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Seismic Analysis of G+10 High Rise Structure Using Shear Wall on Staad Pro

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Abstract: The Shear walls are commonly used as a vertical structural element. They are used for resisting the lateral loads which are induced by the loads due to wind and earthquake. Besides shear walls also carry gravity loads. An attempt is made for seismic analysis of RCC building bare frame & with shear wall at corner position using STAAD Pro Connect Edition V22. A 11 storey building is taken under consideration. Two different Model of RCC building are used, one with no shear wall and other models with corner position of shear wall. Results will be obtained from analysis and plotted to compare and to have knowledge of behavior of RCC framed structures with shear walls using Equivalent lateral force static method Analysis which is subjected to earthquake load in zone V. The parameters like storey drift, lateral displacement, and base shear will be studied and suitable location of shear wall will be determined among these models. The whole analysis is done on STAAD Pro Connect Edition V22 software.
Keywords: STAAD-Pro Connect Edition V22, Bare Frame, Shear Wall, Seismic Analysis, High Rise Building, Lateral Force, Base Shear, Storey Displacement, Storey Drift

I. INTRODUCTION

Now a days in multi-storey buildings, the RC frame structures are constructed initially due to ease of construction and rapid work in progress. Generally, shear wall can be defined as structural vertical member that is able to resist combination of shear, moment and axial load induced by lateral load and gravity load transfer to the wall from another structural member. In modern tall buildings, shear walls are commonly used as a vertical structural element for resisting the lateral loads that may be induced by the effect of wind and earthquakes which cause the failure of structure. Shear wall is one of the excellent means of providing earthquake resistance to multistoried reinforced concrete building. To reduce the effect of earthquake reinforced concrete shear walls are used in the building. Shear walls are usually used in tall building to avoid collapse of buildings. When shear wall is situated in advantageous positions in the building, they can form an efficient lateral force resisting system.

II. OBJECTIVE

The present work is to analyze G+10 High Rise Structure buildings with RCC structure building Seismic Zone V. The components of objectives are as follows:

1) To design and evaluate the seismic behavior of RCC building having different model
2) To obtain and analyze the various loads acting on the structure.
3) To study the variations in parameters such as shear force, bending moment and displacement for seismic zones V as per IS 1893 (Part-1):2016.
4) To evaluate the storey drift and average storey displacement of the high-rise building.

III. SCOPE OF THE STUDY

1) Any structural engineer can use this paper as a guide line for seismic analysis of any multistory building.
2) The study highlights the effect of seismic zone factor in different zones i.e. Zone II, Zone III, Zone IV and Zone V which is considered in the seismic performance evaluation of buildings.
3) The design of structures must incorporate appropriate features for resisting earthquakes, thereby ensuring their capability to withstand lateral forces exerted during seismic events across various seismic zones.
4) Additionally, it is essential to consider both the cost- effectiveness and efficiency of these measures in mitigating potential earthquake- related damage to the structures.

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III. LITERATURE REVIEW

1) Saha Purnachandra, Teja P. Prabhu & P Kumar Vijay (2012) This research is mainly focuses on variation in percentage of steel when building is designed for different seismic zones. As per their research work, they concluded that percentage variation of steel in beams is not varying much as compared to columns. Variation is around 0.07% in columns and overall variation is around 0.91% from Zone-2 to Zone-5.
2) Rahangdale Himalee, Satone S.R. (2013) Design and analysis of multi-storey building with effect of shear wall. The G+5 storey building is analyzed for lateral loading and seismic loading by STAAD-Pro software. They studied with the help of four different models. Model one is bare frame, and other three models have shear wall at different location in building. From result they observed that different location of shear wall effect on axial load on the column. In absence of shear wall axial load and moments are maximum on column. Shear walls are one of the most effective building elements in resisting lateral forces during earthquake. By constructing shear walls damages due to effect of lateral forces due to earthquake and high winds can be minimized. Shear walls construction will provide larger stiffness to the buildings there by reducing the damage to structure and its contents.
3) Sardar Shahzad Jamil, Karadi Umesh. N. (2013) work on effect of change in shear wall location on storey drift of multistorey building subjected to lateral loads. The twenty-five storey building is analyzed for earthquake force by equivalent static analysis and response spectrum analysis by ETAB software. Effectiveness of shear wall has been studied with the help of five different models. Model one is bare frame, model two shear wall placed at Centre of building, model three is shear wall placed at center four shear wall placed at outer edge parallel to Y direction, model four is shear wall placed at center four shear wall placed at outer edge parallel to X direction and model five is shear wall placed at centre and four shear walls placed at outer edge parallel to X and Y direction. From result they observed that in equivalent static analysis it has been found that model-5 shows lesser displacement and lesser inter-storey drift as compared to other models in longitudinal direction. In response spectrum analysis model-5 shows lesser displacement and lesser inter-storey drift as compared to other models in longitudinal direction. The presence of shear wall can affect the seismic behaviour of frame structure to large extent, and the shear wall increases the strength and stiffness of the structure. It has been found that the model-5 shows better location of shear wall since lateral displacement and inter-storey drift are less as compared to other models.
4) Babu B. Giresh (June 2017) has done a seismic analysis and Design of G + 7 Residential Building using STAAD Pro. Earthquake, or Seismic analysis, to calculate the response of a structure subjected to earthquake excitation. He collected various necessary seismic data to carry out the seismic analysis of the structure. In this study, the structures seismic response was investigated under earthquake excitation expressed in member forces, join displacement, support reaction, and story drift.
5) Kankuntala Rani. (2018) They used STAAD Pro to design and assess the G + 4 Building. It was a three-dimensional framed design that included load calculations and STAAD Pro analysis of the entire structure. Limit State Design was utilized in the STAAD-Pro analysis, which followed the Indian Standard Code of Practice. The outcomes were extremely accurate.
6) Sonkar Ankit, Verma Srishti (2023)-In their study they compare & analyze of high-rise buildings, specifically examining the impacts of seismic activity and wind forces. In past years many research has done on Analysis of building with and without shear walls. All the same they work for little Analysis of high-rise building (G+ 10) with & without shear walls. The current work consists the correlation between framed & framed with shear wall building in presence of the wind force, earthquake force etc., for seismic design of buildings, reinforcement concrete structural walls or shear walls are higher earthquake resisting members which abstain from lateral load resistance

IV. METHOD & DESCRIPTION

In this study the behavior of G+10 High-Rise Structure as residential building under seismic loads have been analyzed for seismic zone V with & without shear walls at different corners. An analysis of structure has been carried out for comparison of Base Shear, Storey Displacement and Storey Drift in seismic zone V. The analysis of the building has been carried out by static coefficient method or equivalent lateral force method approach using STAAD-Pro Connect Edition V22. The size of the building plan is 16mX16m and height of structure is 33 m.

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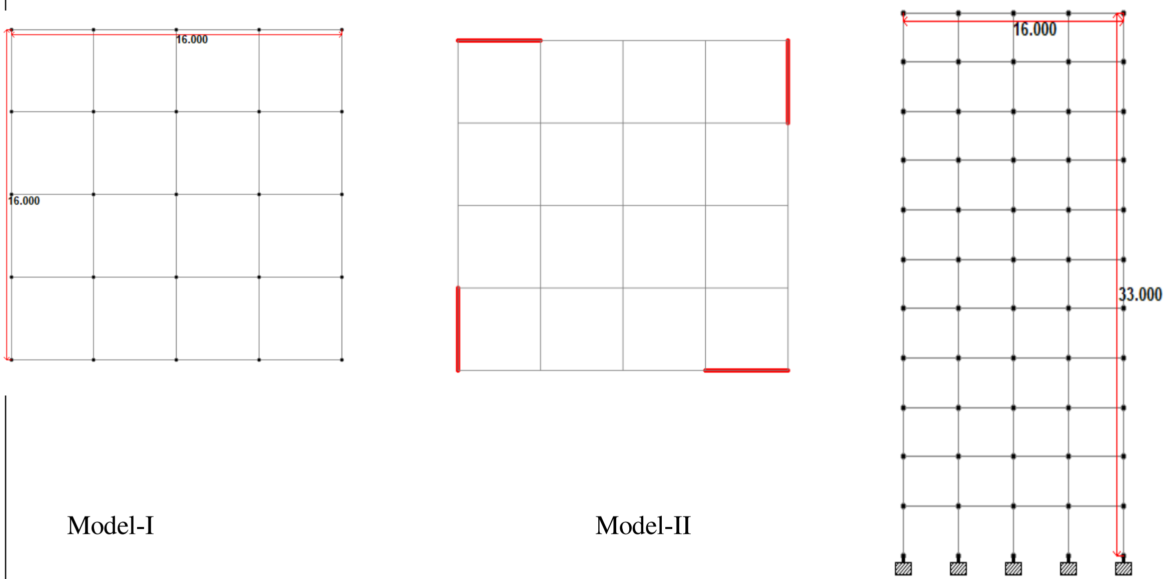
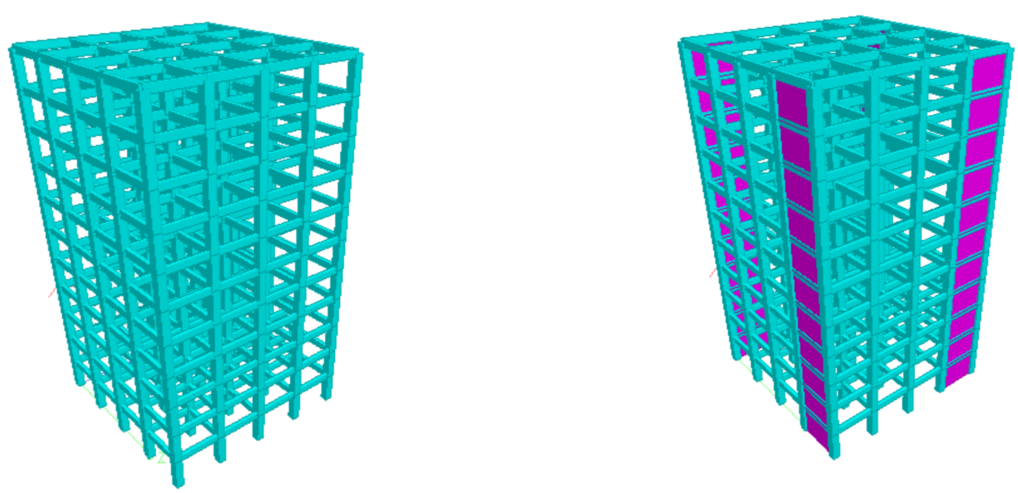


Model-I Model-II

Fig.1 Staaad Pro Plan , Elevation, Model-I Bare Frame & Model-II Shear wall at corner



Model-I Model-II

Fig.2 Staaad Pro 3D rendering view Model I Bare Frame & Model II Shear wall at corner

G+10 High Rise Structure Building with soft storey is modelled in STAAD-Pro Connect Edition V22 software for frame situated in zone V. RCC frame with and without arrangement of shear wall are adopted in the analysis of this study. The geometry of the building is as shown in figure and the building configuration data is shown in table 1 & seismic configuration data in table 2.

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TABLE 1: Structural Modeling for the Project Models

Description	Value
Grade of Concrete	M25
Grade of Steel	Fe500
Bays in X-direction and Length	4 bays of 4m each = 16m
Bays in Z-direction and Width	4 bays of 4m each = 16m
Floor to Floor Height	11 bays of 3m each = 33m
Number of Storey	G+10
Column Size	600mmx600mm
Beam Size	300mmx600mm
Thickness of Slab	150mm
Live Load on Floors	3 KN/m^2
Thickness of External Wall	230mm
Thickness of Internal Wall	115mm
External Plaster	20mm
Internal Plaster	12mm
Density of Concrete	25 KN/m^3
Density of Plaster	18 KN/m^3
Density of Brickwork	20 KN/m^3
Thickness of Shear Wall	230mm

TABLE 2 : Seismic Parameters

Seismic Zone	**Zone V**
Zone Factor (Z)	0.36
Importance Factor (I) All other building	1
Response Reduction Factor Shear Wall with SMRF (R)	5
Type of Soil	Medium soil type II
Damping Percent	5%
Natural Time Period (Ta) SEC X Direction	0.60
Natural Time Period (Ta) Z Direction	0.60
Sa/g X Direction	2.267
Sa/g Z Direction	2.267
Coefficient of Horizontal Acceleration Ah X Direction	0.0816
Z Direction	0.0816

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Types of seismic analysis methods -

1) Static Analysis

Equivalent Lateral Force Method & Pushover Analysis

2) Dynamic Analysis

Response Spectrum Method & Time History Analysis

We using Static Analysis of Equivalent Lateral Force Method for this research:

a) Calculation of Load –

DL of slab = 0.15 x 1 x 25 = 3.75 KN/m^2

- DL of outer brick wall = 0.23 x (3-0.6) x 20 = 11.04 KN/m
  DL of plaster = (0.020+0.012) x 3 x 18 = 1.72 KN/m
  Total DL for outer wall = 11.04+1.72 = 12.76 KN/m
- DL of inner brick wall = 0.115 x (3-0.6) x 20 = 5.52 KN/m
  DL of plaster = (0.012+0.012) x 3 x 18 = 1.23 KN/m
  Total DL for inner wall = 5.52+1.23=6.81 KN/m
- DL of parapet wall = 0.23 x 1 x 20 = 4.60 KN/m
  DL of plaster = (0.02+0.02) x 1 x 18 = 0.72 KN/m
  Total DL for parapet wall = 4.60 + 0.72 = 5.32 KN/m

b) Calculation of Seismic Weight-

As per IS 1893 (Part 1):2016 table 3.1 in clause 7.3.1 of "Percentage of imposed load to be considered in seismic weight calculation"

Total seismic weight floors = 3.75 + (0.25 x3) = 4.5 KN/m^2

Total seismic weight roof floors = 3.75+0 KN/m^2

V. RESULTS & DISCUSSION

In this Research all the various parameters like Base Shear, Storey Displacement, Storey Drift are obtained by STAAD-Pro Connect Edition V22 using referred IS 1893(Part 1):2016, for using criteria and limitations.

A. Base Shear: -

Base shear is resisting lateral force due to earthquake. Base shear is cumulative sum of lateral force from top storey to bottom storey The building is stiff with provided shear walls. The structure is analyzed by equivalent lateral force method, the value of the base shear at lower floor is the maximum and upper floor is the minimum. Base shear at ground level for seismic zone V along X direction and along Z direction respectively. Discuss the result in the table and graphs are plotted below -

TABLE 3 Base Shear Result

Base Shear (kN)		
Zone	**Model-I Bare Frame**	**Model-II Corner Shear Wall**
Zone V	3426.11	3659.59

1) Seismic Zone V the base shear result found to be increasing and is found to be highest in model II.

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2) Base Shear is minimum for model I is 3426.11 KN along X direction and along Z direction.
3) Base Shear is minimum for model II is 3659.59 KN along X direction and along Z direction.
4) When compared base shear for model I & model II is increase by 68.15% along X direction and along Z direction respectively. Hence more lateral force acting on structure from top storey to bottom storey.

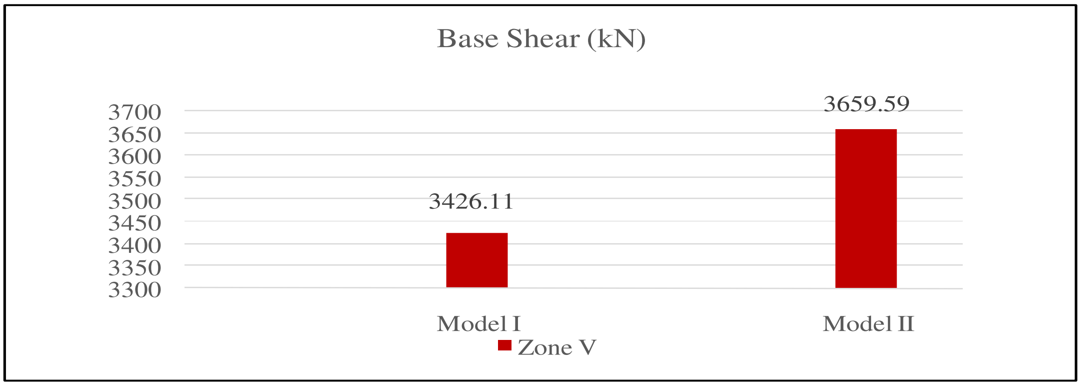

Fig. 3 Base Shear X Direction & Z Direction

B. *Average Storey Displacement*

The average storey displacement is average of all node displacement at that floor level due to lateral forces acting on the structure in that direction. Average Storey Displacement is in increasing order from bottom floor level to top floor level. In this study seismic zone V for model I & model II maximum load combination i.e. load combination LC 12 for X direction and load combination LC 13 for Z direction.

The displacement of building with and without shear wall is calculated by Equivalent lateral force method is used for analysis by STAAD Pro Connect Edition V22 software. For the analysis of building with and without shear wall zone V is considered. Discussing result in the table and graphs are plotted –

1) Average storey displacement is increasing from model I to model II.
2) The minimum average storey displacement obtained for model II is 54.675 mm along X direction and along Z direction respectively.
3) The maximum average storey displacement obtained for model I is 79.950 mm along X direction and along Z direction respectively.
4) Overall maximum average storey displacement of G+10 High Rise Structure is 79.950 mm.

TABLE 4 Average Storey Displacement X Direction & Z Direction

Avg Storey Displacement (mm)				
Floor	Floor Number	Height	Model I	Model II
Ground	0	0	0	0
1	1	3	5.168	2.353
2	2	6	13.934	6.657
3	3	9	23.430	11.828
4	4	12	33.011	17.554
5	5	15	42.380	23.621
6	6	18	51.312	29.821
7	7	21	59.550	35.933
8	8	24	66.820	41.729
9	9	27	72.810	46.965
10	10	30	77.206	51.374
Terrace	11	33	79.950	54.675

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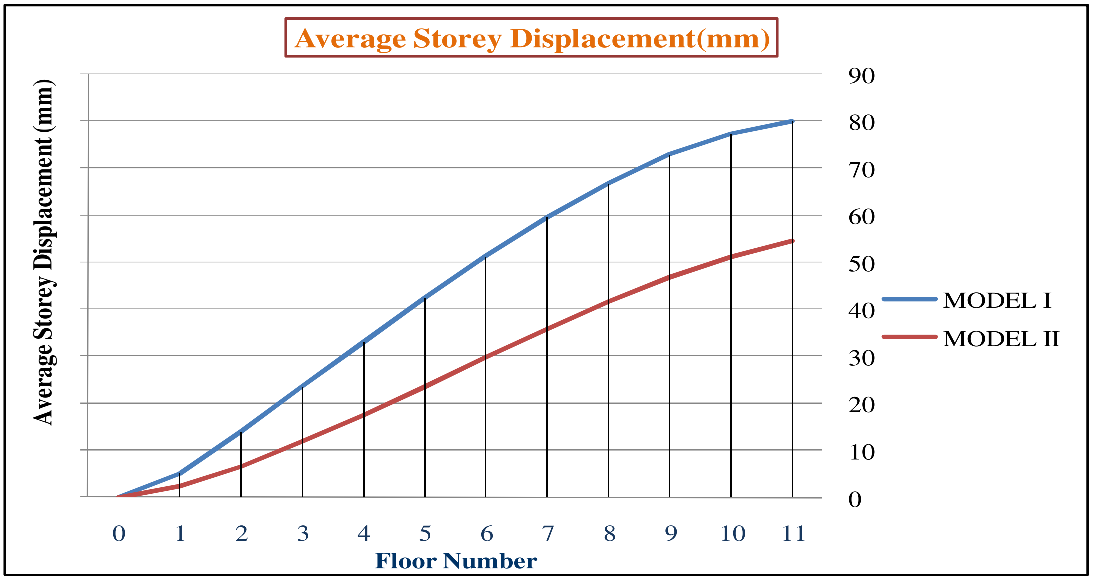


Fig. 4 Storey Displacement Along X Direction & Z Direction

C. Storey Drift :-

Storey drift is the displacement of one storey to the other storey level above or below. The maximum storey drift of building with and without shear wall is calculated by Equivalent lateral force method is used for analysis by STAAD Pro Connect Edition V22 software. For model I & model II maximum load combination i.e. load combination LC 12 for X direction and load combination LC 13 for Z direction. Discussing result in the table and graphs are plotted –

1) Maximum storey drift for model I is 9.573 mm.
2) Maximum storey drift for model II is 6.199 mm
3) Maximum value of the storey drift is 9.573 mm along X direction & along Z direction.
4) As per Indian Standard, Criteria for earthquake resistant design of structures, IS 1893(Part 1): 2016, the storey drift in any story shall not exceed 0.004 times storey height or L/250.
5) Storey drift of G+10 High Rise Structure at 4th storey level 12m is 9.573 mm.
6) Maximum storey drift permitted = 0.004 x3000 = 12 mm. Hence, ok

TABLE 5 Storey Drift Along X Direction & Z Direction

Storey Drift (mm)				
Floor	Floor Number	Height	Model I	Model II
Ground	0	0	0	0
1	1	3	5.168	2.353
2	2	6	8.767	4.304
3	3	9	9.504	5.171
4	4	12	9.573	5.726
5	5	15	9.368	6.067
6	6	18	8.935	6.199
7	7	21	8.245	6.113
8	8	24	7.270	5.796
9	9	27	5.983	5.236
10	10	30	4.396	4.409
Terrace	11	33	2.747	3.301

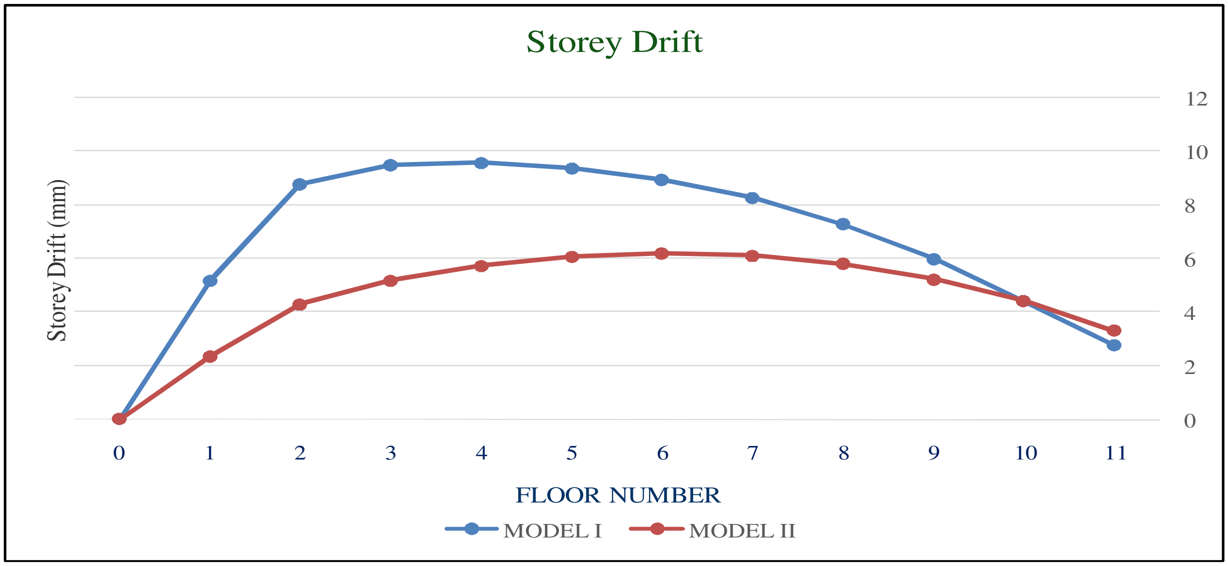


Fig. 5 Storey Drift Along X Direction & Along Z Direction

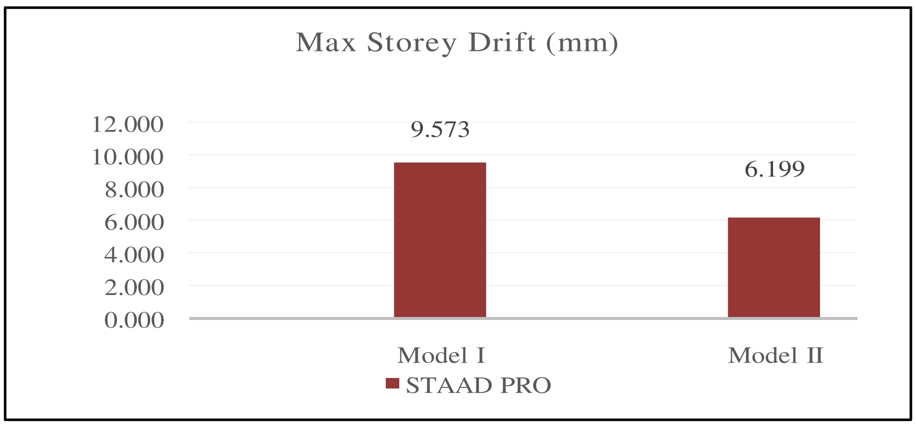


Fig. 6 Maximum Storey Drift Along X Direction & Along Z Direction

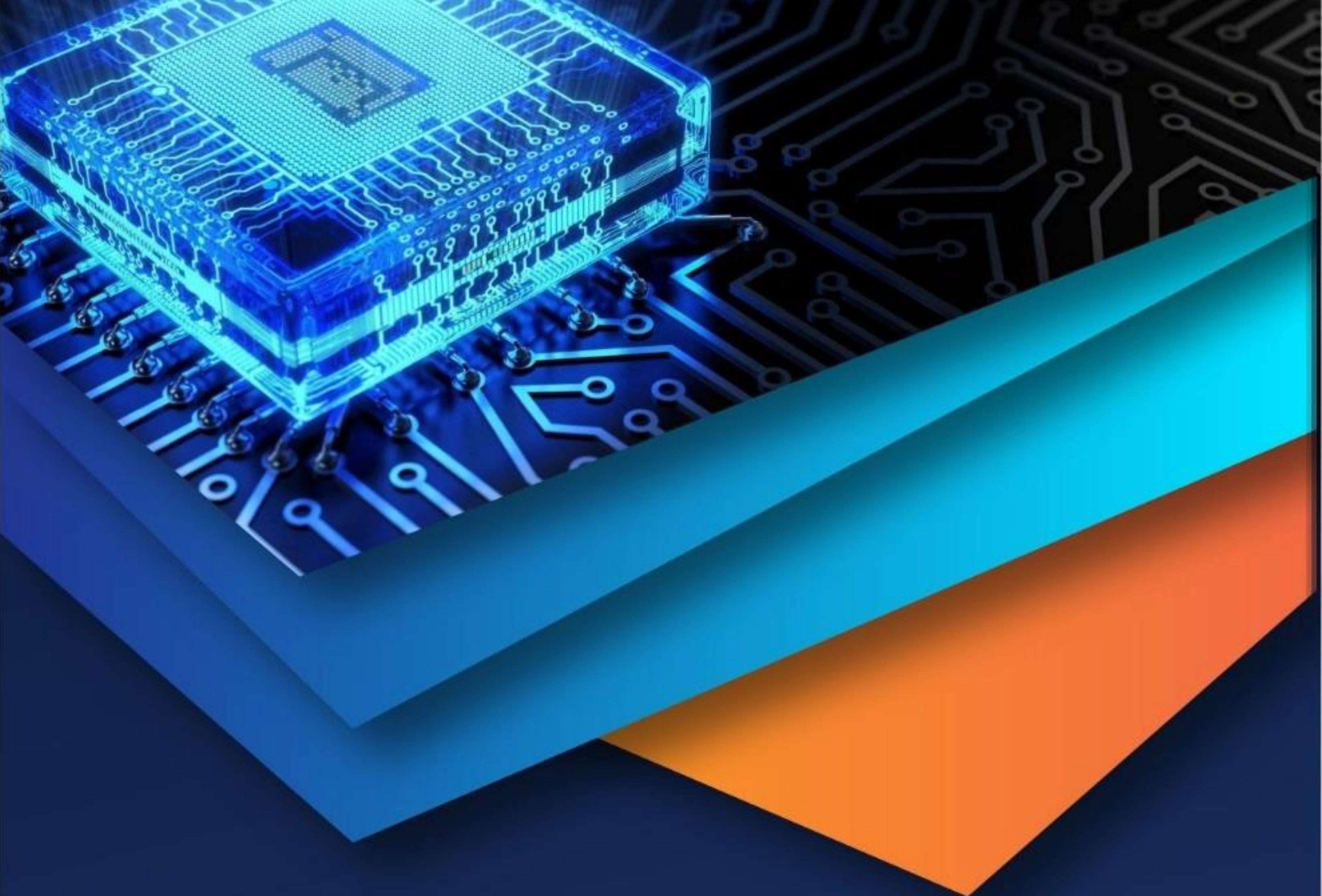
VI. CONCLUSION

In this research our main aim is to comparisons base shear, average storey displacement, storey drift in Seismic zone V by providing with & without shear wall at all corners positions of the building as model I & model II. The data revealed by STAAD-Pro Connect Edition V22 software using seismic coefficient method and various loading combinations following conclusions are obtained:-

1) Seismic analysis was done by STAAD-Pro Connect Edition V22 software as per IS 1893-(Part 1) :2016.
2) Among all the load combinations, the load combination LC 1.5 (DL+LL), LC 1.5(DL+EQX), LC 0.9DL-1.5EQX, LC 0.9DL+1.5EQZ, LC 0.9DL-1.5EQZ, LC 1.5 (DL+LL-EQX), LC 1.5 (DL+LL-EQZ) are critical combination for all the model I & model II at seismic zone V.
3) Base Shear is minimum for model I 3426.11 kN along X direction & Z direction respectively
4) Base Shear is maximum for model II 3659.59 kN along X direction & Z direction respectively
5) The minimum average storey displacement obtained for model II is 54.675 mm along X direction and along Z direction respectively
6) The maximum average storey displacement obtained for model I is 79.950 mm along X direction and along Z direction respectively.
7) Storey drift of G+10 High Rise Structure at 4th storey level 12m is 9.573 mm
8) Maximum storey drift permitted = 0.004 x3000 = 12mm. Hence ok.

REFERENCES

[1] IS 875(part-1)1987 "Code of Practice for Design Loads (Other Than Earthquake) For Building and Structures", Dead load.
[2] IS 875 (part-2)1987 "Code of Practice for Design Loads (Other Than Earthquake) For Building and Structures", Imposed loads.
[3] IS 1893:2016 (Part 1), "Criteria for Earthquake Resistant Design of Structures", Fifth revision, Bureau of Indian Standards.
[4] IS 456:2000, "Plain and Reinforced Concrete Code of Practice", Fourth revision, Bureau of Indian Standards.
[5] Rahangdale Himalee ,Satone S.R., "Design and Analysis Of Multi-Storey Building With Effect Of Shear Wall", International Journal of Engineering Research and Applications (IJERA), Vol. 3, Issue 3, May-Jun 2013.
[6] Shahzad Jamil Sardar , Umesh. N. Karadi, "Effect Of Change In Shear Wall Location On Storey Drift Of Multistorey Building Subjected To Lateral Loads", International Journal of Innovative Research in Science, Engineering and Technology, Vol. 2, Issue 9, September 2013.
[7] B.Srikanth, V.Ramesh, "Comparative Study of Seismic Response for Seismic Coefficient and Response Spectrum Methods", Journal of Engineering Research and Applications, ISSN: 2248-9622, Vol. 3, Issue 5, Sep-Oct 2013
[8] Sonkar Ankit , Verma Srishti " A Study on Seismic Effect on High Rise Building with & Without Shear Wall " International Journal For Multidisciplinary Research. ISSN: Volume 5, Issue 5, September-October 2023.
[9] Neetesh Jain, Rakesh Grover "A Study of Seismic Analysis of High-Rise Structure in Different Seismic Zone Using Staad Pro" International Journal on Recent and Innovation Trends in Computing and Communication ISSN: 2321-8169 Volume: 10 Issue: 7, June 2022
[10] Bhavesh Kumar Daharwal, Rakesh Grover "Study of Seismic Effect on High Rise Building in Two Different Position of Shear Wall using Staad Pro" International Journal for Research in Applied Science & Engineering Technology (IJRASET) ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538 Volume 11 Issue IV Apr 2023



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