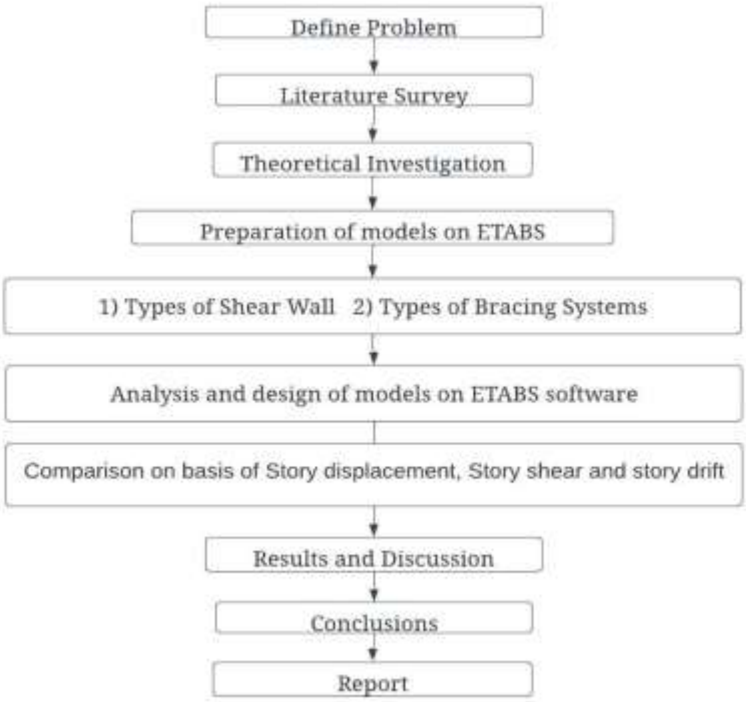


Figure 3.1: Flow chart to accomplish the thesis objectives.

3.4 Problem statement:

In this present dissertation work, it is proposed to carry out a comparative study of the lateral load-resisting system of buildings with and without, a 'Shear wall and bracing system' considering the location and types for 25 stories under seismic loads. The analysis of structure will be carried out using the linear dynamic method (Response Spectrum Method) using ETAB software. Structure situated in seismic zones (V) and seismic parameters are taken from IS-1875 PART I.

4.0 Experiments

4.1 Modeling & Analysis.

To study the seismic response of the reinforced concrete structure, G+25 multi-storied building is considered. The modeling and analysis of work is done by using ETAB software. ETAB is powerful and completely incorporated research software for the analysis of Reinforced concrete structures. The modeling is done using ETABS software.

4.2 Model details:

Material properties

The basic material properties used are as follows:

- Modulus of Elasticity of steel, (Es) = 20,0000 MPa
- Modulus of Elasticity of concrete, (Ec) = 27386.12 MPa
- Grade of concrete for slab = M30
- Grade of concrete for column = M40
- Grade of concrete for beam = M30

4.3 Details of models

Following are the various parameters considered for analysis of the building which is modelled by ETABS software as shown in fig.4.1. Seismic parameters are taken from IS 1893 (Part 1):2016 and details of structure are given in table 4.1.

Parameters that are considered are, Type of Building = RCC

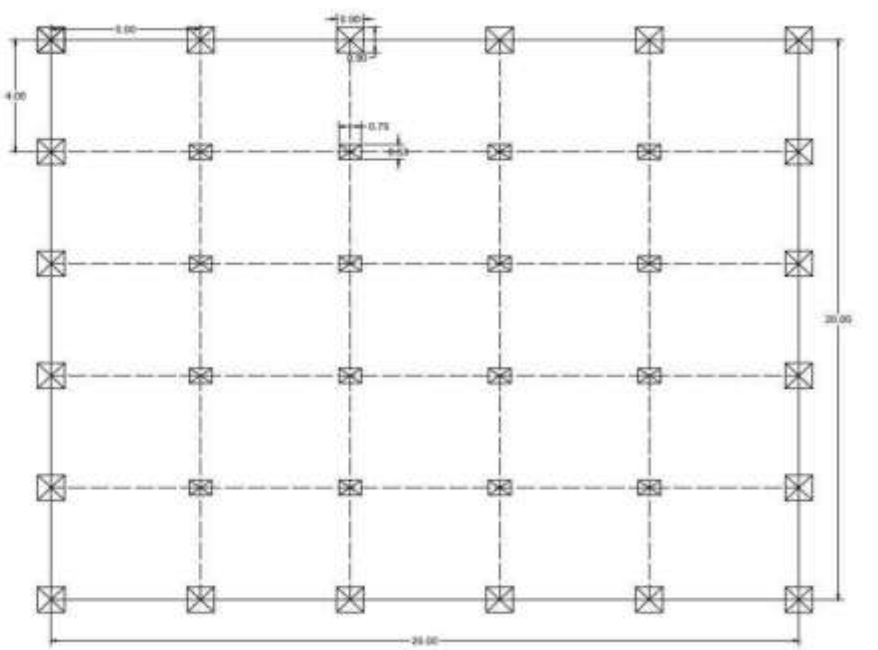
No. of story = G+25 Grade of steel = Fe500

Column = Outer 900X900mm, Inner 750X530 Beam = 300X750mm

Slab thickness = 200mm

Steel Bracing = ISA 110X110X10

Figure 4.1: Plan of given Structure



4.3 Given data for structures:

Table 4.1: Details of Structure

Type of Structure	Bracing Structure and Shear Wall Structure
plan	25 x 20 m
Bays in X- and Y-direction	5 bays of 5m each
Type of soil	Medium soil
Importance factor	1.5
Response Reduction Factor	5
Height of floor	3.6 m

Slab thickness	200 mm
Wind Speed	44 m/sec
Terrain Category	4
Important Factor	1
Risk Coefficient	1
Topography	1

Table 4.1 shows details of structure and design parameters.

- As per IS-1893 Part-I 2016, time *is* more than 0.4 in the Dynamic Analysis performed.
- The period for the building is 0.075h· as per IS-1893 Part-I 2016 Therefore,
- Period is more than 0.4 therefore, Response Spectrum Analysis performed.

4.4 Modeling of buildings

Modeling and analysis of the building is done by using ETABS software. Analysis of G+25 story building with and without bracing system and Shear wall system is done. For this work in bracing systems X-type, Inverted V-type, and K-diamond type bracing is used. In the shear wall system, a shear wall along the periphery, L-type shear wall, and C-type shear wall is used. The various types of models are prepared using ETABS software and their elevation.

Figure 4.2: 3-D view and plan for model 1 conventional RCC Building

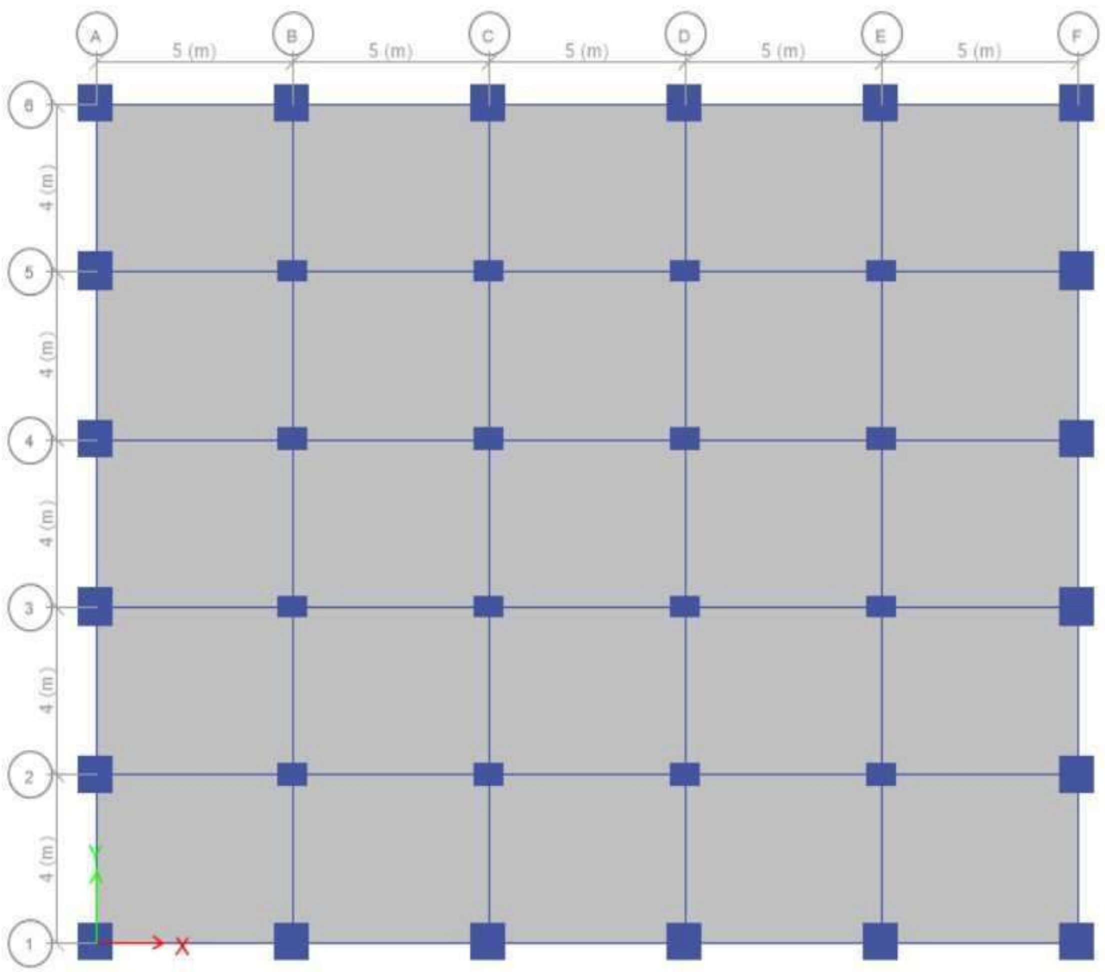
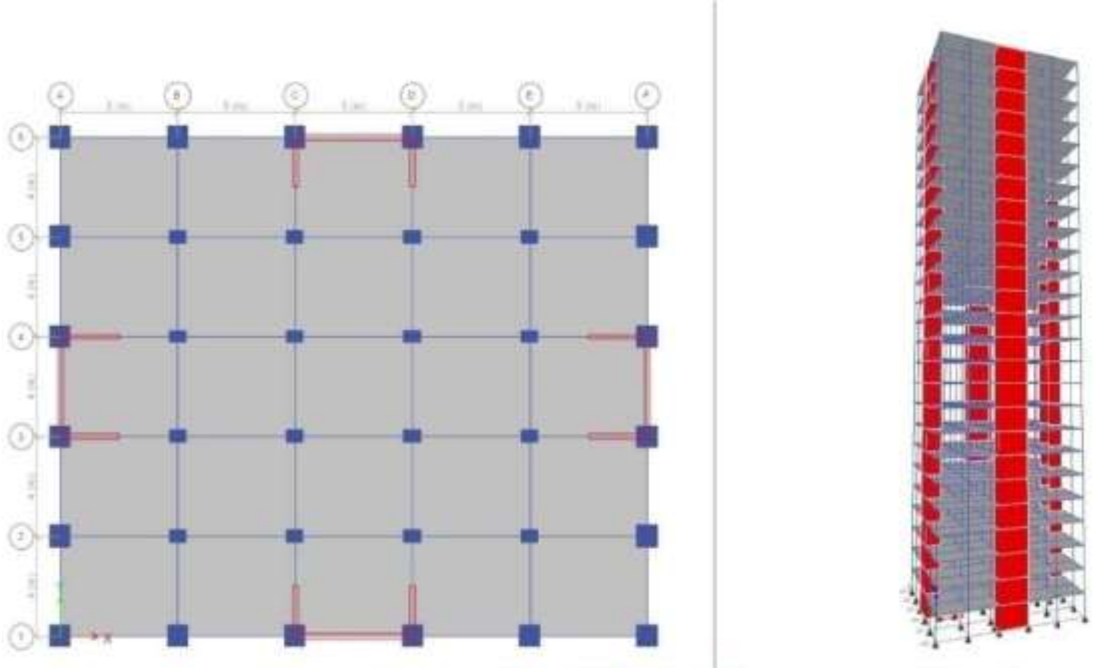


Figure 4.3: Plan and 3D View for model 3C-type shear wall



5.0 RESULTS AND DISCUSSION

5.1 Participation in the Questionnaire Survey

The results are calculated and analysed using ETABS and the seismic analysis method used for analysis is the response spectrum method.

Displacement for various models

Displacement is one parameter considered for the study and it is checked for various models it is checked at the top floor of the building.

a) Displacement for Shear Wall

Table 5.1: Displacement of Shear wall system

Story	Elevation	Normal Building	Shear Wall Type	Shear Wall C-type	Shear Wall Along the periphery
	m	mm	mm	mm	mm
Story25	87	291.006	138.689	134.447	105.862
Story24	83.4	288.103	133.341	130.219	101.677
Story23	79.8	284.327	127.793	125.751	97.326
Story22	76.2	279.502	122.089	121.046	92.861
Story21	72.6	273.612	116.206	116.079	88.268
Story20	69	266.699	110.138	110.841	83.546
Story19	65.4	258.827	103.89	105.332	78.701
Story18	61.8	250.071	97.471	99.563	73.744
Story17	58.2	240.506	90.902	93.552	68.688
Story16	54.6	230.207	84.207	87.325	63.555
Story15	51	219.245	77.416	80.912	58.368

Story14	47.4	207.69	70.567	74.35	53.155
Story13	43.8	195.61	63.699	67.679	47.945
Story12	40.2	183.068	56.858	60.945	42.773
Story11	36.6	170.124	50.096	54.198	37.674
Story10	33	156.837	43.465	47.492	32.69
Story9	29.4	143.257	37.026	40.888	27.863
Story8	25.8	129.433	30.843	34.45	23.237
Story7	22.2	115.402	24.982	28.251	18.862
Story6	18.6	101.19	19.519	22.372	14.789
Story5	15	86.793	14.533	16.902	11.074
Story4	11.4	72.146	10.109	11.943	7.774
Story3	7.8	57.054	6.342	7.613	4.954
Story2	4.2	41.026	3.334	4.051	2.679
Story1	0.6	22.875	1.212	1.45	1.03
Base	-3	0	0	0	0

Fig. 5.1: Displacement for Shear wall

b) Displacement for Bracing System

Table 5.2: Displacement for Bracing System

Story	Elevation	Normal Building	K-Diamon d	Inverted - V	X-Type
	m	mm	mm	mm	mm
Story25	87	291.006	205.564	216.473	205.529
Story24	83.4	288.103	202.105	213.261	202.077

Story23	79.8	284.327	197.972	209.341	197.946
Story22	76.2	279.502	193.133	204.646	193.107
Story21	72.6	273.612	187.613	199.197	187.586
Story20	69	266.699	181.457	193.038	181.429
Story19	65.4	258.827	174.71	186.225	174.681
Story18	61.8	250.071	167.426	178.812	167.396
Story17	58.2	240.506	159.656	170.859	159.625
Story16	54.6	230.207	151.452	162.422	151.42
Story15	51	219.245	142.868	153.558	142.836
Story14	47.4	207.69	133.957	144.324	133.925
Story13	43.8	195.61	124.772	134.776	124.74
Story12	40.2	183.068	115.367	124.968	115.335
Story11	36.6	170.124	105.793	114.954	105.761
Story10	33	156.837	96.104	104.787	96.072
Story9	29.4	143.257	86.351	94.518	86.32
Story8	25.8	129.433	76.586	84.199	76.556
Story7	22.2	115.402	66.86	73.877	66.831
Story6	18.6	101.19	57.223	63.599	57.196
Story5	15	86.793	47.723	53.405	47.698
Story4	11.4	72.146	38.395	43.318	38.376
Story3	7.8	57.054	29.247	33.319	29.236
Story2	4.2	41.026	20.195	23.265	20.196
Story1	0.6	22.875	10.854	12.645	10.869
Base	-3	0	0	0	0

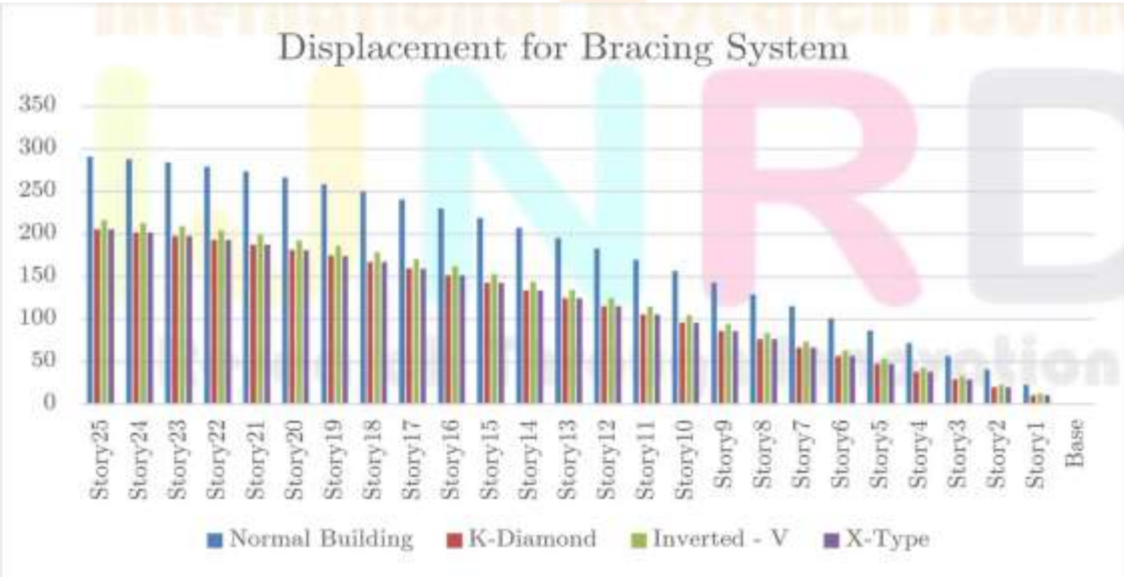


Fig. 5.2: Displacement for Bracing System

5.3 Base shear:

The maximum projected lateral force that will result from ground motion caused by an earthquake at the base of a building structure is called base shear. Base shear is affected by the state of the soil, the structure's dead weight, seismic ground motion, etc. The base shear for the different building models is presented. Base shear values are crucial for understanding the lateral forces acting on a building during seismic events. Figure 5.3provides a comparison of story shear forces for the shear wall and bracing structures in different seismic zones. As expected, the base shear increases with higher seismic zones, reflecting the higher lateral forces experienced by the building.

a) Base Shear for Shear wall System

Table 5.3: Base Shear for Shear Wall System

Story	Elevation	Normal Building	Shear Wall Type	Shear Wall C-type	Shear Wall Along the periphery
	m	-	-	-	-
Story25	87	565.1795	575.805	588.433	588.433
Story24	83.4	1244.472	1285.19	1309.4	1309.4
Story23	79.8	1868.337	1936.68	1971.53	1971.53
Story22	76.2	2439.131	2532.76	2577.34	2577.34
Story21	72.6	2959.215	3075.88	3129.33	3129.33
Story20	69	3430.946	3568.51	3630	3630
Story19	65.4	3856.683	4013.1	4081.85	4081.85
Story18	61.8	4238.785	4412.13	4487.4	4487.4
Story17	58.2	4579.611	4768.05	4849.13	4849.13
Story16	54.6	4881.519	5083.34	5169.56	5169.56
Story15	51	5146.868	5360.44	5451.18	5451.18
Story14	47.4	5378.016	5601.82	5696.51	5696.51
Story13	43.8	5577.322	5809.96	5908.05	5908.05
Story12	40.2	5747.146	5987.3	6088.29	6088.29
Story11	36.6	5889.844	6136.32	6239.74	6239.74
Story10	33	6007.777	6259.48	6364.91	6364.91
Story9	29.4	6103.303	6359.24	6466.29	6466.29
Story8	25.8	6178.78	6438.06	6546.4	6546.4
Story7	22.2	6236.567	6498.4	6607.73	6607.73
Story6	18.6	6279.022	6542.74	6652.79	6652.79
Story5	15	6308.506	6573.53	6684.08	6684.08
Story4	11.4	6327.375	6593.23	6704.11	6704.11
Story3	7.8	6337.989	6604.32	6715.38	6715.38
Story2	4.2	6342.706	6609.25	6720.38	6720.38
Story1	0.6	6343.885	6610.48	6721.63	6721.63
Base	-3	0	0	0	0

Fig. 5.3: Base Shear for Shear Wall System

The modeling and analysis of the seismic response of the G+25 multi-storeyed structure with bracing and shear wall system is done using ETABS software. The modeling, and load conditions are implemented in the structure before the analysis. Providing, the design data to the modeling like structural elements, bracing system, and shear wall. The structures are analysed, and comparative results were obtained using the response spectrum method of analysis.

6.0 CONCLUSION

The conclusions from the study are as follows.

1. In Shear wall System,

- Shear wall along the periphery performs better among all the models.
- Displacement is reduced about 53% as compared to normal building without any lateral load resisting system.
- Max story drift is 0.00148 is seen which is about one fourth times less as compared to normal building.

2. In Bracing System,

- Building with X-Type of bracing performs better among the models.
- Displacement seen is reduced about 30% as compared to normal building.
- Max story drift seen is 0.00302 which is half as compared to normal building.

7. REFERENCE

1. A.A. Qureshi, TarunMagendra, Abhyuday Titiksh (2016), "Optimum Positioning of Shear Walls in Multistorey Buildings." International Journal of Trend in Research and Development, Volume 3(3), PP 666671.

2. Abdul Naveed, Mohammad Salman (2019), "Analysing Multi-storey Building by Static and Dynamic Analysis by Using ETABS With and Without Shear Walls." Journal of Emerging Technologies and Innovative Research (JETIR), Vol. 6, PP 350-358.

3. Anuja Walvekar, H.S. Jadhav, "Parametric Study of Flat Slab Building with And Without Shear Wall to Seismic Performance." International Journal of Research in Engineering and Technology, Vol. 04 Issue 04, pp. 601-607,2015.

4. Anusha K, Raghu K (2018), "Analysis of Braced Frame Multi-Storied Structure with Different Angles as Per Indian Standards" International Research Journal of Engineering and Technology (IRJET) Vol. 5, PP 1816-1818.

5. Krishna raj R. Chavan, H.S. Jadhav (2014), "Seismic Response of RC Building with Different Arrangement of Steel Bracing System" International Journal of Engineering Research and Applications, Vol. 4, PP 218-222.

6. Krupaben J. Patel, Dhruvkumar H. Patel (2021), " Different Types of Bracing System in Multi-Story RCC Building" GRD Journal for Engineering, Vol. 4, PP 19-25.

7. Mohammed Hyderuddin, Mubassir Imran, Syed Mohsin (2016), "Retrofitting of Reinforced Concrete Frames using Steel Bracing." International Journal for Scientific Research & Development| Vol. 4, Issue 08, PP. 297-301.

8. O. Esmaili, S. Epackachi, M. Samadzad and S.R. Mirghaderi, (2008) "Study of Structural RC Shear Wall System in a 56-StoryRC Tall Building" The 14th World Conference on Earthquake Engineering October 12-17, 2008, Beijing, China

9. Prof. Bhosle Ashwini Tanaji, Prof. Shaikh A. N., "Analysis of Reinforced Concrete Building with Different Arrangement of Concrete and Steel Bracing system," IOSR Journal of Mechanical and Civil Engineering, Volume 12, PP 08-12.

10. Prof. N.K. Meshram, Gauravi Munde (2018), "Seismic Analysis of Shear Wall at Different Location on Multi-storey RCC Building" International Journal of Interdisciplinary Innovative Research & Development (IJIIRD), Vol. 2, PP 7-28.

11. Rahul D. Sapkale (2016), "Seismic Response of Multi-Storey Building Equipped with Steel Bracing" International Journal of Advanced Engineering, Management and Science (IJAEMS) Vol. 2, PP 978-982.

12. S. K. Duggal, Earthquake resistant design of structures. Oxford University Press New Delhi, 2007.

13. Vineeth Vijayan, M Helen Santhi and Romy Mohan (2020), "Seismic Performance of High-Rise Buildings with Different Types of Shear Wall." International Journal of Scientific Research in Science, Engineering and Technology, PP 357-362.

Research Through Innovation