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Comparative Seismic Analysis of Reinforced Concrete Building with Different Height and Shear Wall Configurations in Gujarat Region Using ETABS

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Abstract: Earthquakes produce significant lateral forces on multi-storey buildings, which may lead to excessive displacement and structural damage. Reinforced concrete (RC) buildings without adequate lateral load resisting systems may experience large deformations during seismic events. Shear walls are important structural elements used to improve the lateral stiffness and strength of buildings. The present study investigates the seismic performance of RC buildings with different shear wall locations. Several building models were developed and analyzed using ETABS. The analysis considers different shear wall configurations such as core shear wall, corner shear wall and mid-side shear wall arrangements. The seismic behavior of the buildings was evaluated based on important response parameters including storey displacement, storey drift and base shear. A comparative analysis was carried out among different structural models to understand the influence of shear wall placement on overall building performance.

The results indicate that the presence of shear walls significantly improves the seismic behavior of RC buildings by reducing storey displacement and drift. Proper placement of shear walls enhances the structural stiffness and stability of the building. The study helps in identifying the most efficient shear wall configuration for improving seismic performance of multi-storey RC buildings.

Keywords: Reinforced Concrete (RC) Building, Seismic Analysis, Shear Wall, Storey Displacement, Storey Drift, Base Shear, Structural Performance, ETABS Software, Earthquake Resistant Design, Shear Wall Location Optimization.

I. INTRODUCTION

Earthquakes are one of the most destructive natural hazards that can cause severe damage to buildings and infrastructure. Multi-storey reinforced concrete (RC) buildings are widely constructed in urban areas due to their strength, durability and economy. However, during an earthquake, these structures are subjected to significant lateral forces that may lead to excessive displacement, structural damage and even collapse if not properly designed. To improve the seismic performance of buildings, structural systems capable of resisting lateral forces are required. Shear walls are one of the most effective lateral load resisting elements used in reinforced concrete buildings. These vertical structural elements provide high stiffness and strength, which help in controlling lateral displacement and improving overall stability of the structure. The placement and configuration of shear walls play a crucial role in the seismic behavior of buildings. Different arrangements such as core shear walls, corner shear walls and mid-side shear walls can influence the structural response in different ways.

Therefore, it is important to study the effect of shear wall location on the seismic performance of buildings. With the advancement of structural analysis software such as ETABS, it has become possible to model and analyses complex building structures accurately. This study focuses on analyzing the seismic behavior of reinforced concrete buildings with different shear wall configurations and evaluating important response parameters such as storey displacement, storey drift and base shear.

A. Research Objectives

- To study the effect of building height on seismic behavior of RC buildings.
- To analyses the influence of different shear wall locations (core, corner, mid-side, and combined) on structural performance.
- To evaluate and compare storey displacement of various building models under earthquake loading.

- To analyses and compare storey drift values as per seismic code limits.
- To study and compare base shear for different shear wall configurations.
- To maintain uniform structural parameters (material, loads, sections, and load combinations) for fair comparison.
- To identify the most efficient shear wall location based on minimum displacement, minimum drift, and optimum base shear.
- To recommend the best shear wall arrangement for mid-rise RC buildings in seismic zones of Gujarat region.

B. Research Gap

- From the Literature Review, it is observed that several Studies have been conducted on the Seismic Behaviors of RC Buildings with Shear Walls Considering Different Aspects such as Openings. Strengthening Techniques, Optimization and Experimental Investigations.
- However, Very Limited Studies are Available that Present a Systematic Group Wise Comparative Analysis of Multi Storey RC Building Considering's.
- Variation in Buildings Height.
- Different Shear Wall Locations.
- Unified Comparison Framework.

Therefore, there exists a research gap in developing a comprehensive comparative study to identify the most efficient Shear Wall Locations for Multi-Storey Buildings.

C. Scope of Proposed Work

The scope of the present study includes the following:

- Modelling and analysis of reinforced concrete buildings with different heights.
- Comparative study of different shear wall locations such as core, corner and mid-side positions.
- Evaluation of seismic performance using parameters like storey displacement, storey drift and base shear.
- Study of the effect of building height on structural behavior under earthquake loading.
- Identification of the most effective shear wall configuration for better seismic performance.
- The study focuses only on analytical investigation using ETABS software.

II. RESEARCH METHODOLOGY

The methodology adopted for the present study is described as follows:

1) A typical reinforced concrete multi-storey building plan was selected as the base model for analysis.
2) Different building heights such as G+5, G+8, G+10, G+12 and G+15 were considered to study the effect of height on seismic behavior.
3) Different shear wall configurations such as core location, corner location and mid-side location were selected to evaluate their influence on structural performance.
4) Structural modelling of all buildings was carried out using the ETABS software.
5) The material properties, beam and column sizes, slab thickness, loads and load combinations were kept the same for all models to ensure uniform comparison.
6) Seismic loads were defined according to IS 1893 (Part 1): Criteria for Earthquake Resistant Design of Structures.
7) Linear static analysis was performed for all the models.
8) Important structural response parameters such as storey displacement, storey drift and base shear were obtained from the analysis results.
9) The results were compared to study the effect of building height and shear wall location on seismic performance.
10) Based on the comparative results, the most efficient shear wall configuration was identified.

III. MODEL OVERVIEW

In this study, several reinforced concrete (RC) building models were developed to evaluate the influence of shear wall locations on the seismic behavior of multi-storey structures. All the models were created using ETABS while maintaining identical geometric dimensions, material properties, storey heights, and loading conditions to ensure a consistent basis for comparison.

The developed models include a bare frame model without shear walls and various shear wall configurations placed at different strategic locations within the building plan.

These configurations were selected to examine how the position of shear walls affects the seismic response of the structure. The building models were categorized into different groups based on the location of shear walls, including core shear wall models, corner shear wall models, mid-side shear wall models, and optimized shear wall configurations. Each model was analyzed under earthquake loading conditions to evaluate important seismic response parameters such as storey displacement and storey drift. This model overview provides a clear framework for understanding the different structural configurations considered in the study and facilitates a comparative assessment of their seismic performance.

A. Proposed Model Classifications:

A total of 20 structural models is proposed and classified into five groups to study the effect of building height and shear wall location on seismic performance.

- Group – 1: Bare Frame Models Without Shear Wall.
- Group – 2: Core Shear Wall Models
- Group – 3: Corner Shear Wall Models
- Group – 4: Mid-side Shear Wall Models

This classification ensures systematic comparison and clarity in results.

1) Group wise Models:

- Group – 1: Bare Frame Models (Without Shear Wall)
- Purpose:
  - ➢ To study the effect of increase in building height on Seismic Response.
  - ➢ To establish Baseline (Control) Models Without Shear Walls for Comparison.

- Base /Control Models:

Model No	Description
M1	G+5 Bare Frame
M2	G+8 Bare Frame
M3	G+10 Bare Frame
M4	G+12 Bare Frame
M5	G+15 Bare Frame

- Group – 2: Core Shear Wall Models
- Effect**:**
  - ➢ Provides Balanced Lateral Stiffness.
  - ➢ Reduces Torsional Effects.
  - ➢ Represents Commonly Adopted Practical Design.

- Most Practical Configuration:

Model No	Description
M6	G+5 With Core Shear Wall
M7	G+8 With Core Shear Wall
M8	G+10 With Core Shear Wall
M9	G+12 With Core Shear Wall
M10	G+15 With Core Shear Wall

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- Group – 3: Corners Shear Wall Models
- Effect:
  - Provides Maximum Lateral Stiffness.
  - Results in Minimum Storey Drift and Displacement.
- Maximum Lever Arm Effect:

Model No	Description
M11	G+5 With Corner Shear Walls
M12	G+8 With Corner Shear Walls
M13	G+10 With Corner Shear Walls
M14	G+12 With Corner Shear Walls
M15	G+15 With Corner Shear Walls

- Group – 4: Mid – Side Shear Walls Models
- Effect:
  - Provides Moderates Lateral Stiffness.
  - Some Torsional Effects may occur depending on wall placement.
- Load Distribution Study:

Model No	Description
M16	G+5 With Mid side Shear Walls
M17	G+8 With Mid side Shear Walls
M18	G+10 With Mid side Shear Walls
M19	G+12 With Mid side Shear Walls
M20	G+15 With Mid side Shear Walls

- Reason for Selection of Building Heights and Shear Wall Locations: -

In the present study, different building heights and shear wall locations were selected to evaluate their influence on the seismic performance of reinforced concrete buildings. A total of twenty building models were developed and categorized into four groups based on the presence and location of shear walls.

The building heights considered in this study are 5, 8, 10, 12, and 15 storeys. These heights represent low-rise to mid-rise buildings commonly constructed in urban areas. By analyzing buildings with different heights, the variation in seismic response with increasing structural height can be clearly observed.

Different shear wall locations such as core, corner, and mid-side positions were selected because the placement of shear walls significantly affects the lateral stiffness and overall behavior of the building during earthquake loading. Core shear walls are typically placed around lift or staircase areas, while corner and mid-side shear walls represent alternative structural configurations used in building design.

By analyzing these different configurations, the study aims to identify the most effective shear wall arrangement that reduces storey displacement and storey drift and improves the seismic stability of the structure.

The structural models were developed and analyses using ETABS to compare the seismic performance of different building configurations under earthquake loading conditions.

2) Building Data/Modal Information: -

Sr No	Parameters	Value
1.	Analysis Software	ETABS
2.	Structural System	Reinforced Concrete Frame Structure

3.	Concrete Grade	M30
4.	Reinforcement Steel	HYSD500
5.	Beam Size	300mm x 450mm
6.	Column Size	350mm X 600mm
7.	Slab Thickness	150mm
8.	Shear Wall Thickness	150mm
9.	Storey Heights	5,8,10,12,15
10.	Shear Wall Locations	Core, Corner, Mid
11.	Storey Height	3.5m
12.	Type of Analysis	Linear Dynamic Analysis
13.	Seismic Code Used	IS 1893 (Part:1):2016
14.	Seismic Load Cases	EQX, EQY

B. Model Details: -

Sr No	Models No	Description
1.	M1	G+5 Bare Frame
2.	M2	G+8 Bare Frame
3.	M3	G+10 Bare Frame
4.	M4	G+12 Bare Frame
5.	M5	G+15 Bare Frame
6	M6	G+5 With Core Shear Wall
7.	M7	G+8 With Core Shear Wall
8.	M8	G+10 With Core Shear Wall
9.	M9	G+12 With Core Shear Wall
10.	M10	G+15 With Core Shear Wall
11.	M11	G+5 With Corner Shear Walls
12.	M12	G+8 With Corner Shear Walls
13.	M13	G+10 With Corner Shear Walls
14.	M14	G+12 With Corner Shear Walls
15.	M15	G+15 With Corner Shear Walls
16.	M16	G+5 With Mid side Shear Walls
17.	M17	G+8 With Mid side Shear Walls
18.	M18	G+10 With Mid side Shear Walls
19.	M19	G+12 With Mid side Shear Walls
20.	M20	G+15 With Mid side Shear Walls

IV. SOFTWARE VALIDATION

Group Wise Results: -

- Group – 1: Bare Frame Models Without Shear Wall.
- Group – 2: Core Shear Wall Models
- Group – 3: Corner Shear Wall Models
- Group – 4: Mid-side Shear Wall Models

A. Group – 1 Bare Frame Models: -

M1 – G+5 Bare Frame -

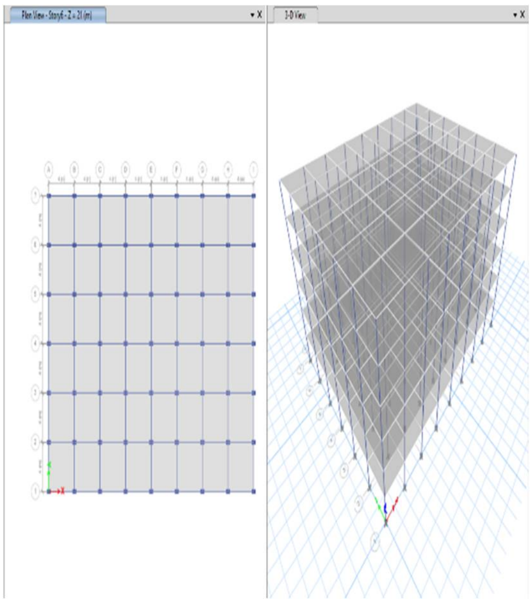


Fig 33 – M1 – G+5 Bare Frame

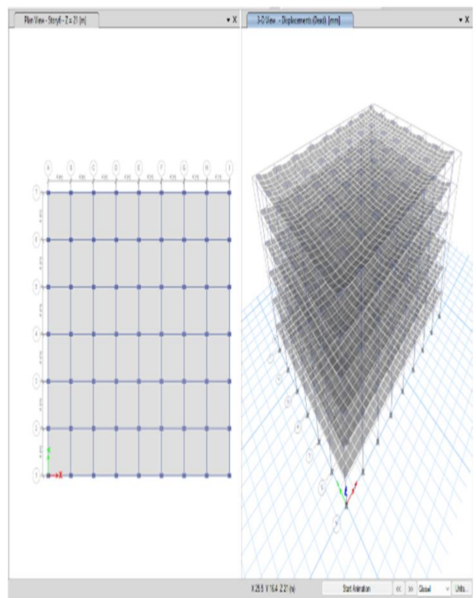
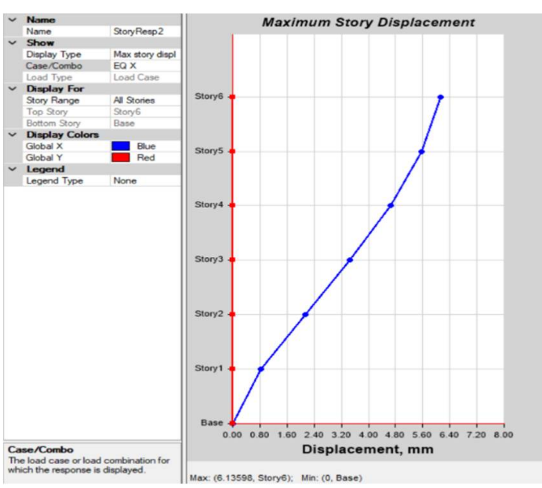


Fig 34 M1 – G+5 Bare Frame Model Run Models Display

1) Storey Displacement: -

M1 - G+5 Bare Frame –



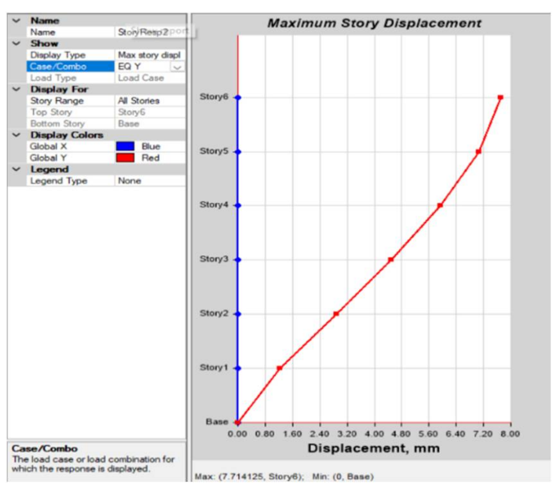


Fig 35 – M1 G+5 Storey Displacement EQX Fig 36 – M1 G+5 Storey Displacement EQY
Top Storey Dis EQX – 6.133Top Storey Dis EQY – 7.71
Bare Frame Bare Frame

Result: - The storey displacement results for the 5-storey bare frame model indicate that the maximum displacement occurs at the top storey of the building. The displacement obtained in the X-direction is 6.13 mm, while the displacement in the Y-direction is 7.71 mm under seismic loading. It is observed that the displacement in the Y-direction is slightly higher compared to the X-direction.

2) Storey Drift: -

M1 – G+5 Bare Frame: -

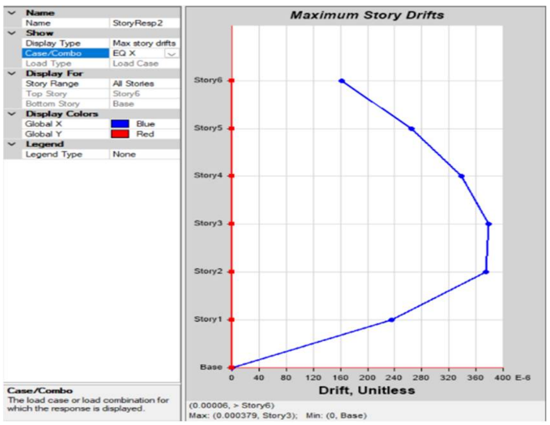


Fig 37 – M1 G+5 Storey Drift EQX
Top Storey Drift EQX - 0.000162
Bare Frame

Fig 38 – M1 G+5 Storey Drift EQY
Top Storey Drift EQY - 0.000188
Bare Frame

Result: - The G+5 bare frame model, the maximum storey drift occurs at the top storey. The X-direction drift is 0.000379, while the Y-direction drift is 0.000473. The Y-direction drift is slightly higher, indicating that the building sways a bit more in the width-wise direction under

3) Base Shear: -

EQX – 1083.75kn, EQY – 842.57kn

Result: -In the G+5 bare frame model, the base shear under seismic loading is observed to be 1083.75 kN in the X-direction and 842.57 kN in the Y-direction. The higher base shear in the X-direction indicates that the building experiences greater lateral seismic forces along its length compared to its width. This observation helps in understanding the distribution of seismic forces in bare frame structures and serves as a reference for comparing models with shear walls.

M2 – G+8 Bare Frame -

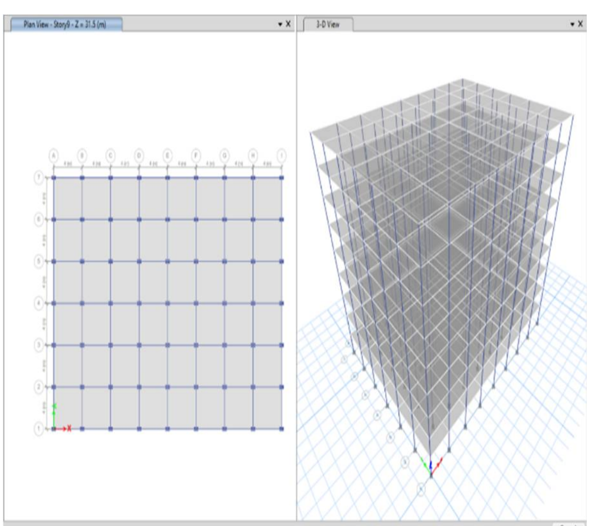


Fig 39 – M2 – G+8Bare Frame Display

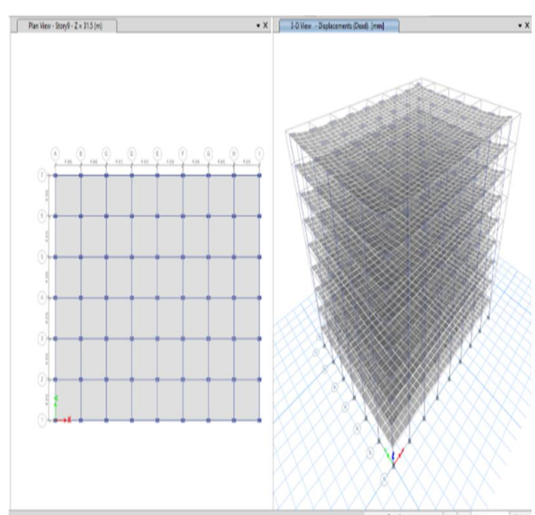


Fig 40 – M2 – G+8Bare Frame Run

4) Storey Displacement: -

M2 – G+8 Bare Frame –

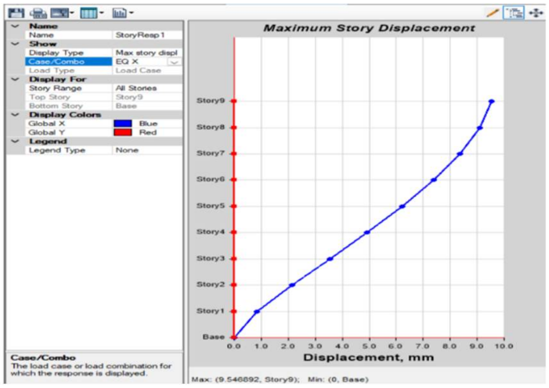


Fig 41 – M2 G+8 Storey Displacement EQX
Top Storey Dis EQX – 9.54
Bare Frame

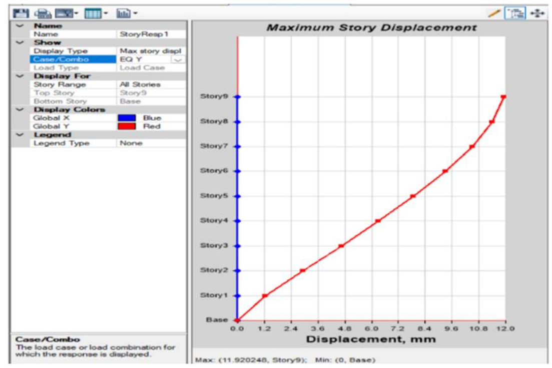


Fig 42 – M2 G+8 Storey Displacement EQY
Top Storey Dis EQY – 11.92
Bare Frame

Result: - In the G+8 bare frame model, the maximum storey displacement occurs at the top storey. The displacement in the X-direction is 9.54 mm, while in the Y-direction it is 11.92 mm under seismic loading. The higher displacement in the Y-direction indicates that the building sways more along its width compared to its length. This observation can be used to compare with other models to evaluate the effect of shear wall placement on controlling lateral sway.

5) Storry Drift: -

M2 – G+8 Bare Frame –

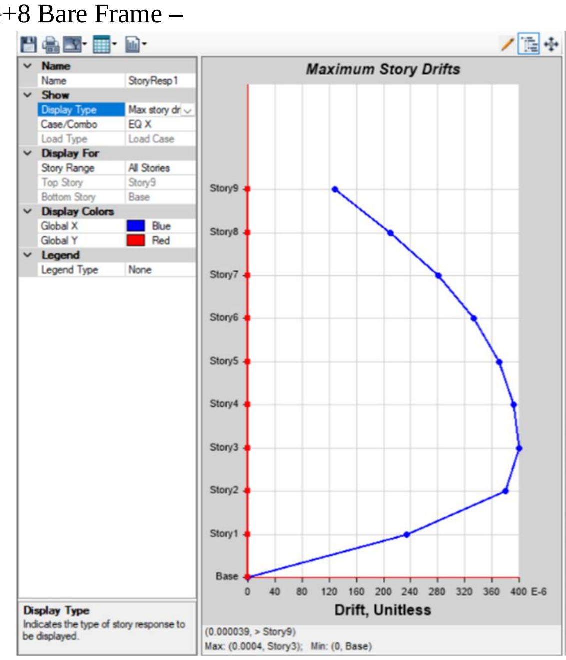


Fig 43 – M2 G+8 Storey Drift EQX
Top Storey Drift EQX – 0.0004
Bare Frame

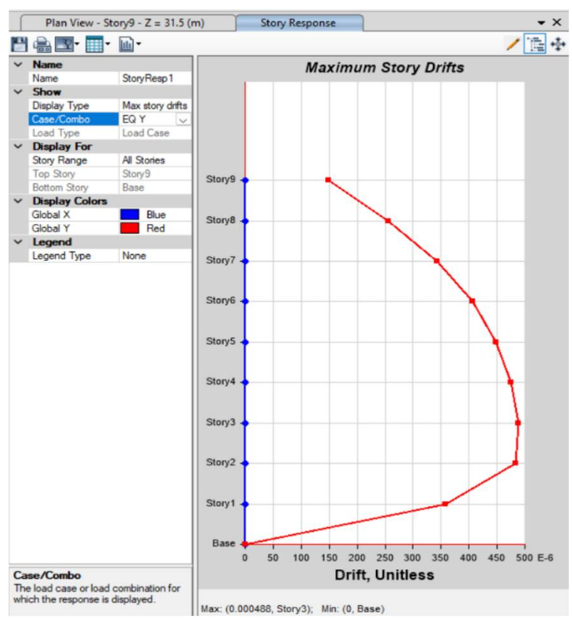


Fig 44 – M2 G+8 Storey Drift EQY
Top Storey Drift EQY – 0.000488
Bare Frame

Result: - In the G+8 bare frame model, the maximum storey drift occurs at the top storey. The X-direction drift is 0.0004, while the Y-direction drift is 0.000488 under seismic loading. The higher drift in the Y-direction indicates that the building sways slightly more width-wise compared to length-wise. This observation is useful for evaluating the effect of shear wall placement on controlling lateral movement.

6) Base Shear: -

M2 – G+8 Bare Shear –

EQX – 1072.66kn, EQY – 845.94kn

Result: -In the G+8 bare frame model, the base shear under seismic loading is observed to be 1072.66 kN in the X-direction and 845.94 kN in the Y-direction. The higher base shear in the X-direction indicates that the building experiences greater lateral seismic forces along its length compared to its width. This observation helps in understanding the distribution of seismic forces in bare frame structures and serves as a reference for comparing models with shear walls.

M3 – G+10 Bare Frame: -

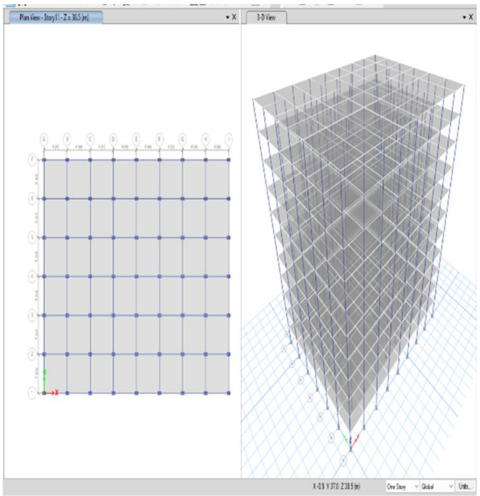


Fig 45 – M3 – G+10 – Bare Fram Display

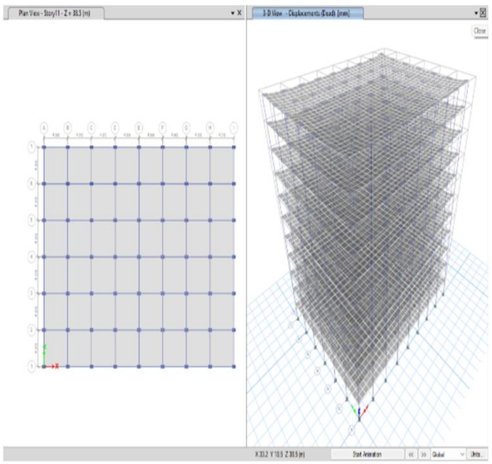


Fig 46 – M3 – G+10 – Bare Frame Run

7) Storey Displacement: -

M3 – G+10 Bare Frame-

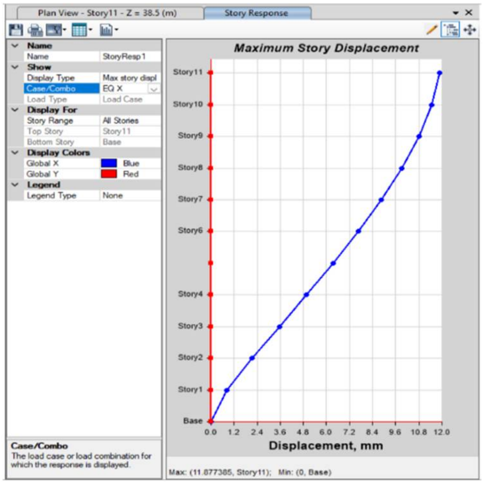


Fig 47 – M3 G+10 Storey Displacement EQX
Top Storey Dis EQX – 11.77
Bare Frame

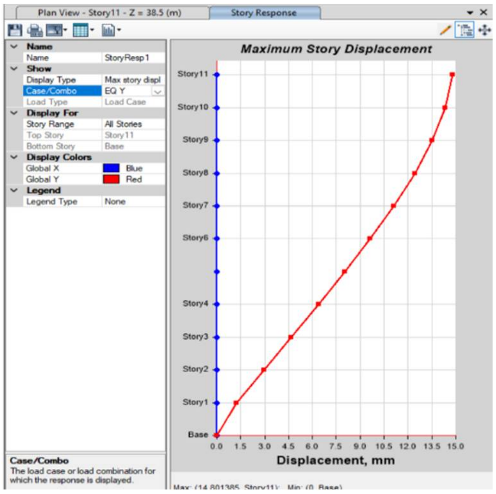
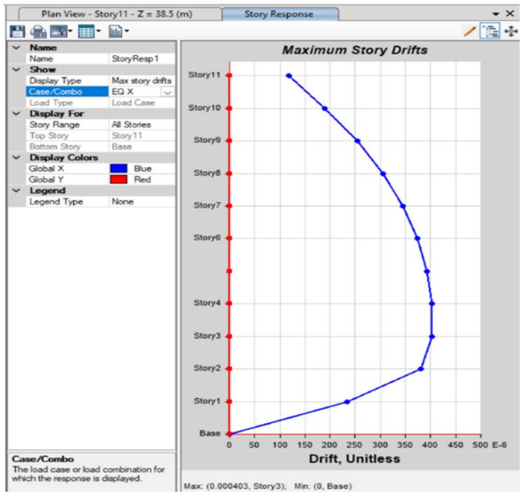


Fig 48 – M3 G+10 Storey Displacement EQY
Top Storey Dis EQY – 14.801
Bare Frame

Result: - In the M3 G+10 bare frame model, the maximum storey displacement occurs at the top storey. The displacement in the X-direction is 11.77 mm, while in the Y-direction it is 14.801 mm under seismic loading. The higher displacement in the Y-direction indicates that the building sways more width-wise than length-wise. This information can be used for comparing the lateral flexibility with other models and evaluating the effect of shear wall placement.

8) Storey Drift: -

M3 – G+10 Bare Frame –



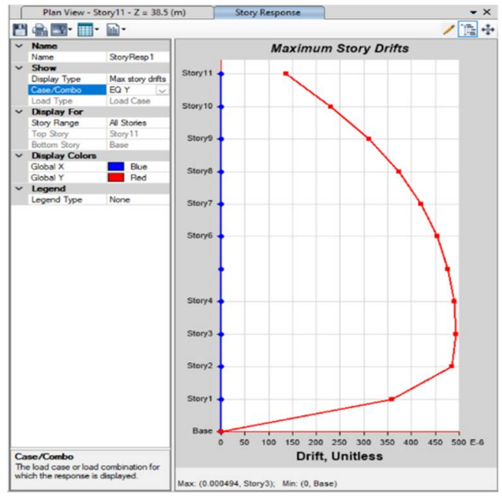


Fig 49 – M3 G+10 Storey Drift EQX
Top Storey Drift EQX –0.000403
Bare Frame

Fig 50 – M3 G+10 Storey Drift EQY
Top Storey Drift EQY –0.000494
Bare Frame

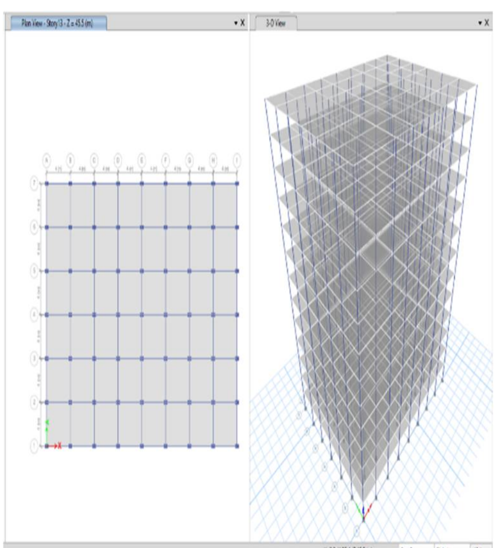
Result: - For the same G+10 bare frame model, the storey drift at the top storey is 0.000403 in the X-direction and 0.000494 in the Y-direction. The slightly higher drift in the Y-direction confirms that the building experiences more lateral sway width-wise. Storey drift is an important parameter to assess the building's stability and seismic performance.

9) Base Shear: -

EQX - 1065.7968kn, EQY - 844.7373kn

Result: - The base shear for the M3 G+10 bare frame model is 1065.80 kN in the X-direction and 844.74 kN in the Y-direction. The higher base shear in the X-direction indicates that the building resists greater lateral seismic forces along its length compared to its width. This result is useful for understanding the distribution of seismic forces in bare frame structures and for comparing with models that include shear walls.

M4 G+12 Bare Frame: –



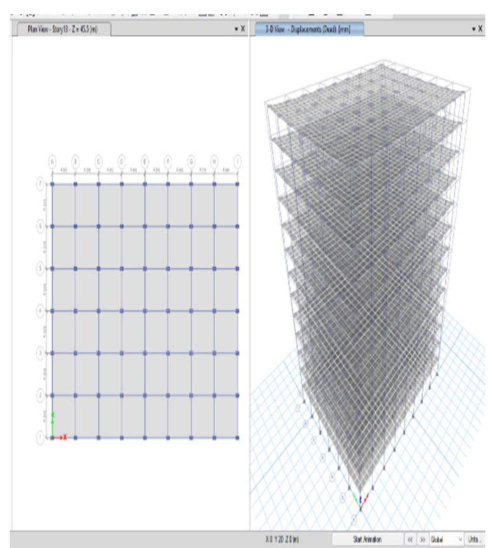


Fig 51- M4 G+12 Bare Frame Display

Fig 52 – M4 G+12 Bare Frame Run

10) Storey Displacement: -

M4 G+12 Bare Frame –

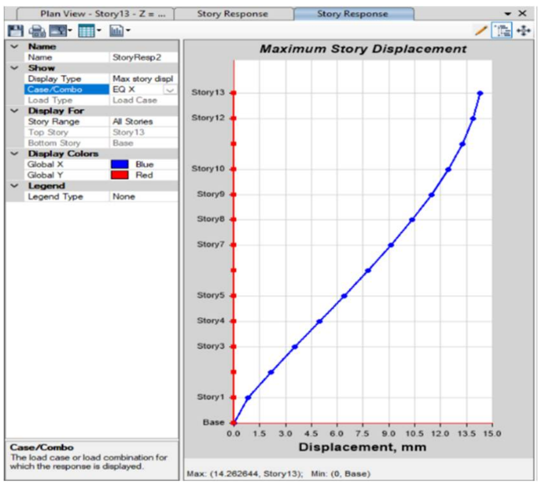


Fig 53 – M4 G+12 Storey Displacement EQX
Top Storey Dis EQX – 14.26
Bare Frame

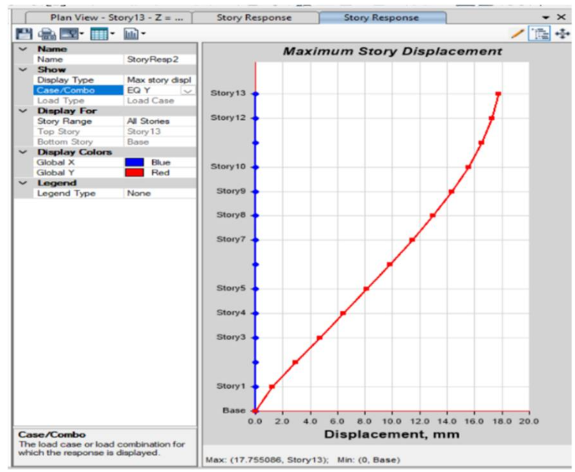
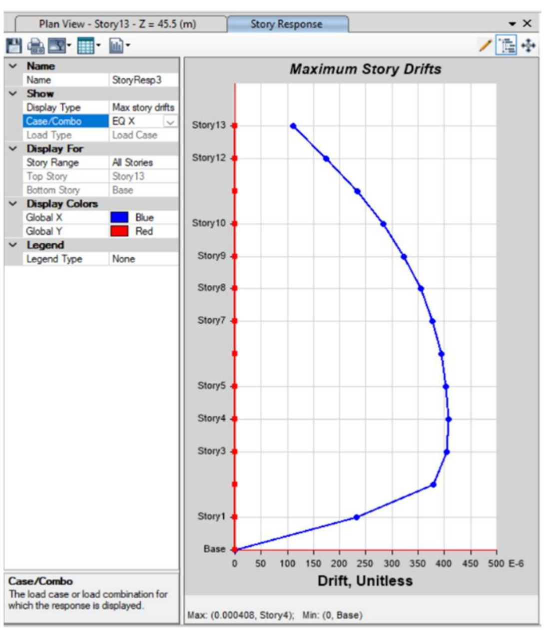


Fig 54 – M4 G+12 Storey Displacement EQY
Top Storey Dis EQY – 17.75
Bare Frame

Result: - In the G+12 bare frame model, the maximum storey displacement occurs at the top storey. The displacement in the X-direction is 14.26 mm, while in the Y-direction it is 17.75 mm under seismic loading. The Y-direction displacement is higher than the X-direction, indicating that the building sways more width-wise than length-wise. This information can be used to compare lateral flexibility with other models and assess the effect of shear wall placement.

11) Storey Drift: -

M4 – G+12 Storey Drift -



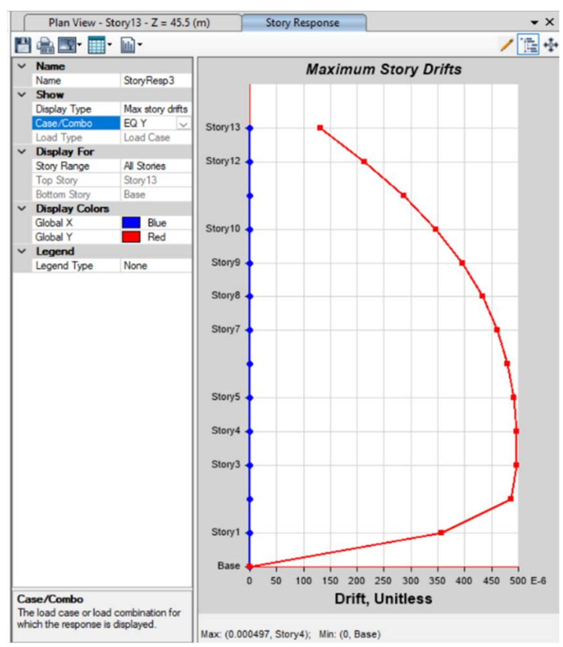


Fig 55 – M4 G+12 Storey Drift EQX
Top Storey Drift EQX –0.000408
Bare Frame

Fig 56 – M4 G+12 Storey Drift EQY
Top Storey Drift EQY –0.000497
Bare Frame

Result: -For the G+12 bare frame model, the storey drift at the top storey is 0.000408 in the X-direction and 0.000497 in the Y-direction. The slightly higher drift in the Y-direction confirms that the building experiences more lateral sway along its width. Storey drift is a critical parameter to assess the building's seismic performance and overall stability.

12) Base Shear: -

EQX - 1058.905kn, EQY - 842.0706kn

Result: - The base shear for the G+12 bare frame model is 1058.905 kN in the X-direction and 842.071 kN in the Y-direction. The higher base shear in the X-direction indicates that the building resists greater lateral seismic forces along its length compared to its width. This result is useful for understanding seismic force distribution in bare frame structures and for comparing with models that include shear walls.

M5 – G+15 Bare Frame: -

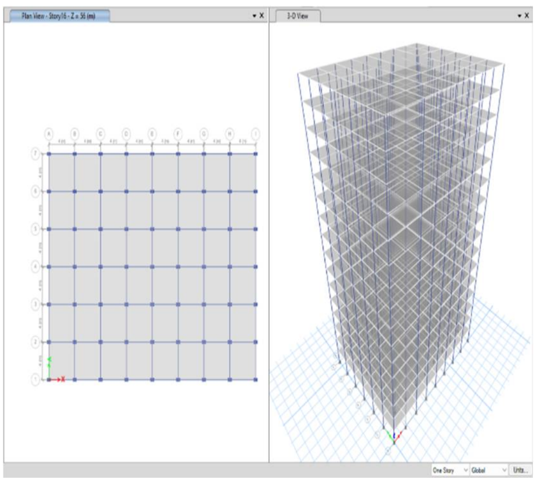


Fig 57 – M5 – G+15 Bare Frame – Display

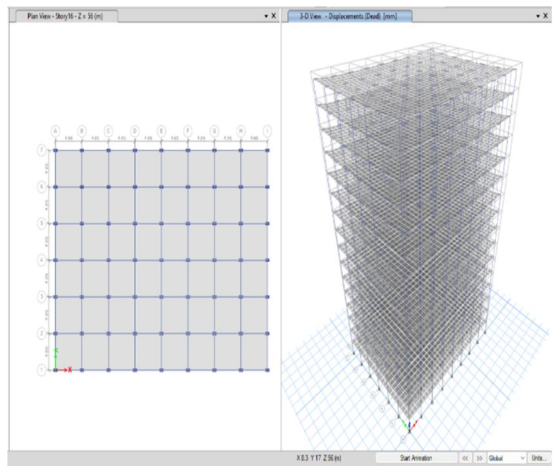


Fig 58 – M5 – G+15 Bare Frame - Run

13) Storey Displacement: -

M5 – G+15 – Bare Frame –

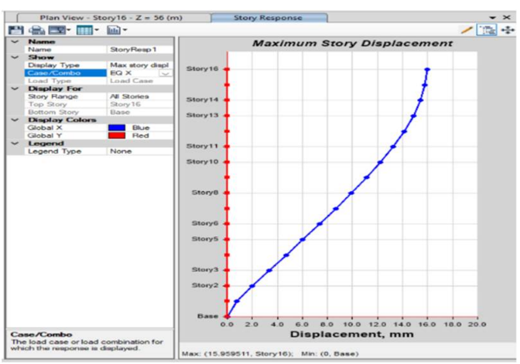


Fig 59 – M5 G+15 – Storey Displacement EQX
Tod Storey Dis EQX –15.95
Bare Frame

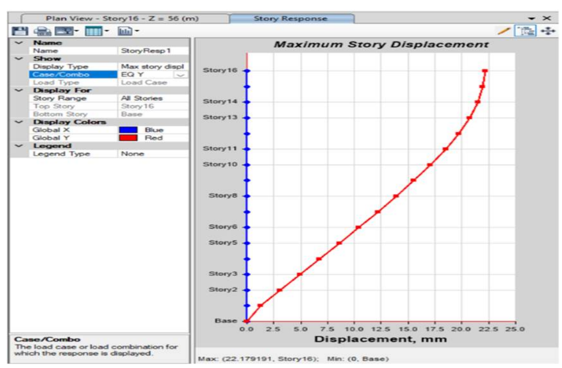
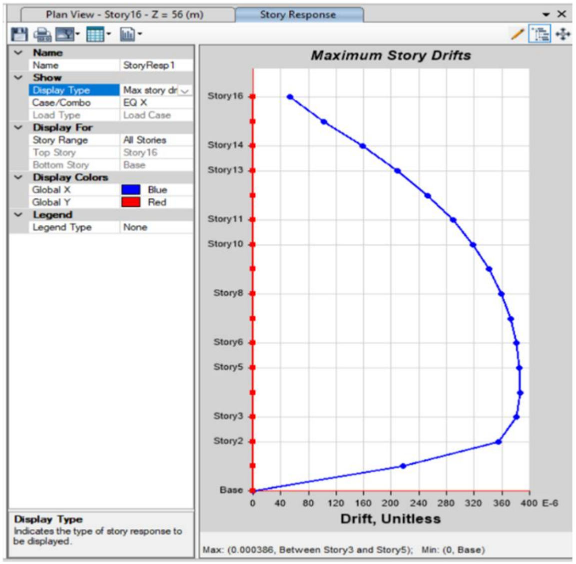


Fig – 60 – M5 G+15 Storey DisplacementEQY
Top Storey Dis EQY – 22.17
Bare Frame

Result: - In the G+15 bare frame model, the maximum storey displacement occurs at the top storey. The displacement in the X-direction is 15.95 mm, while in the Y-direction it is 22.17 mm under seismic loading. The higher displacement in the Y-direction indicates that the building sways more in the width-wise direction compared to the length-wise direction. These results help in evaluating the lateral flexibility of the structure and can be used for comparison with models having shear walls.

14) Storey Drift: -

M5 – G+15 Storey Drift-



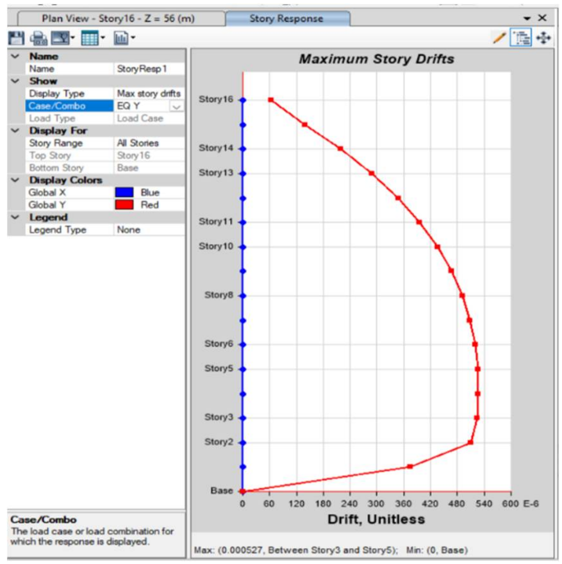


Fig 61 – M5 G+15 Storey Drift EQX
Top Storey Drift EQX –0.000386
Bare Frame

Fig 62 – M5 G+15 Storey Drift EQY
Top Storey Drift EQY –0.000527
Bare Frame

Result: -For the G+15 bare frame model, the storey drift at the top storey is 0.000386 in the X-direction and 0.000527 in the Y-direction. The slightly higher drift in the Y-direction indicates that the building experiences more lateral sway along its width. Storey drift is an important parameter used to evaluate the seismic performance and stability of the structure.

15) Base Shear: -

EQX - 989.4122kn, EQY - 881.7368kn

Result: - The base shear for the G+15 bare frame model is 989.41 kN in the X-direction and 881.74 kN in the Y-direction. The base shear value in the X-direction is slightly higher than in the Y-direction, indicating that the structure experiences greater seismic force along its length. This result helps in understanding the distribution of seismic forces in the structure.

B. Group – 2 Core Shear Wall: -

M6 – G+5 Core Shear Wall: -

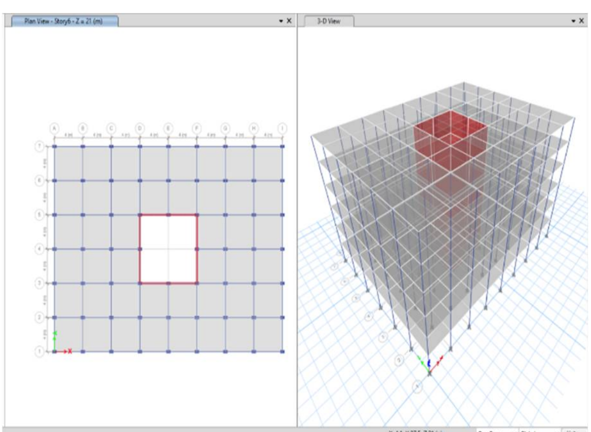


Fig 63 – M6 – G+5 Core Shear Wall Display

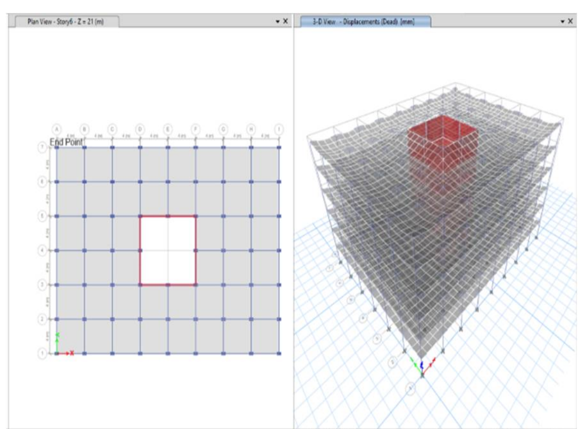


Fig 64 – M6 – G+5 Core Shear Wall – Run

1) Storey Displacement: -

M6 – G+5 Storey Displacement –

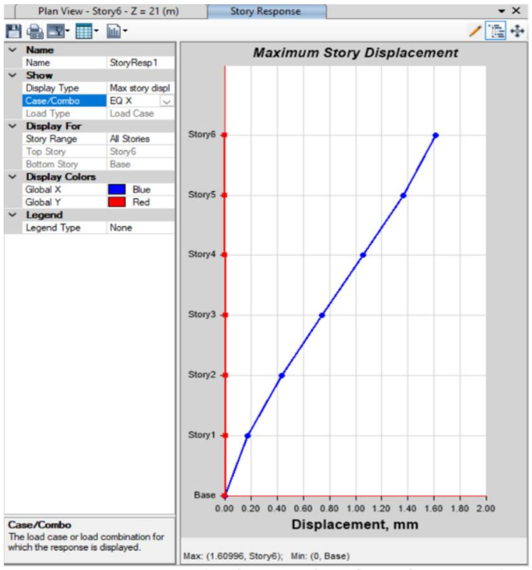


Fig 65 – M6 – G+5 Storey Dis EQX
Top Storey Dis EQX – 1.60
Core Shear Wall

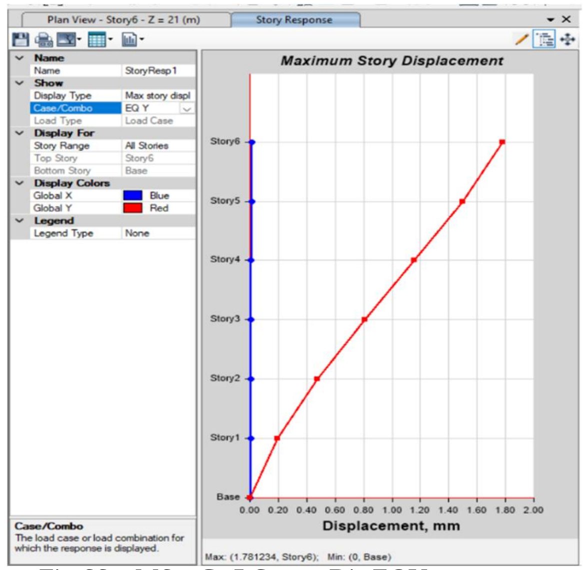


Fig 66 – M6 – G+5 Storey Dis EQY
Top Storey Dis EQY – 1.78
Core Shear Wall

Result: - In the M6 G+5 core shear wall model, the maximum storey displacement occurs at the top storey. The displacement in the X-direction is 1.60 mm, while in the Y-direction it is 1.78 mm under seismic loading. The displacement values are significantly lower compared to the bare frame model, indicating that the presence of the core shear wall increases the lateral stiffness of the structure and reduces the overall building sway.

2) Storey Drift: -

M6 – G+5 Core Shear Wall –

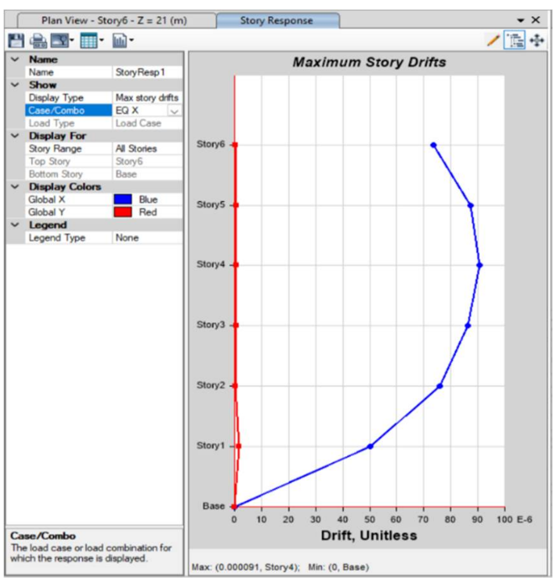


Fig 67 – M6- G+5Storey Drift EQX
Top Storey Drift EQX – 0.000091
Core Shear Wall

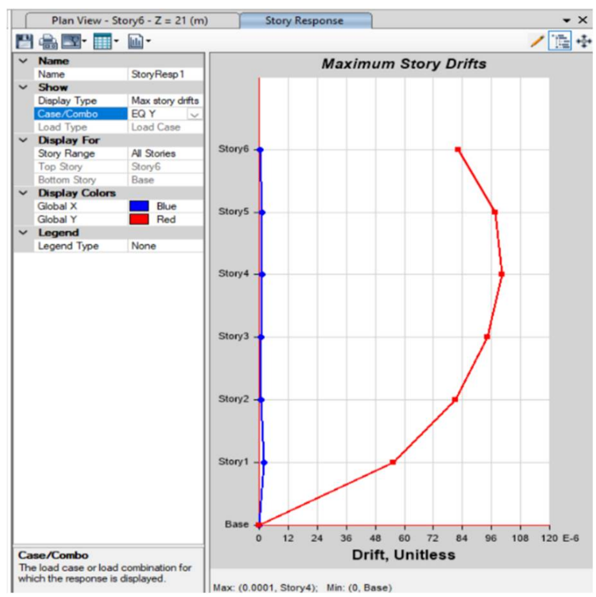


Fig 68 – M6 – G+5 Storey Drift EQY
Top Storey Drift EQY – 0.0001
Core Shear Wall

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Result: - For the M6 G+5 core shear wall model, the storey drift at the top storey is 0.000091 in the X-direction and 0.0001 in the Y-direction. The drift values are very small, indicating improved structural stability. The slightly higher drift in the Y-direction shows that the building experiences marginally more sway along its width.

3) Base Shear: -

EQX - 1278.7114kn, EQY - 1278.7114kn

Result: - The base shear for the M6 G+5 core shear wall model is 1278.71 kN in both the X and Y directions under seismic loading. The equal base shear values in both directions indicate a symmetrical structural response due to the centrally placed core shear wall. The higher base shear compared to the bare frame model shows that the structure with shear walls attracts more seismic forces due to its increased stiffness.

M7 – G+8 Core Shear Wall: -

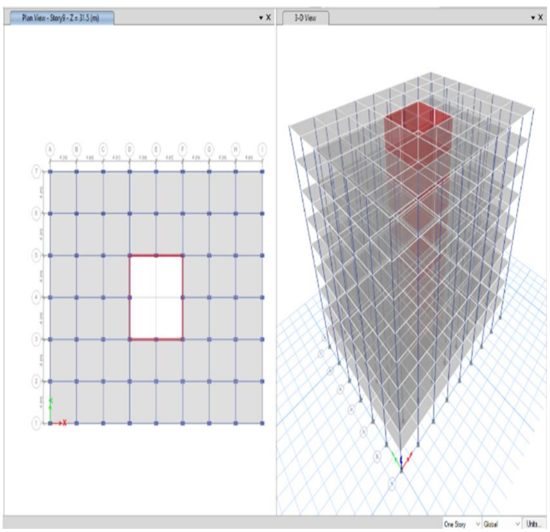


Fig 69 – M7 – G+8 Core Shear Wall Display

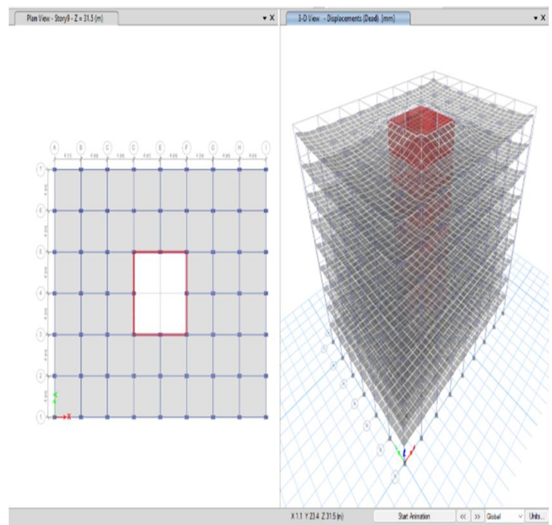


Fig 70- M7 – G+8 Core Shear Wall Run

4) Storey Displacement: -

M7 – G+8 Core Shear Wall –

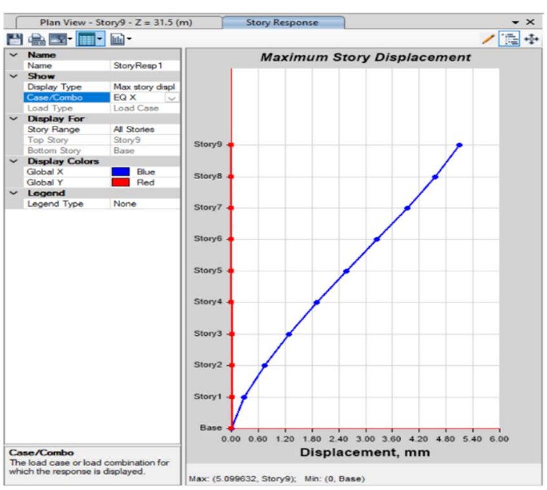


Fig 71 – M7 – G+8 Storey Dis EQX
Top Storey Dis EQX – 5.09
Core Shear Wall

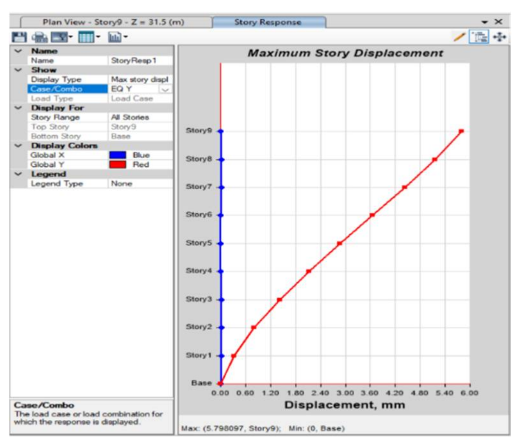


Fig 72 – M7 – G+8 Story Dis EQY
Top Storey Dis EQY – 5.79
Core Shear Wall

Result: - In the M7 G+8 core shear wall model, the maximum storey displacement occurs at the top storey. The displacement in the X-direction is 5.09 mm, while in the Y-direction it is 5.79 mm under seismic loading. The displacement in the Y-direction is slightly higher than in the X-direction, indicating marginally greater lateral sway along the width of the building. However, the presence of the core shear wall significantly reduces the overall displacement compared to the bare frame model.

5) Storey Drift: -

M7 – G+8 Core Shear Wall –

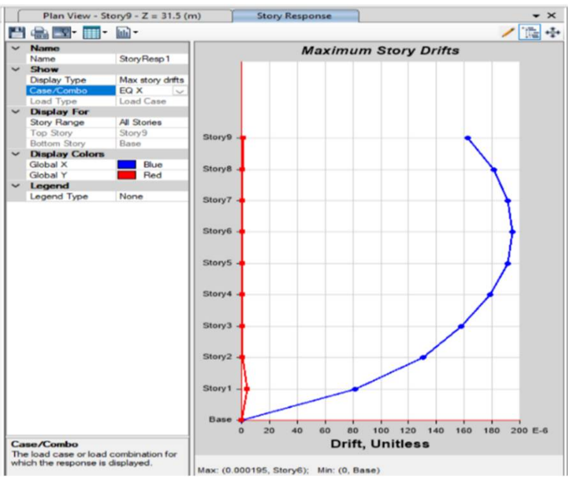


Fig 73 – M7 – G+8 Storey Drift EQX
Top Storey Drift EQX – 0.000195
Core Shear Wall

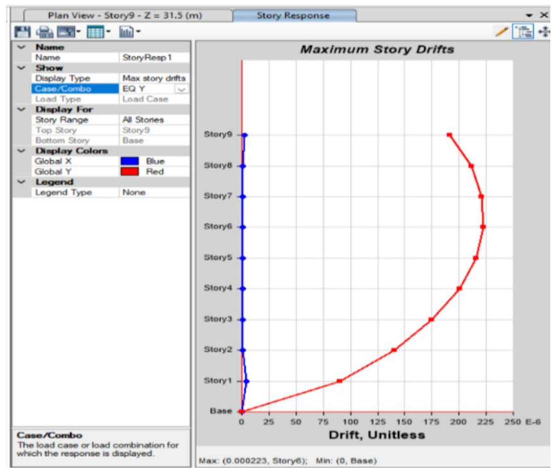


Fig 74 – M7 – G+8 Storey Drift EQY
Top Storey Drift EQY – 0.000223
Core Shear Wall

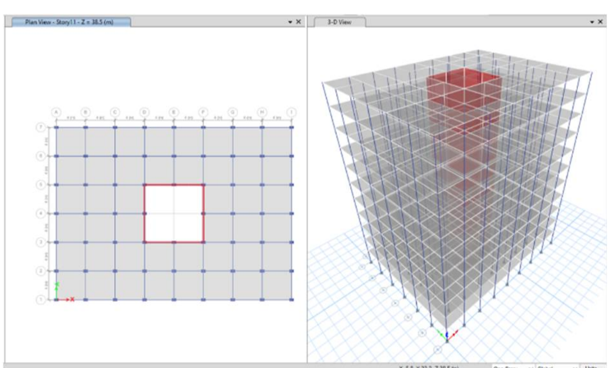
Result: - For the M7 G+8 core shear wall model, the storey drift at the top storey is 0.000195 in the X-direction and 0.000223 in the Y-direction. The drift values are relatively small, indicating improved lateral stability of the structure. The slightly higher drift in the Y-direction shows that the building experiences marginally more sway width-wise.

6) Base Shear: -

EQX - 1933.655kn, EQY - 1933.655kn

Result: - The base shear for the M7 G+8 core shear wall model is 1933.66 kN in both the X and Y directions under seismic loading. The equal base shear values in both directions indicate symmetrical structural behavior due to the centrally located core shear wall. The higher base shear value reflects increased stiffness of the structure, which attracts greater seismic forces.

M8 – G+10 Core Shear Wall: -



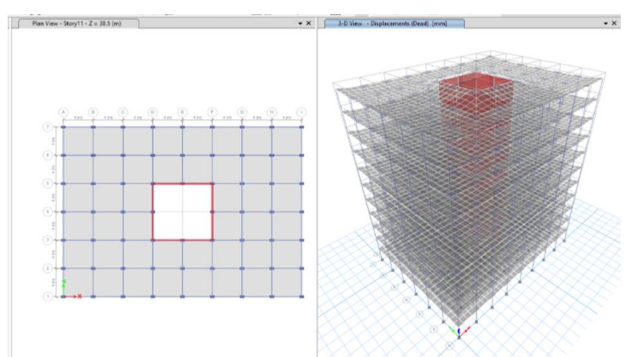


Fig 75 – M8 – G+10 Core Shear Wall Display Fig 76 – M8 – G+10 Core Shear Wall Run

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7) Storey Displacement: -

M8 – G+10 Core Shear Wall –

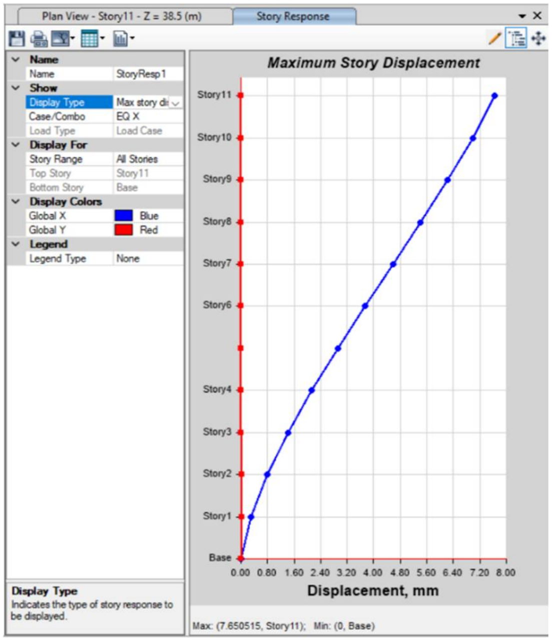

Fig 77 – M8 – G+10 Storey Dis EQX
Top Storey Dis EQX – 7.65
Core Shear Wall

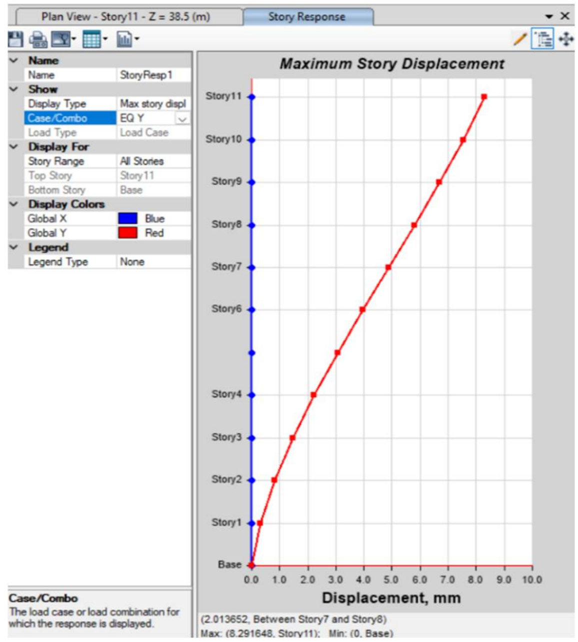

Fig 78 – M8 – G+10 Storey Dis EQY
Top Storey Dis EQY – 8.29
Core Shear Wall

Result: - The maximum storey displacement for the G+10 core shear wall structure is 7.65 mm in the EQX direction and 8.29 mm in the EQY direction. The displacement is slightly higher in the EQY direction due to the structural response in that direction.

8) Storey Drift: -

M8 – G+10 – Core Storey Wall –

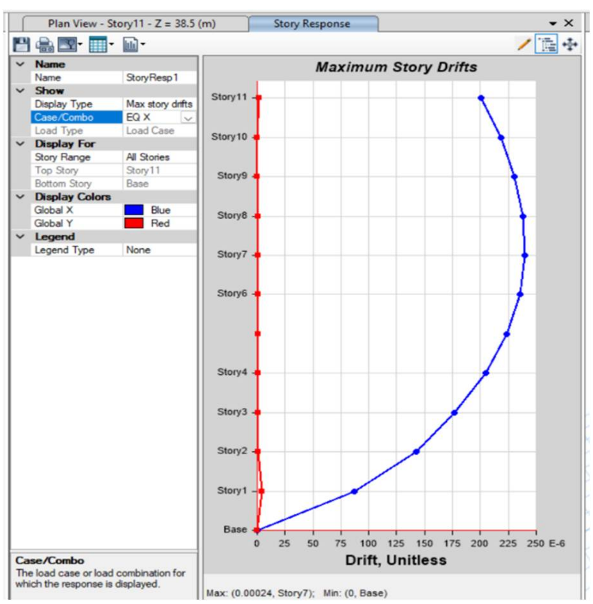

Fig 79 – M8 – G+10 – Storey Drift EQX
Top Storey Drift EQX – 0.00024
Core Storey Drift

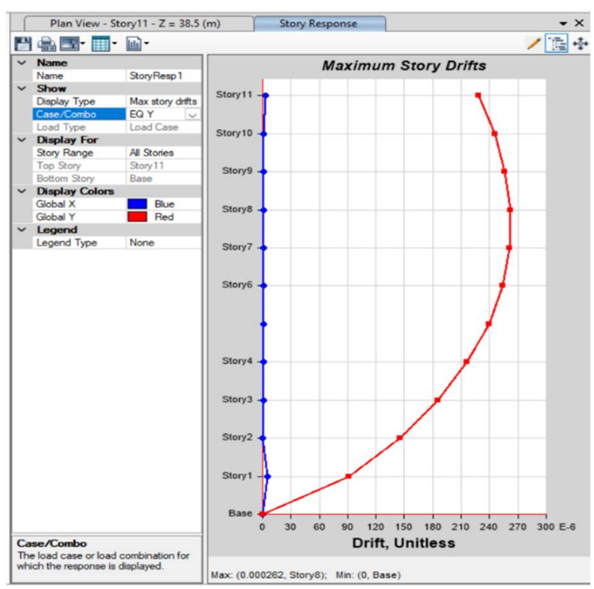

Fig 80 – M8 – G+10 – Storey Drift EQY
Top Storey Drift EQY – 0.000262
Core Storey Drift

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Result: - The maximum storey drift values are 0.00024 in the EQX direction and 0.000262 in the EQY direction. These values are well within the permissible limit of 0.004 as per IS 1893, indicating that the structure satisfies the drift criteria and is considered safe.

9) Base Shear: -

EQX - 2007.6792kn, EQY - 1875.5221kn

Result: - The base shear for the structure is 2007.6792 kN in the EQX direction and 1875.5221 kN in the EQY direction. The presence of a core shear wall increases the stiffness of the building, which helps the structure effectively resist seismic forces.

M9 – G+12 – Core Shear Wall: -

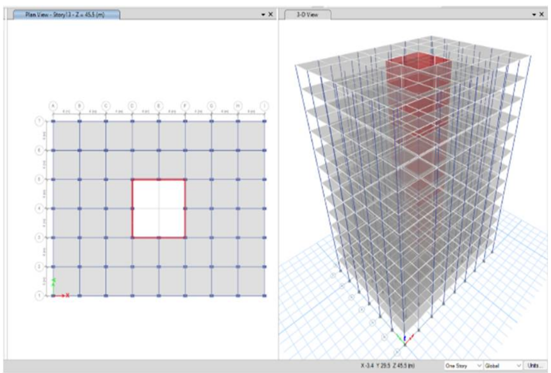


Fig 81 – M9 – G+12 Core Shear Wall Display

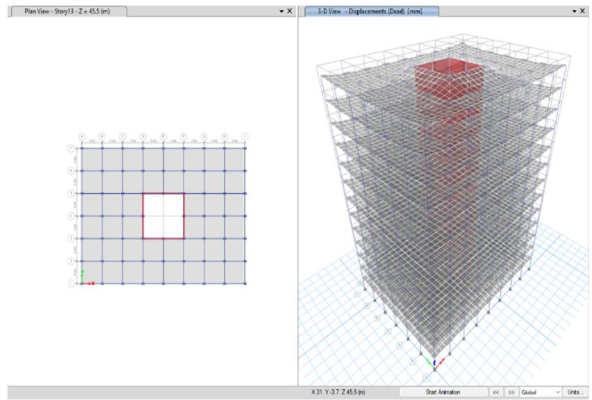


Fig 82 – M9 – G+12 Core Shear Wall Run

10) Storey Displacement: -

M9 – G+12 – Core Shear Wall –

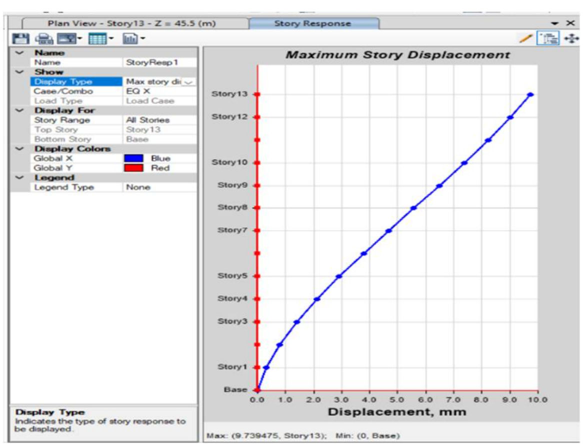


Fig 83 M9 – G+12 –Storey Dis EQX
Top Storey Dis EQX – 9.73
Core Shear Wall

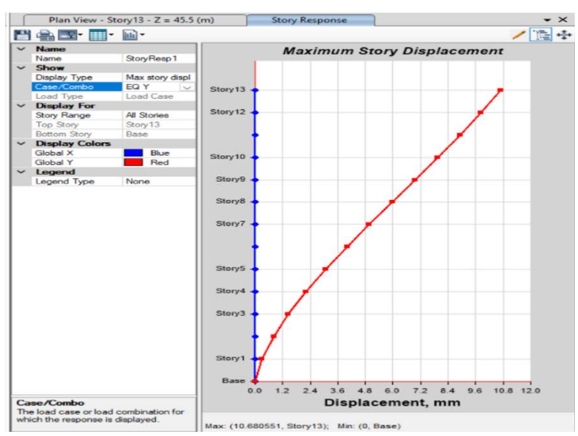


Fig 84 M9 – G+12 – Storey Drift EQY
Top Storey Dis EQY – 10.68
Core Shear Wal

Result: - For the G+12 core shear wall structure, the maximum storey displacement occurs at the top storey. The displacement is 9.73 mm in the EQX direction and 10.68 mm in the EQY direction under seismic loading. The displacement in the Y-direction is slightly higher than in the X-direction, indicating comparatively greater lateral movement along the width of the building. However, the presence of the core shear wall improves the lateral stiffness of the structure, which helps in controlling the overall displacement.

11) Storey Drift: -

M9 – G+12 Core Shear Wall –

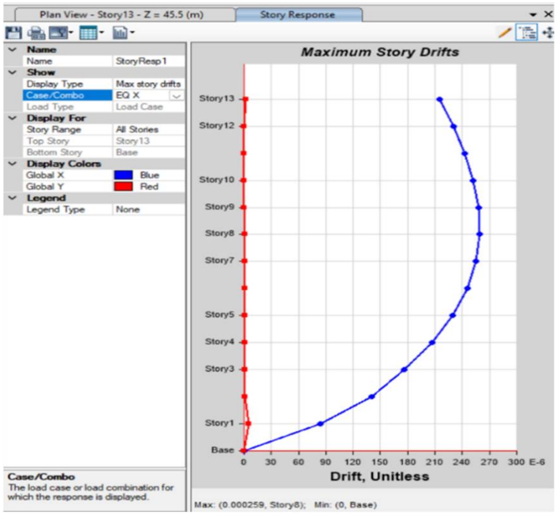


Fig 85 - M9 – G+12 Storey Drift EQX
Top Storey Drift EQX – 0.000259
Core Shear Wall

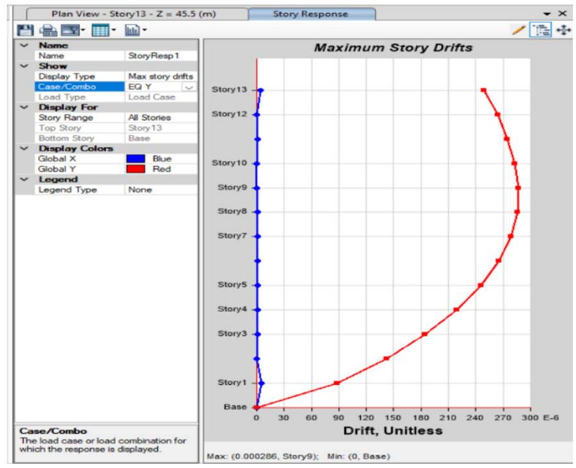


Fig 86 – M9 – G+12 Storey Drift EQY
Top Storey Drift EQY – 0.000286
Core Shear Wall

Results: -For the G+12 core shear wall structure, the maximum storey drift is 0.000259 in the EQX direction and 0.000286 in the EQY direction under seismic loading. The drift value in the Y-direction is slightly higher than in the X-direction, indicating comparatively greater lateral sway in that direction.

However, both values are well within the permissible limit of 0.004 as per IS 1893, which confirms that the structure satisfies the drift criteria and remains stable under seismic forces.

12) Base Shear: -

EQX - 1893.5726kn, EQY - 1752.6791kn

Result: - The base shear for the structure is 1893.57 kN in the EQX direction and 1752.68 kN in the EQY direction under seismic loading. The higher base shear in the X-direction indicates that the structure experiences greater lateral seismic force along that direction. The presence of the core shear wall increases the stiffness of the structure, enabling it to effectively resist seismic forces.

M10 – G+15 Core Shear Wall: -

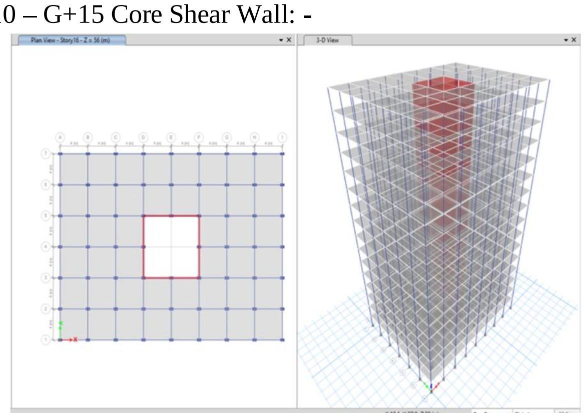


Fig 87– M10 – G+15Core Shear Wall

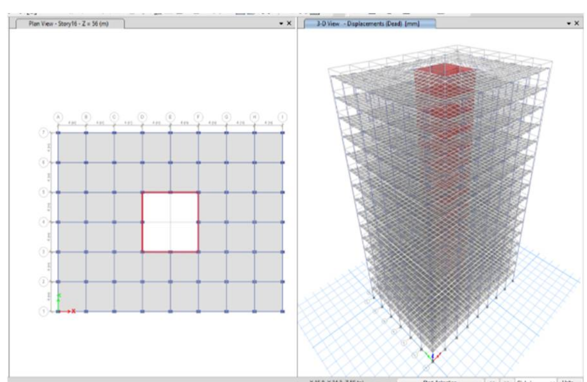


Fig 88 – M10 – G+15Core Shear Wall Display Run

Storey Displacement: -

M9 – G+12 Core Shear Wall –

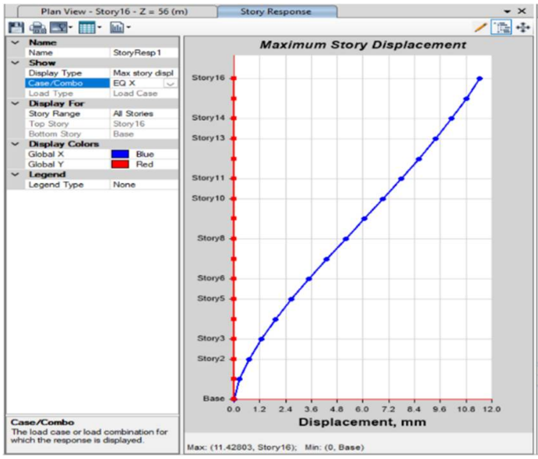


Fig 89– M10 – G+15 Storey Dis EQX
Top Storey Dis EQX – 11.42
Core Shear Wall

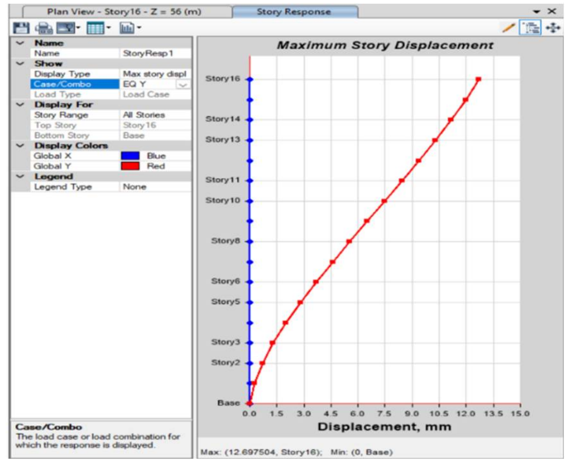


Fig 90 – M10 – G+15 Storey Dis EQY
Top Storey Dis EQY – 12.69
Core Shear Wall

Result: - For the G+15 core shear wall structure, the maximum storey displacement occurs at the top storey. The displacement obtained is 11.42 mm in the EQX direction and 12.69 mm in the EQY direction under seismic loading. The displacement in the Y-direction is slightly higher than in the X-direction, indicating comparatively greater lateral movement in that direction.

13) Storey Drift: -

M10 – G+15 Core Shear Wall –

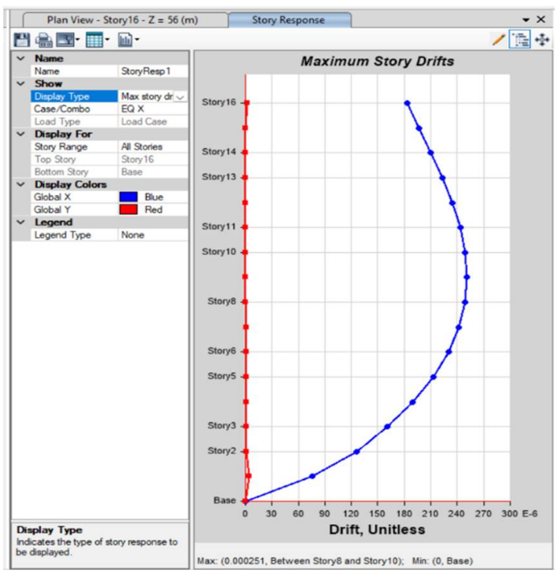


Fig 91– M10 – G+15 Storey Drift EQX
Top Storey Drift EQX – 0.000251
Core Shear Wall

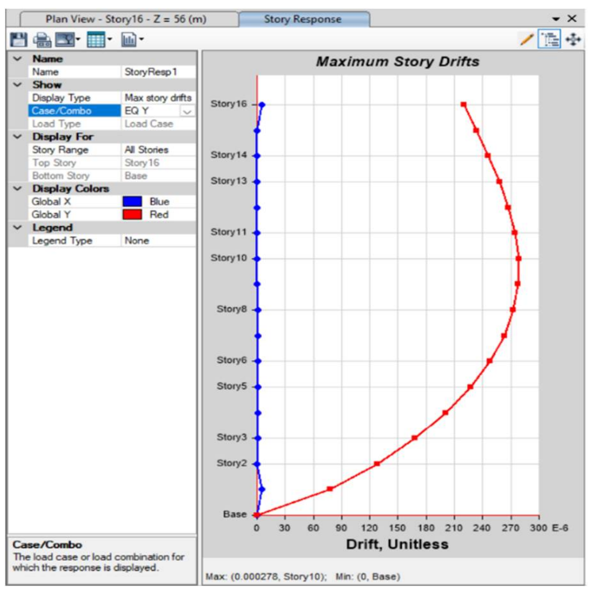


Fig 92 – M10 – G+15 Storey Drift EQY
Top Storey Drift EQY – 0.000278
Core Shear Wall

Result: - The maximum storey drift is 0.000251 in the EQX direction and 0.000278 in the EQY direction. The drift value in the Y-direction is slightly higher, indicating relatively greater lateral sway. However, both values are within the permissible limit of 0.004 as per IS 1893, confirming that the structure satisfies the drift criteria.

14) Base Shear: -

EQX - 1666.4949kn, EQY - 1523.7872kn

Result: - The base shear for the structure is 1666.49 kN in the EQX direction and 1523.79 kN in the EQY direction under seismic loading. The higher base shear in the X-direction indicates that the building experiences greater seismic force along that direction. The presence of the core shear wall enhances the stiffness of the structure, allowing it to effectively resist seismic loads.

C. Group – 3 Corner Shear Wall: -

M11 – G+5 Corner Shear Wall: -

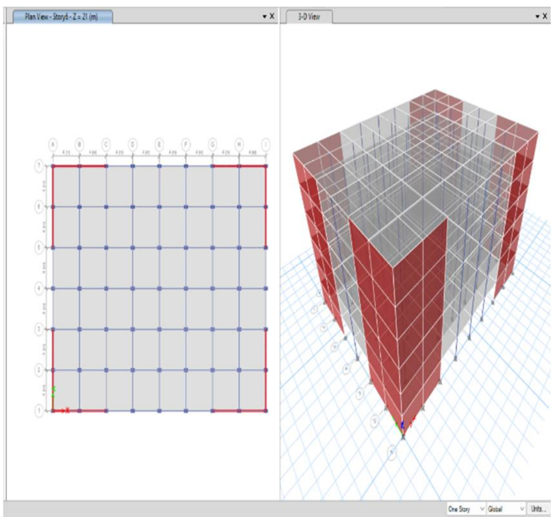


Fig 93– M11 – G+5Corner Shear Display

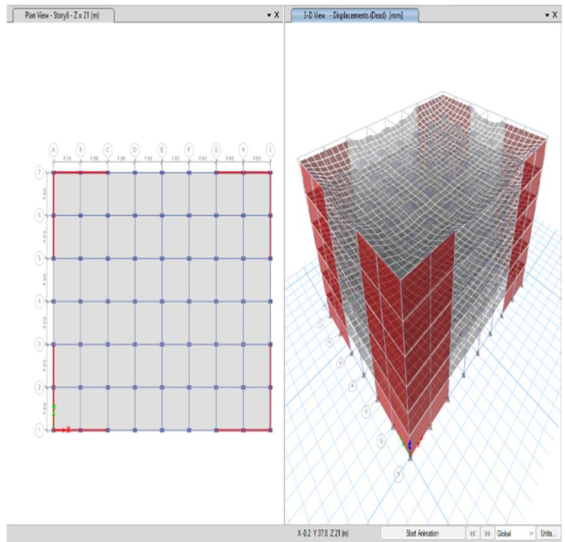


Fig 94 – M11 – G+5Corner Shear Wall Run

1) Storey Displacement: -

M11 – G+5 Corner Shear Wall –

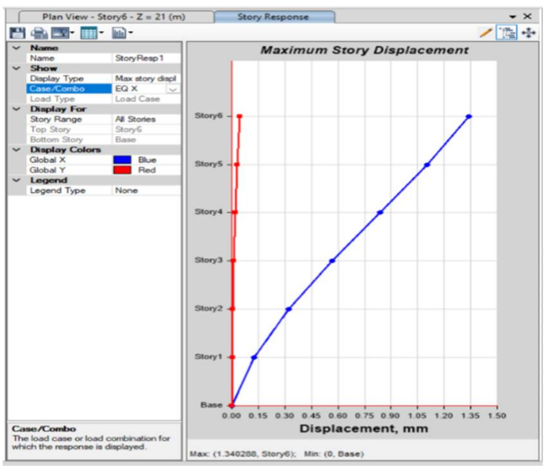


Fig 95– M11 – G+5 Storey Dis EQX
Top Storey Dis EQX – 1.34
Corner Shear Wall

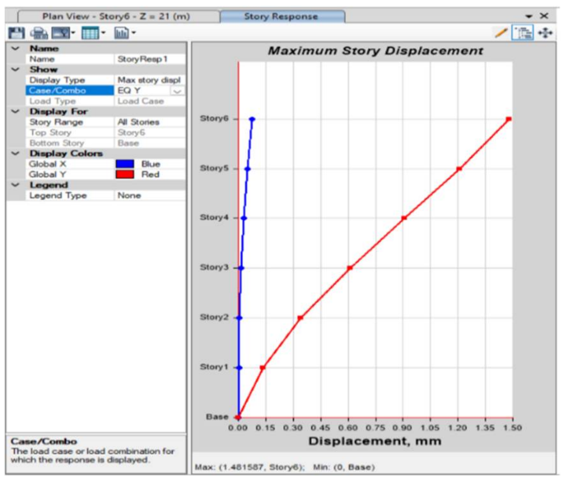
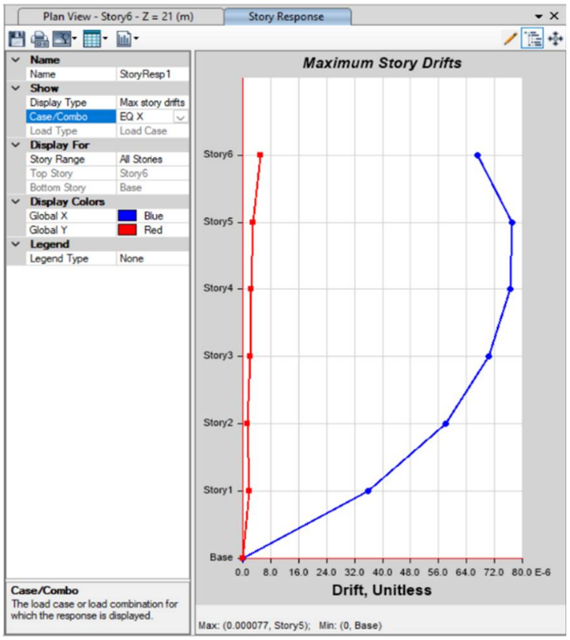


Fig 96 – M11 – G+5 Storey Dis EQY
Top Storey Drift EQY – 1.48
Corner Shear Wall

Result: - For the G+5 corner shear wall structure, the maximum storey displacement occurs at the top storey. The displacement obtained is 1.34 mm in the EQX direction and 1.48 mm in the EQY direction under seismic loading. The displacement in the Y-direction is slightly higher than in the X-direction, indicating comparatively greater lateral movement in that direction. However, the displacement values are very low due to the presence of corner shear walls which increase the lateral stiffness of the structure.

2) Storey Drift: -

M11 – G+5 Corner Shear Wall –



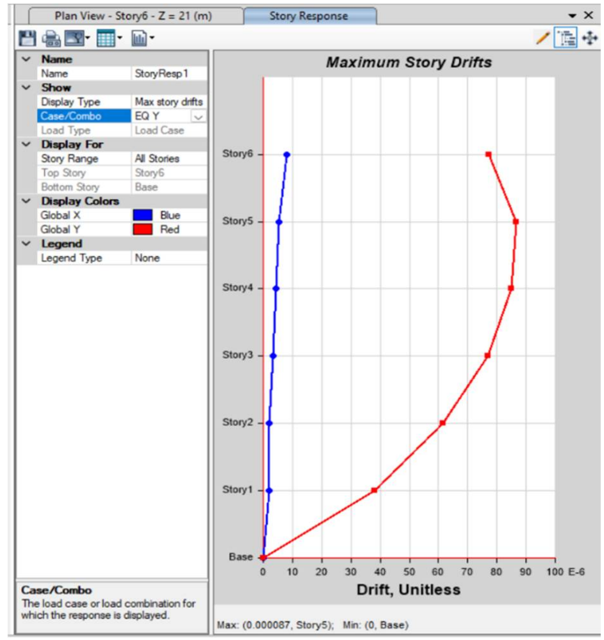


Fig 97– M11 – G+5 Storey Drift EQX
Top Storey Dis EQX– 0.000077
Corner Shear Wall

Fig 98 – M11 – G+5 Storey Drift EQY
Top Storey Drift EQY – 0.000087Top
Corner Shear Wall

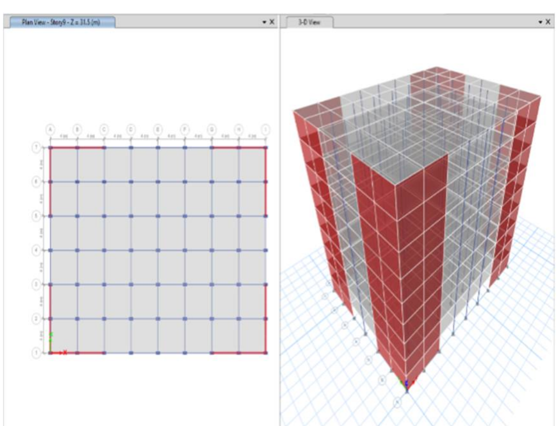
Result: - The maximum storey drift at the top storey is 0.000077 in the EQX direction and 0.000087 in the EQY direction. These drift values are much lower than the permissible limit of 0.004 as per IS 1893, indicating that the structure satisfies the drift criteria and performs well under seismic loading.

3) Base Shear: -

EQX - 1444.1261kn, EQY - 1444.1261kn

Result: -The base shear for the structure is 1444.1261 kN in both EQX and EQY directions. The equal base shear in both directions indicates a symmetrical structural response due to the placement of shear walls at the building corners, which helps the structure effectively resist seismic forces.

M12 – G+8 Corner Shear Wall –



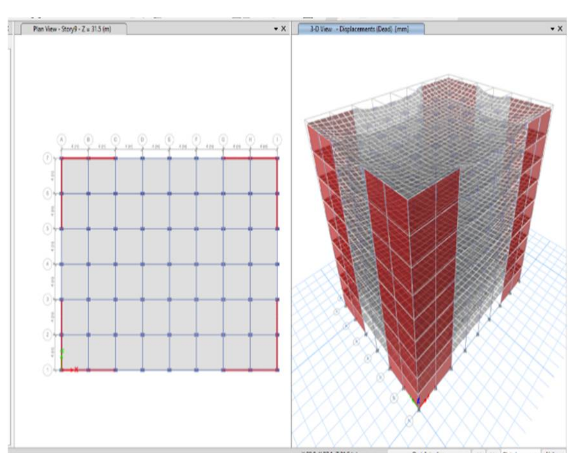


Fig 99– M12 – G+8Corner Shear Wall Display

Fig 100 M12 – G+5Corner Shear Wall Run

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4) Storey Displacement: -

M12 – G+8 Corner Shear Wall –

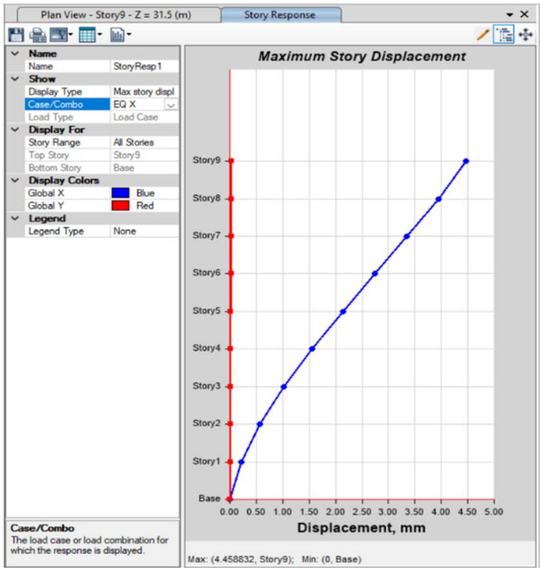

Fig 101 – M12 – G+8 Storey Dis EQX
Top Storey Dis EQX – 4.45
Corner Shear Wall

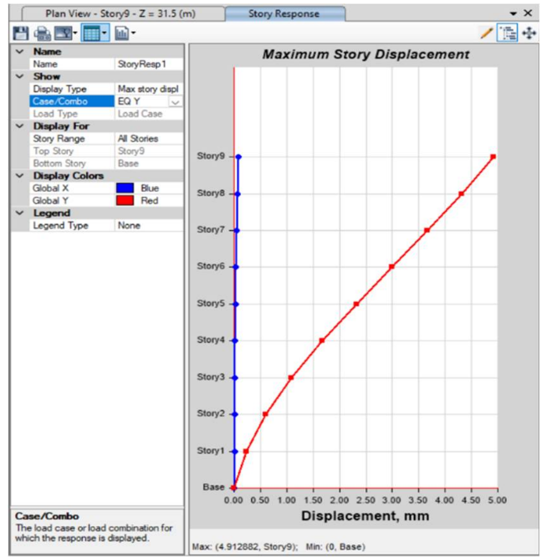

Fig 102 – M12 – G+8 Storey Dis EQY
Top Storey Dis EQY – 4.91
Corner Shear Wall

Result: -For the G+8 corner shear wall structure, the maximum storey displacement occurs at the top storey. The displacement obtained is 4.45 mm in the EQX direction and 4.91 mm in the EQY direction under seismic loading. The displacement in the Y-direction is slightly higher than in the X-direction, indicating comparatively greater lateral movement in that direction.

5) Storey Drift: -

M12 – G+8 Corner Shear Wall –

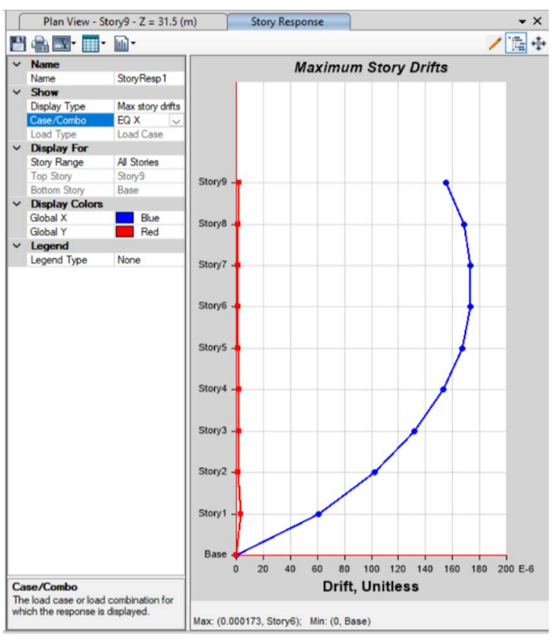

Fig 103 – M12 – G+8 Storey Drift EQX
Top Storey Drift EQX – 0.000173
Corner Shear Wall

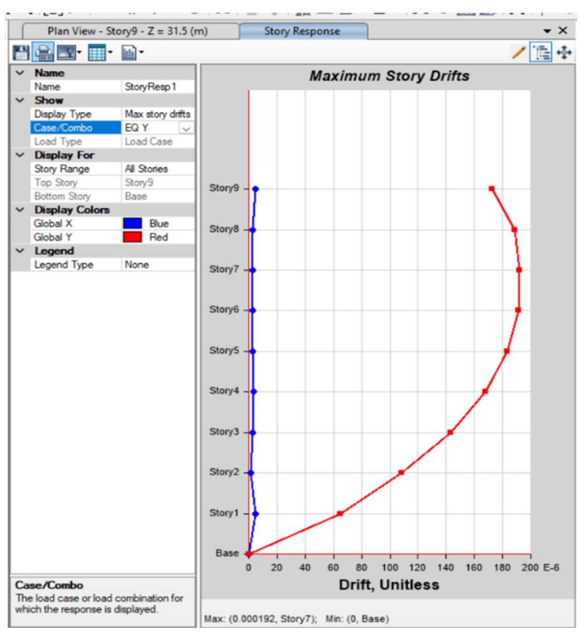

Fig 104 – M12 – G+8 Storey Drift EQY
Top Storey Drift EQY – 0.000192
Corner Shear Wall

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Result: - The maximum storey drift at the top storey is 0.000173 in the EQX direction and 0.000192 in the EQY direction. These values are well within the permissible limit of 0.004 as per IS 1893, indicating that the structure satisfies the drift criteria and remains stable under seismic loading.

6) Base Shear: -

EQX - 2186.1595kn, EQY - 2186.1595kn

Result: -The base shear for the structure is 2186.1595 kN in both EQX and EQY directions. The equal base shear values indicate a symmetrical seismic response of the structure due to the placement of shear walls at the building corners, which helps the building effectively resist seismic forces.

M13 – G+10 Corner Shear Wall –

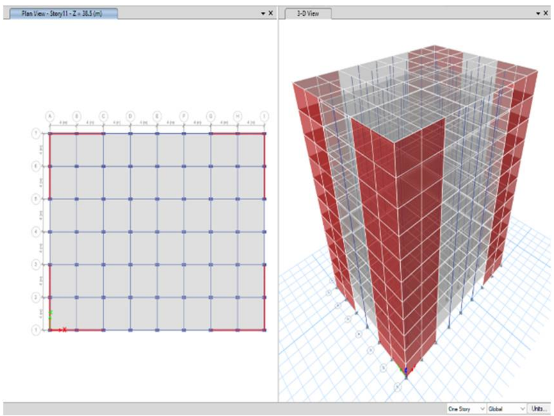

Fig 105 – M13 – G+10Corner Shear Wall Display

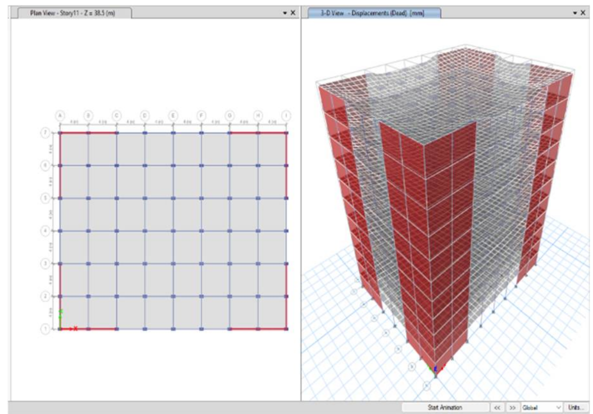

Fig 106 – M13 – G+10Corner Shear Wall Run

7) Storey Displacement: -

M13 – G+10 Corner Shear Wall –

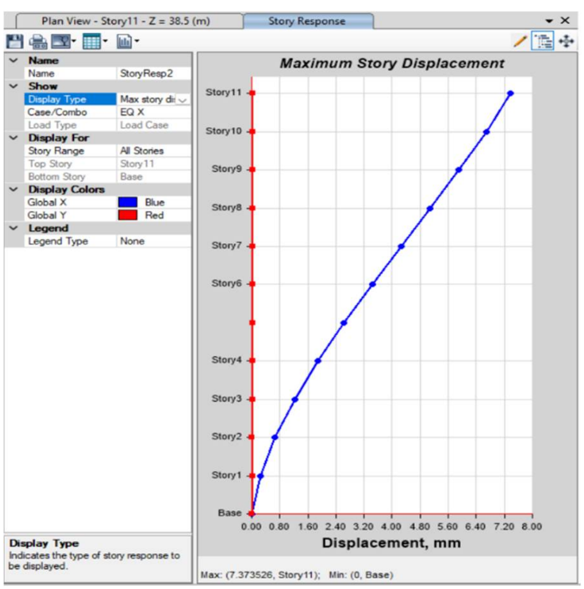

Fig 107 – M13 – G+10 Storey Dis EQX
Top Storey Dis EQX – 7.37
Corner Shear Wall

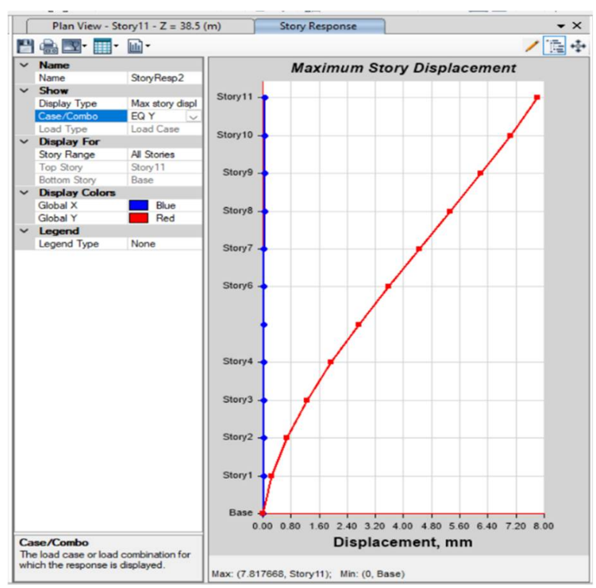

Fig 108 – M13 – G+10 Storey Dis EQY
Top Storey Dis EQY – 7.81
Corner Shear Wall

Result: -For the G+10 corner shear wall structure, the maximum storey displacement occurs at the top storey. The displacement obtained is 7.37 mm in the EQX direction and 7.81 mm in the EQY direction under seismic loading. The displacement in the Y-direction is slightly higher than in the X-direction, indicating comparatively greater lateral movement in that direction.

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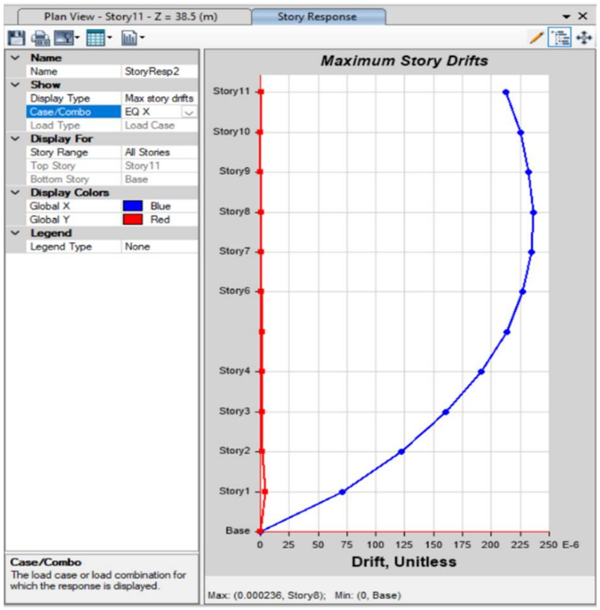
8) Storey Drift: -

M13 – G+10 Corner Shear Wall -



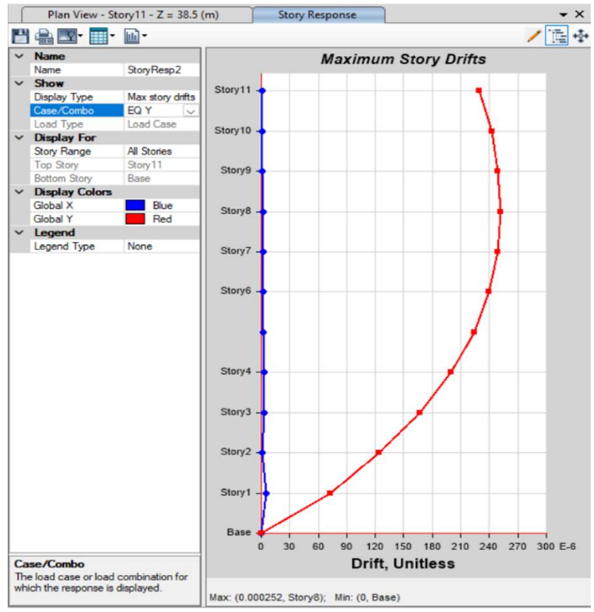


Fig 109 – M13 – G+10 Storey Drist EQX
Top Storey Drift EQX – 0.000236
Corner Shear Wall

Fig 110 – M13 – G+10 Storey Drift EQY
Top Storey Drift EQY – 0.000252
Corner Shear Wall

Result: -The maximum storey drift at the top storey is 0.000236 in the EQX direction and 0.000252 in the EQY direction. These values are well within the permissible limit of 0.004 as per IS 1893, indicating that the structure satisfies the drift criteria and remains stable under seismic loading.

9) Base Shear: -

EQX - 2422.7299kn, EQY - 2309.865kn

Result: -The base shear for the structure is 2422.73 kN in the EQX direction and 2309.87 kN in the EQY direction under seismic loading. The higher base shear in the X-direction indicates that the structure experiences comparatively greater seismic force along that direction. The placement of shear walls at the corners improves the overall stiffness and seismic resistance of the building.

M14 – G+12 Corner Shear Wall: -

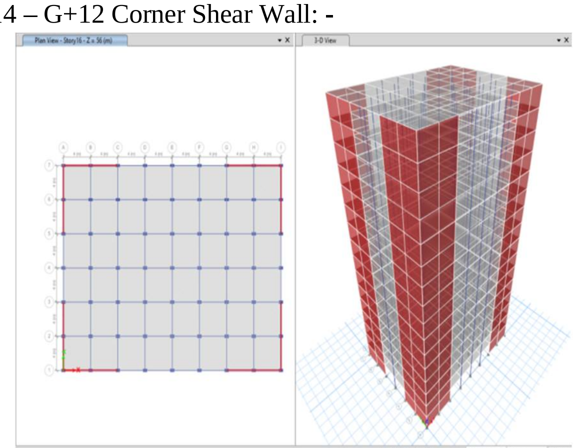


Fig 111 – M14 – G+12 Corner Shear Wall Display

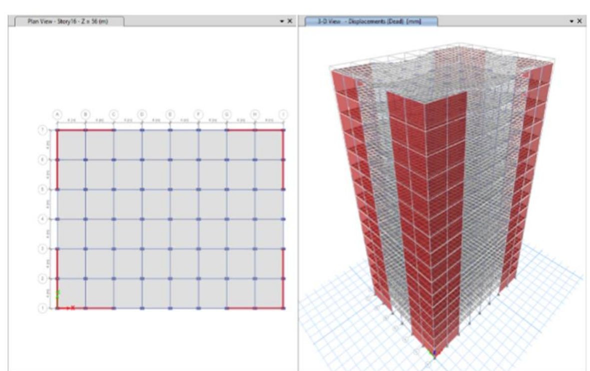


Fig 112 – M14 – G+12 Corner Shear Run

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10) Storey Displacement: -

M14 – G+12 Corner Shear Wall: -

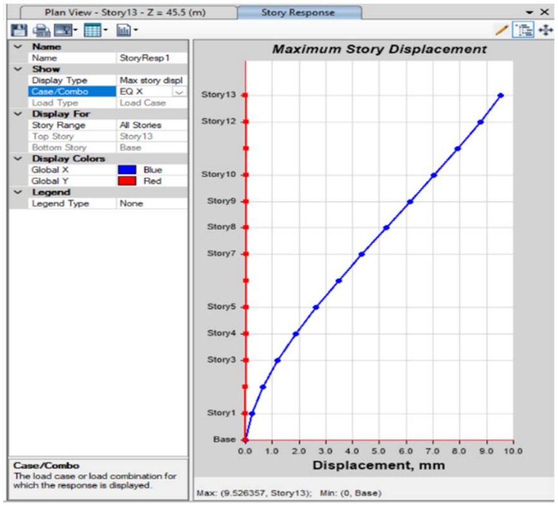

Fig 113 – M14 – G+12 Storey Dis EQX
Top Storey Dis EQX – 9.52
Corner Shear Wall

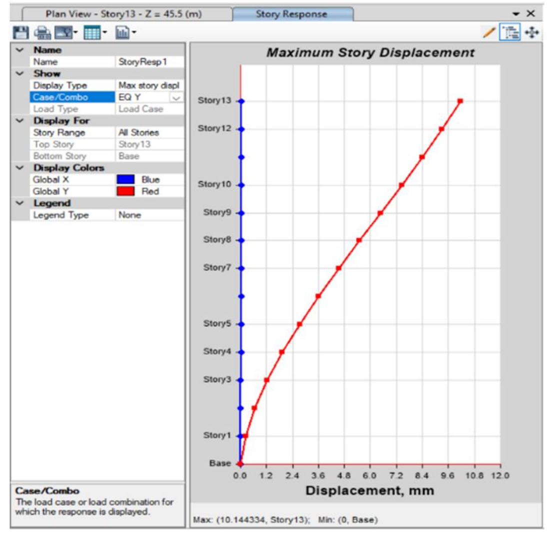

Fig 114 – M14 – G+12 Storey Drift EQY
Top Storey Drift EQY – 10.14
Corner Shear Wall

Result: - For the G+12 corner shear wall structure, the maximum storey displacement occurs at the top storey. The displacement obtained is 9.52 mm in the EQX direction and 10.14 mm in the EQY direction under seismic loading. The displacement in the Y-direction is slightly higher than in the X-direction, indicating comparatively greater lateral movement in that direction.

11) Storey Drift: -

M14 – G+12 Corner Shear Wall: -

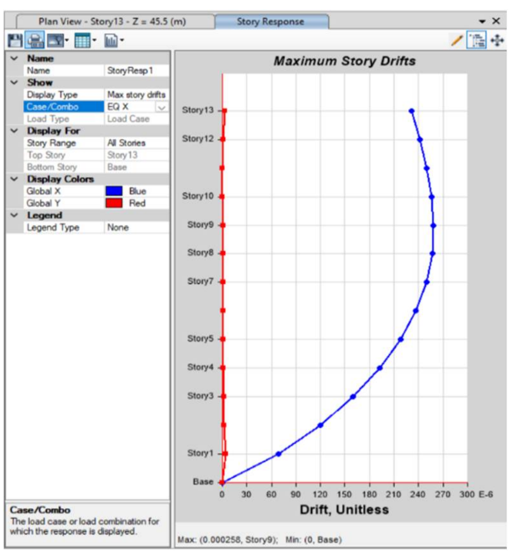

Fig 115 – M14 – G+12 Storey Drift EQX
Top Storey Drift EQX – 0.000258
Corner Shear Wall

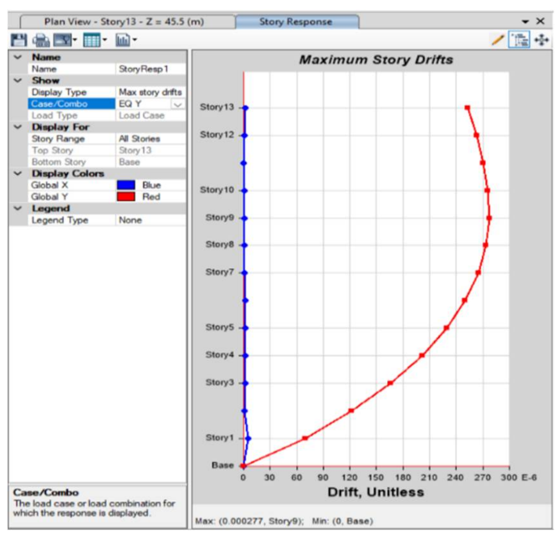

Fig 116 – M14 – G+12 Storey Drift EQY
Top Storey Drift EQY – 0.000277
Corner Shear Wall

Result: - The maximum storey drift is 0.000258 in the EQX direction and 0.000277 in the EQY direction. The drift value in the Y-direction is slightly higher compared to the X-direction. However, both values are within the permissible limit of 0.004 as per IS 1893, indicating that the structure satisfies the drift criteria and remains safe under seismic loading.

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12) Base Shear: **-**

EQX **-** 2251.3885kn, EQY **-** 2134.1481kn

Result: **-** The base shear for the structure is 2251.39 kN in the EQX direction and 2134.15 kN in the EQY direction under seismic loading. The higher base shear in the X-direction indicates that the building experiences comparatively greater seismic force along that direction. The presence of corner shear walls increases the lateral stiffness of the structure, helping it resists seismic forces effectively.

M15 – G+15 Corner Shear Wall: **-**

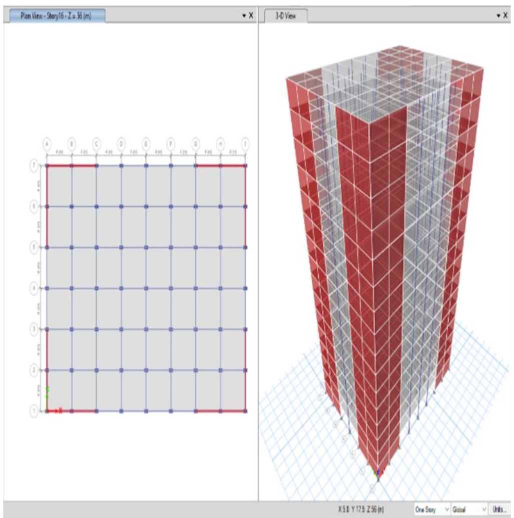


Fig 117 – M15 – G+15Corner Shear Wall Display

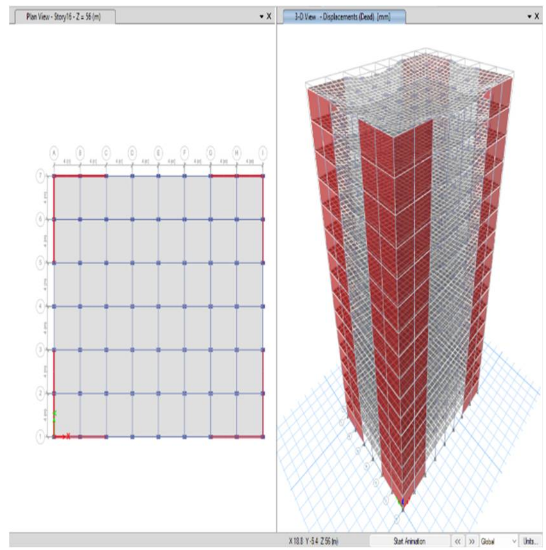


Fig 118 – M14 – G+12Corner Shear WallRun

13) Storey Displacement: **-**

M5 – G+15 Corner Shear Wall –

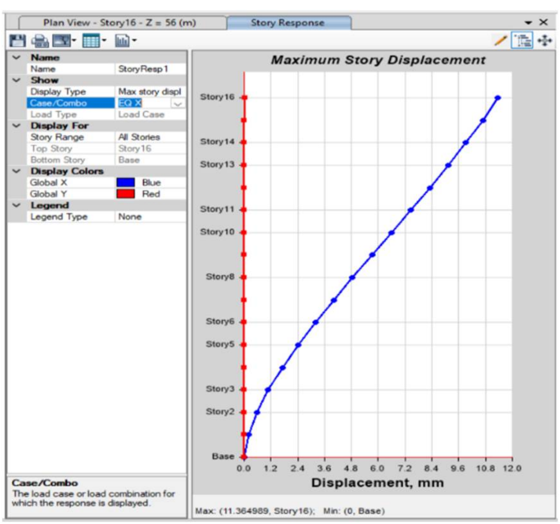


Fig 119 – M15 – G+15 Storey Dis EQX
Top Storey Dis EQX – 11.36
Corner Shear Wall

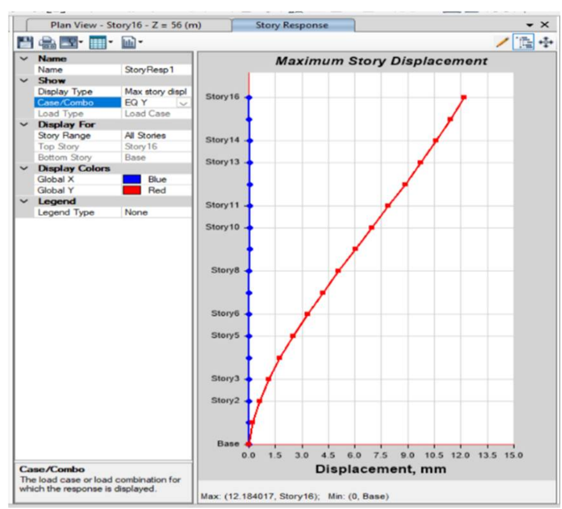
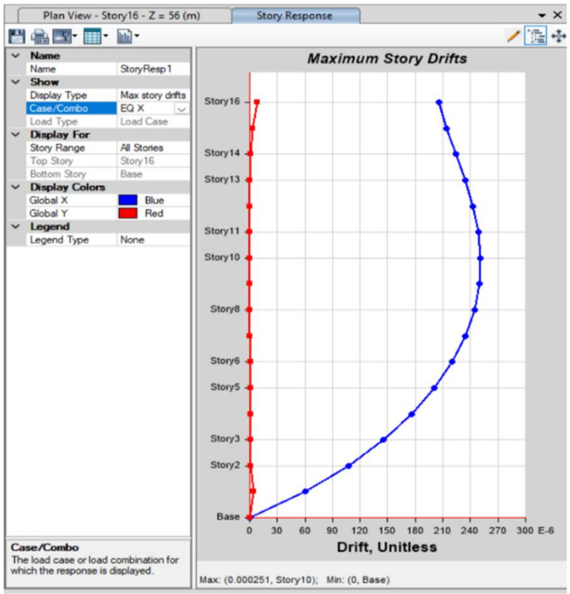


Fig 120 – M15 – G+15 Storey Dis EQY
Top Storey Dis EQY – 12.18
Corner Shear Wall

Result: **-** For the G+15 corner shear wall structure, the maximum storey displacement occurs at the top storey. The displacement obtained is 11.36 mm in the EQX direction and 12.18 mm in the EQY direction under seismic loading. The displacement in the Y-direction is slightly higher than in the X-direction, indicating comparatively greater lateral movement in that direction.

14) Storey Drift: -

M15 – G+15 Corner Shear Wall –



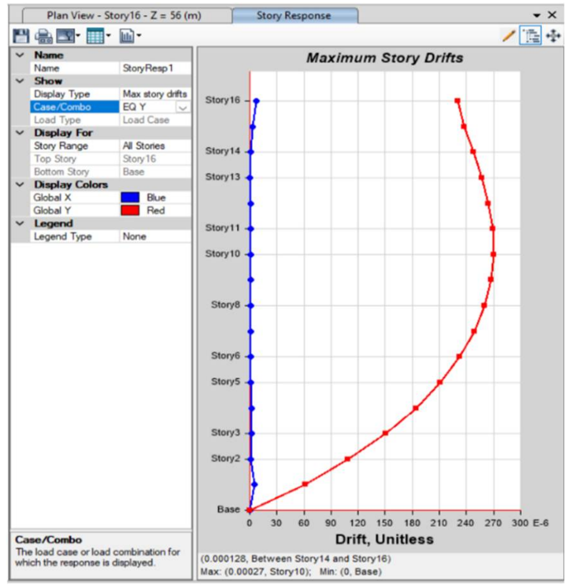


Fig 121 – M15 – G+15 Storey Drift EQX
Top Storey Drift EQX – 0.000251
Corner Shear Wall

Fig 122 – M15 – G+15 Storey Drift EQY
Top Storey Drift EQY – 0.00027
Corner Shear Wall

Result: **-** The maximum storey drift is 0.000251 in the EQX direction and 0.00027 in the EQY direction. The drift value in the Y-direction is slightly higher compared to the X-direction. However, both values are within the permissible limit of 0.004 as per IS 1893, indicating that the structure satisfies the drift criteria and remains safe under seismic loading.

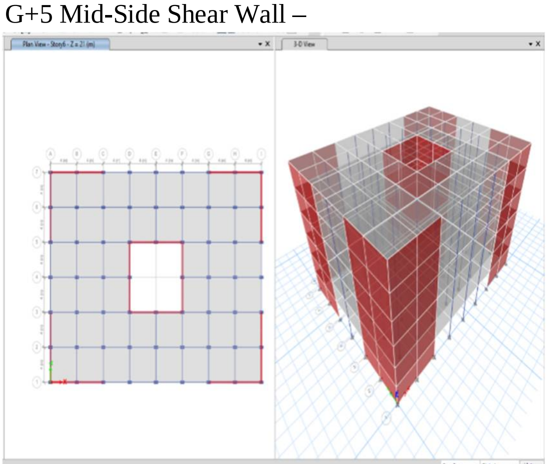
15) Base Shear: -

EQX - 1952.6394kn, EQY - 1835.8443kn

Result: **-** The base shear for the structure is 1952.64 kN in the EQX direction and 1835.84 kN in the EQY direction under seismic loading. The higher base shear in the X-direction indicates that the building experiences comparatively greater seismic force along that direction. The placement of shear walls at the corners improves the overall stiffness and seismic resistance of the building.

D. Group – 4 Mid – Side Shear Wall: -

M16 – G+5 Mid-Side Shear Wall –



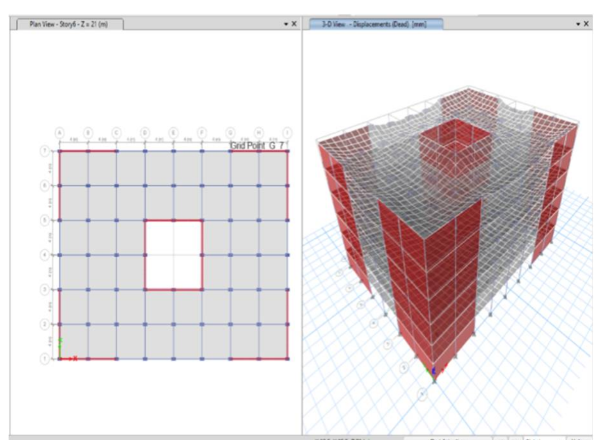
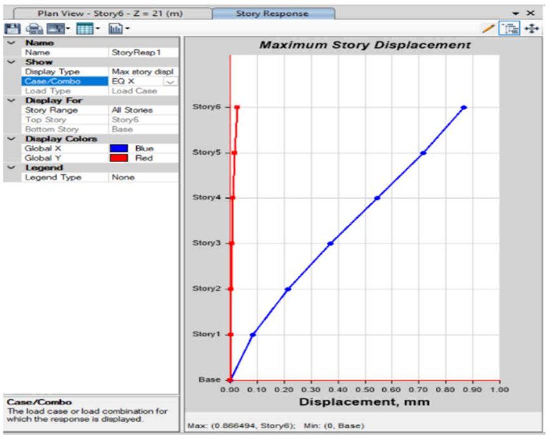


Fig 123 – M16 – G+5Mid-Side Shear Wall Display

Fig 124 – M16 – G+5Mid-Side Shear Run

1) Storey Displacement: -

M16 – G+5 Mid-Side Shear Wall –



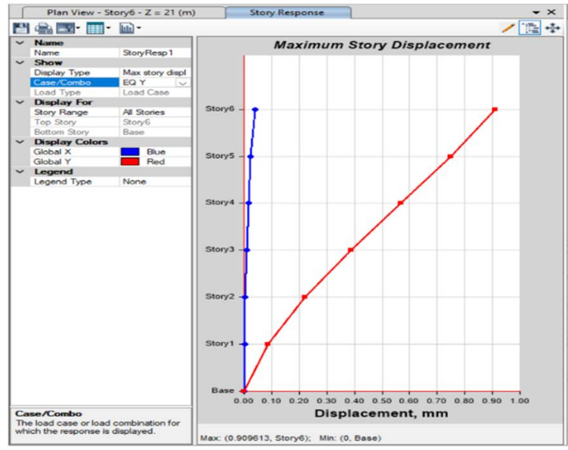


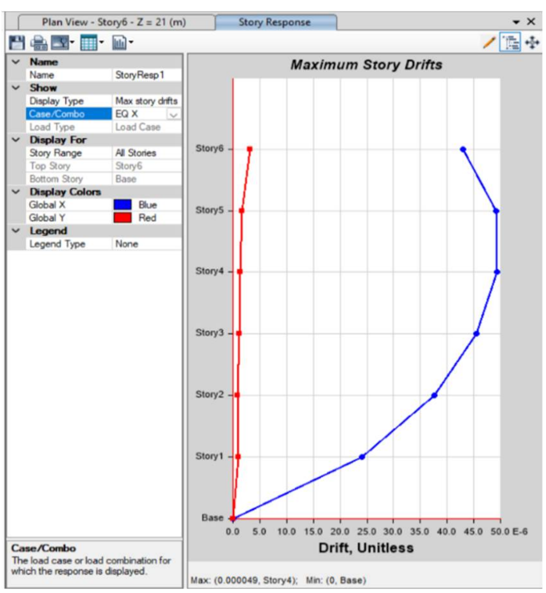
Fig 125 – M16 – G+5 Storey Dis EQX
Top Storey Dis EQX – 0.86
Mid-Side Shear Wall

Fig 126 – M16 – G+5 Storey Dis EQY
Top Storey Dis EQY – 0.90
Mid-Side Shear Wall

Result: - For the G+5 mid-side shear wall structure, the maximum storey displacement occurs at the top storey. The displacement obtained is 0.86 mm in the EQX direction and 0.90 mm in the EQY direction under seismic loading. The displacement in the Y-direction is slightly higher than in the X-direction, indicating comparatively small lateral movement due to the presence of shear walls.

2) Storey Drift: -

M16 – G+5 Mid-Side Shear Wall –



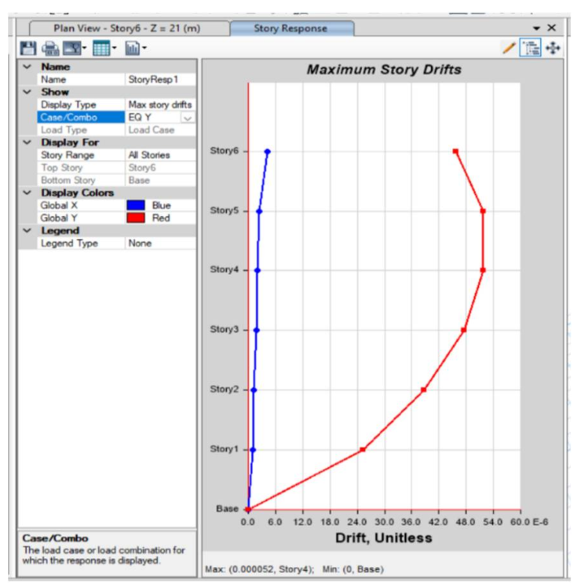


Fig 127 – M16 – G+5 Storey Drift EQX
Top Storey Drift EQX – 0.000049
Mid-Side Shear Wall

Fig 128 – M16 – G+5 Storey Drift EQY
Top Storey Drift EQY – 0.000052
Mid-Side Shear Wall

Result: - The maximum storey drift is 0.000049 in the EQX direction and 0.000052 in the EQY direction. These values are much lower than the permissible limit of 0.004 as per IS 1893, indicating that the structure satisfies the drift criteria and shows very stable seismic performance.

3) Base Shear: -

EQX **-** 1463.4569kn, EQY **-**1463.4569kn

Result: **-** The base shear for the structure is 1463.46 kN in both EQX and EQY directions under seismic loading. The equal base shear values indicate a symmetrical seismic response of the structure due to the balanced placement of mid-side shear walls, which improves the stiffness and seismic resistance of the building.

M17 – G+8 Mid-Side Shear Wall –

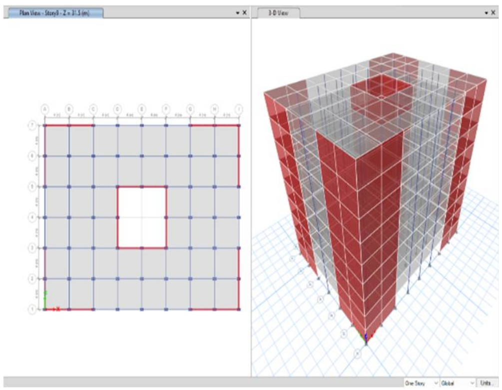


Fig 129 – M17 – G+8Mid-Side Shear WallDisplay

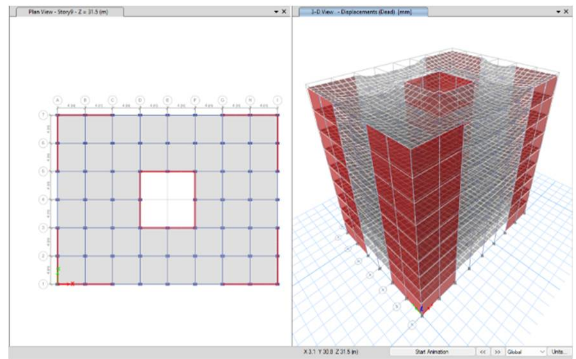


Fig 130 – M17 – G+8Mid-Side Shear Run

4) Storey Displacement: -

M17 – G+8 Mid-Side Shear Wall –

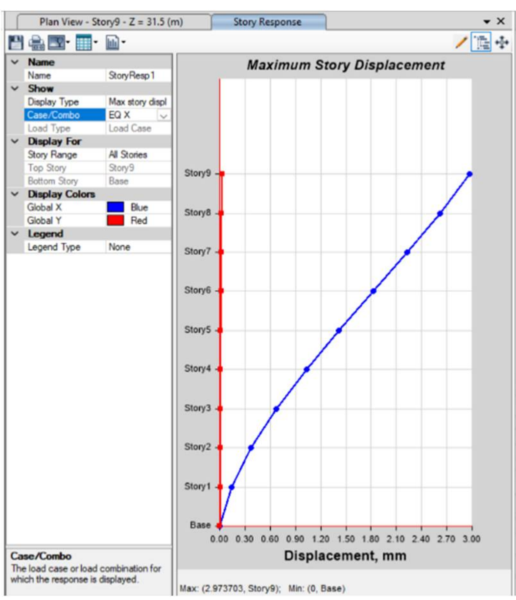


Fig 131 – M17 – G+8 Storey Dis EQX

Top Storey Dis EQX – 2.97

Mid-Side Shear Wall

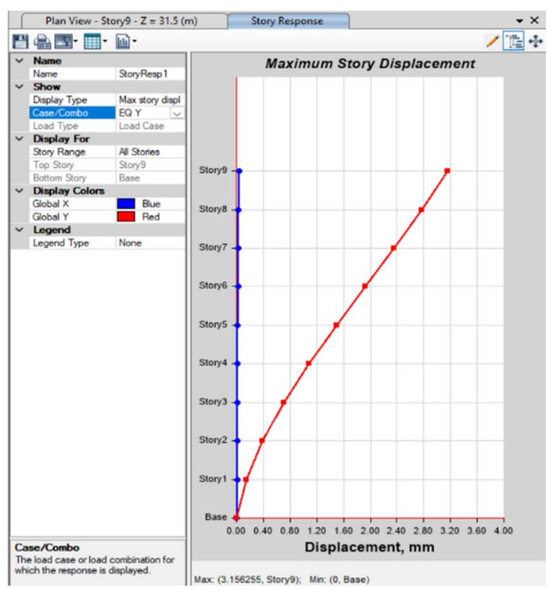


Fig 132 – M17 – G+8 Storey Dis EQY

Top Storey Dis EQY – 3.15

Mid-Side Shear Wall

Result: **-** For the G+8 mid-side shear wall structure, the maximum storey displacement occurs at the top storey. The displacement obtained is 2.97 mm in the EQX direction and 3.15 mm in the EQY direction under seismic loading. The displacement in the Y-direction is slightly higher than in the X-direction, indicating comparatively greater lateral movement in that direction.

5) Storey Drift: -

M17 – G+8 Mid-Side Shear Wall –

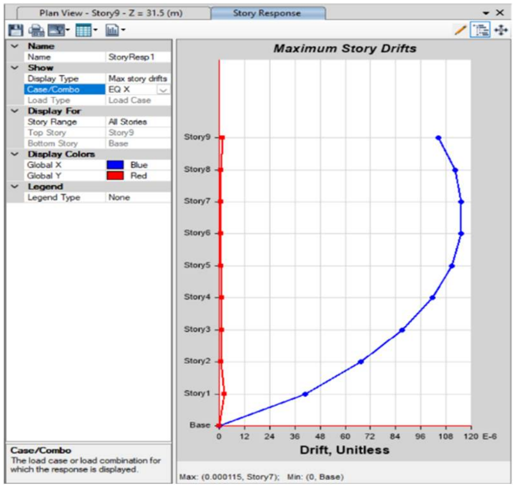


Fig 133 – M17 – G+8 Storey Drift EQX
Top Storey Drift EQX – 0.000115
Mid-Side Shear Wall

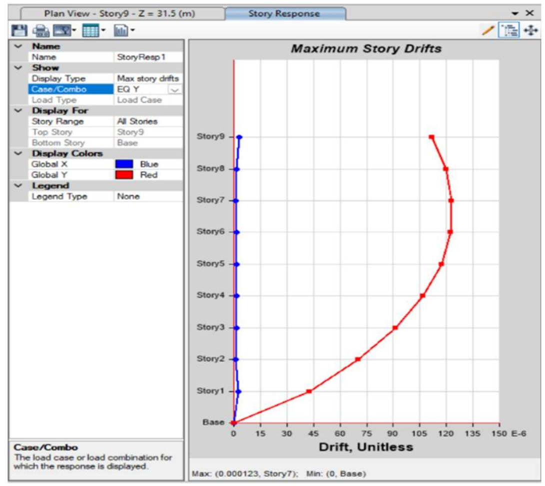


Fig 134 – M17 – G+8 Storey Drift EQY
Top Storey Drift EQY – 0.000123
Mid-Side Shear Wall

Result: - The maximum storey drift is 0.000115 in the EQX direction and 0.000123 in the EQY direction. These values are well within the permissible limit of 0.004 as per IS 1893, indicating that the structure satisfies the drift criteria and performs safely under seismic loading.

6) Base Shear: -

EQX - 2219.1707kn, EQY - 2219.1707kn

Result: - The base shear for the structure is 2219.17 kN in both EQX and EQY directions under seismic loading. The equal base shear values indicate a symmetrical seismic response of the structure due to the balanced placement of mid-side shear walls, which enhances the stiffness and seismic resistance of the building.

M18 – G+10 Mid-Side Shear Wall –

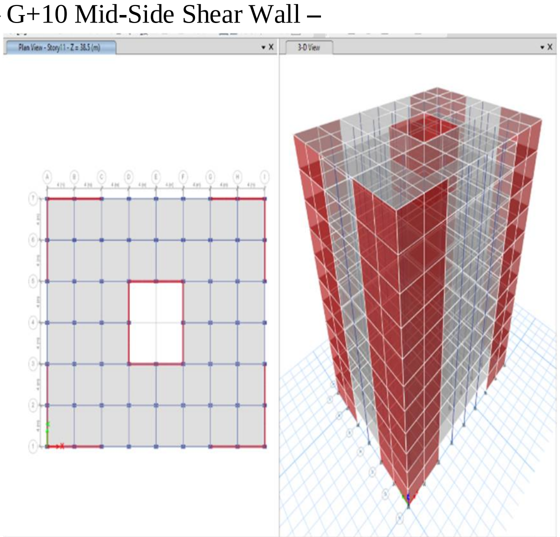


Fig 135 – M18 – G+10Mid-Side Shear WallDisplay

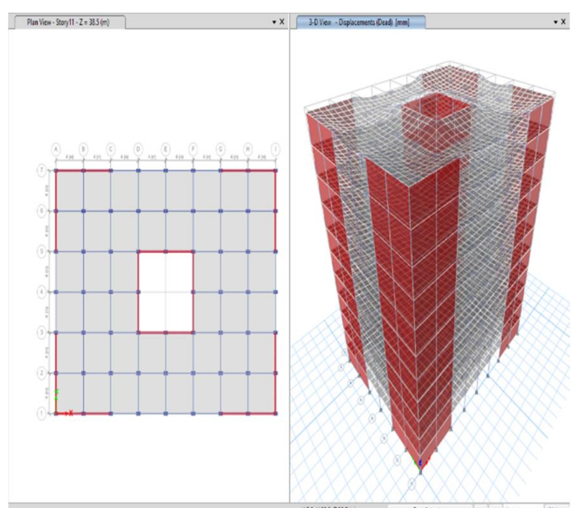


Fig 136 – M18 – G+10Mid-Side Shear Run

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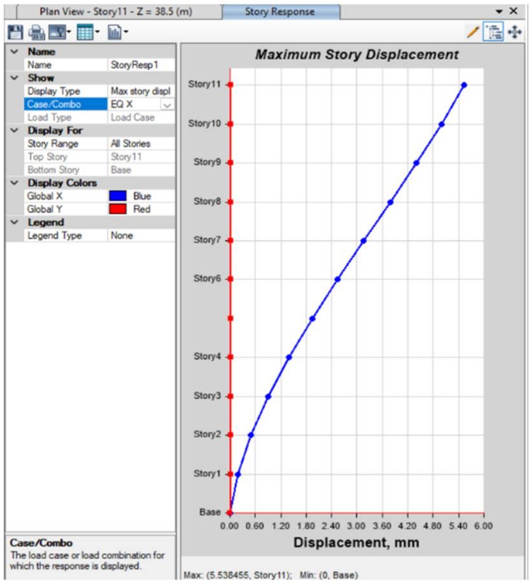
7) Storey Displacement: -

M18 – G+10 Mid-Side Shear Wall –



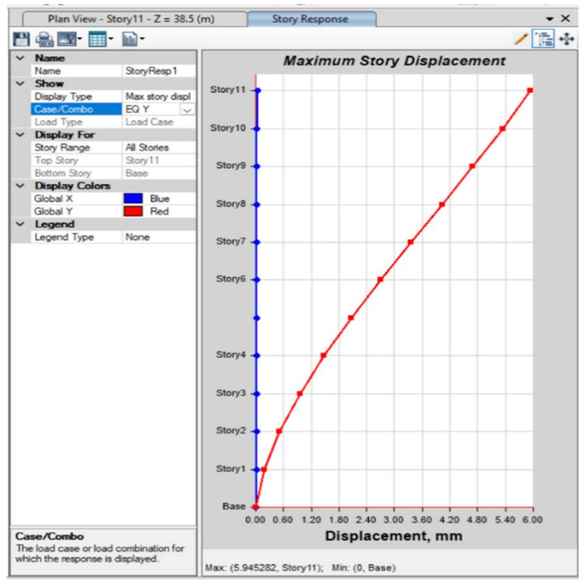


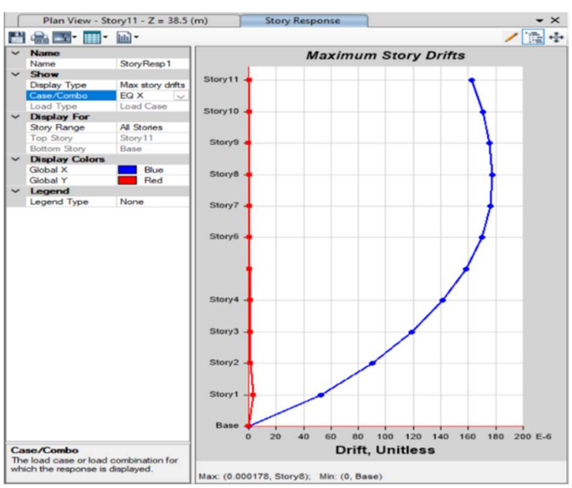
Fig 137 – M18 – G+10 Storey Dis EQX
Top Storey Dis EQX – 5.53
Mid-Side Shear Wall

Fig 138 – M18 – G+10 Storey Dis EQY
Top Storey Dis EQY – 5.94
Mid-Side Shear Wall

Result: - For the G+10 mid-side shear wall structure, the maximum storey displacement occurs at the top storey. The displacement obtained is 5.53 mm in the EQX direction and 5.94 mm in the EQY direction under seismic loading. The displacement in the Y-direction is slightly higher than in the X-direction, indicating comparatively greater lateral movement in that direction.

8) Storey Drift: -

M18 – G+10 Mid-Side Shear Wall –



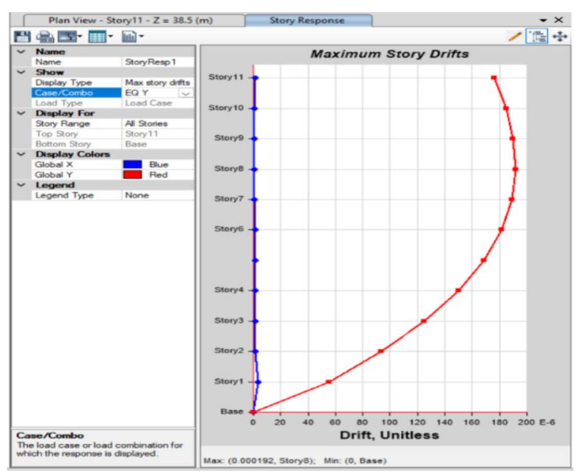


Fig 139 – M18 – G+10 Storey Drift EQX
Top Storey Drift EQX – 0.000176
Mid-Side Shear Wall

Fig 140 – M18 – G+10 Storey Drift EQY
Top Storey Drift EQY – 0.000192
Mid-Side Shear Wall

Result: - The maximum storey drift is 0.000176 in the EQX direction and 0.000192 in the EQY direction. These values are well within the permissible limit of 0.004 as per IS 1893, indicating that the structure satisfies the drift criteria and remains safe under seismic loading.

9) Base Shear: -

EQX - 2722.9799kn, EQY - 2722.9799kn

Result: - The base shear for the structure is 2722.98 kN in both EQX and EQY directions under seismic loading. The equal base shear values indicate a symmetrical seismic response due to the balanced placement of mid-side shear walls, which improves the overall stiffness and seismic resistance of the building.

M19 – G+12 Mid-Side Shear Wall –

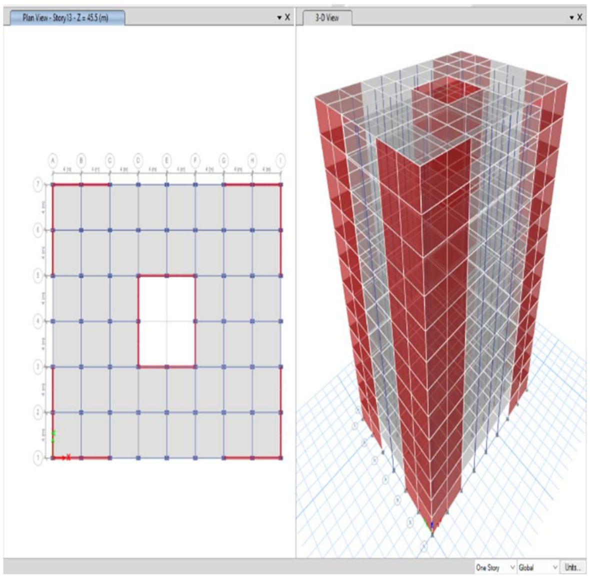


Fig 141 – M19 – G+12Mid-Side Shear WallDisplay

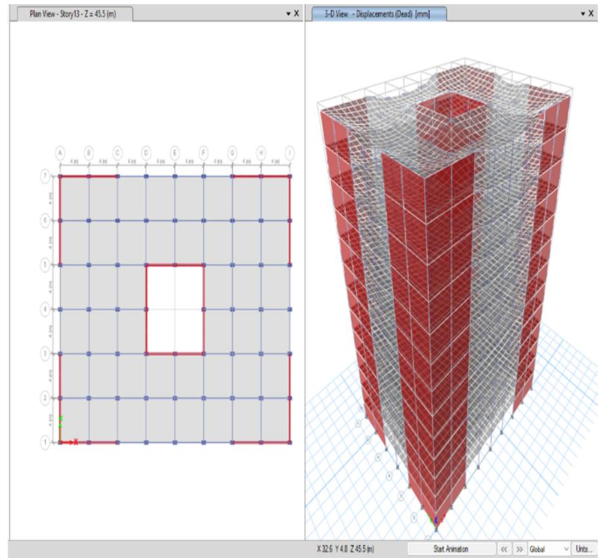


Fig 142 – M19 – G+12Mid-Side Shear Run

10) Storey Displacement: -

M19 – G+12 Mid-Side Shear Wall -

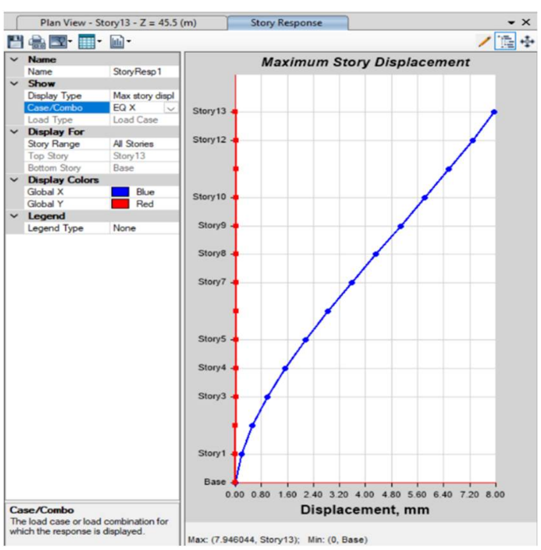


Fig 143 – M19 – G+12 Storey Dis EQX
Top Storey Dis EQX –7.94
Mid-Side Shear Wall

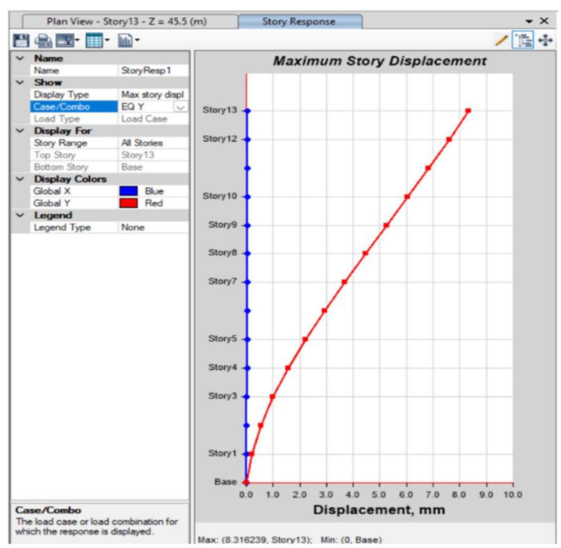
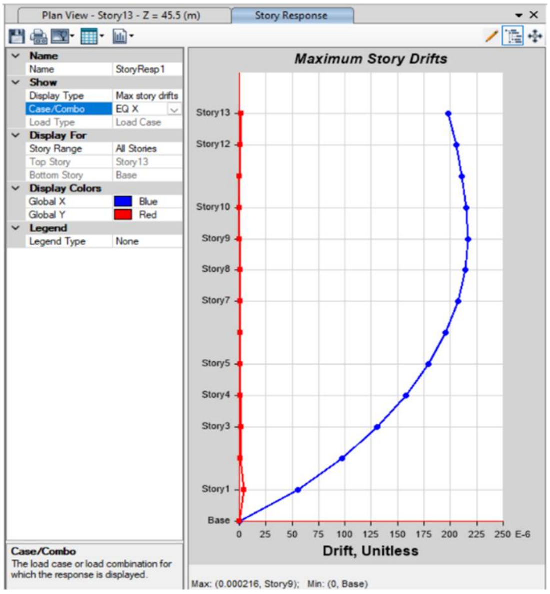


Fig 144 – M19 – G+12 Storey Dis EQY
Top Storey Dis EQY – 8.31
Mid-Side Shear Wall

Result: - For the G+12 mid-side shear wall structure, the maximum storey displacement occurs at the top storey. The displacement obtained is 7.94 mm in the EQX direction and 8.31 mm in the EQY direction under seismic loading. The displacement in the Y-direction is slightly higher than in the X-direction, indicating comparatively greater lateral movement in that direction.

11) Storey Drift: -

M19 – G+12 Mid-Side Shear Wall –



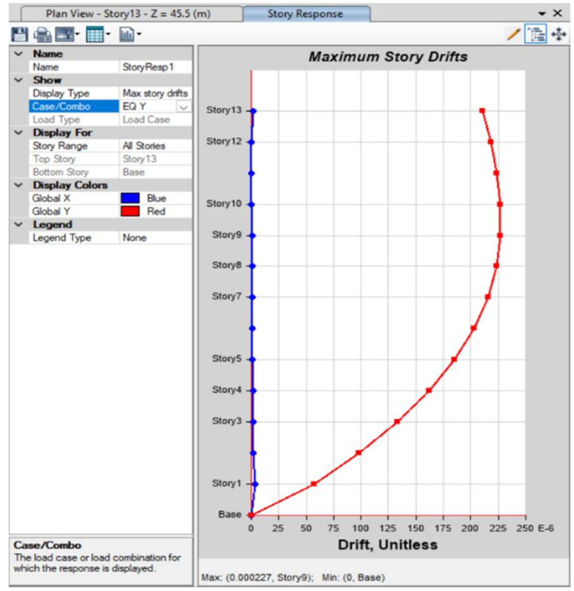


Fig 145 – M19 – G+12 Storey Drift EQX
Top Storey Drift EQX – 0.000216
Mid-Side Shear Wall

Fig 146 – M19 – G+12 Storey Drift EQY
Top Storey Drift EQY – 0.000227
Mid-Side Shear Wall

Result: - The maximum storey drift at the top storey is 0.000216 in the EQX direction and 0.000227 in the EQY direction. These values are well within the permissible limit of 0.004 as per IS 1893, indicating that the structure satisfies the drift criteria and remains safe under seismic loading.

12) Base Shear: -

EQX - 2770.0552kn, EQY - 2667.2968kn

Result: - The base shear for the structure is 2770.06 kN in the EQX direction and 2667.30 kN in the EQY direction under seismic loading. The higher base shear in the X-direction indicates that the structure experiences comparatively greater seismic force along that direction. The presence of mid-side shear walls increases the lateral stiffness and improves the seismic resistance of the building.

M20 – G+15 Mid-Side Shear Wall –

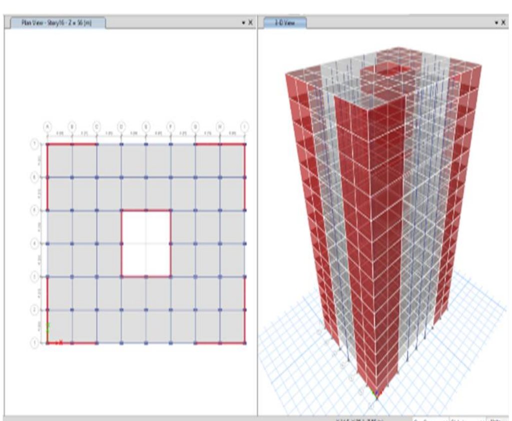


Fig 147 – M20 – G+15Mid-Side Shear Wall Display

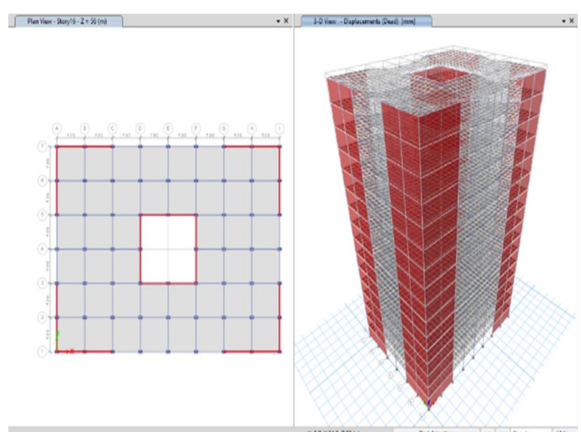
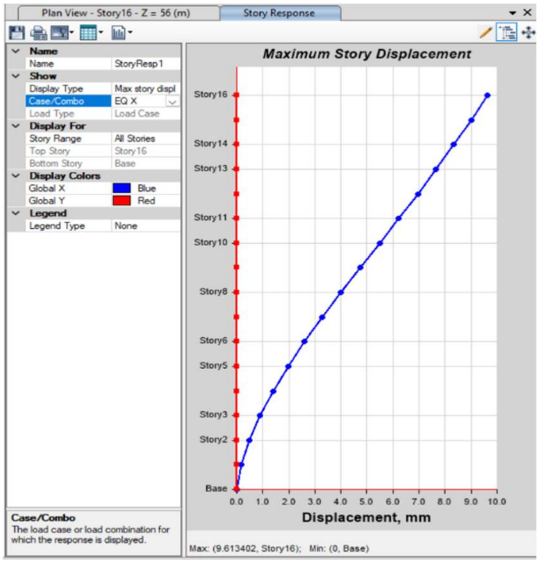


Fig 148 – M20 – G+15Mid-Side Shear Run

13) Storey Displacement: -

M20 – G+15 Mid-Side Shear Wall –



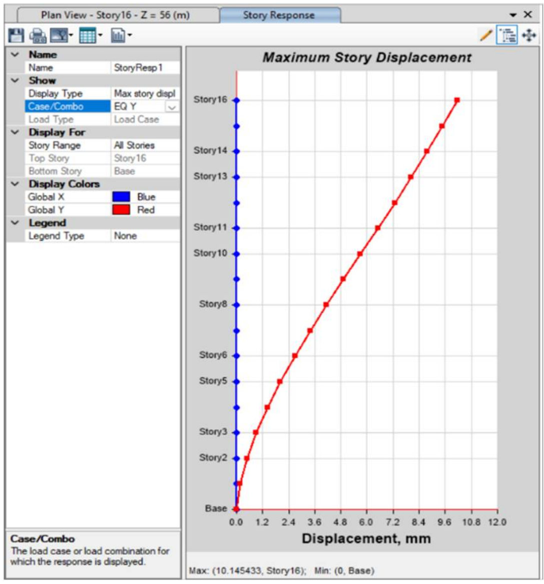


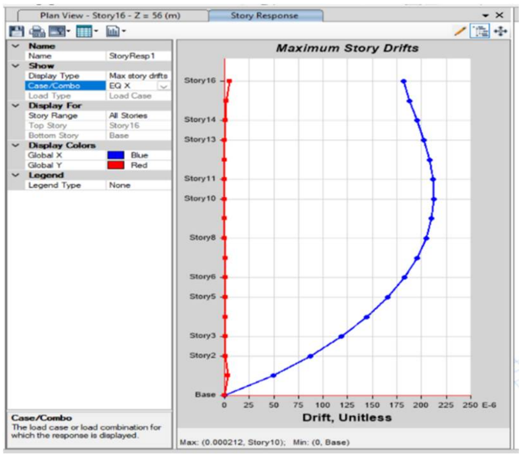
Fig 149 – M20 – G+15Storey Dis EQX
Top Storey Dis EQX – 9.61
Mid-Side Shear Wall

Fig 150 – M20 – G+15Storey Dis EQY
Top Store Dis EQY – 10.14
Mid-Side Shear Wall

Result: - For the G+15 mid-side shear wall structure, the maximum storey displacement occurs at the top storey. The displacement obtained is 9.61 mm in the EQX direction and 10.14 mm in the EQY direction under seismic loading. The displacement in the Y-direction is slightly higher than in the X-direction, indicating comparatively greater lateral movement in that direction.

14) Storey Drift: -

M20 – G+15 Mid-Side Shear Wall –



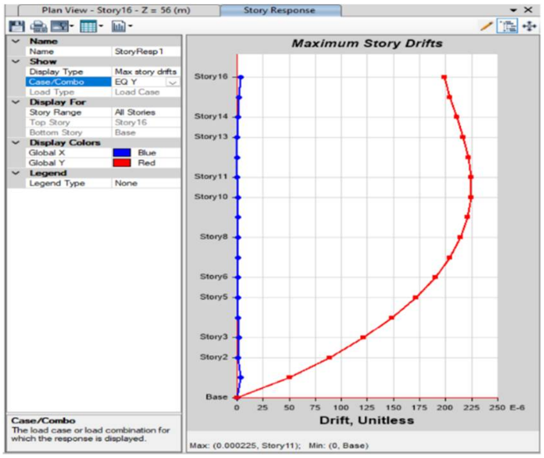


Fig 151 – M20 – G+15Storey Drift EQX
Top Storey Drift EQX – 0.000212
Mid-Side Shear Wall

Fig 152 – M20 – G+15Storey Drift EQY
Top Store Drift EQY – 0.000225
Mid-Side Shear Wall

Result: - The maximum storey drift at the top storey is 0.000212 in the EQX direction and 0.000225 in the EQY direction. These values are well within the permissible limit of 0.004 as per IS 1893, indicating that the structure satisfies the drift criteria and remains safe under seismic loading.

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15) Base Shear: -

EQX - 2385.4334kn, EQY -2276.0395kn

Result: -The base shear for the structure is 2385.43 kN in the EQX direction and 2276.04 kN in the EQY direction under seismic loading. The higher base shear in the X-direction indicates that the building experiences comparatively greater seismic force along that direction. The presence of mid-side shear walls improves the overall stiffness and seismic resistance of the structure.

a) Group – 1 Bare Frame Result Data and Chart

GROUP - 1 BARE FRAME - STOREY DISPLACEMENT				
Sr No	Model No	Storey Height	Top Storey Displacement EQX	Top Storey Displacement EQY
1	M1	G+5	6.133	7.71
2	M2	G+8	954	11.92
3	M3	G+10	11.77	14.8
4	M4	G+12	14.26	17.75
5	M5	G+15	15.95	22.17

GROUP - 1 BARE FRAME - STOREY DRIFT				
Sr No	Model No	Storey Height	TopStorey Displacement EQX	Top Storey Displacement EQY
1	M1	G+5	0.000162	0.000188
2	M2	G+8	0.0004	0.000488
3	M3	G+10	0.00040.	0.000494
4	M4	G+12	0.000408	0.000497
5	M5	G+15	0.000386	0.000527

GROUP - 1 BARE FRAME BASE SHEAR				
Sr No	Model No	Storey Height	Top Storey Displacement EQX (kN)	Top Storey Displacement EQY (kN)
1	M1	G+5	1083.75	842.57
2	M2	G+8	1072.66	845.94
3	M3	G+10	1065.79	844.73
4	M4	G+12	1058.9	842.07
5	M5	G+15	989.41	88.73

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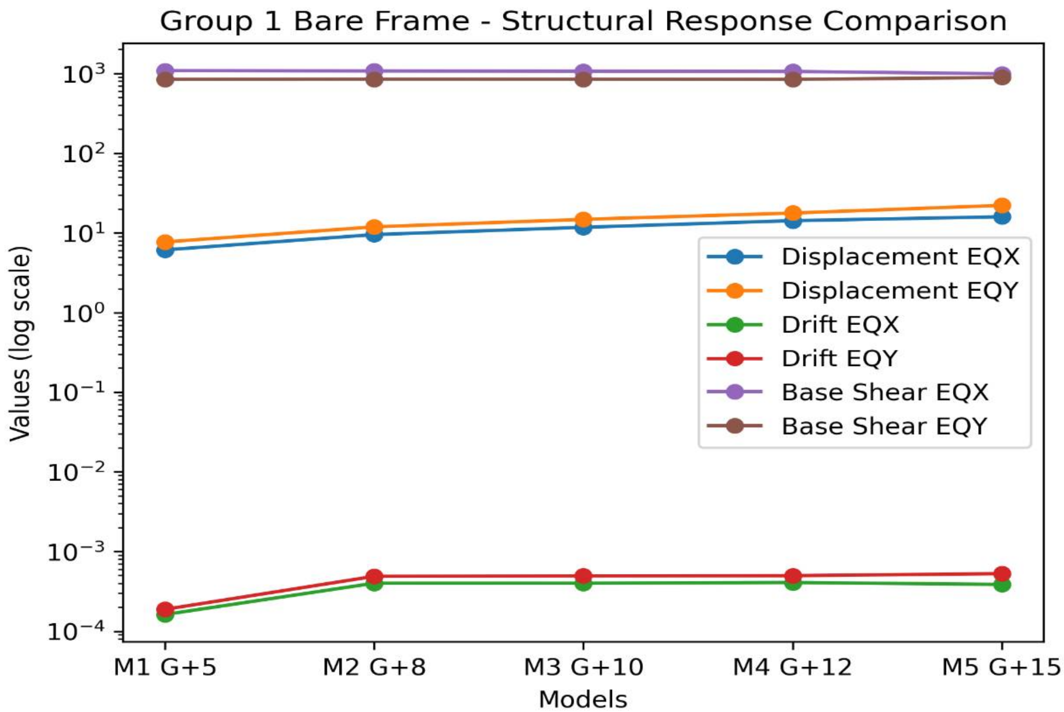

Chart – 1 Group – 1 Bare Frame Structural Response Comparison

1) Storey Displacement: - Storey displacement represents the lateral movement of the building when earthquake forces act on it.From the chart, it can be observed that storey displacement increases as the building height increases. The displacement value for Model M1 (G+5) is the lowest, while Model M5 (G+15) shows the highest displacement.This happens because taller buildings are more flexible and experience greater lateral movement during earthquakes. Also, displacement in the EQY direction is slightly higher than in the EQX direction.As the number of storeys increases, the displacement of the building also increases.
2) Storey Drift: - Storey drift is the relative displacement between two consecutive storeys of a building during earthquake loading. From the results, it can be seen that storey drift values slightly increase with the increase in building Height. However, all drift values are much smaller than the permissible limit specified in IS 1893 (0.004 times the storey height). This indicates that the structure performs safely under seismic loading conditions. Although drift increases slightly with height, all models are within the safe limit.
3) Base Shear: -Base shear is the total horizontal seismic force acting at the base of the structure.

From the data, it is observed that base shear slightly decreases as the building height increases.

Model M1 (G+5) has the highest base shear, while Model M5 (G+15) has the lowest.

This occurs because taller buildings have a higher natural time period, which reduces the seismic force acting on the structure.

Overall Conclusion Group – 1: -In this study, seismic analysis of bare frame buildings with different heights such as G+5, G+8, G+10, G+12 and G+15 was carried out. From the analysis results, some important observations were made.

It was observed that storey displacement increases as the height of the building increases. This happens because taller buildings are more flexible and tend to move more during earthquake loading.

The storey drift values also increase slightly with the increase in building height, but all the values are within the permissible limits specified in IS 1893. Therefore, the structures are considered safe with respect to drift limits.

It was also found that base shear decreases slightly as the building height increases. This occurs due to the increase in the natural time period of taller buildings.

However, in bare frame structures the lateral stiffness is lower, so displacement and drift are generally higher compared to buildings with shear walls. Providing shear walls can improve the seismic performance and increase the overall stability of the structure.

Therefore, it can be concluded that bare frame buildings can perform safely under seismic loads, but for taller buildings the use of shear walls provides better safety and structural stability.

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b) Group – 2 Core Shear Wall Result Data and Chart: -

GROUP - 2 CORE SHEAR WALL - STOREY DISPLACEMENT				
Sr No	Model No	Storey Height	Top Storey Displacement EQX	Top Storey Displacement EQY
1	M6	G+5	1.6	1.78
2	M7	G+8	5.09	5.79
3	M8	G+10	7.65	8.29
4	M9	G+12	9.73	10.68
5	M10	G+15	11.42	12.69

GROUP - 2 CORE SHEAR WALL - STOREY DRIFT				
Sr No	Model No	Storey Height	Top Storey Displacement EQX	Top Storey Displacement EQY
1	M6	G+5	0.000091	0.0001
2	M7	G+8	0.000195	0.000223
3	M8	G+10	0.00024	0.000262
4	M9	G+12	0.000259	0.000289
5	M10	G+15	0.000251	0.000278

GROUP - 2 CORE SHEAR WALL BASE SHEAR				
Sr No	Model No	Storey Height	Top Storey Displacement EQX	Top Storey Displacement EQY
1	M6	G+5	1248.71	1278.71
2	M7	G+8	1933.65	1933.65
3	M8	G+10	2007.67	1875.52
4	M9	G+12	1893.57	1752.67
5	M10	G+15	1666.46	1523.78

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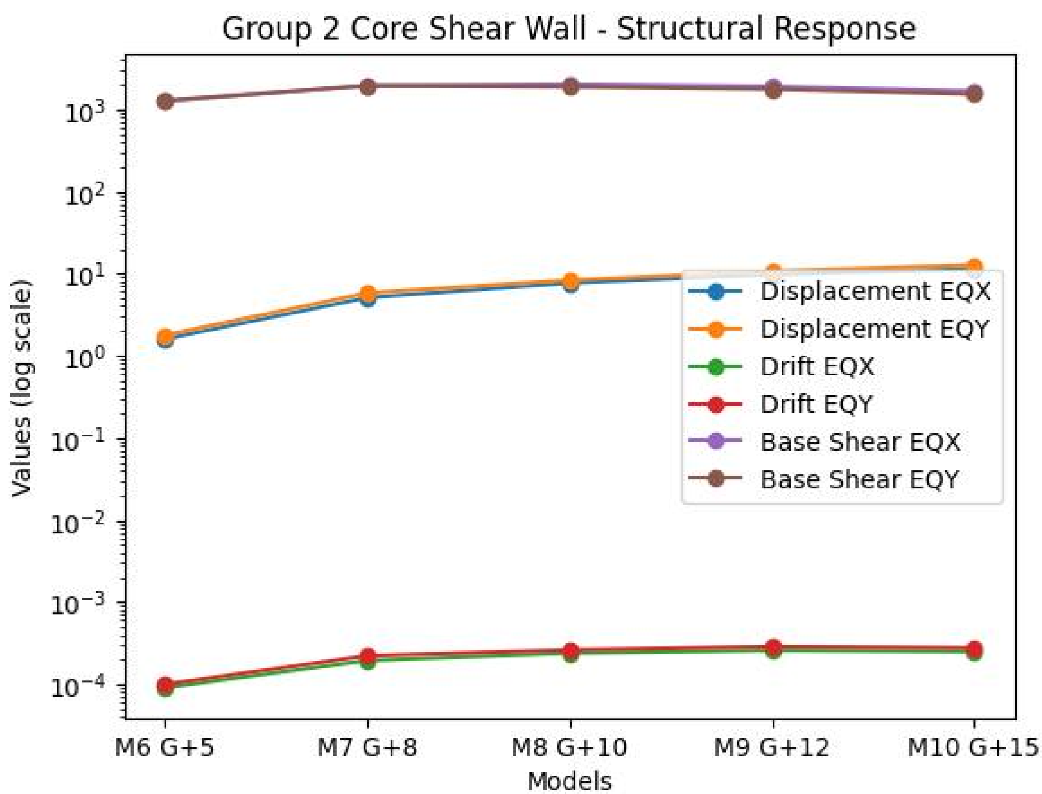

Chart –2 Group – 2Core Shear Wall Structural Response Comparison

1) Storey Displacement: - Storey displacement represents the lateral movement of the building when earthquake forces act on it.
   From the results, it can be observed that storey displacement increases as the building height increases.
   The displacement value is lowest for Model M6 (G+5) and highest for Model M10 (G+15).
   However, compared to the bare frame structure, the displacement values are significantly lower. This is because the core shear wall increases the stiffness of the building, which helps in reducing lateral movement during earthquakes.
   It is also observed that displacement in the EQY direction is slightly higher than in the EQX direction.
2) Storey Drift: - Storey drift is the relative displacement between two consecutive storeys of a building during earthquake loading.
   From the analysis results, it can be seen that storey drift slightly increases with the increase in building height.
   However, all drift values are within the permissible limit specified in IS 1893.
   The presence of a core shear wall helps in controlling storey drift, which improves the seismic performance of the structure.
3) Base Shear: - Base shear represents the total horizontal seismic force acting at the base of the structure.

From the results, it is observed that base shear increases from G+5 to G+10 and then slightly decreases for taller buildings.

This happens because the natural time period of the structure changes as the building height increases, which affects the seismic forces acting on the building.

Overall Conclusion Group – 2: -From the analysis of Group 2 models with core shear wall, it can be observed that the storey displacement and storey drift values are relatively smaller compared to bare frame structures.

The core shear wall increases the stiffness and stability of the building, which helps in controlling lateral movement during earthquakes.

All the drift values are within the permissible limits specified by IS 1893, indicating that the structure is safe under seismic loading conditions.

Therefore, it can be concluded that providing a core shear wall significantly improves the seismic performance and overall stability of the building.

c) Group – 3 Corner Shear Wall Result Data and Chart: -

GROUP - 3 CORNER SHEAR WALL - STOREY DISPLACEMENT				
Sr No	Model No	Storey Height	Top Storey Displacement EQX	Top Storey Displacement EQY
1	M11	G+5	1.34	1.48
2	M12	G+8	4.45	4.91
3	M13	G+10	7.37	7.81
4	M14	G+12	9.52	10.14
5	M15	G+15	11.36	12.18

GROUP - 3 CORNER SHEAR WALL - STOREY DRIFT				
Sr No	**Model No**	**Storey Height**	**Top Storey Displacement EQX**	**Top Storey Displacement EQY**
1	M11	G+5	0.000077	0.000087
2	M12	G+8	0.000173	0.000192
3	M13	G+10	0.000236	0.000252
4	M14	G+12	0.000258	0.000277
5	M15	G+15	0.000251	0.00027

GROUP - 3 CORNER SHEAR WALL BASE SHEAR				
Sr No	Model No	Storey Height	Top Storey Displacement EQX	Top Storey Displacement EQY
1	M11	G+5	1.444.12	1444.12
2	M12	G+8	2186.15	2186.15
3	M13	G+10	2422.72	2309.86
4	M14	G+12	2251.38	2134.14
5	M15	G+15	1952.63	1835.84

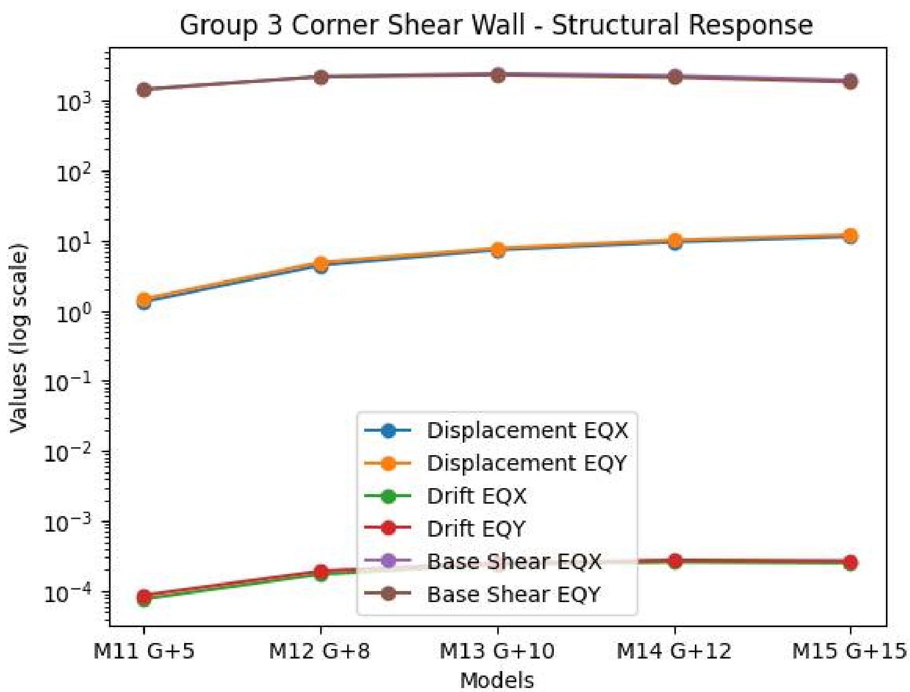

Chart –3 Group – 3Corner Shear Wall Structural Response Comparison

1) Storey Displacement: - Storey displacement represents the lateral movement of the building when earthquake forces act on it. From the results, it can be observed that storey displacement increases as the building height increases.
The displacement value is lowest for Model M11 (G+5) and highest for Model M15 (G+15).
However, compared to the bare frame structure, the displacement values are considerably lower. This is because the corner shear walls increase the lateral stiffness of the structure, which helps in reducing the lateral movement of the building during earthquake loading.
It is also observed that displacement in the EQY direction is slightly higher than in the EQX direction.

2) Storey Drift: -From the analysis results, it can be seen that storey drift values slightly increase with the increase in building height.However, all drift values are within the permissible limit specified in IS 1893.
The presence of shear walls at the corners helps in controlling the storey drift and improves the overall seismic behavior of the building.

3) Base Shear: -Base shear represents the total horizontal seismic force acting at the base of the structure.
From the results, it is observed that base shear increases from G+5 to G+10 and then gradually decreases for taller buildings. This variation occurs because the natural time period of the structure increases with building height, which influences the seismic forces acting on the building.

Overall Conclusion Group – 3: -From the analysis of Group 3 models with corner shear walls, it can be observed that the storey displacement and storey drift values are significantly lower compared to the bare frame structure.
The corner shear wall configuration increases the stiffness and strength of the structure, which helps in controlling lateral displacement during earthquake loading.
All drift values are within the permissible limits specified by IS 1893, indicating that the structure is safe under seismic conditions.
Therefore, it can be concluded that providing shear walls at the corners of the building improves the seismic performance and structural stability compared to the bare frame system.

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d) Group – 4 Mid-Side Shear Wall: -

GROUP - 4 MID-SIDE SHEAR WALL - STOREY DISPLACEMENT				
Sr No	Model No	Storey Height	Top Storey Displacement EQX	Top Storey Displacement EQY
1	M16	G+5	0.86	0.9
2	M17	G+8	2.97	3.15
3	M18	G+10	5.53	5.94
4	M19	G+12	7.94	8.31
5	M20	G+15	9.61	10.14

GROUP - 4 MID-SIDE SHEAR WALL - STOREY DRIFT				
Sr No	Model No	Storey Height	Top Storey Drift EQX	Top Storey Drift EQY
1	M16	G+5	0.000049	0.00052
2	M17	G+8	0.000115	0.000123
3	M18	G+10	0.000176	0.000192
4	M19	G+12	0.000216	0.000227
5	M20	G+15	0.000212	0.000225

GROUP - 4 MID-SIDE SHEAR WALL BASE SHEAR				
Sr No	Model No	Storey Height	Top Storey Displacement EQX	Top Storey Displacement EQY
1	M16	G+5	1463.45	1463.45
2	M17	G+8	2219.17	2219.17
3	M18	G+10	2722.97	2722.97
4	M19	G+12	2770.29	2667.29
5	M20	G+15	2385.43	2776.03

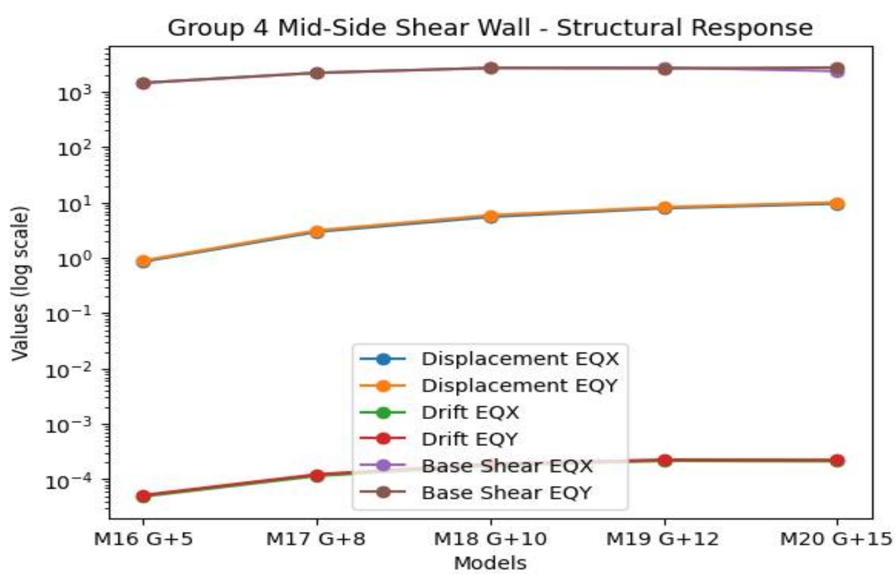

Chart – 4 Group – 4 Mid-Side Shear Wall Structural Response

1) Storey Displacement: - Storey displacement represents the lateral movement of the building when earthquake forces act on it. From the results, it can be observed that storey displacement increases as the building height increases. The displacement value is lowest for Model M16 (G+5) and highest for Model M20 (G+15). However, compared to the bare frame structure, the displacement values are significantly lower. This is because the mid-side shear walls increase the lateral stiffness of the building, which helps in reducing the lateral movement of the structure during earthquake loading. It is also observed that displacement in the EQY direction is slightly higher than in the EQX direction.
2) Storey Drift: - Storey drift is the relative displacement between two consecutive storeys of a building during earthquake loading. From the analysis results, it can be seen that storey drift values slightly increase with the increase in building height. However, all drift values are within the permissible limit specified in IS 1893.The presence of mid-side shear walls helps in effectively controlling the storey drift and improves the seismic performance of the structure.
3) Base Shear: - Base shear represents the total horizontal seismic force acting at the base of the structure. From the results, it is observed that base shear increases from G+5 to G+12 and then slightly decreases for the tallest building model. This behavior occurs because the natural time period of the building changes as the height increases, which affects the magnitude of seismic forces acting on the structure.

Overall Conclusion Group – 4: -From the analysis of Group 4 models with mid-side shear walls, it can be observed that the storey displacement and storey drift values are smaller compared to the bare frame structure and other shear wall configurations.

The mid-side shear wall arrangement increases the stiffness and stability of the structure, which helps in reducing lateral movement during earthquakes.All drift values are within the permissible limits specified in IS 1893, indicating that the structure is safe under seismic loading conditions. Therefore, it can be concluded that providing shear walls at the mid-side locations significantly improves the seismic performance and overall stability of the building.

V. COMPARISONS BETWEEN DIFFERENT GROUPS

1) Group 1 vs Group – 2: - Group 1 represents the bare frame structure, while Group 2 consists of a core shear wall system. From the analysis results, it can be observed that the storey displacement and storey drift values in Group 1 are much higher than those in Group 2. This is mainly because the bare frame structure has lower lateral stiffness and is more flexible under earthquake loading. In contrast, the core shear wall in Group 2 increases the stiffness of the structure, which helps in reducing lateral movement and controlling storey drift. Therefore, the core shear wall system performs better than the bare frame structure in terms of seismic resistance and stability.
2) Group 2 vs Group 3: -Group 2 includes core shear walls located at the center of the building, while Group 3 consists of shear walls placed at the corners of the structure. From the results, it is observed that both systems significantly reduce storey displacement and drift compared to the bare frame structure. However, the corner shear wall system shows slightly better control over lateral displacement in some cases, because the placement of shear walls at the corners provides better resistance against lateral forces and improves structural stability. Thus, the corner shear wall configuration may provide better seismic performance compared to the core shear wall system in certain conditions.
3) Group 3 vs Group – 4: - Group 3 represents the corner shear wall system, whereas Group 4 consists of mid-side shear wall locations. From the comparison of results, it can be observed that Group 4 shows lower storey displacement and drift values compared to Group 3. This indicates that the mid-side shear wall arrangement provides better distribution of lateral stiffness in the structure, which helps in controlling lateral movement more effectively during earthquake loading. Therefore, the mid-side shear wall configuration performs better than the corner shear wall system in terms of seismic performance.

a) Effect of Building Height on Seismic Behavior: -

The effect of building height on the seismic behavior of reinforced concrete buildings was studied by analyzing different building models with heights ranging from G+5 to G+15. From the analysis results, it was observed that storey displacement increases as the height of the building increases. This occurs because taller buildings tend to be more flexible and experience greater lateral movement during earthquake loading.Similarly, storey drift values also show a slight increase with the increase in building height, although all the drift values obtained from the analysis remain within the permissible limits specified in IS 1893. This indicates that the structural models are safe with respect to drift criteria.

The results also indicate that building height has a noticeable influence on the seismic response of the structure, and the effect becomes more significant for taller buildings.

Therefore, providing adequate lateral load resisting systems such as shear walls becomes important for controlling displacement and improving structural stability in taller buildings.

b) Final Comparisons Result Data and Chart: -

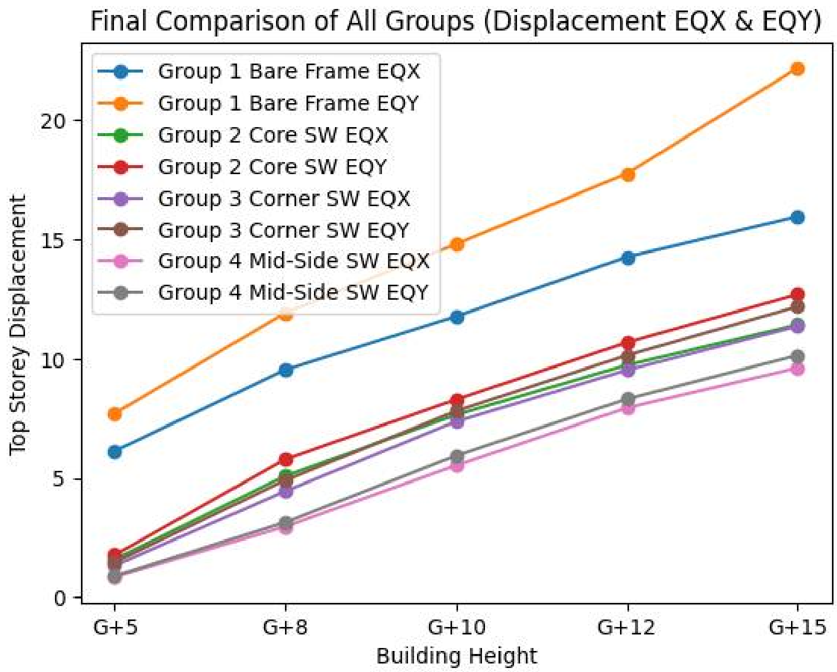

Chart – 5 Final Comparisons of All Groups (Displacement EQX & EQY)

Different structural configurations considered in this study are:
Group 1 – Bare Frame
Group 2 – Core Shear Wall
Group 3 – Corner Shear Wall
Group 4 – Mid-Side Shear Wall
The comparison is made for different building heights from G+5 to G+15.

- X-Axis Represent: - the building height.

The different models considered are:
G+5
G+8
G+10
G+12
G+15
As we move from left to right, the height of the building increases.

- Y-Axis Represent: -the top storey displacement. This value indicates the lateral movement of the building during earthquake loading. Higher displacement means the building moves more under seismic forces.
- Blue Line – Bare Frame (Group – 1): -This line shows the displacement of the bare frame structure without shear walls. It has the highest displacement values, which means the structure is more flexible and experiences larger lateral movement.
- Orange Line – Core Shear Wall (Group 2): - This line represents the core shear wall system. The displacement values are lower than the bare frame, because the shear wall increases the stiffness of the structure.
- Green Line – Corner Shear Wall (Group – 3): -This line shows the behavior of the corner shear wall system.
- The displacement is slightly lower than the core shear wall system, which indicates better lateral stability.

- Red Line – Mid – Side Shear Wall (Group – 4): -This line represents the mid-side shear wall system.
  It shows the lowest displacement values among all groups, indicating the best performance under seismic loading.
- Height Increase Observation: - From the chart it can be clearly observed that displacement increases with the increase in building height.This happens because taller buildings tend to be more flexible.
- Final Observation: -

From the comparison of all groups, it can be observed that:

- Bare frame → Highest Displacement
- Core shear wall → Displacement Reduces
- Corner shear wall → Better Control
- Mid-side shear wall → Lowest Displacement

VI. CONCLUSION

The present study focused on the comparative seismic analysis of reinforced concrete buildings with different heights and shear wall configurations using ETABS software. The analysis was carried out to understand the influence of building height and shear wall location on the seismic performance of RC buildings.

From the analysis results, it was observed that storey displacement increases with the increase in building height. Taller buildings tend to be more flexible and therefore experience greater lateral movement during earthquake loading. The results also show that the introduction of shear walls significantly improves the seismic behavior of the structure.

The bare frame structure showed the highest storey displacement and storey drift values, indicating lower lateral stiffness. When shear walls were introduced in different locations such as core, corner and mid-side positions, a noticeable reduction in displacement and drift was observed.

Among all the configurations analyzed in this study, the mid-side shear wall configuration showed the best overall seismic performance. This configuration provided the lowest storey displacement and storey drift values for different building heights, indicating better lateral stiffness and improved structural stability.

Another important observation from the analysis is that all the storey drift values obtained from the ETABS analysis are within the permissible limits specified in IS 1893, which confirms that the models are safe under seismic loading conditions.

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