DYNAMIC ANALYSIS OF G+13 MULTI STORIED BUILDING USING SHEAR WALLS IN VARIOUS LOCATIONS FOR DIFFERENT SEISMIC ZONES OF BANGLADESH

Submitted By

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A thesis submitted to the Department of Civil Engineering, Daffodil International University in Partial Fulfillment of the Requirements for the Degree of

Bachelor of Sciences in Civil Engineering

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June 2024

DECLARATION

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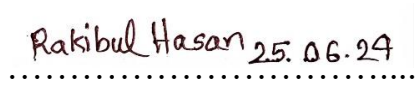
Signature of the candidates



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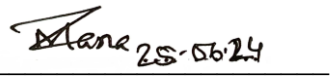

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ABSTRACT

The primary focus of structural engineers is to determine how a structure will behave when exposed to horizontal forces. High-rise buildings must have sufficient stiffness to withstand the forces generated by wind and earthquakes. Shear walls, which are added to the interior of the proposed building, are used to counteract the horizontal stresses and lateral loads created by earthquakes as well as to give the structure more rigidity. This paper aims to study the usage of shear walls at different locations in a G+13 multi storied residential building and to study the nature of the structure exposed to earthquake by adopting Response Spectrum Analysis. The Multi storied building with G+13 is analyzed for story drift, base shear, base reaction, story shear, displacement and torsional irregularity. The analysis and modeling for the whole structure is done by using prominent FEM integrated software named ETABS 2016. In this thesis the dynamic analysis is carried out SD type stiff soil for different cases based on the location of shear wall (Case A: Building Without shear wall, Case B: Building with shear wall at two lower end, Case C: Building with shear wall at two upper end, Case D: Building with shear wall two end diagonally upper left and lower right, Case E: Building with shear wall two end diagonally upper right and lower left and Case F: Building with shear wall at four ends) and based on the zones of Bangladesh (Zone II, Zone III and Zone IV). It is concluded that the structure with shear walls Case F placed symmetrically will show better results in terms of all the seismic parameters when compared with other cases.

Key words: Displacement, Base shear, Story drift, Seismic zone, Torsional irregularity, Shear wall.

LIST OF ABBREVIATION

BNBC	Bangladesh National Building Code
RC	Reinforcement Cement
RCC	Reinforcement Cement Concreate
SDOF	Single Degree of Freedom System
ACI	American Concreate Institute
ASTM	American Society for Testing and Materials
IS	Indian Standard Code

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CHAPTER 1
INTRODUCTION

Earthquake is a natural dreaded calamity and sudden shaking of the ground caused by the passage of seismic waves through Earth's rocks. Seismic waves are produced when some form of energy storied in Earth's crust is suddenly released, usually when masses of rock straining against one another suddenly fracture and slip. which outcomes from sudden discharge of energy beneath the earth and it is considered as one of the worst natural disaster which leads to shaking up a part of the earth surface and all the manmade objects, living and non-living things existing on it. The vibrations originate from the energy discharged and it is all because of internal and external matter with in the surface and give onto loss in life and damage to structures. Earthquakes may vary with different intensities and magnitudes, and it is very essential to study the seismic behavior of RC structure for different functions in terms of responses such as base shear , displacements etc. For a structure to be safe and to study their nature during tremors the dynamic analysis should have to be carried out for finding out the maximum response to a base excitation. The structures in addition to gravity loads are also subjected to lateral loads resulting from earthquakes which produce sway. When compared with buildings which are high rise the probability of sway is very much less in low rise buildings. Due to expansion of industries, economical factors, population and their way of life in urban areas results in buildings which are high rise and are more vulnerable to lateral loads. Structural engineers have been trying to combat these lateral loads and to acquire adequate stiffness by providing moment resisting frames, cross braces, diaphragms and shear walls which are central to reinforcing a building. Shear walls are erected to counteract the impacts of lateral loads and it produces required strength and stiffness for a structure when subjected to quake tremor (BNBC, 2020; Gulshan & Dhiman, 2016). Shear wall considers as most effective when compared with all the lateral force resisting systems especially for tall building (Reddy & Peera, 2015). Approximately a quarter of the population currently resides in urban areas. Over the next few decades, between 60% and 70% of people will live in cities. Even though the city's population is increasing at a startling rate, there is less land available for new development. Growing the increase in population and urbanization have increased the need for multistory building in order to house the millions of people. The behavior of the system becomes more unpredictable as building height increases. Because these structures are more vulnerable to dynamic loads like wind and earthquakes, so we need to be very careful to design them.

1.1 Seismic zoning

Bangladesh has been divided into four seismic zones with different levels of ground motion. Figure 1.1 presents a map of Bangladesh showing the boundaries of the four zones. Each zone has a seismic zone coefficient (Z) which represents the maximum considered peak ground acceleration (PGA). The zone coefficients (Z) of the four zones are: Z 0.12 (Zone I), Z 0.20 (Zone II), Z 0.28 (Zone III) and Z 0.36 (Zone IV). Zone IV, which includes Sylhet, is the northeastern region is the most earthquake prone zone and has a maximum PGA value of 0.36g. Dhaka city falls in the moderate seismic intensity zone with Z 0.2, while Chittagong city falls in a severe intensity zone with Z 0.28 (BNBC, 2020).

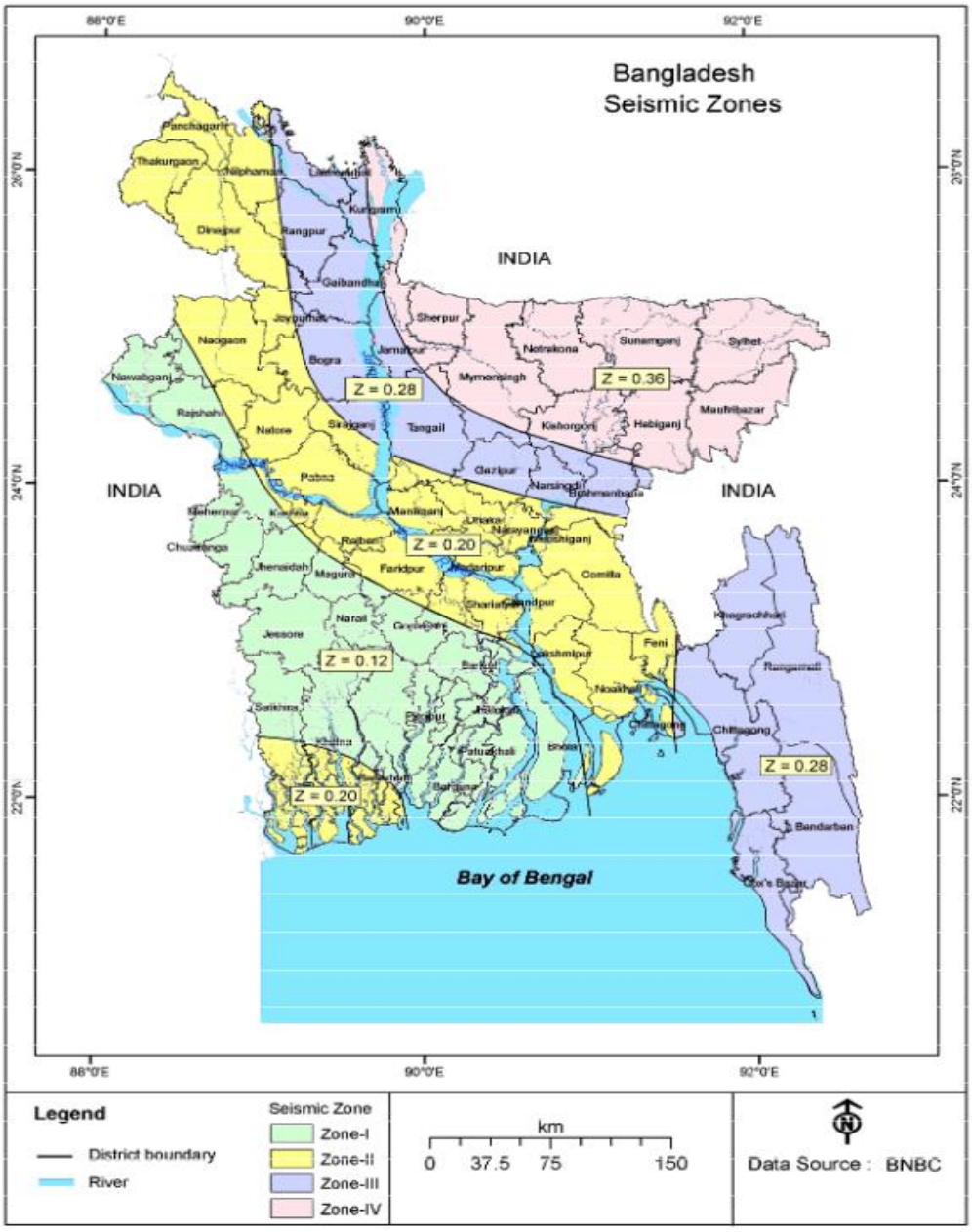

Figure 1.1: Seismic zoning map of Bangladesh (BNBC, 2020)

1.2 Shear wall

Shear walls are used to reduce the effects of lateral stresses operating on buildings. We use shear walls, which can be erected as vertically oriented wide beams in a reinforced concrete framed structure. These are added to a structure in addition to slabs, beams, and columns. They provide the necessary stiffness, especially for residential projects, and they usually create a case within the structure. Shear walls have been widely used in mid and high-rise structures for the past 20 years. Because shear walls are more susceptible to seismic pressures and lateral loads, they are especially important for high-rise structures (BNBC, 2020). High-rise buildings have very large beam and column dimensions and significant reinforcing at the beam-column joints, which causes clogging at joints. Shear walls are essential to providing enough support in these kinds of practical situations (Reddy & Peera, 2015).The thickness of the shear wall may differ from 140 mm to 500 mm and the construction method is also too quick when compared to the conventional one (Ramprasad & Mouli, 2019).

1.3 Geometry and location of shear wall

Shear walls often have different cross sections, such as L, T, C, and U, and generally have forms like rectangles or other irregular shapes (B.M.E & Eswaramoorthi, 2018).While irregular sections are less common, rectangular cross sections. Where one dimension is much greater than the other one. The structure's behavior can be significantly affected by the placement of shear wall and shape of a shear wall, which helps it withstand seismic pressures and lateral stresses. Shear walls have been placed at desirable places within a building in order to minimize lateral displacements caused by seismic loads and provide an effective lateral force resisting system (BNBC, 2020).The symmetrical and torsional shear walls must be positioned in the proper ways for a construction to be successful.

1.4 Types of earthquake analysis methods

Earthquake analysis methods are usually categorized as the following types:

1. Equivalent static analysis
2. Linear dynamic analysis
3. Non Linear dynamic analysis
4. Response spectrum analysis
5. Time history analysis
6. Push over analysis
7. Non Linear static analysis

For high rise and irregular buildings, dynamic analysis is carried out as per BNBC 2020. Dynamic analysis is done either by Response spectrum method or Time History

method. The current study related with the analysis of a multi storied structure in ETABS software by using response spectrum analysis. Response Spectrum can be defined as a plot of the peak or the graph showing the maximum response (maximum displacement, velocity and acceleration) against the natural frequency of a single degree of freedom system (SDOF) (Lakshmaiah,2017). This method involves finding out the maximum allowable limit of the displacements values and the forces in each mode of vibrations using smooth design spectra which is the average of earthquake motions. The main constraint of the Response spectrum analysis is that they are globally suitable to linear systems only. The current study also related with Analysis of regular and irregular configurations for multi-story buildings in different seismic zones (Nair, 2017).

1.5 Requirement for dynamic analysis

For the following buildings, dynamic analysis should be performed to determine the design seismic force, as well as how the force is distributed among the various lateral load resisting elements and levels along the building's height:

(a) Regular buildings with height greater than 40 m in Zones II, III, IV and greater than 90 m in Zone I (BNBC, 2020).

(b) Irregular buildings with height greater than 12 m in Zones II, III, IV and greater than 40 m in Zone I (BNBC, 2020).

1.6 Objectives of this thesis

The main objectives of this thesis are:

1. To analyze the structure in terms of base shear, displacements, drifts, story deflection, story shear and torsional irregularities by changing stiffness of the structure with different seismic zones of Bangladesh by performing dynamic analysis.

2. To locate the positioning of the shear wall, so that it can effectively resist lateral loads.

3. To compare the behavior of multi storied building with and without shear walls and the results obtained from the analysis.

CHAPTER 2
LITERATURE

(Ahamad & Pratap, 2020) conducted a test on a G+20 story RCC building and contrasted the model's output utilizing shear walls at the structure's two ends and both ends. Their findings indicate that shear walls placed at all four building sides are more effective than those placed at only two. For high-rise buildings, shear walls are also highly advised in order to avoid torsional anomalies.

(Venkatesh Rajeeva & Manilal, 2017) investigated and published the findings of an ETABS research on the seismic response analysis of RC framed buildings with and without shear walls. Their results indicate that shear walls play a critical role in mitigating the effects of seismic activity and subsequent stresses. The study found that utilizing a shear wall significantly lessens lateral displacement and tale drift. It was also shown that in high-rise buildings, the shear wall's placement is crucial.

(B.M.E & Eswaramoorthi, 2018) conducted a comparison study on the best locations for shear walls in various seismic zones for a multi-story RCC construction. For the study, four models were created, and attributes including story shear, displacement, and drift were identified in each of the four zones (Zones II, III, IV, and V). It has been discovered that shear walls work best when they are placed close to the edges of the structure, with zone V seeing the most displacement and drift of stories.

(Magendra,2016) investigated into and released the findings of a research. The ideal position for shear walls in multi-story buildings is examined in this study. It is found that when shear walls are arranged in a box shape in the center or corners of a building, the structure is more stable with respect to features like drift and story displacement, and that overturning moments are reduced compared to conventional structures.

(M & M, 2012) studied the positional arrangement of shear walls under seismic stresses. It has been noticed that the intermediate location of shear walls is ideally fitted when compared to the core and periphery locations.

(Kodag & M, 2013) used three models to conduct a lateral load evaluation of the R.C.C. Building (G+13). The shear wall and bracing systems are absent from the first model, the shear wall system is different in the second model, and the bracing system is different in the third model. In high seismic zone, ETABS is used to do a computerized study that calculates the effective lateral load system during an earthquake. Demand capacity, Base shear, Story shear and drifts, and Lateral displacement are used to gauge the building's performance.

(Hari Krishna, 2016) performed a dynamic analysis of a G+14 story RCC building, using shear walls in the edge and core sections of the construction, and compared the

findings to other seismic zones. Using a shear wall decreased displacement in all earthquake zones, according to the study. In a similar vein, when applied in the core part rather than the outside portion, the same amount of shear wall will sustain a larger lateral force.

(Kabbo, 2024) performed a Dynamic Using shear walls in three different locations on different seismic zones, a G+13 story RCC building was the subject of a dynamic analysis. According to IS 1893:2016, the maximum story displacement and drift are seen to be higher in seismic zone V. This analysis was done to determine the best shear wall placement in a high-slender building by analyzing story displacement, story drift, base shear, and fundamental time period in various seismic zones. When shifting higher seismic zones, torsional anomalies are seen, and the shear wall at each of the four corners performed better than the core of the structure alone.

(Saikumar & Mandava, 2022) comparative analysis of shear wall systems and bracings in earthquake resistant building design using ETABS, the ETABS software is used for modeling a G+13 building, and response spectrum analysis is used for analysis. Results for building models constructed with steel bracings and shear wall systems were compared, including story drift, story shear, story bending, time period, and frequency. The seismic response of the braced frame and shear-wall frame, respectively, is significantly influenced by the position of the bracing and shear-wall elements. The central placements of the brace member and shear wall are advantageous because they effectively reduce.

(Yadav & Reddy, 2017) optimal dimensions reduces costs compared to standard state-of-the-art design methods and includes the ideal stiffness co-relation among structural parts. There have been difficulties in the quest for ever-higher buildings. The rigidity of the structure is increasingly significant as the building gets taller. Tall buildings have persisted in rising taller and higher despite odd loading effects and extremely high loading values brought on by lateral loads that dominate. For tall structures, strength, serviceability, stability, and human comfort are the design factors. Because of this, the impacts of lateral loads such as wind loads and seismic forces are becoming more and more significant, and nearly all designers must deal with the challenge of offering sufficient stability and strength against lateral loads.

(Basavalingappa & B, 2020) shear wall and framed are primarily flexural elements that are typically used in high-rise structures to prevent the buildings from collapsing completely when subjected to seismic stresses. Shear walls are used in elevator each face, corner, and core of the structure to improve the stiffness and behavior of the structure and efficiently withstand both horizontal and vertical forces. Shear walls in the RCC structure have been moved about in this investigation in order to analyze the building. The investigation's findings indicate that shear walls have an influence on high-rise structural systems throughout all seismic zones.

CHAPTER 3
METHODOLOGY

The full process of this thesis is showed in figure 3.1.

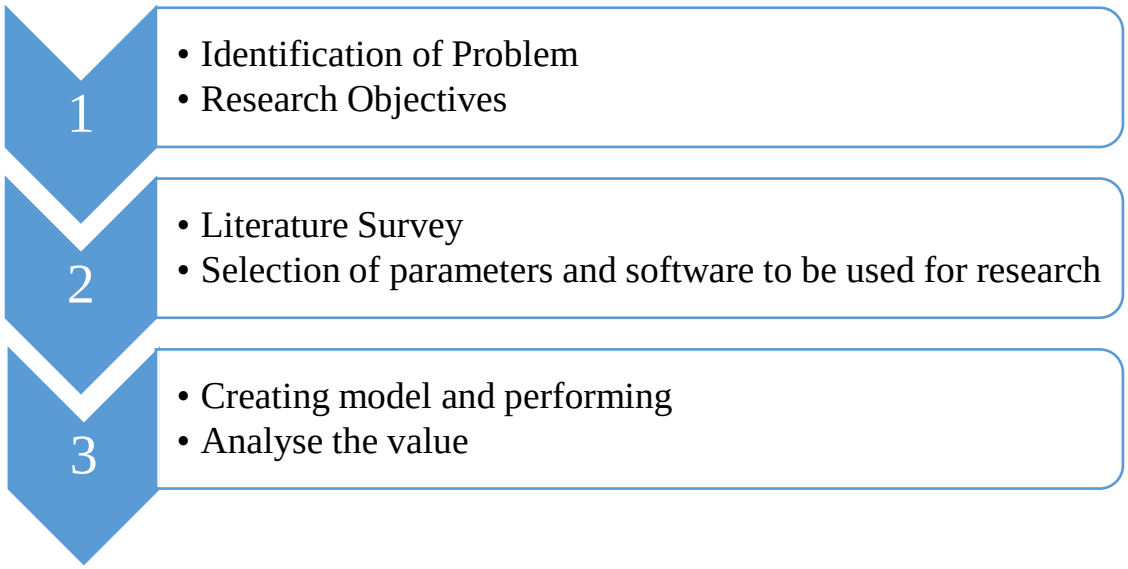

Figure 3.1: Working steps

3.1 Building model and analysis of structure

A G+13 Reinforced concrete building is modeled, analyzed and studied. The model is analyzed for finding out the ideal location of shear walls in the building by using ETABS in the seismic zones of Bangladesh (Zone II, Zone III and Zone IV).The building model specifications, material properties and the loading information can be mentioned as given table 3.1, 3.2 and 3.3.

Table 3.1: Load details for the building

Load type	**Load**
Live load	40 lb/ft^2
Stair live load	100 lb/ft^2
Roof live load	100 lb/ft^2
Wall load on beams	258.3 lb/ft^2
Floor Finishing load	20 lb/ft^2

Table 3.2: Specifications of structure

Parameter	Value
Height of building	136 ft.
Type of structure	Multi story RC frame (G+13)
Floor to Floor height	10 ft.
Soil type	SD
Damping	5%
Support conditions	Fixed
Importance Factor, I	1.35
Response Reduction Factor, R	8
Size of beam	12″x20″
Thickness of slab	5″
Seismic zone	II,III and IV

Table 3.3: Column size

Name of column	Ground Floor	1st floor	2nd floor	3rd to 12th floor
C1	16″x34″	12″x30″	12″x30″	12″x30″
C2	18″x28″	12″x25″	12″x25″	12″x25″
C3	18″x34″	15″x30″	15″x30″	12″x30″

3.2 Optimum location of shear wall

The present work deals with studying the ideal location of a shear wall in a G+13 Multi storied residential building subjected to earthquake loads. G+13 Multi storied residential building column layout plan shown in figure 3.1 and ETABS plan view,3D view and elevation view shown in figure 3.2, 3.3, 3.4,3.5 and 3.6 .Shear walls are located at different locations in a proposed plan and the ideal location of shear walls have been found out by using software ETABS 2016 (Kakpure & Mundhada, 2017). In this paper six different cases have been considered as follows:

Case A: Building without shear wall.
Case B: Building with shear wall at two lower end.
Case C: Building with shear wall at two upper end.
Case D: Building with shear wall diagonally upper left and lower right.
Case E: Building with shear wall diagonally upper right and lower left.
Case F: Building with shear walls at four ends.

The plans of the above cases (Case A, Case B, Case C, Case D, Case E and Case F) are shown in figures 3.7-3.12.

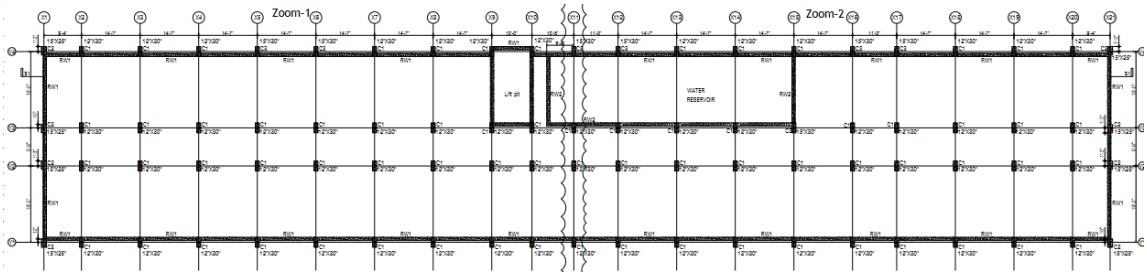

Figure 3.2: Building column layout

3.3 Structural models from ETABS are below:

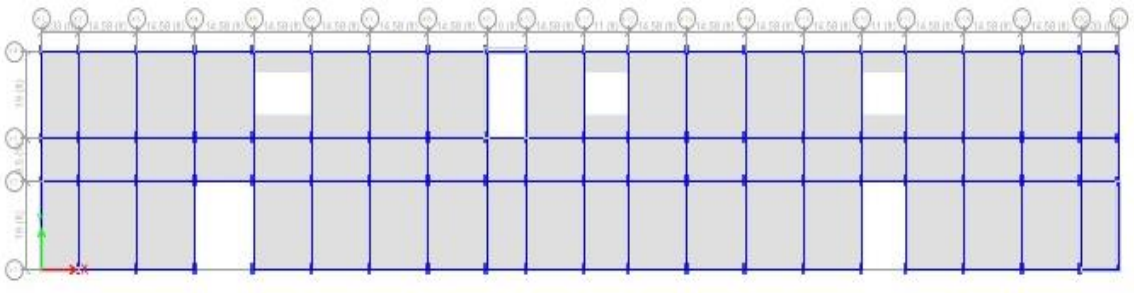

Figure 3.3: Plan of the building

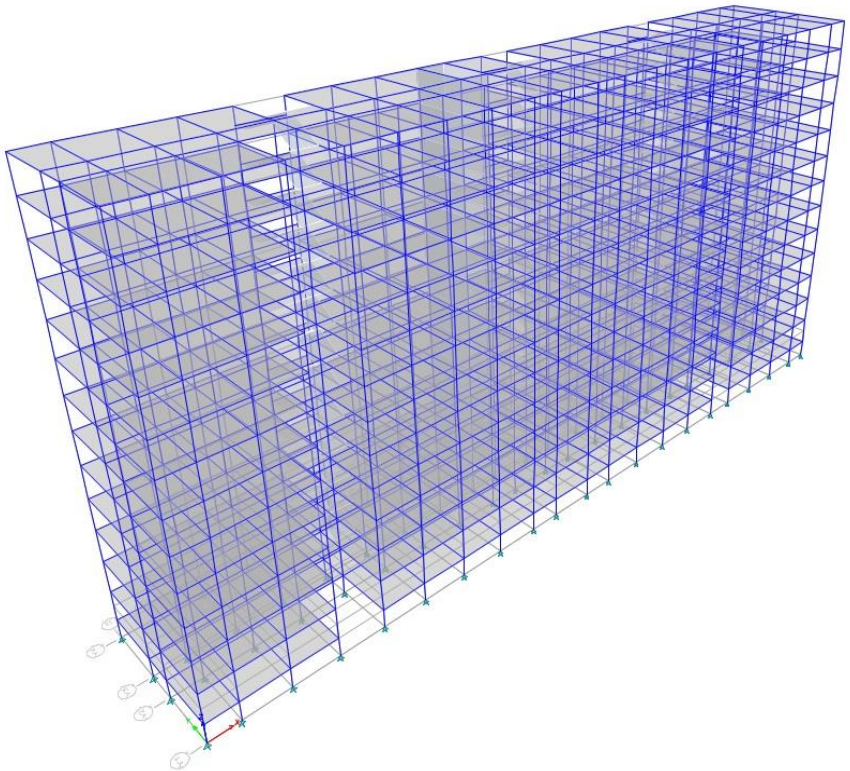

Figure 3.4: 3D view of the building

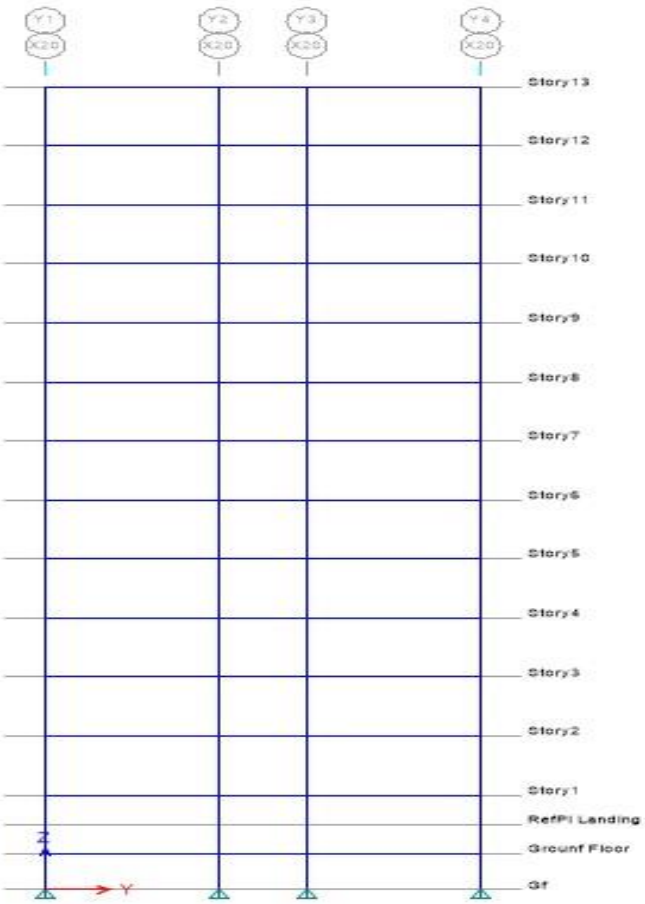

Figure 3.5: Elevation (X20) view of the building

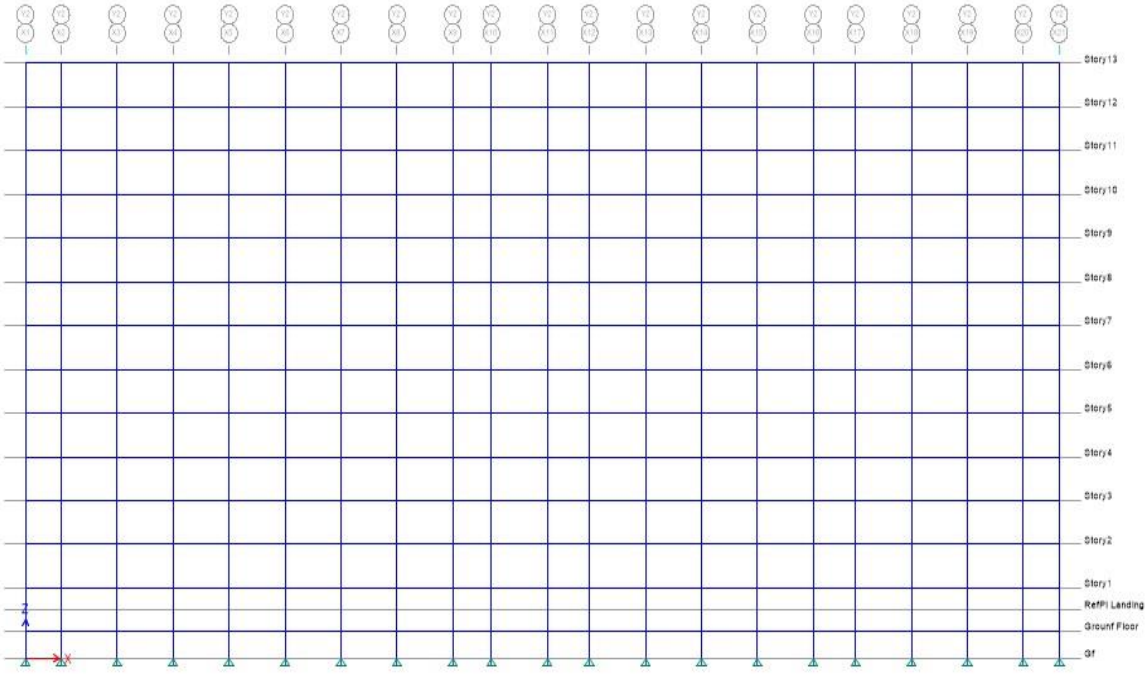

Figure 3.6: Elevation (Y2) view of the building

3.4 Shear wall cases:

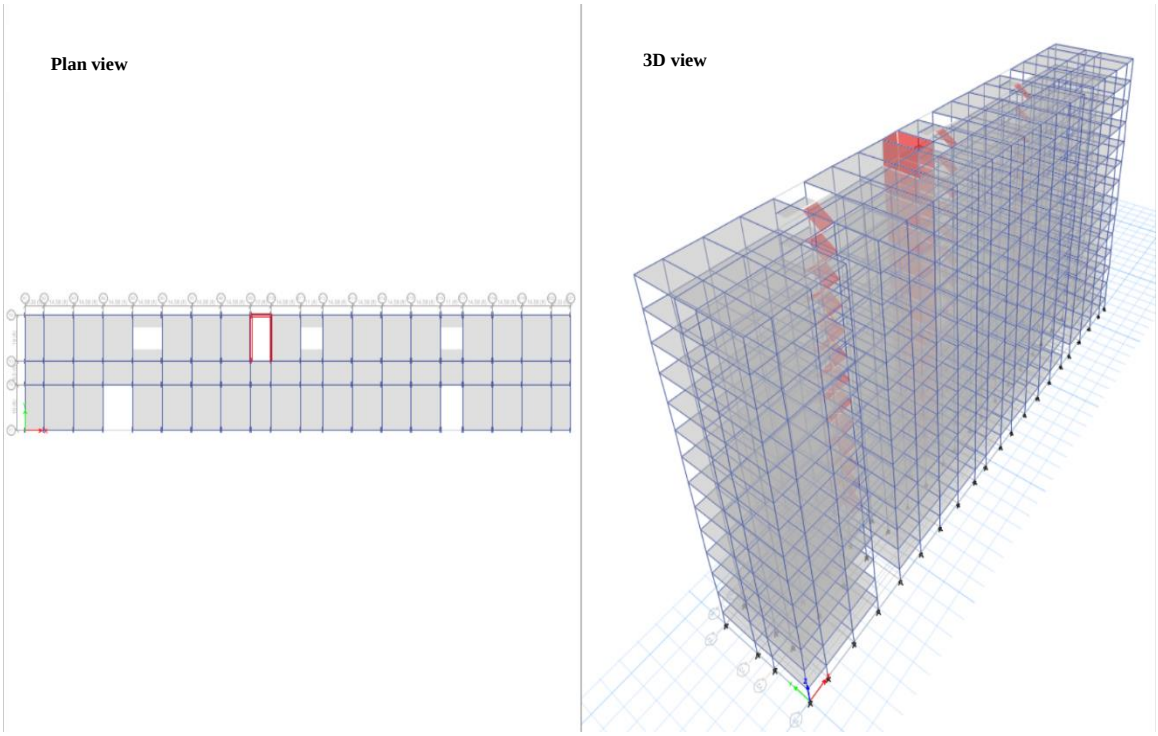

Figure 3.7: Case A (Building without Shear wall)

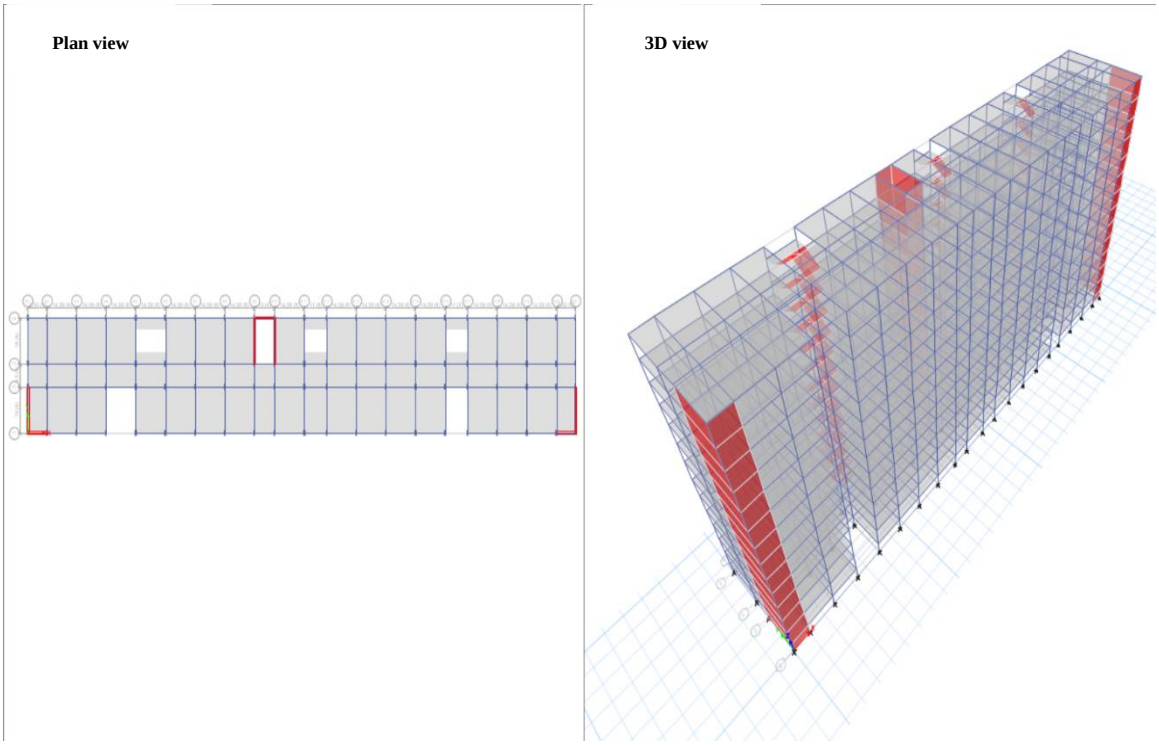

Figure 3.8: Case B (Building shear wall at two lower end)

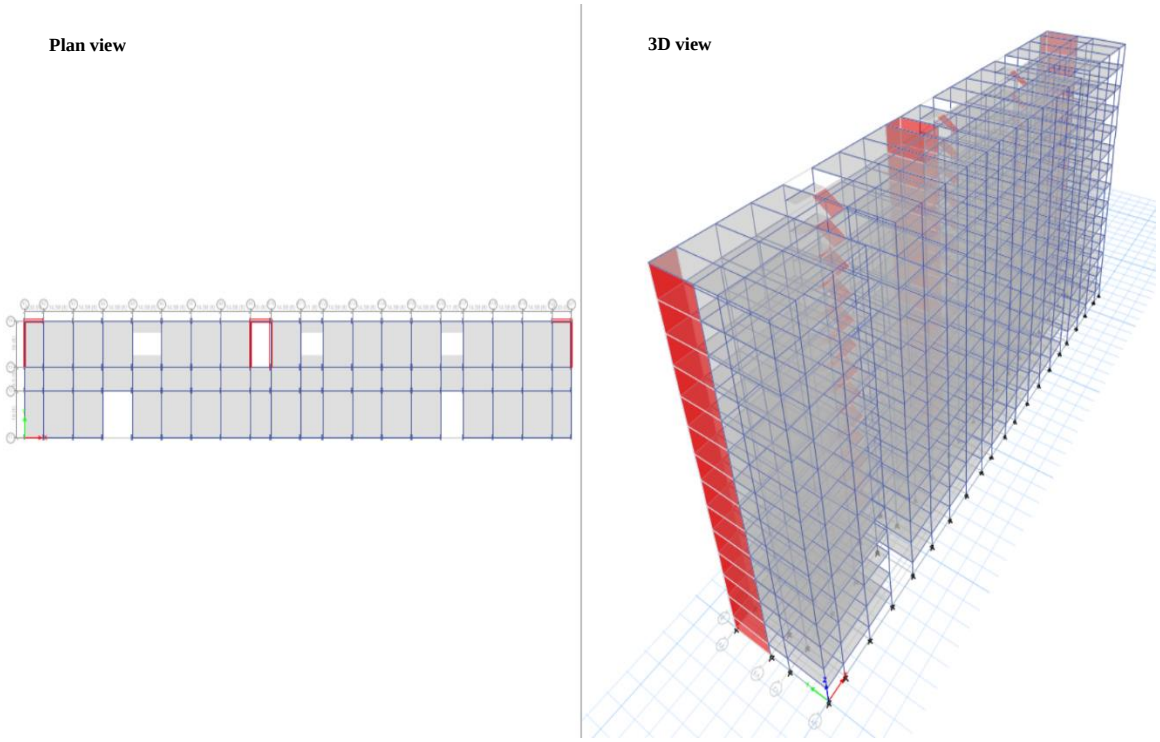

Figure 3.9: Case C (Building Shear wall at two upper end)

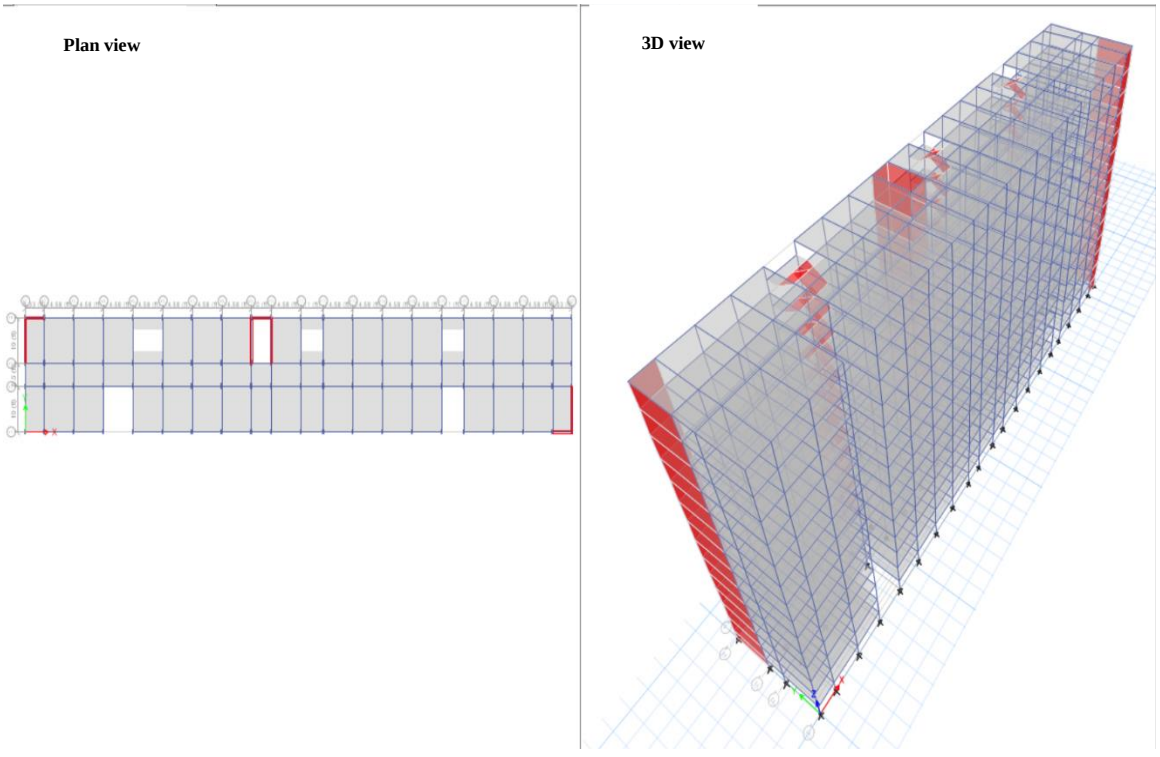

Figure 3.10: Case D (Building shear wall at two side diagonally upper left and lower right)

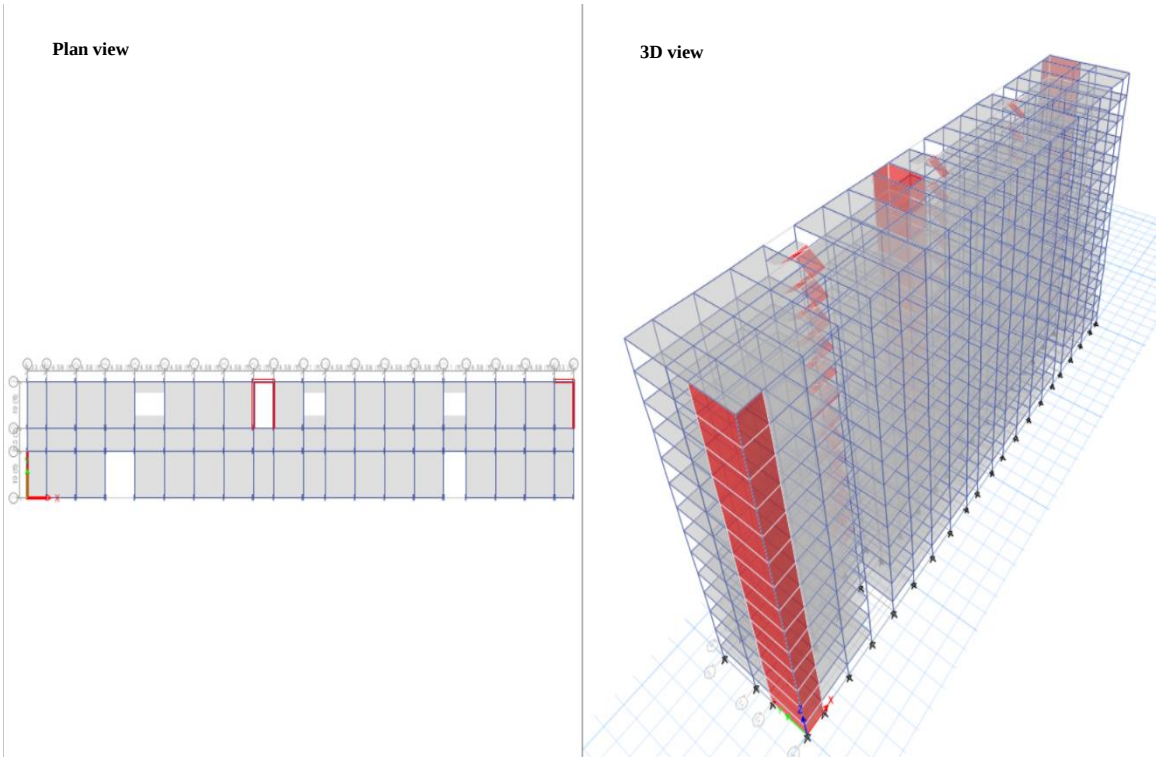

Figure 3.11: Case E (Building shear wall at two side diagonally upper right and lower left)

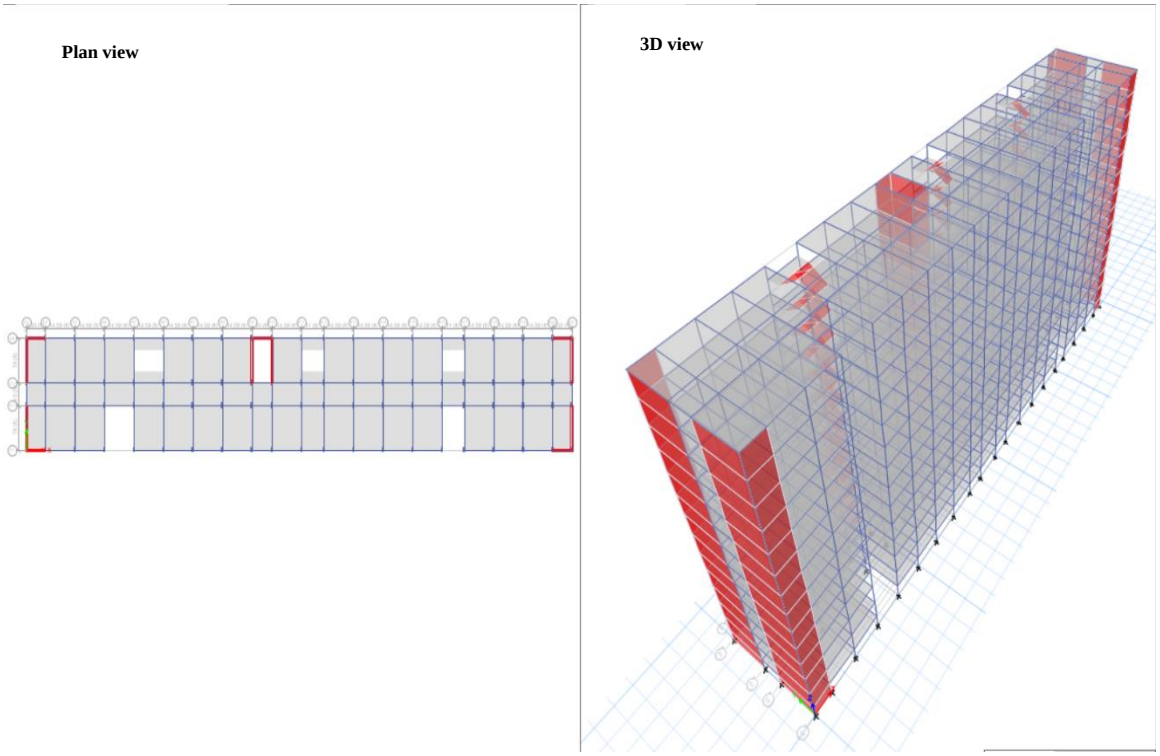

Figure 3.12: Case F (Building shear wall at four ends)

CHAPTER 4
RESULT AND DISCUSSION

4.1 Displacement

Displacement values are shown the following table 4.3-4.8.These tables provide information about the maximum and average displacement due to earthquake load along X and Y direction for seismic zones II, III, IV and for all the cases (A, B, C, D, E and F).

4.2 Story drift

The displacement of one story relative to other story above or below is known as story drift. Story drift values are shown in the following table 4.9-4.14.These tables provide information about the maximum and average story drift due to earthquake load along X and Y direction for seismic zones II, III, IV and for all the case cases (A, B, C, D, E and F).

4.3 Sway

Sway limitation as per as BNBC 2020 the overall sway at the top level of the building due to wind loading shall not exceed 1/500 times of the total height of the building above ground (BNBC, 2020). For this building sway limitation is 3.26 inch. The load combination for sway:

For, X direction: D+0.5L+0.7Wx

For, Y direction: D+0.5L+0.7Wy

The maximum and average sway values for zone II, III and IV and for all the case cases (A, B, C, D, E and F) are showing in the following tables 4.15-4.20. For this building sway limitation is 3.26 inch.

4.4 Base shear

The base shear coefficient, C=0.04229 and K=1.41 for zone II. For zone III and IV the base shear coefficient are C=0.0592 and K=1.41 and C=0.0761 and K=1.41. The base shear for zone II, III, IV and for all the cases (A, B, C, D, E and F) are showing in the tables 4.21, 4.22 and 4.23.

4.5 Time period and frequency

Time and period frequency values zone II, III, IV and for all the cases (A, B, C, D, E and F) are showing in the following tables 4.24, 4.25 and 4.26.

4.6 Base reaction

According to ACI code the base shear that has calculated from the response spectrum function (RSX, RSY) must be at least 85% of the calculated static base shear (Ex1, Ex2 and Ey1, Ey2). For seismic zones II, III and IV for all the case (A, B, C, D, E and F) along X and Y direction the base reaction values shown in the following tables 4.27, 4.28 and 4.29.If the base reaction is less than 85% then we can scale the response spectrum function to be more than 85%.

4.7 Torsional Irregularity

The maximum story drift including accidental torsion, at one end of the structure transverse to an axis is more 1.2 times the average of the story drifts at two ends of the structure.

The average story drifts, $\boldsymbol{\partial}$avg = $\frac{\partial max+\partial min}{2}$

Torsional irregularity coefficient, η= $\frac{\partial max}{\partial avg}$

If, η > 1.2, Torsional Irregularity exit.

If, η > 1.4, Extreme Torsional Irregularity exit.

4.8 Building time period

The time period of a building is it's natural period of oscillation when subjected to ground shaking in the event of an earthquake. The building time period is, T=1.33.

Table 4.1: Torsional check along X direction

Zone	Case A	Case B	Case C	Case D	Case E	Case F
II	1.7	1.02	1.05	1.01	1.01	1
III	1.7	1.02	1.05	1.01	1.01	1
IV	1.7	1.02	1.05	1.01	1.01	1

Table 4.2: Torsional check along Y direction

Zone	Case A	Case B	Case C	Case D	Case E	Case F
II	6.81	1.1	1.11	1.08	1.12	1.05
III	6.81	1.1	1.11	1.08	1.12	1.05
IV	6.81	1.1	1.11	1.05	1.12	1.05

Table 4.3: Maximum and average story displacement due to earthquake load Ex in the direction of X in zone II.

Story	Along X direction																	
	Case A			Case B			Case C			Case D			Case E			Case F		
	Maximum in	Average in	Ratio	Maximum in	Average in	Ratio	Maximum in	Average in	Ratio	Maximum in	Average in	Ratio	Maximum in	Average in	Ratio	Maximum in	Average in	Ratio
Story 13	3.6595	2.7756	1.3180	1.5094	1.4718	1.0260	1.7917	1.6984	1.0550	1.5150	1.4963	1.0120	1.5324	1.5072	1.0170	1.2368	1.2278	1.0070
Story 12	3.4547	2.5955	1.3310	1.3680	1.3338	1.0260	1.6238	1.5394	1.0550	1.3722	1.3554	1.0120	1.3881	1.3654	1.0170	1.1182	1.1101	1.0070
Story 11	3.2299	2.4033	1.3440	1.2253	1.1945	1.0260	1.4545	1.3789	1.0550	1.2283	1.2134	1.0120	1.2425	1.2223	1.0170	0.9989	0.9917	1.0070
Story 10	2.9820	2.1973	1.3570	1.0818	1.0545	1.0260	1.2843	1.2176	1.0550	1.0838	1.0707	1.0120	1.0964	1.0786	1.0160	0.8794	0.8731	1.0070
Story 9	2.7109	1.9779	1.3710	0.9385	0.9147	1.0260	1.1143	1.0564	1.0550	0.9396	0.9284	1.0120	0.9506	0.9353	1.0160	0.7606	0.7552	1.0070
Story 8	2.4194	1.7473	1.3850	0.7970	0.7767	1.0260	0.9462	0.8971	1.0550	0.7973	0.7878	1.0120	0.8066	0.7937	1.0160	0.6438	0.6392	1.0070
Story 7	2.1115	1.5087	1.4000	0.6591	0.6422	1.0260	0.7823	0.7418	1.0550	0.6587	0.6510	1.0120	0.6665	0.6559	1.0160	0.5304	0.5267	1.0070
Story 6	1.7922	1.2658	1.4160	0.5269	0.5133	1.0260	0.6251	0.5928	1.0540	0.5261	0.5199	1.0120	0.5323	0.5238	1.0160	0.4222	0.4192	1.0070
Story 5	1.4678	1.0234	1.4340	0.4028	0.3924	1.0270	0.4775	0.4529	1.0540	0.4017	0.3971	1.0120	0.4065	0.4001	1.0160	0.3212	0.3190	1.0070
Story 4	1.1461	0.7871	1.4560	0.2896	0.2821	1.0270	0.3428	0.3252	1.0540	0.2884	0.2852	1.0110	0.2918	0.2873	1.0160	0.2295	0.2279	1.0070
Story 3	0.8359	0.5635	1.4830	0.1901	0.1852	1.0270	0.2245	0.2131	1.0540	0.1890	0.1869	1.0110	0.1912	0.1883	1.0150	0.1495	0.1485	1.0070
Story 2	0.5493	0.3609	1.5220	0.1076	0.1048	1.0270	0.1265	0.1201	1.0530	0.1068	0.1056	1.0110	0.1080	0.1064	1.0150	0.0838	0.0832	1.0070
Story 1	0.2974	0.1877	1.5840	0.0456	0.0445	1.0260	0.0532	0.0506	1.0520	0.0452	0.0447	1.0100	0.0457	0.0450	1.0140	0.0350	0.0347	1.0060
Ground Floor	0.0956	0.0562	1.7000	0.0087	0.0085	1.0240	0.0100	0.0095	1.0480	0.0086	0.0085	1.0100	0.0087	0.0086	1.0130	0.0064	0.0064	1.0060

Table 4.4: Maximum and average story displacement due to earthquake load Ey in the direction of Y in zone II.

Story	Along Y direction																	
	Case A			Case B			Case C			Case D			Case E			Case F		
	Maximum in	Average in	Ratio	Maximum in	Average in	Ratio	Maximum in	Average in	Ratio	Maximum in	Average in	Ratio	Maximum in	Average in	Ratio	Maximum in	Average in	Ratio
Story 13	4.57175	1.407208	3.249	0.582502	0.534067	1.091	0.591028	0.534541	1.106	0.588595	0.555563	1.059	0.626205	0.559624	1.119	0.393245	0.376849	1.044
Story 12	4.367332	1.298265	3.364	0.525213	0.481453	1.091	0.532923	0.481883	1.106	0.530787	0.500929	1.06	0.564712	0.504601	1.119	0.354562	0.339757	1.044
Story 11	4.129944	1.185067	3.485	0.467737	0.428683	1.091	0.474626	0.429068	1.106	0.472785	0.446126	1.06	0.503014	0.449406	1.119	0.31576	0.302556	1.044
Story 10	3.856037	1.067733	3.611	0.410426	0.376077	1.091	0.416492	0.376417	1.106	0.414935	0.391478	1.06	0.441476	0.394366	1.119	0.277067	0.265462	1.044
Story 9	3.54616	0.94698	3.745	0.353739	0.32406	1.092	0.358987	0.324356	1.107	0.357699	0.337417	1.06	0.380582	0.339915	1.12	0.238796	0.228777	1.044
Story 8	3.204109	0.824154	3.888	0.298285	0.273188	1.092	0.302725	0.273439	1.107	0.301687	0.284519	1.06	0.320981	0.286633	1.12	0.201359	0.192893	1.044
Story 7	2.834714	0.700889	4.044	0.244783	0.224122	1.092	0.248438	0.224329	1.107	0.247626	0.233472	1.061	0.263446	0.235212	1.12	0.165242	0.158277	1.044
Story 6	2.444106	0.579144	4.22	0.194057	0.177615	1.093	0.196961	0.17778	1.108	0.196351	0.185061	1.061	0.208864	0.186444	1.12	0.131	0.125463	1.044
Story 5	2.039682	0.461163	4.423	0.147017	0.134502	1.093	0.149217	0.134628	1.108	0.14878	0.140157	1.062	0.158218	0.141205	1.12	0.099248	0.095037	1.044
Story 4	1.630637	0.349512	4.665	0.104641	0.09568	1.094	0.106202	0.09577	1.109	0.105908	0.099701	1.062	0.112571	0.100445	1.121	0.070647	0.067633	1.045
Story 3	1.227334	0.247002	4.969	0.06797	0.062101	1.095	0.068975	0.06216	1.11	0.068793	0.064691	1.063	0.073057	0.06517	1.121	0.045896	0.043923	1.045
Story 2	0.84347	0.156914	5.375	0.03809	0.03476	1.096	0.038641	0.034793	1.111	0.038539	0.036175	1.065	0.04086	0.036438	1.121	0.025726	0.024607	1.045
Story 1	0.488987	0.082122	5.954	0.016123	0.014685	1.098	0.016345	0.014698	1.112	0.016299	0.015244	1.069	0.017216	0.015348	1.122	0.010894	0.010409	1.047
Ground Floor	0.174331	0.025564	6.819	0.003216	0.002912	1.104	0.003253	0.002914	1.116	0.003243	0.002999	1.081	0.003387	0.003016	1.123	0.002167	0.002064	1.05

Table 4.5: Maximum and average story displacement due to earthquake load Ex in the direction of X in zone III

Story	Along X direction																	
	Case A			Case B			Case C			Case D			Case E			Case F		
	Maximum in	Average in	Ratio	Maximum in	Average in	Ratio	Maximum in	Average in	Ratio	Maximum in	Average in	Ratio	Maximum in	Average in	Ratio	Maximum in	Average in	Ratio
Story 13	5.122756	3.88542	1.318	2.112974	2.060344	1.026	2.508124	2.37753	1.055	2.120723	2.094623	1.012	2.145106	2.109923	1.017	1.731349	1.718778	1.007
Story 12	4.836104	3.633357	1.331	1.914955	1.867073	1.026	2.273156	2.154877	1.055	1.920922	1.897419	1.012	1.943076	1.911329	1.017	1.565273	1.55396	1.007
Story 11	4.521468	3.364309	1.344	1.71519	1.672114	1.026	2.036151	1.930273	1.055	1.719484	1.698583	1.012	1.739385	1.711086	1.017	1.398293	1.388238	1.007
Story 10	4.174347	3.075931	1.357	1.514346	1.476136	1.026	1.797845	1.704425	1.055	1.517144	1.498832	1.012	1.534769	1.509912	1.016	1.231058	1.222255	1.007
Story 9	3.794838	2.768793	1.371	1.313822	1.28051	1.026	1.559829	1.478845	1.055	1.315322	1.299567	1.012	1.33066	1.309217	1.016	1.064784	1.057217	1.007
Story 8	3.386838	2.446023	1.385	1.115712	1.08728	1.026	1.324547	1.255853	1.055	1.116119	1.102862	1.012	1.129184	1.111088	1.016	0.901203	0.894842	1.007
Story 7	2.95584	2.111922	1.4	0.92261	0.898977	1.026	1.095062	1.038354	1.055	0.922137	0.91129	1.012	0.932967	0.918113	1.016	0.742445	0.737246	1.007
Story 6	2.508854	1.77189	1.416	0.73754	0.718547	1.026	0.874987	0.82977	1.054	0.736414	0.727849	1.012	0.745084	0.733314	1.016	0.590981	0.58688	1.007
Story 5	2.054736	1.432563	1.434	0.563902	0.549304	1.027	0.668411	0.633973	1.054	0.562365	0.555913	1.012	0.568993	0.560091	1.016	0.449579	0.446493	1.007
Story 4	1.604356	1.101886	1.456	0.405432	0.394885	1.027	0.479857	0.455247	1.054	0.403749	0.399195	1.011	0.408498	0.402186	1.016	0.321268	0.319094	1.007
Story 3	1.170092	0.788821	1.483	0.266177	0.259231	1.027	0.314248	0.298247	1.054	0.264623	0.261702	1.011	0.267712	0.263643	1.015	0.209306	0.207915	1.007
Story 2	0.768884	0.505239	1.522	0.150655	0.146731	1.027	0.17709	0.168188	1.053	0.149487	0.147884	1.011	0.151196	0.148953	1.015	0.117247	0.116487	1.007
Story 1	0.416285	0.262787	1.584	0.063878	0.062244	1.026	0.074467	0.07082	1.052	0.06326	0.06261	1.01	0.063947	0.063035	1.014	0.048941	0.048636	1.006
Ground Floor	0.133839	0.078719	1.7	0.012204	0.011918	1.024	0.013937	0.013304	1.048	0.012071	0.011955	1.01	0.012182	0.012023	1.013	0.009006	0.008955	1.006

Table 4.6: Maximum and average story displacement due to earthquake load Ey in the direction of Y in zone III

Story	Along Y direction																	
	Case A			Case B			Case C			Case D			Case E			Case F		
	Maximum in	Average in	Ratio	Maximum in	Average in	Ratio	Maximum in	Average in	Ratio	Maximum in	Average in	Ratio	Maximum in	Average in	Ratio	Maximum in	Average in	Ratio
Story 13	6.399802	1.969891	3.249	0.81542	0.747617	1.091	0.827355	0.748281	1.106	0.823949	0.77771	1.059	0.876598	0.783394	1.119	0.550487	0.527535	1.044
Story 12	6.113646	1.817386	3.364	0.735224	0.673965	1.091	0.746016	0.674567	1.106	0.743026	0.701229	1.06	0.790517	0.70637	1.119	0.496336	0.475612	1.044
Story 11	5.781336	1.658925	3.485	0.654766	0.600095	1.091	0.664409	0.600634	1.106	0.661832	0.624514	1.06	0.704148	0.629105	1.119	0.442019	0.423535	1.044
Story 10	5.397905	1.494675	3.611	0.574538	0.526455	1.091	0.583029	0.526931	1.106	0.580851	0.548013	1.06	0.618003	0.552056	1.119	0.387854	0.371609	1.044
Story 9	4.96412	1.325638	3.745	0.495185	0.453639	1.092	0.502531	0.454052	1.107	0.500728	0.472336	1.06	0.532761	0.475833	1.12	0.334281	0.320255	1.044
Story 8	4.485298	1.153698	3.888	0.417557	0.382425	1.092	0.423773	0.382776	1.107	0.422319	0.398286	1.06	0.449328	0.401245	1.12	0.281874	0.270023	1.044
Story 7	3.968197	0.981145	4.044	0.342662	0.313738	1.092	0.347778	0.314028	1.107	0.346642	0.326827	1.061	0.368787	0.329263	1.12	0.231315	0.221566	1.044
Story 6	3.421402	0.81072	4.22	0.271653	0.248636	1.093	0.275717	0.248867	1.108	0.274863	0.259059	1.061	0.29238	0.260995	1.12	0.183382	0.17563	1.044
Story 5	2.855266	0.645563	4.423	0.205802	0.188283	1.093	0.208883	0.18846	1.108	0.208271	0.1962	1.062	0.221482	0.197667	1.12	0.138933	0.133038	1.044
Story 4	2.28266	0.489267	4.665	0.146482	0.133938	1.094	0.148668	0.134064	1.109	0.148256	0.139567	1.062	0.157584	0.140609	1.121	0.098895	0.094677	1.045
Story 3	1.718093	0.345768	4.969	0.095148	0.086933	1.095	0.096556	0.087015	1.11	0.0963	0.090558	1.063	0.102269	0.091229	1.121	0.064247	0.061486	1.045
Story 2	1.180738	0.219657	5.375	0.05332	0.04866	1.096	0.054092	0.048705	1.111	0.053949	0.05064	1.065	0.057198	0.051009	1.121	0.036013	0.034446	1.045
Story 1	0.684512	0.114959	5.954	0.02257	0.020556	1.098	0.02288	0.020575	1.112	0.022816	0.021339	1.069	0.024099	0.021485	1.122	0.01525	0.014572	1.047
Ground Floor	0.244039	0.035786	6.819	0.004501	0.004076	1.104	0.004554	0.004079	1.116	0.00454	0.004199	1.081	0.004742	0.004222	1.123	0.003034	0.00289	1.05

Table 4.7: Maximum and average story displacement due to earthquake load Ex in the direction of X in zone IV

Story	Along X direction																	
	Case A			Case B			Case C			Case D			Case E			Case F		
	Maximum in	Average in	Ratio	Maximum in	Average in	Ratio	Maximum in	Average in	Ratio	Maximum in	Average in	Ratio	Maximum in	Average in	Ratio	Maximum in	Average in	Ratio
Story 13	6.585164	4.994602	1.318	2.716171	2.648516	1.026	3.224126	3.056251	1.055	2.726132	2.692581	1.012	2.757475	2.712249	1.017	2.225603	2.209442	1.007
Story 12	6.216681	4.670582	1.331	2.461623	2.400072	1.026	2.922081	2.770036	1.055	2.469293	2.439081	1.012	2.497771	2.456962	1.017	2.012116	1.997573	1.007
Story 11	5.812225	4.324728	1.344	2.20483	2.149458	1.026	2.617417	2.481314	1.055	2.210351	2.183483	1.012	2.235933	2.199555	1.017	1.797468	1.784543	1.007
Story 10	5.366011	3.954026	1.357	1.94665	1.897532	1.026	2.311081	2.190992	1.055	1.950248	1.926708	1.012	1.972904	1.940951	1.016	1.582491	1.571176	1.007
Story 9	4.878162	3.559209	1.371	1.688883	1.646061	1.026	2.005118	1.901016	1.055	1.690811	1.670558	1.012	1.710528	1.682963	1.016	1.368751	1.359024	1.007
Story 8	4.353689	3.144297	1.385	1.434217	1.397669	1.026	1.702669	1.614365	1.055	1.43474	1.417699	1.012	1.451535	1.428274	1.016	1.158472	1.150296	1.007
Story 7	3.799653	2.714819	1.4	1.185991	1.155611	1.026	1.407673	1.334776	1.055	1.185383	1.171439	1.012	1.199304	1.18021	1.016	0.954393	0.947709	1.007
Story 6	3.225064	2.277717	1.416	0.948088	0.923673	1.026	1.124772	1.066647	1.054	0.94664	0.93563	1.012	0.957786	0.942655	1.016	0.75969	0.754418	1.007
Story 5	2.641308	1.841521	1.434	0.724881	0.706115	1.027	0.859224	0.814955	1.054	0.722906	0.714611	1.012	0.731426	0.719981	1.016	0.577921	0.573955	1.007
Story 4	2.062357	1.416445	1.456	0.521172	0.507614	1.027	0.616843	0.585207	1.054	0.519009	0.513154	1.011	0.525114	0.516999	1.016	0.412981	0.410186	1.007
Story 3	1.504122	1.014008	1.483	0.342164	0.333234	1.027	0.403957	0.383389	1.054	0.340166	0.336411	1.011	0.344136	0.338906	1.015	0.269057	0.267269	1.007
Story 2	0.988379	0.649471	1.522	0.193663	0.188619	1.027	0.227645	0.216201	1.053	0.192161	0.190101	1.011	0.194358	0.191475	1.015	0.150717	0.149741	1.007
Story 1	0.535123	0.337806	1.584	0.082113	0.080013	1.026	0.095725	0.091037	1.052	0.08132	0.080483	1.01	0.082202	0.08103	1.014	0.062912	0.06252	1.006
Ground Floor	0.172047	0.101192	1.7	0.015688	0.015321	1.024	0.017915	0.017102	1.048	0.015517	0.015368	1.01	0.01566	0.015455	1.013	0.011577	0.011511	1.006

Table 4.8: Maximum and average story displacement due to earthquake load Ey in the direction of Y in zone IV

Story	Along Y direction																	
	Case A			Case B			Case C			Case D			Case E			Case F		
	Maximum in	Average in	Ratio	Maximum in	Average in	Ratio	Maximum in	Average in	Ratio	Maximum in	Average in	Ratio	Maximum in	Average in	Ratio	Maximum in	Average in	Ratio
Story 13	8.226772	2.532242	3.249	1.0482	0.961042	1.091	1.063543	0.961895	1.106	0.334106	0.323624	1.032	1.126843	1.007032	1.119	0.707637	0.678132	1.044
Story 12	7.858926	2.336201	3.364	0.945111	0.866364	1.091	0.958984	0.867138	1.106	0.302667	0.293192	1.032	1.016188	0.908019	1.119	0.638027	0.611386	1.044
Story 11	7.431751	2.132504	3.485	0.841684	0.771406	1.091	0.854079	0.772099	1.106	0.270994	0.262535	1.032	0.905163	0.808698	1.119	0.568204	0.544443	1.044
Story 10	6.938861	1.921364	3.611	0.738553	0.676743	1.091	0.749469	0.677356	1.106	0.239162	0.231718	1.032	0.794427	0.709653	1.119	0.498576	0.477694	1.044
Story 9	6.381242	1.704072	3.745	0.636547	0.58314	1.092	0.64599	0.583672	1.107	0.207364	0.200928	1.032	0.68485	0.61167	1.12	0.429709	0.41168	1.044
Story 8	5.765729	1.483048	3.888	0.536758	0.491596	1.092	0.544748	0.492048	1.107	0.175917	0.170469	1.032	0.5776	0.51579	1.12	0.362341	0.347107	1.044
Story 7	5.10101	1.261236	4.044	0.440482	0.403302	1.092	0.447059	0.403675	1.107	0.14523	0.140738	1.032	0.474065	0.423259	1.12	0.297349	0.284817	1.044
Story 6	4.39812	1.042159	4.22	0.349202	0.319615	1.093	0.354427	0.319912	1.108	0.11579	0.112208	1.032	0.375846	0.335501	1.12	0.235732	0.225768	1.044
Story 5	3.670367	0.829854	4.423	0.264553	0.242033	1.093	0.268513	0.24226	1.108	0.088155	0.085419	1.032	0.28471	0.254096	1.12	0.178595	0.171017	1.044
Story 4	2.934298	0.628939	4.665	0.188299	0.172174	1.094	0.191109	0.172336	1.109	0.062945	0.060975	1.032	0.20257	0.180749	1.121	0.127127	0.121705	1.045
Story 3	2.208563	0.444476	4.969	0.122311	0.11175	1.095	0.12412	0.111855	1.11	0.04084	0.039538	1.033	0.131464	0.117273	1.121	0.082588	0.079039	1.045
Story 2	1.517807	0.282364	5.375	0.068541	0.06255	1.096	0.069533	0.062609	1.111	0.022607	0.021857	1.034	0.073526	0.06557	1.121	0.046293	0.044279	1.045
Story 1	0.879921	0.147776	5.954	0.029013	0.026425	1.098	0.029412	0.026448	1.112	0.009099	0.008764	1.038	0.030979	0.027619	1.122	0.019603	0.018731	1.047
Ground Floor	0.313706	0.046002	6.819	0.005786	0.00524	1.104	0.005854	0.005244	1.116	0.001445	0.001368	1.056	0.006095	0.005427	1.123	0.0039	0.003715	1.05

Table 4.9: Maximum and average story drifts due to earthquake load Ex in the direction of X in zone II

Story	Along X direction																	
	Case A			Case B			Case C			Case D			Case E			Case F		
	Maximum in	Average in	Ratio	Maximum in	Average in	Ratio	Maximum in	Average in	Ratio	Maximum in	Average in	Ratio	Maximum in	Average in	Ratio	Maximum in	Average in	Ratio
Story 13	0.204772	0.180064	1.137	0.141456	0.138064	1.025	0.167851	0.159054	1.055	0.14273	0.140874	1.013	0.144322	0.141867	1.017	0.118638	0.117739	1.008
Story 12	0.224763	0.192196	1.169	0.142704	0.139271	1.025	0.169307	0.160448	1.055	0.143898	0.14204	1.013	0.145508	0.143045	1.017	0.119284	0.118384	1.008
Story 11	0.247968	0.206005	1.204	0.143475	0.139999	1.025	0.170236	0.161336	1.055	0.144543	0.142694	1.013	0.146169	0.14371	1.017	0.119466	0.118571	1.008
Story 10	0.271105	0.219406	1.236	0.143245	0.139747	1.025	0.170028	0.161145	1.055	0.144173	0.142347	1.013	0.145807	0.143369	1.017	0.118779	0.117896	1.007
Story 9	0.291458	0.230574	1.264	0.141522	0.138036	1.025	0.168076	0.159296	1.055	0.142303	0.140517	1.013	0.143927	0.141535	1.017	0.116855	0.115994	1.007
Story 8	0.307887	0.238668	1.29	0.137944	0.134516	1.025	0.163934	0.155372	1.055	0.138572	0.136851	1.013	0.140169	0.137853	1.017	0.11341	0.11258	1.007
Story 7	0.319308	0.242904	1.315	0.132206	0.128891	1.026	0.157213	0.149004	1.055	0.132673	0.131043	1.012	0.134216	0.132013	1.017	0.1082	0.107415	1.007
Story 6	0.324403	0.242401	1.338	0.12404	0.120901	1.026	0.147569	0.139869	1.055	0.124333	0.122823	1.012	0.125792	0.123743	1.017	0.101012	0.100286	1.007
Story 5	0.321732	0.236222	1.362	0.113204	0.11031	1.026	0.134695	0.127675	1.055	0.113309	0.111953	1.012	0.114651	0.112801	1.016	0.09166	0.091009	1.007
Story 4	0.31022	0.223641	1.387	0.099478	0.096906	1.027	0.118304	0.112154	1.055	0.099386	0.098219	1.012	0.100572	0.098969	1.016	0.079981	0.079421	1.007
Story 3	0.286607	0.202579	1.415	0.082524	0.080365	1.027	0.09798	0.092909	1.055	0.082248	0.081307	1.012	0.083234	0.08193	1.016	0.065764	0.065313	1.007
Story 2	0.251882	0.173198	1.454	0.06199	0.060354	1.027	0.07331	0.069556	1.054	0.061597	0.060917	1.011	0.062327	0.061376	1.015	0.048795	0.04847	1.007
Story 1	0.201767	0.13149	1.534	0.036914	0.035951	1.027	0.04324	0.041087	1.052	0.036568	0.036185	1.011	0.036979	0.036441	1.015	0.028528	0.028347	1.006
Ground Floor	0.095609	0.056234	1.7	0.008718	0.008514	1.024	0.009956	0.009504	1.048	0.008623	0.00854	1.01	0.008702	0.008589	1.013	0.006434	0.006397	1.006

Table 4. 10 Maximum and average story drifts due to earthquake load Ey in the direction of Y in zone II

Story	Along Y direction																	
	Case A			Case B			Case C			Case D			Case E			Case F		
	Maximum in	Average in	Ratio	Maximum in	Average in	Ratio	Maximum in	Average in	Ratio	Maximum in	Average in	Ratio	Maximum in	Average in	Ratio	Maximum in	Average in	Ratio
Story 13	0.204418	0.108943	1.876	0.057289	0.052614	1.089	0.058105	0.052658	1.103	0.057808	0.054635	1.058	0.061493	0.055023	1.118	0.038683	0.037092	1.043
Story 12	0.237388	0.113198	2.097	0.057476	0.05277	1.089	0.058297	0.052815	1.104	0.058002	0.054802	1.058	0.061698	0.055194	1.118	0.038802	0.037201	1.043
Story 11	0.273907	0.117334	2.334	0.057311	0.052605	1.089	0.058134	0.05265	1.104	0.05785	0.054649	1.059	0.061538	0.055041	1.118	0.038693	0.037094	1.043
Story 10	0.309878	0.120752	2.566	0.056686	0.052017	1.09	0.057505	0.052062	1.105	0.057236	0.054061	1.059	0.060893	0.054451	1.118	0.03827	0.036685	1.043
Story 9	0.34205	0.122827	2.785	0.055455	0.050872	1.09	0.056261	0.050917	1.105	0.056012	0.052898	1.059	0.059601	0.053282	1.119	0.037438	0.035884	1.043
Story 8	0.369396	0.123264	2.997	0.053502	0.049067	1.09	0.054287	0.04911	1.105	0.054061	0.051047	1.059	0.057536	0.051421	1.119	0.036117	0.034616	1.043
Story 7	0.390607	0.121745	3.208	0.050726	0.046507	1.091	0.051477	0.046548	1.106	0.051276	0.048411	1.059	0.054582	0.048768	1.119	0.034241	0.032815	1.043
Story 6	0.404424	0.117981	3.428	0.047041	0.043113	1.091	0.047744	0.043153	1.106	0.047571	0.044904	1.059	0.050646	0.045238	1.12	0.031752	0.030426	1.044
Story 5	0.409046	0.111652	3.664	0.042376	0.038822	1.092	0.043015	0.038858	1.107	0.042872	0.040456	1.06	0.045646	0.04076	1.12	0.028602	0.027403	1.044
Story 4	0.403303	0.102509	3.934	0.036671	0.033579	1.092	0.037227	0.03361	1.108	0.037116	0.03501	1.06	0.039515	0.035275	1.12	0.024751	0.02371	1.044
Story 3	0.383864	0.090088	4.261	0.029881	0.027341	1.093	0.030334	0.027367	1.108	0.030254	0.028515	1.061	0.032197	0.028732	1.121	0.02017	0.019316	1.044
Story 2	0.354483	0.074792	4.74	0.021966	0.020076	1.094	0.022296	0.020095	1.11	0.02224	0.020932	1.063	0.023644	0.02109	1.121	0.014832	0.014197	1.045
Story 1	0.314655	0.056558	5.563	0.012908	0.011773	1.096	0.013092	0.011784	1.111	0.013056	0.012244	1.066	0.013829	0.012332	1.121	0.008727	0.008345	1.046
Ground Floor	0.174331	0.025564	6.819	0.003216	0.002912	1.104	0.003253	0.002914	1.116	0.003243	0.002999	1.081	0.003387	0.003016	1.123	0.002167	0.002064	1.05

Table 4. 11: Maximum and average story drifts due to earthquake load Ex in the direction of X in zone III

Story	Along X direction																	
	Case A			Case B			Case C			Case D			Case E			Case F		
	Maximum in	Average in	Ratio	Maximum in	Average in	Ratio	Maximum in	Average in	Ratio	Maximum in	Average in	Ratio	Maximum in	Average in	Ratio	Maximum in	Average in	Ratio
Story 13	0.286652	0.252063	1.137	0.198019	0.19327	1.025	0.234968	0.222653	1.055	0.199802	0.197204	1.013	0.20203	0.198594	1.017	0.166077	0.164818	1.008
Story 12	0.314636	0.269048	1.169	0.199765	0.194959	1.025	0.237005	0.224604	1.055	0.201437	0.198836	1.013	0.20369	0.200243	1.017	0.16698	0.165721	1.008
Story 11	0.347121	0.288378	1.204	0.200844	0.195979	1.025	0.238306	0.225848	1.055	0.20234	0.199752	1.013	0.204616	0.201174	1.017	0.167235	0.165983	1.008
Story 10	0.379509	0.307137	1.236	0.200523	0.195626	1.025	0.238016	0.22558	1.055	0.201822	0.199265	1.013	0.204109	0.200696	1.017	0.166274	0.165038	1.007
Story 9	0.408	0.32277	1.264	0.19811	0.19323	1.025	0.235282	0.222992	1.055	0.199204	0.196704	1.013	0.201477	0.198128	1.017	0.163581	0.162375	1.007
Story 8	0.430998	0.334101	1.29	0.193102	0.188303	1.025	0.229485	0.217499	1.055	0.193981	0.191572	1.013	0.196216	0.192975	1.017	0.158758	0.157597	1.007
Story 7	0.446986	0.340032	1.315	0.18507	0.18043	1.026	0.220075	0.208584	1.055	0.185724	0.183442	1.012	0.187883	0.1848	1.017	0.151464	0.150366	1.007
Story 6	0.454118	0.339327	1.338	0.173638	0.169244	1.026	0.206576	0.195797	1.055	0.174048	0.171935	1.012	0.176091	0.173223	1.017	0.141402	0.140386	1.007
Story 5	0.45038	0.330677	1.362	0.15847	0.154418	1.026	0.188554	0.178727	1.055	0.158616	0.156719	1.012	0.160495	0.157905	1.016	0.128311	0.1274	1.007
Story 4	0.434264	0.313065	1.387	0.139255	0.135655	1.027	0.165609	0.156999	1.055	0.139126	0.137493	1.012	0.140787	0.138543	1.016	0.111962	0.111178	1.007
Story 3	0.401209	0.283582	1.415	0.115522	0.1125	1.027	0.137157	0.130059	1.055	0.115136	0.113818	1.012	0.116516	0.11469	1.016	0.09206	0.091428	1.007
Story 2	0.352599	0.242452	1.454	0.086778	0.084487	1.027	0.102623	0.097368	1.054	0.086226	0.085275	1.011	0.087249	0.085918	1.015	0.068306	0.067851	1.007
Story 1	0.282446	0.184068	1.534	0.051674	0.050326	1.027	0.06053	0.057516	1.052	0.05119	0.050654	1.011	0.051765	0.051012	1.015	0.039935	0.039681	1.006
Ground Floor	0.133839	0.078719	1.7	0.012204	0.011918	1.024	0.013937	0.013304	1.048	0.012071	0.011955	1.01	0.012182	0.012023	1.013	0.009006	0.008955	1.006

Table 4.12: Maximum and average story drifts due to earthquake load Ey in the direction of Y in zone III

Story	Along Y direction																	
	Case A			Case B			Case C			Case D			Case E			Case F		
	Maximum in	Average in	Ratio	Maximum in	Average in	Ratio	Maximum in	Average in	Ratio	Maximum in	Average in	Ratio	Maximum in	Average in	Ratio	Maximum in	Average in	Ratio
Story 13	0.286156	0.152505	1.876	0.080196	0.073652	1.089	0.081339	0.073714	1.103	0.080922	0.076481	1.058	0.086081	0.077024	1.118	0.054151	0.051923	1.043
Story 12	0.33231	0.158461	2.097	0.080458	0.073871	1.089	0.081608	0.073933	1.104	0.081194	0.076716	1.058	0.086369	0.077264	1.118	0.054317	0.052076	1.043
Story 11	0.38343	0.164251	2.334	0.080228	0.07364	1.089	0.081379	0.073703	1.104	0.080981	0.0765	1.059	0.086145	0.077049	1.118	0.054165	0.051926	1.043
Story 10	0.433785	0.169036	2.566	0.079353	0.072816	1.09	0.080499	0.072879	1.105	0.080123	0.075677	1.059	0.085242	0.076223	1.118	0.053573	0.051354	1.043
Story 9	0.478822	0.17194	2.785	0.077628	0.071214	1.09	0.078758	0.071276	1.105	0.078409	0.074049	1.059	0.083433	0.074587	1.119	0.052407	0.050233	1.043
Story 8	0.517101	0.172553	2.997	0.074895	0.068686	1.09	0.075995	0.068747	1.105	0.075677	0.071459	1.059	0.080542	0.071982	1.119	0.050559	0.048457	1.043
Story 7	0.546795	0.170426	3.208	0.071009	0.065103	1.091	0.072061	0.065161	1.106	0.071779	0.067768	1.059	0.076407	0.068269	1.119	0.047933	0.045936	1.043
Story 6	0.566136	0.165156	3.428	0.065851	0.060353	1.091	0.066835	0.060408	1.106	0.066592	0.062859	1.059	0.070897	0.063327	1.12	0.044448	0.042592	1.044
Story 5	0.572606	0.156297	3.664	0.05932	0.054345	1.092	0.060215	0.054396	1.107	0.060014	0.056633	1.06	0.063899	0.057059	1.12	0.040038	0.038361	1.044
Story 4	0.564566	0.143499	3.934	0.051334	0.047005	1.092	0.052113	0.04705	1.108	0.051956	0.049009	1.06	0.055315	0.04938	1.12	0.034648	0.033191	1.044
Story 3	0.537356	0.126111	4.261	0.041828	0.038273	1.093	0.042464	0.03831	1.108	0.042351	0.039918	1.061	0.045071	0.040221	1.121	0.028235	0.02704	1.044
Story 2	0.496226	0.104699	4.74	0.03075	0.028103	1.094	0.031212	0.02813	1.11	0.031133	0.029301	1.063	0.033098	0.029523	1.121	0.020763	0.019874	1.045
Story 1	0.440473	0.079173	5.563	0.018069	0.01648	1.096	0.018326	0.016496	1.111	0.018277	0.01714	1.066	0.019358	0.017263	1.121	0.012216	0.011682	1.046
Ground Floor	0.244039	0.035786	6.819	0.004501	0.004076	1.104	0.004554	0.004079	1.116	0.00454	0.004199	1.081	0.004742	0.004222	1.123	0.003034	0.00289	1.05

Table 4.13: Maximum and average story drifts due to earthquake load Ex in the direction of X in zone IV

Story	Along X direction																	
	Case A			Case B			Case C			Case D			Case E			Case F		
	Maximum in	Average in	Ratio	Maximum in	Average in	Ratio	Maximum in	Average in	Ratio	Maximum in	Average in	Ratio	Maximum in	Average in	Ratio	Maximum in	Average in	Ratio
Story 13	0.368483	0.324021	1.137	0.254547	0.248444	1.025	0.302045	0.286215	1.055	0.25684	0.2535	1.013	0.259704	0.255287	1.017	0.213487	0.211869	1.008
Story 12	0.404457	0.345853	1.169	0.256793	0.250615	1.025	0.304664	0.288722	1.055	0.258942	0.255598	1.013	0.261839	0.257407	1.017	0.214648	0.21303	1.008
Story 11	0.446214	0.370702	1.204	0.25818	0.251925	1.025	0.306336	0.290322	1.055	0.260103	0.256775	1.013	0.263029	0.258604	1.017	0.214976	0.213367	1.008
Story 10	0.487848	0.394817	1.236	0.257767	0.251471	1.025	0.305963	0.289976	1.055	0.259437	0.25615	1.013	0.262376	0.257989	1.017	0.21374	0.212152	1.007
Story 9	0.524473	0.414913	1.264	0.254666	0.248392	1.025	0.302449	0.28665	1.055	0.256071	0.252858	1.013	0.258993	0.254689	1.017	0.210279	0.208728	1.007
Story 8	0.554037	0.429478	1.29	0.248227	0.242058	1.025	0.294996	0.279589	1.055	0.249358	0.246261	1.013	0.252231	0.248064	1.017	0.204079	0.202586	1.007
Story 7	0.574589	0.437101	1.315	0.237902	0.231937	1.026	0.282901	0.26813	1.055	0.238743	0.235809	1.012	0.241519	0.237555	1.017	0.194703	0.193291	1.007
Story 6	0.583756	0.436196	1.338	0.223208	0.217558	1.026	0.265548	0.251691	1.055	0.223734	0.221018	1.012	0.22636	0.222673	1.017	0.181769	0.180463	1.007
Story 5	0.578951	0.425076	1.362	0.203709	0.198501	1.026	0.242381	0.229748	1.055	0.203897	0.201457	1.012	0.206312	0.202983	1.016	0.16494	0.163769	1.007
Story 4	0.558235	0.402437	1.387	0.179008	0.174381	1.027	0.212886	0.201819	1.055	0.178843	0.176743	1.012	0.180978	0.178093	1.016	0.143924	0.142917	1.007
Story 3	0.515743	0.364537	1.415	0.1485	0.144615	1.027	0.176312	0.167188	1.055	0.148004	0.14631	1.012	0.149778	0.147431	1.016	0.11834	0.117529	1.007
Story 2	0.453257	0.311666	1.454	0.11155	0.108605	1.027	0.13192	0.125164	1.054	0.110842	0.109618	1.011	0.112156	0.110445	1.015	0.087805	0.08722	1.007
Story 1	0.363076	0.236614	1.534	0.066425	0.064692	1.027	0.07781	0.073935	1.052	0.065803	0.065115	1.011	0.066542	0.065575	1.015	0.051335	0.051009	1.006
Ground Floor	0.172047	0.101192	1.7	0.015688	0.015321	1.024	0.017915	0.017102	1.048	0.015517	0.015368	1.01	0.01566	0.015455	1.013	0.011577	0.011511	1.006

Table 4.14: Maximum and average story drifts due to earthquake load Ey in the direction of Y in zone IV

Story	Along Y direction																	
	Case A			Case B			Case C			Case D			Case E			Case F		
	Maximum in	Average in	Ratio	Maximum in	Average in	Ratio	Maximum in	Average in	Ratio	Maximum in	Average in	Ratio	Maximum in	Average in	Ratio	Maximum in	Average in	Ratio
Story 13	0.367846	0.196041	1.876	0.10309	0.094678	1.089	0.104559	0.094757	1.103	0.104024	0.098314	1.058	0.110655	0.099013	1.118	0.06961	0.066746	1.043
Story 12	0.427175	0.203697	2.097	0.103427	0.094959	1.089	0.104904	0.095039	1.104	0.104373	0.098616	1.058	0.111025	0.099321	1.118	0.069823	0.066943	1.043
Story 11	0.492889	0.21114	2.334	0.103131	0.094662	1.089	0.104611	0.094743	1.104	0.104099	0.098339	1.059	0.110737	0.099045	1.118	0.069628	0.06675	1.043
Story 10	0.557619	0.217292	2.566	0.102006	0.093603	1.09	0.103479	0.093684	1.105	0.102995	0.097281	1.059	0.109576	0.097983	1.118	0.068867	0.066014	1.043
Story 9	0.615513	0.221025	2.785	0.099789	0.091544	1.09	0.101241	0.091624	1.105	0.100793	0.095188	1.059	0.107251	0.09588	1.119	0.067368	0.064573	1.043
Story 8	0.66472	0.221812	2.997	0.096276	0.088294	1.09	0.097689	0.088373	1.105	0.097281	0.091859	1.059	0.103534	0.092531	1.119	0.064992	0.06229	1.043
Story 7	0.70289	0.219077	3.208	0.09128	0.083688	1.091	0.092632	0.083763	1.106	0.09227	0.087114	1.059	0.098219	0.087758	1.119	0.061616	0.059049	1.043
Story 6	0.727753	0.212304	3.428	0.084649	0.077582	1.091	0.085914	0.077652	1.106	0.085602	0.080803	1.059	0.091136	0.081405	1.12	0.057137	0.054751	1.044
Story 5	0.73607	0.200915	3.664	0.076255	0.069859	1.092	0.077404	0.069924	1.107	0.077147	0.072801	1.06	0.08214	0.073347	1.12	0.051468	0.049312	1.044
Story 4	0.725735	0.184464	3.934	0.065988	0.060424	1.092	0.066989	0.060481	1.108	0.066789	0.063	1.06	0.071106	0.063476	1.12	0.044539	0.042666	1.044
Story 3	0.690756	0.162112	4.261	0.053769	0.049199	1.093	0.054586	0.049246	1.108	0.054441	0.051313	1.061	0.057938	0.051702	1.121	0.036295	0.034759	1.044
Story 2	0.637885	0.134587	4.74	0.039528	0.036126	1.094	0.040122	0.03616	1.11	0.040021	0.037666	1.063	0.042547	0.037951	1.121	0.02669	0.025548	1.045
Story 1	0.566216	0.101774	5.563	0.023227	0.021185	1.096	0.023558	0.021205	1.111	0.023494	0.022033	1.066	0.024884	0.022192	1.121	0.015704	0.015017	1.046
Ground Floor	0.313706	0.046002	6.819	0.005786	0.00524	1.104	0.005854	0.005244	1.116	0.005835	0.005397	1.081	0.006095	0.005427	1.123	0.0039	0.003715	1.05

Table 4.15: Maximum and average sway due to wind load Wx in the direction of X in zone II

Along X direction																		
Story	Case A			Case B			Case C			Case D			Case E			Case F		
	Maximum in	Average in	Ratio	Maximum in	Average in	Ratio	Maximum in	Average in	Ratio	Maximum in	Average in	Ratio	Maximum in	Average in	Ratio	Maximum in	Average in	Ratio
Story 13	3.048739	1.6866	1.808	0.168111	0.164771	1.02	0.271531	0.232093	1.17	0.216565	0.215429	1.005	0.271531	0.232093	1.17	0.129022	0.127624	1.011
Story 12	2.974323	1.645595	1.807	0.152667	0.1496	1.02	0.246584	0.210872	1.169	0.196389	0.195431	1.005	0.246584	0.210872	1.169	0.116819	0.115562	1.011
Story 11	2.878569	1.592985	1.807	0.137155	0.134367	1.021	0.221509	0.189536	1.169	0.176147	0.175357	1.005	0.221509	0.189536	1.169	0.104596	0.103482	1.011
Story 10	2.756219	1.525549	1.807	0.121591	0.119087	1.021	0.196339	0.168104	1.168	0.155868	0.155236	1.004	0.196339	0.168104	1.168	0.092379	0.091406	1.011
Story 9	2.604291	1.441486	1.807	0.106044	0.103829	1.021	0.171183	0.146665	1.167	0.135649	0.135162	1.004	0.171183	0.146665	1.167	0.080236	0.0794	1.011
Story 8	2.421734	1.340141	1.807	0.090639	0.088719	1.022	0.146238	0.125383	1.166	0.115654	0.115297	1.003	0.146238	0.125383	1.166	0.068266	0.067565	1.01
Story 7	2.208412	1.221387	1.808	0.075535	0.073911	1.022	0.121763	0.104478	1.165	0.096095	0.095849	1.003	0.121763	0.104478	1.165	0.0566	0.056027	1.01
Story 6	1.964809	1.085508	1.81	0.060937	0.059607	1.022	0.098091	0.084234	1.165	0.077239	0.077085	1.002	0.098091	0.084234	1.165	0.045396	0.044944	1.01
Story 5	1.693059	0.933715	1.813	0.047089	0.046045	1.023	0.075629	0.064997	1.164	0.059403	0.059323	1.001	0.075629	0.064997	1.164	0.034843	0.034503	1.01
Story 4	1.397451	0.768449	1.819	0.034274	0.033503	1.023	0.054854	0.047179	1.163	0.042962	0.042935	1.001	0.054854	0.047179	1.163	0.025158	0.024917	1.01
Story 3	1.08403	0.593224	1.827	0.02283	0.02231	1.023	0.036331	0.031267	1.162	0.028367	0.028359	1	0.036331	0.031267	1.162	0.016593	0.016438	1.009
Story 2	0.764669	0.414907	1.843	0.013149	0.012847	1.023	0.020728	0.01784	1.162	0.016134	0.01611	1.001	0.020728	0.01784	1.162	0.009434	0.00935	1.009
Story 1	0.450537	0.24056	1.873	0.005702	0.005574	1.023	0.008836	0.00759	1.164	0.006818	0.006794	1.003	0.008836	0.00759	1.164	0.004017	0.003982	1.009
Ground Floor	0.159919	0.08293	1.928	0.001139	0.001116	1.021	0.001691	0.001462	1.157	0.001259	0.001246	1.01	0.001691	0.001462	1.157	0.00077	0.000764	1.008

Table 4.16: Maximum and average sway due to wind load Wy in the direction of Y in zone II

Along Y direction																		
Story	Case A			Case B			Case C			Case D			Case E			Case F		
	Maximum in	Average in	Ratio	Maximum in	Average in	Ratio	Maximum in	Average in	Ratio	Maximum in	Average in	Ratio	Maximum in	Average in	Ratio	Maximum in	Average in	Ratio
Story 13	8.264112	4.385041	1.885	0.36025	0.299059	1.205	0.461117	0.344698	1.338	0.316167	0.286607	1.103	0.461117	0.344698	1.338	0.175325	0.16325	1.074
Story 12	8.01095	4.240345	1.889	0.326686	0.271529	1.203	0.417909	0.31304	1.335	0.286836	0.26021	1.102	0.417909	0.31304	1.335	0.159055	0.148138	1.074
Story 11	7.700954	4.066439	1.894	0.293005	0.243927	1.201	0.374494	0.281233	1.332	0.257367	0.233699	1.101	0.374494	0.281233	1.332	0.142747	0.133253	1.071
Story 10	7.323607	3.858021	1.898	0.259299	0.216305	1.199	0.331032	0.249112	1.329	0.22785	0.207138	1.1	0.331032	0.249112	1.329	0.126447	0.118357	1.068
Story 9	6.874243	3.612832	1.903	0.225695	0.1887	1.196	0.287733	0.216926	1.326	0.198386	0.180645	1.098	0.287733	0.216926	1.326	0.110185	0.10344	1.065
Story 8	6.352494	3.330861	1.907	0.192468	0.161305	1.193	0.24497	0.185049	1.324	0.169208	0.154476	1.095	0.24497	0.185049	1.324	0.094261	0.088686	1.063
Story 7	5.759742	3.012994	1.912	0.159984	0.13441	1.19	0.203231	0.153959	1.32	0.140633	0.128566	1.094	0.203231	0.153959	1.32	0.079027	0.074336	1.063
Story 6	5.098226	2.660611	1.916	0.128687	0.108382	1.187	0.163093	0.124055	1.315	0.113487	0.103934	1.092	0.163093	0.124055	1.315	0.06413	0.060306	1.063
Story 5	4.374355	2.277257	1.921	0.099112	0.083677	1.184	0.125251	0.095679	1.309	0.088093	0.080466	1.095	0.125251	0.095679	1.309	0.049842	0.046853	1.064
Story 4	3.599754	1.869186	1.926	0.07189	0.06084	1.182	0.090512	0.069463	1.303	0.064424	0.058684	1.098	0.090512	0.069463	1.303	0.036499	0.034292	1.064
Story 3	2.789884	1.444663	1.931	0.047732	0.040496	1.179	0.059793	0.046133	1.296	0.043166	0.039195	1.101	0.059793	0.046133	1.296	0.024494	0.022996	1.065
Story 2	1.974354	1.019205	1.937	0.027466	0.023372	1.175	0.034145	0.026528	1.287	0.025128	0.022691	1.107	0.034145	0.026528	1.287	0.014286	0.013408	1.065
Story 1	1.177394	0.60563	1.944	0.012029	0.010283	1.17	0.014757	0.011594	1.273	0.011215	0.010001	1.121	0.014757	0.011594	1.273	0.006393	0.005997	1.066
Ground Floor	0.429588	0.220062	1.952	0.002525	0.002181	1.158	0.003007	0.002408	1.249	0.002453	0.002165	1.133	0.003007	0.002408	1.249	0.001401	0.001308	1.071

Table 4.17: Maximum and average sway due to wind load Wx in the direction of X in zone III

Along X direction																		
Story	Case A			Case B			Case C			Case D			Case E			Case F		
	Maximum in	Average in	Ratio	Maximum in	Average in	Ratio	Maximum in	Average in	Ratio	Maximum in	Average in	Ratio	Maximum in	Average in	Ratio	Maximum in	Average in	Ratio
Story 13	3.048739	1.6866	1.808	0.271531	0.232093	1.17	0.271531	0.232093	1.17	0.216565	0.215429	1.005	0.287737	0.278434	1.033	0.129022	0.127624	1.011
Story 12	2.974323	1.645595	1.807	0.246584	0.210872	1.169	0.246584	0.210872	1.169	0.196389	0.195431	1.005	0.261509	0.253047	1.033	0.116819	0.115562	1.011
Story 11	2.878569	1.592985	1.807	0.221509	0.189536	1.169	0.221509	0.189536	1.169	0.176147	0.175357	1.005	0.235121	0.22751	1.033	0.104596	0.103482	1.011
Story 10	2.756219	1.525549	1.807	0.196339	0.168104	1.168	0.196339	0.168104	1.168	0.155868	0.155236	1.004	0.208598	0.201843	1.033	0.092379	0.091406	1.011
Story 9	2.604291	1.441486	1.807	0.171183	0.146665	1.167	0.171183	0.146665	1.167	0.135649	0.135162	1.004	0.182047	0.176152	1.033	0.080236	0.0794	1.011
Story 8	2.421734	1.340141	1.807	0.146238	0.125383	1.166	0.146238	0.125383	1.166	0.115654	0.115297	1.003	0.155673	0.150632	1.033	0.068266	0.067565	1.01
Story 7	2.208412	1.221387	1.808	0.121763	0.104478	1.165	0.121763	0.104478	1.165	0.096095	0.095849	1.003	0.129748	0.125548	1.033	0.0566	0.056027	1.01
Story 6	1.964809	1.085508	1.81	0.098091	0.084234	1.165	0.098091	0.084234	1.165	0.077239	0.077085	1.002	0.104628	0.101243	1.033	0.045396	0.044944	1.01
Story 5	1.693059	0.933715	1.813	0.075629	0.064997	1.164	0.075629	0.064997	1.164	0.059403	0.059323	1.001	0.080744	0.078134	1.033	0.034843	0.034503	1.01
Story 4	1.397451	0.768449	1.819	0.054854	0.047179	1.163	0.054854	0.047179	1.163	0.042962	0.042935	1.001	0.058608	0.056716	1.033	0.025158	0.024917	1.01
Story 3	1.08403	0.593224	1.827	0.036331	0.031267	1.162	0.036331	0.031267	1.162	0.028367	0.028359	1	0.03883	0.037576	1.033	0.016593	0.016438	1.009
Story 2	0.764669	0.414907	1.843	0.020728	0.01784	1.162	0.020728	0.01784	1.162	0.016134	0.01611	1.001	0.022132	0.021414	1.034	0.009434	0.00935	1.009
Story 1	0.450537	0.24056	1.873	0.008836	0.00759	1.164	0.008836	0.00759	1.164	0.006818	0.006794	1.003	0.009379	0.009068	1.034	0.004017	0.003982	1.009
Ground Floor	0.159919	0.08293	1.928	0.001691	0.001462	1.157	0.001691	0.001462	1.157	0.001259	0.001246	1.01	0.001741	0.001676	1.038	0.00077	0.000764	1.008

Table 4.18: Maximum and average sway due to wind load Wy in the direction of Y in zone III

Along Y direction																		
Story	Case A			Case B			Case C			Case D			Case E			Case F		
	Maximum in	Average in	Ratio	Maximum in	Average in	Ratio	Maximum in	Average in	Ratio	Maximum in	Average in	Ratio	Maximum in	Average in	Ratio	Maximum in	Average in	Ratio
Story 13	8.01095	4.240345	1.889	0.461117	0.344698	1.338	0.461117	0.344698	1.338	0.316167	0.286607	1.103	0.384089	0.311309	1.234	0.159055	0.148138	1.074
Story 12	7.700954	4.066439	1.894	0.417909	0.31304	1.335	0.417909	0.31304	1.335	0.286836	0.26021	1.102	0.348381	0.28274	1.232	0.142747	0.133253	1.071
Story 11	7.323607	3.858021	1.898	0.374494	0.281233	1.332	0.374494	0.281233	1.332	0.257367	0.233699	1.101	0.312511	0.254072	1.23	0.126447	0.118357	1.068
Story 10	6.874243	3.612832	1.903	0.331032	0.249112	1.329	0.331032	0.249112	1.329	0.22785	0.207138	1.1	0.276607	0.22537	1.227	0.110185	0.10344	1.065
Story 9	6.352494	3.330861	1.907	0.287733	0.216926	1.326	0.287733	0.216926	1.326	0.198386	0.180645	1.098	0.240788	0.196663	1.224	0.094261	0.088686	1.063
Story 8	5.759742	3.012994	1.912	0.24497	0.185049	1.324	0.24497	0.185049	1.324	0.169208	0.154476	1.095	0.205332	0.168147	1.221	0.079027	0.074336	1.063
Story 7	5.098226	2.660611	1.916	0.203231	0.153959	1.32	0.203231	0.153959	1.32	0.140633	0.128566	1.094	0.170635	0.140121	1.218	0.06413	0.060306	1.063
Story 6	4.374355	2.277257	1.921	0.163093	0.124055	1.315	0.163093	0.124055	1.315	0.113487	0.103934	1.092	0.137174	0.112972	1.214	0.049842	0.046853	1.064
Story 5	3.599754	1.869186	1.926	0.125251	0.095679	1.309	0.125251	0.095679	1.309	0.088093	0.080466	1.095	0.105537	0.087183	1.211	0.036499	0.034292	1.064
Story 4	2.789884	1.444663	1.931	0.090512	0.069463	1.303	0.090512	0.069463	1.303	0.064424	0.058684	1.098	0.076415	0.06333	1.207	0.024494	0.022996	1.065
Story 3	1.974354	1.019205	1.937	0.059793	0.046133	1.296	0.059793	0.046133	1.296	0.043166	0.039195	1.101	0.050597	0.042086	1.202	0.014286	0.013408	1.065
Story 2	1.177394	0.60563	1.944	0.034145	0.026528	1.287	0.034145	0.026528	1.287	0.025128	0.022691	1.107	0.028987	0.02422	1.197	0.006393	0.005997	1.066
Story 1	0.429588	0.220062	1.952	0.014757	0.011594	1.273	0.014757	0.011594	1.273	0.011215	0.010001	1.121	0.012607	0.010603	1.189	0.001401	0.001308	1.071
Ground Floor	0.429588	0.220062	1.952	0.003007	0.002408	1.249	0.003007	0.002408	1.249	0.002453	0.002165	1.133	0.00261	0.002225	1.173	0.001401	0.001308	1.071

Table 4.19: Maximum and average sway due to wind load Wx in the direction of X in zone IV

Along X direction																		
Story	Case A			Case B			Case C			Case D			Case E			Case F		
	Maximum in	Average in	Ratio	Maximum in	Average in	Ratio	Maximum in	Average in	Ratio	Maximum in	Average in	Ratio	Maximum in	Average in	Ratio	Maximum in	Average in	Ratio
Story 13	3.048739	1.6866	1.808	0.168111	0.164771	1.02	0.271531	0.232093	1.17	0.216565	0.215429	1.005	0.287737	0.278434	1.033	0.129022	0.127624	1.011
Story 12	2.974323	1.645595	1.807	0.152667	0.1496	1.02	0.246584	0.210872	1.169	0.196389	0.195431	1.005	0.261509	0.253047	1.033	0.116819	0.115562	1.011
Story 11	2.878569	1.592985	1.807	0.137155	0.134367	1.021	0.221509	0.189536	1.169	0.176147	0.175357	1.005	0.235121	0.22751	1.033	0.104596	0.103482	1.011
Story 10	2.756219	1.525549	1.807	0.121591	0.119087	1.021	0.196339	0.168104	1.168	0.155868	0.155236	1.004	0.208598	0.201843	1.033	0.092379	0.091406	1.011
Story 9	2.604291	1.441486	1.807	0.106044	0.103829	1.021	0.171183	0.146665	1.167	0.135649	0.135162	1.004	0.182047	0.176152	1.033	0.080236	0.0794	1.011
Story 8	2.421734	1.340141	1.807	0.090639	0.088719	1.022	0.146238	0.125383	1.166	0.115654	0.115297	1.003	0.155673	0.150632	1.033	0.068266	0.067565	1.01
Story 7	2.208412	1.221387	1.808	0.075535	0.073911	1.022	0.121763	0.104478	1.165	0.096095	0.095849	1.003	0.129748	0.125548	1.033	0.0566	0.056027	1.01
Story 6	1.964809	1.085508	1.81	0.060937	0.059607	1.022	0.098091	0.084234	1.165	0.077239	0.077085	1.002	0.104628	0.101243	1.033	0.045396	0.044944	1.01
Story 5	1.693059	0.933715	1.813	0.047089	0.046045	1.023	0.075629	0.064997	1.164	0.059403	0.059323	1.001	0.080744	0.078134	1.033	0.034843	0.034503	1.01
Story 4	1.397451	0.768449	1.819	0.034274	0.033503	1.023	0.054854	0.047179	1.163	0.042962	0.042935	1.001	0.058608	0.056716	1.033	0.025158	0.024917	1.01
Story 3	1.08403	0.593224	1.827	0.02283	0.02231	1.023	0.036331	0.031267	1.162	0.028367	0.028359	1	0.03883	0.037576	1.033	0.016593	0.016438	1.009
Story 2	0.764669	0.414907	1.843	0.013149	0.012847	1.023	0.020728	0.01784	1.162	0.016134	0.01611	1.001	0.022132	0.021414	1.034	0.009434	0.00935	1.009
Story 1	0.450537	0.24056	1.873	0.005702	0.005574	1.023	0.008836	0.00759	1.164	0.006818	0.006794	1.003	0.009379	0.009068	1.034	0.004017	0.003982	1.009
Ground Floor	0.159919	0.08293	1.928	0.001139	0.001116	1.021	0.001691	0.001462	1.157	0.001259	0.001246	1.01	0.001741	0.001676	1.038	0.00077	0.000764	1.008

Table 4.20: Maximum and average sway due to wind load Wy in the direction of Y in zone IV

Along Y direction																		
Story	Case A			Case B			Case C			Case D			Case E			Case F		
	Maximum in	Average in	Ratio	Maximum in	Average in	Ratio	Maximum in	Average in	Ratio	Maximum in	Average in	Ratio	Maximum in	Average in	Ratio	Maximum in	Average in	Ratio
Story 13	8.264112	4.385041	1.885	0.36025	0.299059	1.205	0.461117	0.344698	1.338	0.316167	0.286607	1.103	0.384089	0.311309	1.234	0.175325	0.16325	1.074
Story 12	8.01095	4.240345	1.889	0.326686	0.271529	1.203	0.417909	0.31304	1.335	0.286836	0.26021	1.102	0.348381	0.28274	1.232	0.159055	0.148138	1.074
Story 11	7.700954	4.066439	1.894	0.293005	0.243927	1.201	0.374494	0.281233	1.332	0.257367	0.233699	1.101	0.312511	0.254072	1.23	0.142747	0.133253	1.071
Story 10	7.323607	3.858021	1.898	0.259299	0.216305	1.199	0.331032	0.249112	1.329	0.22785	0.207138	1.1	0.276607	0.22537	1.227	0.126447	0.118357	1.068
Story 9	6.874243	3.612832	1.903	0.225695	0.1887	1.196	0.287733	0.216926	1.326	0.198386	0.180645	1.098	0.240788	0.196663	1.224	0.110185	0.10344	1.065
Story 8	6.352494	3.330861	1.907	0.192468	0.161305	1.193	0.24497	0.185049	1.324	0.169208	0.154476	1.095	0.205332	0.168147	1.221	0.094261	0.088686	1.063
Story 7	5.759742	3.012994	1.912	0.159984	0.13441	1.19	0.203231	0.153959	1.32	0.140633	0.128566	1.094	0.170635	0.140121	1.218	0.079027	0.074336	1.063
Story 6	5.098226	2.660611	1.916	0.128687	0.108382	1.187	0.163093	0.124055	1.315	0.113487	0.103934	1.092	0.137174	0.112972	1.214	0.06413	0.060306	1.063
Story 5	4.374355	2.277257	1.921	0.099112	0.083677	1.184	0.125251	0.095679	1.309	0.088093	0.080466	1.095	0.105537	0.087183	1.211	0.049842	0.046853	1.064
Story 4	3.599754	1.869186	1.926	0.07189	0.06084	1.182	0.090512	0.069463	1.303	0.064424	0.058684	1.098	0.076415	0.06333	1.207	0.036499	0.034292	1.064
Story 3	2.789884	1.444663	1.931	0.047732	0.040496	1.179	0.059793	0.046133	1.296	0.043166	0.039195	1.101	0.050597	0.042086	1.202	0.024494	0.022996	1.065
Story 2	1.974354	1.019205	1.937	0.027466	0.023372	1.175	0.034145	0.026528	1.287	0.025128	0.022691	1.107	0.028987	0.02422	1.197	0.014286	0.013408	1.065
Story 1	1.177394	0.60563	1.944	0.012029	0.010283	1.17	0.014757	0.011594	1.273	0.011215	0.010001	1.121	0.012607	0.010603	1.189	0.006393	0.005997	1.066
Ground Floor	0.429588	0.220062	1.952	0.002525	0.002181	1.158	0.003007	0.002408	1.249	0.002453	0.002165	1.133	0.00261	0.002225	1.173	0.001401	0.001308	1.071

Table 4. 21: Base shear in the direction of X and Y in zone II

Direction	Case A		Case B		Case C		Case D		Case E		Case F	
	Weight Used kip	Base Shear Kip	Weight Used kip	Base Shear Kip	Weight Used kip	Base Shear Kip	Weight Used kip	Base Shear Kip	Weight Used kip	Base Shear Kip	Weight Used kip	Base Shear Kip
X	37473.16	1584.74	41165.69	1740.897	41165.69	1740.897	41165.69	1740.897	41165.69	1740.897	44858.23	1897.054
X + Ecc. Y	37473.16	1584.74	41165.69	1740.897	41165.69	1740.897	41165.69	1740.897	41165.69	1740.897	44858.23	1897.054
X - Ecc. Y	37473.16	1584.74	41165.69	1740.897	41165.69	1740.897	41165.69	1740.897	41165.69	1740.897	44858.23	1897.054
Y	37473.16	1584.74	41165.69	1740.897	41165.69	1740.897	41165.69	1740.897	41165.69	1740.897	44858.23	1897.054
Y + Ecc. X	37473.16	1584.74	41165.69	1740.897	41165.69	1740.897	41165.69	1740.897	41165.69	1740.897	44858.23	1897.054
Y - Ecc. X	37473.16	1584.74	41165.69	1740.897	41165.69	1740.897	41165.69	1740.897	41165.69	1740.897	44858.23	1897.054

Table 4 22: Base shear in the direction of X and Y in zone III

Direction	Case A		Case B		Case C		Case D		Case E		Case F	
	Weight Used kip	Base Shear Kip	Weight Used kip	Base Shear Kip	Weight Used kip	Base Shear Kip	Weight Used kip	Base Shear Kip	Weight Used kip	Base Shear Kip	Weight Used kip	Base Shear Kip
X	37473.16	2218.411	41165.69	2437.009	41165.69	2437.009	41165.69	2437.009	41165.69	2437.009	44858.23	2655.607
X + Ecc. Y	37473.16	2218.411	41165.69	2437.009	41165.69	2437.009	41165.69	2437.009	41165.69	2437.009	44858.23	2655.607
X - Ecc. Y	37473.16	2218.411	41165.69	2437.009	41165.69	2437.009	41165.69	2437.009	41165.69	2437.009	44858.23	2655.607
Y	37473.16	2218.411	41165.69	2437.009	41165.69	2437.009	41165.69	2437.009	41165.69	2437.009	44858.23	2655.607
Y + Ecc. X	37473.16	2218.411	41165.69	2437.009	41165.69	2437.009	41165.69	2437.009	41165.69	2437.009	44858.23	2655.607
Y - Ecc. X	37473.16	2218.411	41165.69	2437.009	41165.69	2437.009	41165.69	2437.009	41165.69	2437.009	44858.23	2655.607

Table 4. 23: Base shear in the direction of X and Y in zone IV

Direction	Case A		Case B		Case C		Case D		Case E		Case F	
	Weight Used kip	Base Shear Kip	Weight Used kip	Base Shear Kip	Weight Used kip	Base Shear Kip	Weight Used kip	Base Shear Kip	Weight Used kip	Base Shear Kip	Weight Used kip	Base Shear Kip
X	37473.16	2851.708	41165.69	3132.709	41165.69	3132.709	41165.69	3132.709	41165.69	3132.709	44858.23	3413.711
X + Ecc. Y	37473.16	2851.708	41165.69	3132.709	41165.69	3132.709	41165.69	3132.709	41165.69	3132.709	44858.23	3413.711
X - Ecc. Y	37473.16	2851.708	41165.69	3132.709	41165.69	3132.709	41165.69	3132.709	41165.69	3132.709	44858.23	3413.711
Y	37473.16	2851.708	41165.69	3132.709	41165.69	3132.709	41165.69	3132.709	41165.69	3132.709	44858.23	3413.711
Y + Ecc. X	37473.16	2851.708	41165.69	3132.709	41165.69	3132.709	41165.69	3132.709	41165.69	3132.709	44858.23	3413.711
Y - Ecc. X	37473.16	2851.708	41165.69	3132.709	41165.69	3132.709	41165.69	3132.709	41165.69	3132.709	44858.23	3413.711

Table 4. 24: Time period and frequency in zone II

Case	Mode	Case A		Case B		Case C		Case D		Case E		Case F	
		Period sec	Frequency cyc/sec	Period sec	Frequency cyc/sec	Period sec	Frequency cyc/sec	Period sec	Frequency cyc/sec	Period sec	Frequency cyc/sec	Period sec	Frequency cyc/sec
Modal	1	3.685	0.271	1.258	0.795	1.371	0.729	1.275	0.784	1.284	0.779	1.138	0.879
Modal	2	1.309	0.764	0.751	1.332	0.75	1.333	0.744	1.345	0.741	1.35	0.628	1.592
Modal	3	1.129	0.885	0.59	1.694	0.584	1.713	0.592	1.688	0.593	1.686	0.469	2.133
Modal	4	1.005	0.995	0.255	3.929	0.276	3.621	0.255	3.917	0.257	3.895	0.219	4.562
Modal	5	0.586	1.707	0.136	7.345	0.136	7.35	0.135	7.402	0.135	7.42	0.114	8.763
Modal	6	0.36	2.781	0.108	9.253	0.115	8.676	0.109	9.182	0.109	9.189	0.09	11.076
Modal	7	0.282	3.551	0.107	9.303	0.107	9.338	0.107	9.373	0.107	9.318	0.086	11.634
Modal	8	0.241	4.147	0.063	15.755	0.067	14.938	0.063	15.882	0.063	15.824	0.053	19.022
Modal	9	0.183	5.466	0.055	18.039	0.055	18.049	0.055	18.158	0.055	18.195	0.047	21.435
Modal	10	0.149	6.721	0.044	22.955	0.045	22.117	0.043	23.24	0.043	23.178	0.036	27.784
Modal	11	0.125	7.999	0.034	29.738	0.034	29.186	0.034	29.412	0.034	29.745	0.027	36.474
Modal	12	0.074	13.587	0.031	32.52	0.032	31.566	0.031	32.771	0.031	32.629	0.026	38.852
Modal	13	0.064	15.715	0.019	52.752	0.02	50.095	0.019	51.803	0.019	53.105	0.015	66.584
Modal	14	0.036	27.794	0.018	56.288	0.017	57.513	0.018	56.713	0.018	55.844	0.015	68.385

Table 4. 25: Time period and frequency in zone III

Case	Mode	Case A		Case B		Case C		Case D		Case E		Case F	
		Period sec	Frequency cyc/sec	Period sec	Frequency cyc/sec	Period sec	Frequency cyc/sec	Period sec	Frequency cyc/sec	Period sec	Frequency cyc/sec	Period sec	Frequency cyc/sec
Modal	1	3.685	0.271	1.258	0.795	1.371	0.729	1.275	0.784	1.284	0.779	1.138	0.879
Modal	2	1.309	0.764	0.751	1.332	0.75	1.333	0.744	1.345	0.741	1.35	0.628	1.592
Modal	3	1.129	0.885	0.59	1.694	0.584	1.713	0.592	1.688	0.593	1.686	0.469	2.133
Modal	4	1.005	0.995	0.255	3.929	0.276	3.621	0.255	3.917	0.257	3.895	0.219	4.562
Modal	5	0.586	1.707	0.136	7.345	0.136	7.35	0.135	7.402	0.135	7.42	0.114	8.763
Modal	6	0.36	2.781	0.108	9.253	0.115	8.676	0.109	9.182	0.109	9.189	0.09	11.076
Modal	7	0.282	3.551	0.107	9.303	0.107	9.338	0.107	9.373	0.107	9.318	0.086	11.634
Modal	8	0.241	4.147	0.063	15.755	0.067	14.938	0.063	15.882	0.063	15.824	0.053	19.022
Modal	9	0.183	5.466	0.055	18.039	0.055	18.049	0.055	18.158	0.055	18.195	0.047	21.435
Modal	10	0.149	6.721	0.044	22.955	0.045	22.117	0.043	23.24	0.043	23.178	0.036	27.784
Modal	11	0.125	7.999	0.034	29.738	0.034	29.186	0.034	29.412	0.034	29.745	0.027	36.474
Modal	12	0.074	13.587	0.031	32.52	0.032	31.566	0.031	32.771	0.031	32.629	0.026	38.852
Modal	13	0.064	15.715	0.019	52.752	0.02	50.095	0.019	51.803	0.019	53.105	0.015	66.584
Modal	14	0.036	27.794	0.018	56.288	0.017	57.513	0.018	56.713	0.018	55.844	0.015	68.385

Table 4.26: Time period and frequency in zone IV

Case	Mode	Case A		Case B		Case C		Case D		Case E		Case F	
		Period sec	Frequency cyc/sec	Period sec	Frequency cyc/sec	Period sec	Frequency cyc/sec	Period sec	Frequency cyc/sec	Period sec	Frequency cyc/sec	Period sec	Frequency cyc/sec
Modal	1	3.685	0.271	1.258	0.795	1.371	0.729	1.275	0.784	1.284	0.779	1.138	0.879
Modal	2	1.309	0.764	0.751	1.332	0.75	1.333	0.744	1.345	0.741	1.35	0.628	1.592
Modal	3	1.129	0.885	0.59	1.694	0.584	1.713	0.592	1.688	0.593	1.686	0.469	2.133
Modal	4	1.005	0.995	0.255	3.929	0.276	3.621	0.255	3.917	0.257	3.895	0.219	4.562
Modal	5	0.586	1.707	0.136	7.345	0.136	7.35	0.135	7.402	0.135	7.42	0.114	8.763
Modal	6	0.36	2.781	0.108	9.253	0.115	8.676	0.109	9.182	0.109	9.189	0.09	11.076
Modal	7	0.282	3.551	0.107	9.303	0.107	9.338	0.107	9.373	0.107	9.318	0.086	11.634
Modal	8	0.241	4.147	0.063	15.755	0.067	14.938	0.063	15.882	0.063	15.824	0.053	19.022
Modal	9	0.183	5.466	0.055	18.039	0.055	18.049	0.055	18.158	0.055	18.195	0.047	21.435
Modal	10	0.149	6.721	0.044	22.955	0.045	22.117	0.043	23.24	0.043	23.178	0.036	27.784
Modal	11	0.125	7.999	0.034	29.738	0.034	29.186	0.034	29.412	0.034	29.745	0.027	36.474
Modal	12	0.074	13.587	0.031	32.52	0.032	31.566	0.031	32.771	0.031	32.629	0.026	38.852
Modal	13	0.064	15.715	0.019	52.752	0.02	50.095	0.019	51.803	0.019	53.105	0.015	66.584
Modal	14	0.036	27.794	0.018	56.288	0.017	57.513	0.018	56.713	0.018	55.844	0.015	68.385

Table 4.27: Base reaction due to earthquake load Ex and Ey in zone II

Load Case	Case A		Case B		Case C		Case D		Case E		Case F	
	Fx (kip)	Fy (Kip)	Fx (kip)	Fy (Kip)	Fx (kip)	Fy (Kip)	Fx (kip)	Fy (Kip)	Fx (kip)	Fy (Kip)	Fx (kip)	Fy (Kip)
EX 1	-1584.74	-5.74E-06	-1740.9	0	-1740.9	0	-1740.9	0	-1740.9	0	-1897.05	0
EX 2	-1584.74	-5.24E-06	-1740.9	0	-1740.9	0	-1740.9	0	-1740.9	0	-1897.05	0
RS-X Max	1600.155	1415.147	1364.37	2932.771	1812.706	2023.787	1973.506	2046.055	1477.11	2901.486	2339.199	2570.429
EY 1	0	-1584.74	0	-1740.9	0	-1740.9	0	-1740.9	0	-1740.9	0	-1897.05
EY 2	0	-1584.74	0	-1740.9	0	-1740.9	0	-1740.9	0	-1740.9	0	-1897.05
RS-Y Max	1134.821	2017.289	1364.37	2932.771	1256.329	2940.517	1451.349	2885.258	1477.11	2901.486	1602.678	3751.888

Table 4.28: Base reaction due to earthquake load Ex and Ey in zone III

Load Case	Case A		Case B		Case C		Case D		Case E		Case F	
	Fx (kip)	Fy (Kip)	Fx (kip)	Fy (Kip)	Fx (kip)	Fy (Kip)	Fx (kip)	Fy (Kip)	Fx (kip)	Fy (Kip)	Fx (kip)	Fy (Kip)
EX 1	-2218.41	-8.03E-06	-2437.01	0	-2437.01	0	-2437.01	0	-2437.01	0	-2655.61	0
EX 2	-2218.41	-7.33E-06	-2437.01	0	-2437.01	0	-2437.01	0	-2437.01	0	-2655.61	0
RS-X Max	1600.155	1415.147	1986.103	2011.817	1812.706	2023.787	1973.506	2046.055	1965.511	2078.419	2339.199	2570.429
EY 1	0	-2218.41	0	-2437.01	0	-2437.01	0	-2437.01	0	-2437.01	0	-2655.61
EY 2	0	-2218.41	0	-2437.01	0	-2437.01	0	-2437.01	0	-2437.01	0	-2655.61
RS-Y Max	1134.821	2017.289	1364.37	2932.771	1256.329	2940.517	1451.349	2885.258	1477.11	2901.486	1602.678	3751.888

Table 4.29: Base reaction due to earthquake load Ex and Ey in zone IV

Load Case	Case A		Case B		Case C		Case D		Case E		Case F	
	Fx (kip)	Fy (Kip)	Fx (kip)	Fy (Kip)	Fx (kip)	Fy (Kip)	Fx (kip)	Fy (Kip)	Fx (kip)	Fy (Kip)	Fx (kip)	Fy (Kip)
EX 1	-2851.71	-1.03E-05	-3132.71	0	0	-3132.71	-3132.71	0	-3132.71	0	-3413.71	0
EX 2	-2851.71	-9.43E-06	-3132.71	0	0	-3132.71	-3132.71	0	-3132.71	0	-3413.71	0
RS-X Max	1600.155	1415.147	1986.103	2011.817	1256.329	2940.517	1451.349	2885.258	1965.511	2078.419	2339.199	2570.429
EY 1	0	-2851.71	0	-3132.71	0	-3132.71	0	-3132.71	0	-3132.71	0	-3413.71
EY 2	0	-2851.71	0	-3132.71	0	-3132.71	0	-3132.71	0	-3132.71	0	-3413.71
RS-Y Max	1134.821	2017.289	1364.37	2932.771	1256.329	2940.517	1451.349	2885.258	1477.11	2901.486	1602.678	3751.888

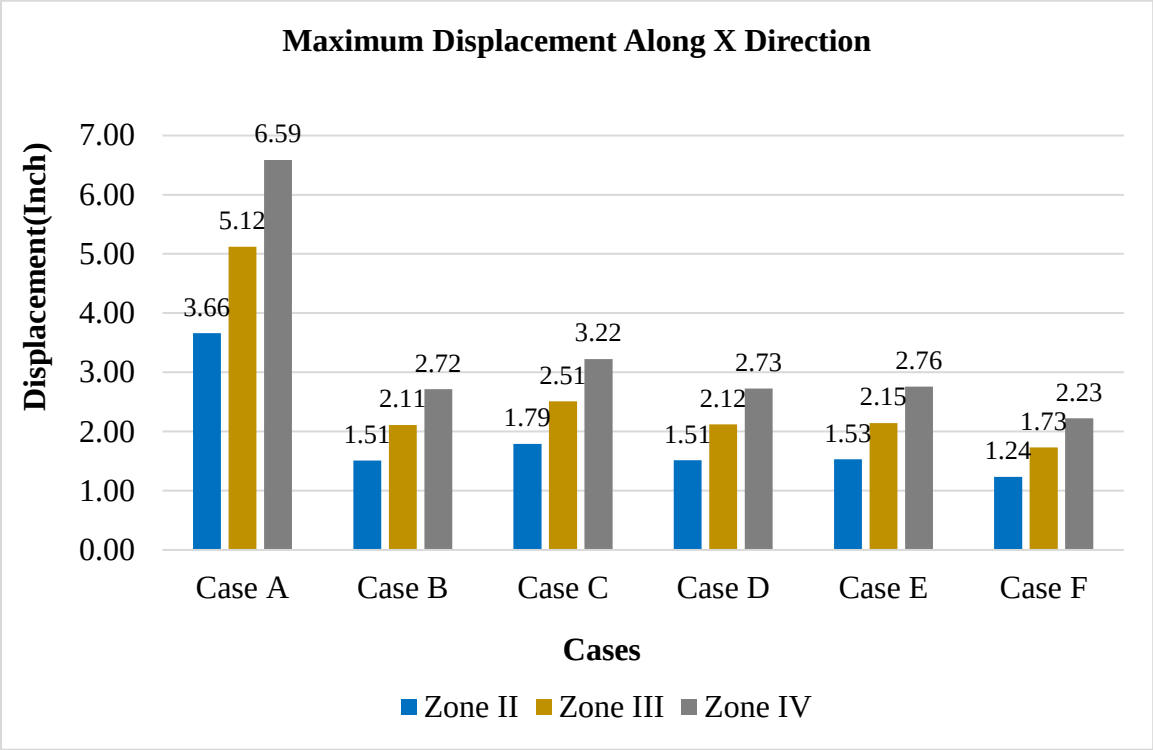

Figure 4.1: Maximum displacement along X direction

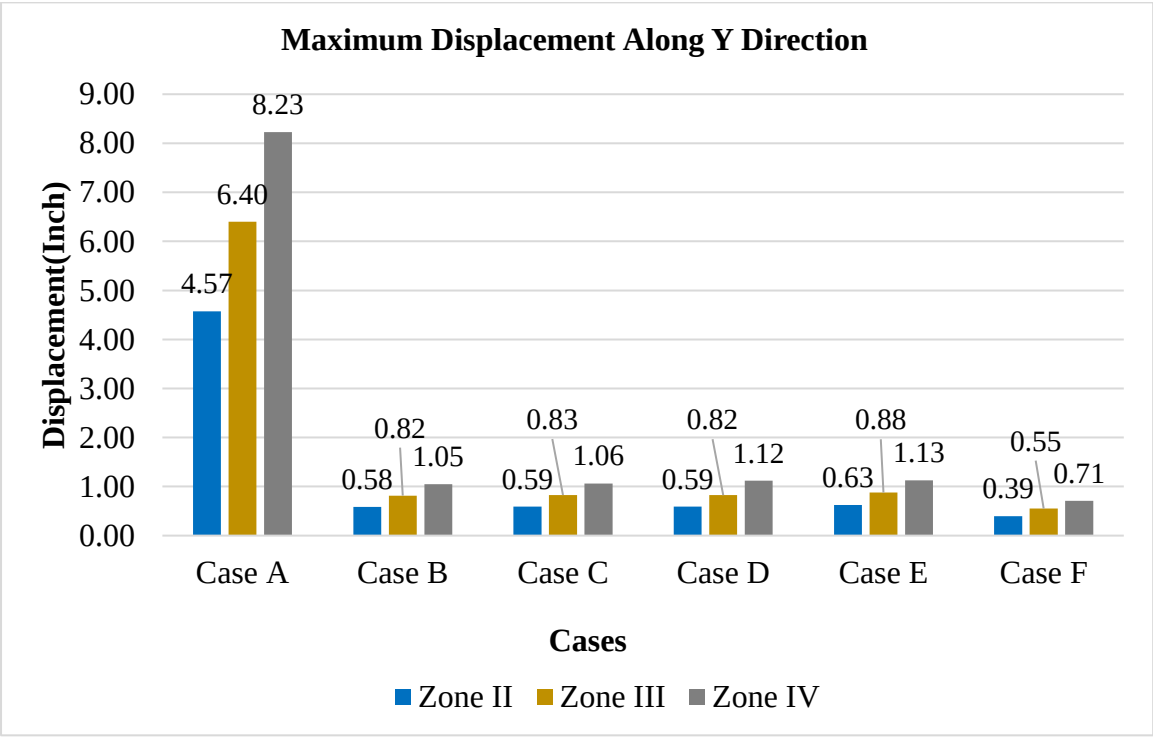

Figure 4.2: Maximum displacement along Y direction

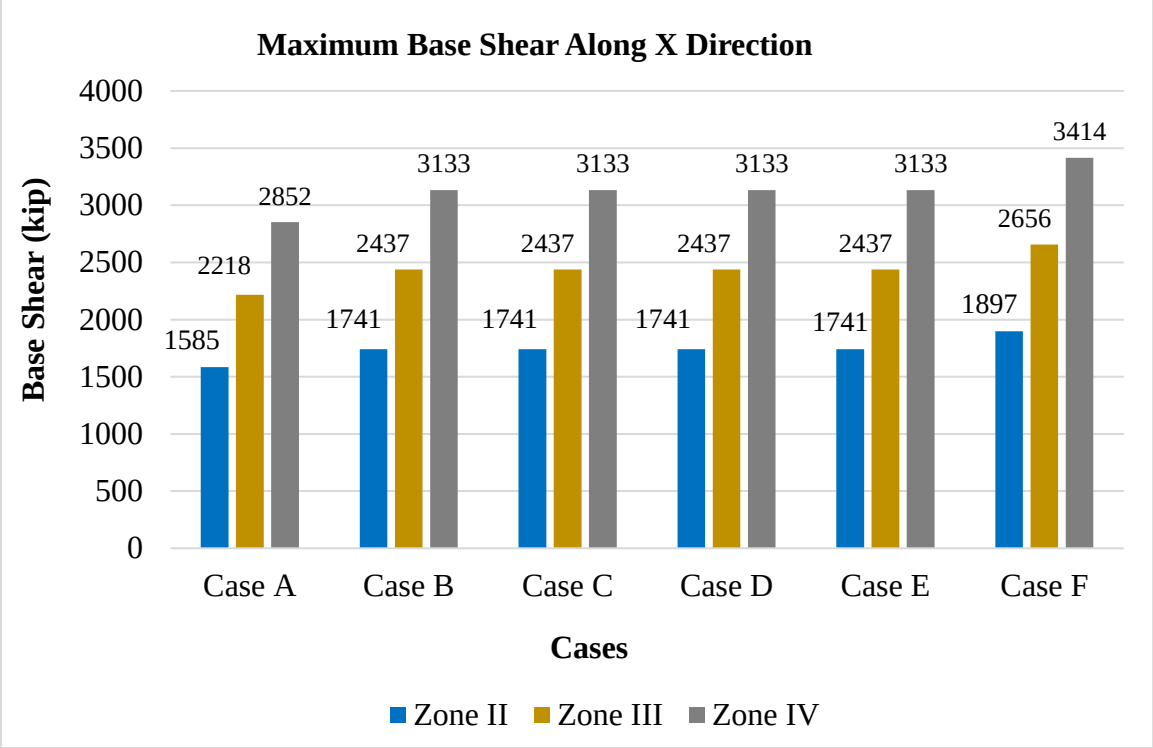

Figure 4.3: Maximum base shear along X direction

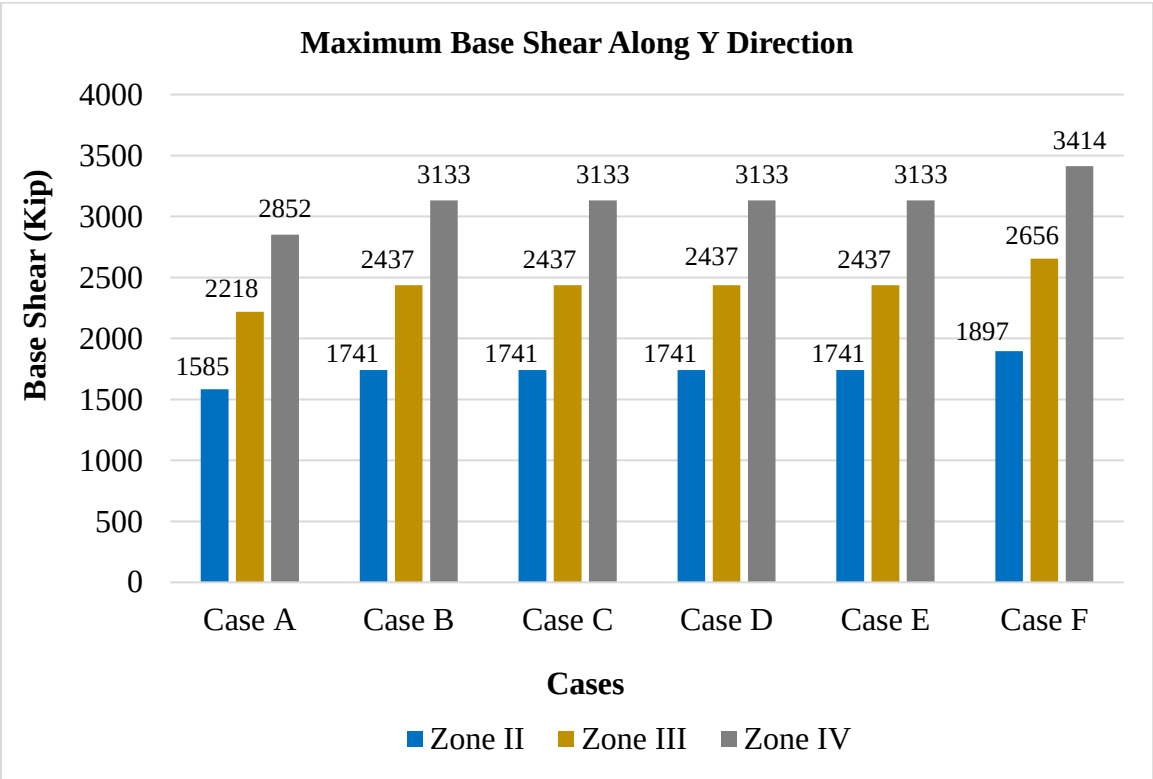

Figure 4.4: Maximum base shear along Y direction

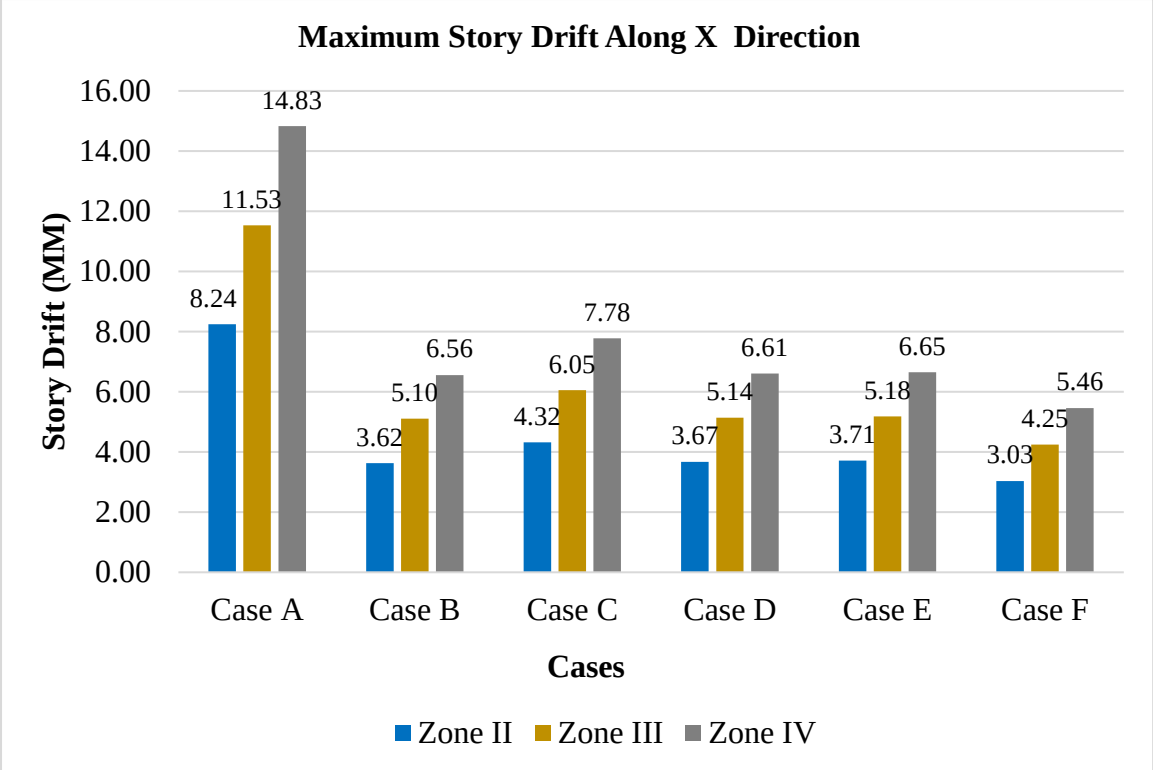

Figure 4.5: Maximum story drift along X direction

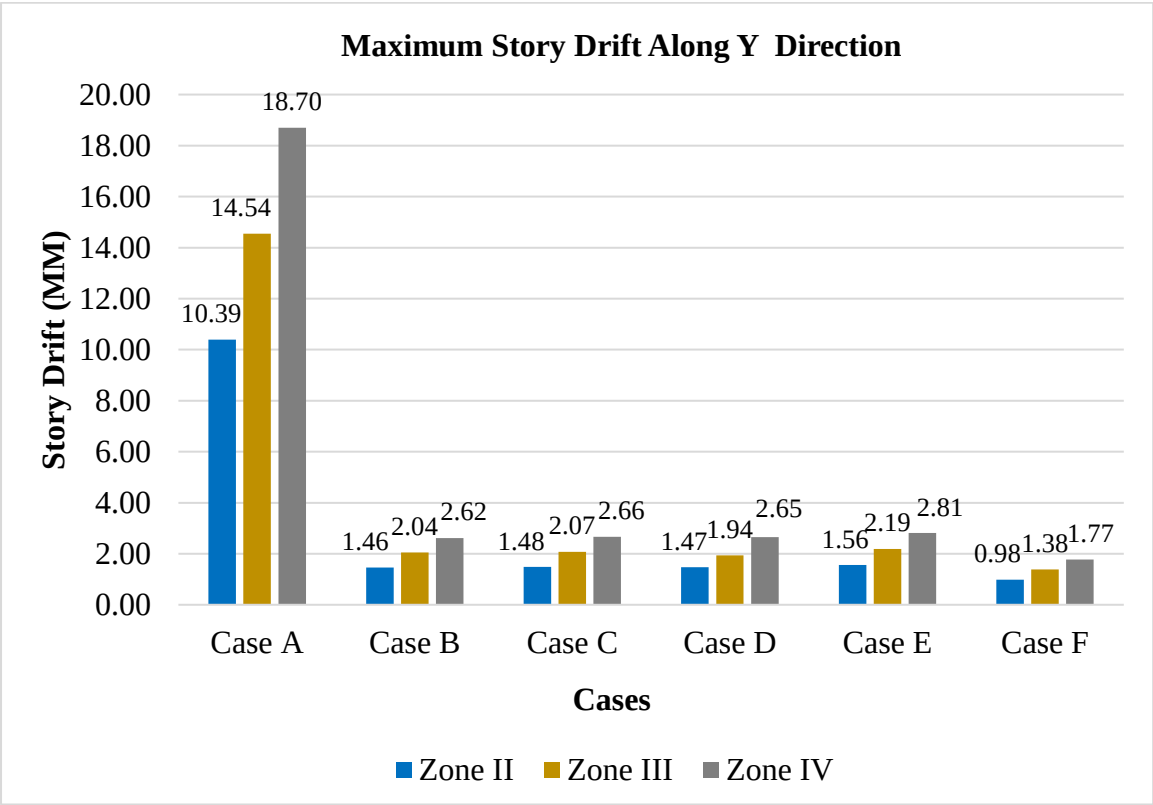

Figure 4.6: Maximum story drift along Y direction

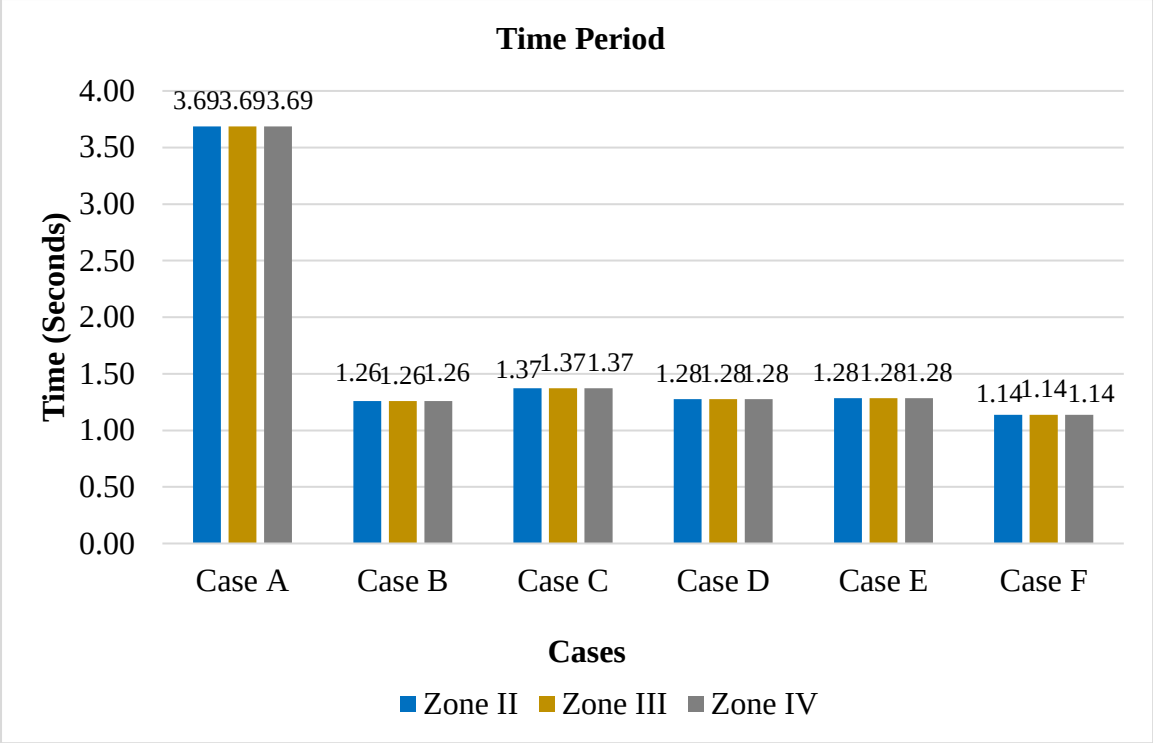

Figure 4.7: Building time period

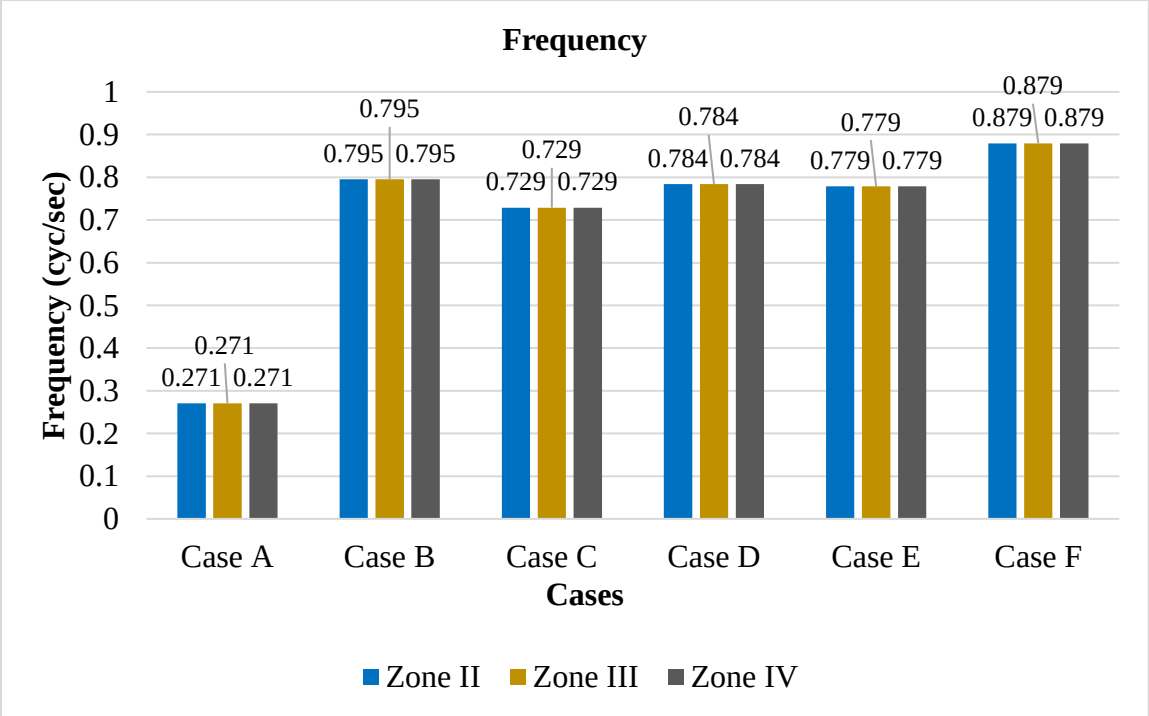

Figure 4.8: Building frequency

4.9 Zone II: Case A (Story response plot)

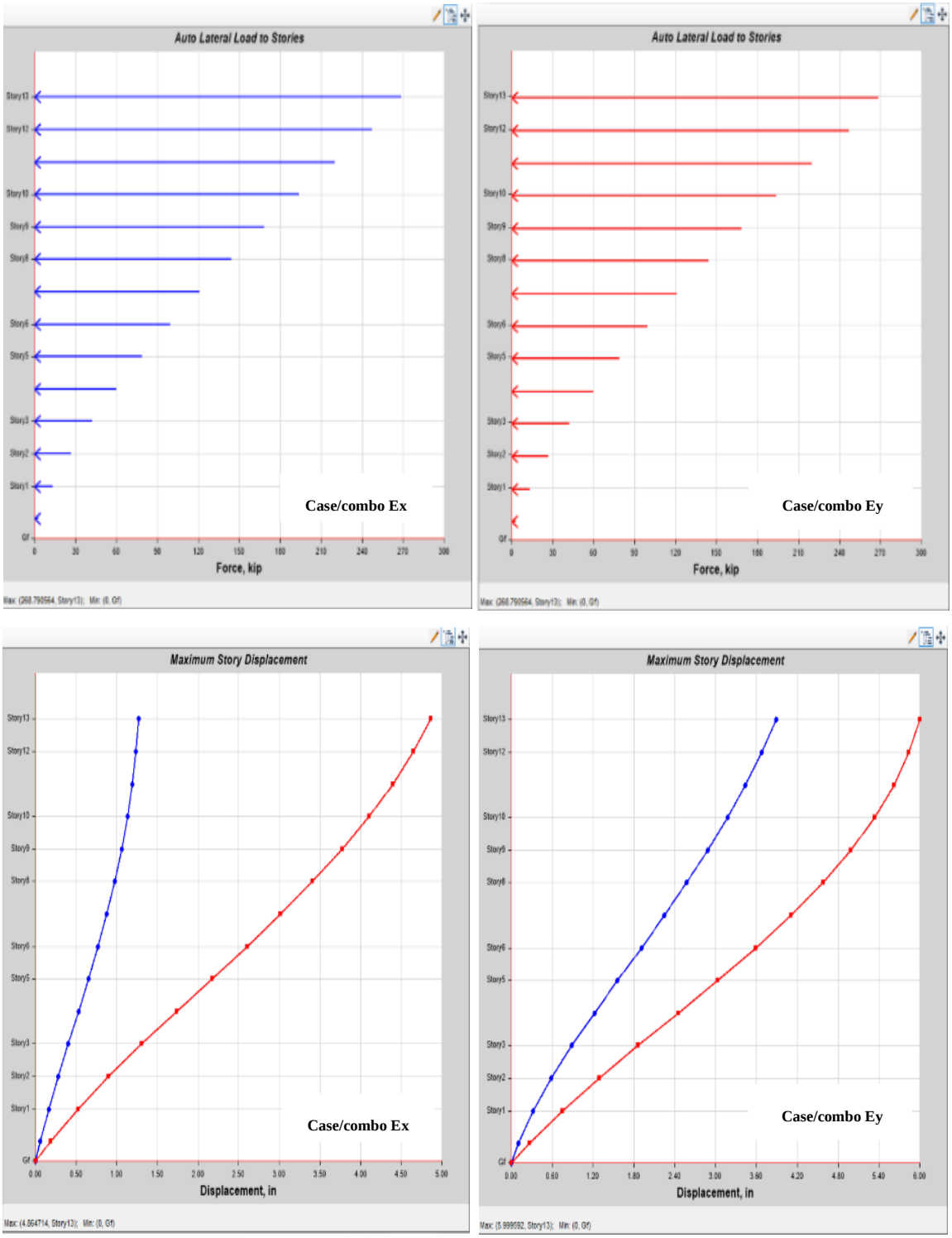

Figure 4.9: Lateral load, maximum story displacement due to earthquake load zone II (Case A)

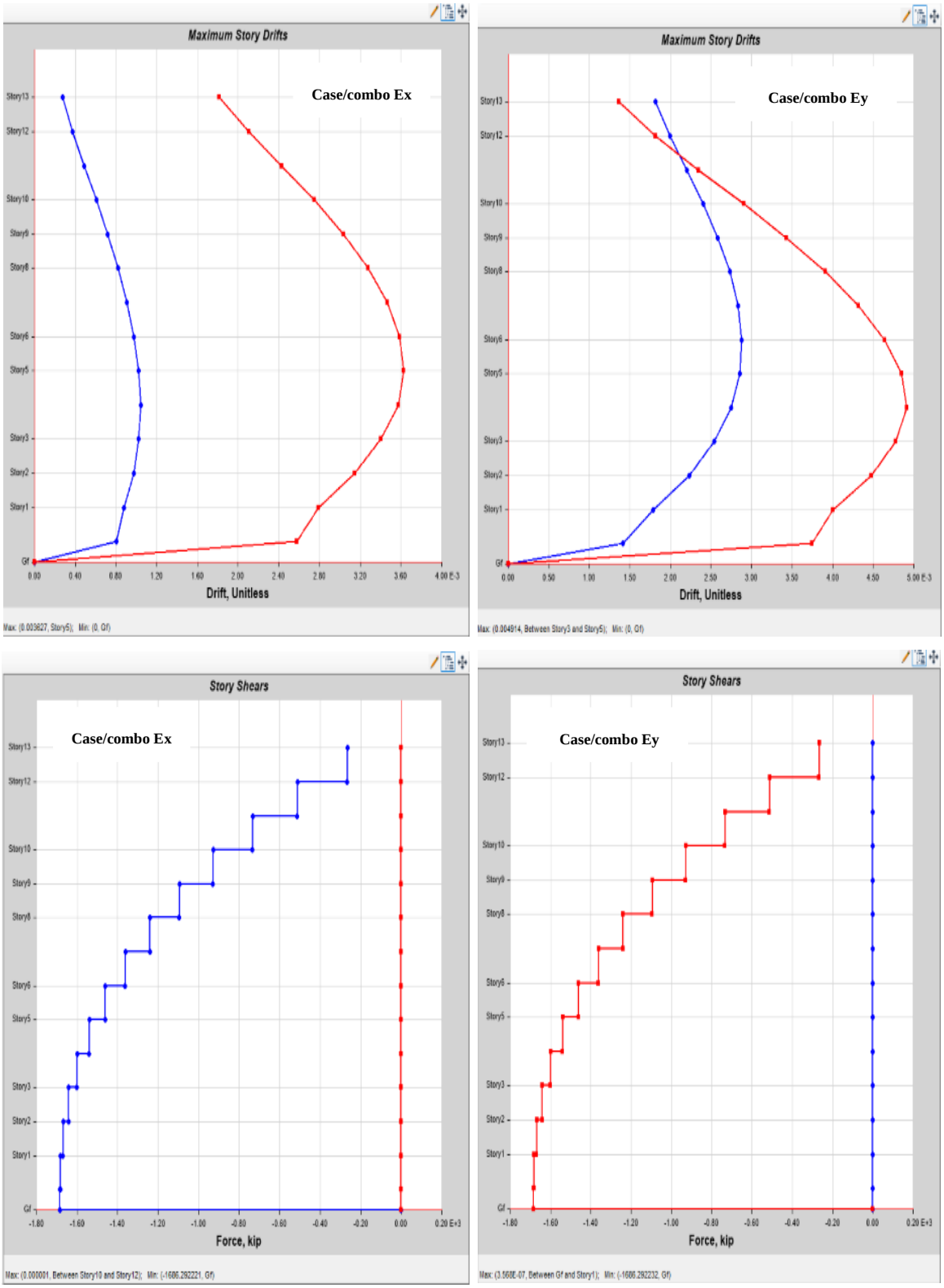

Figure 4.10: Maximum story drift and story shear due to earthquake load zone II (Case A)

4.10 Zone II: Case F (Story response plot)

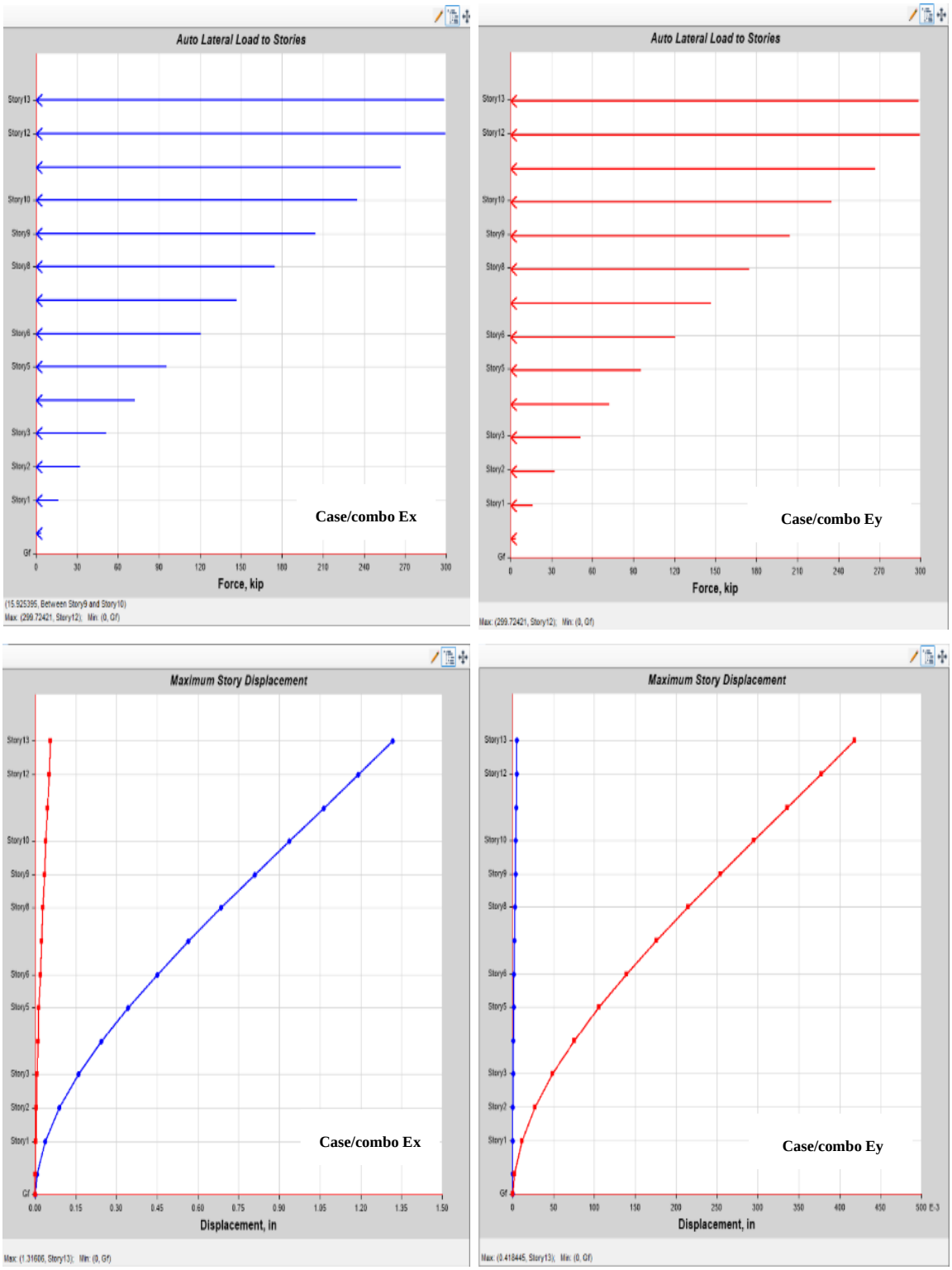

Figure 4.11: Lateral load, maximum story displacement due to earthquake load zone II (Case F)

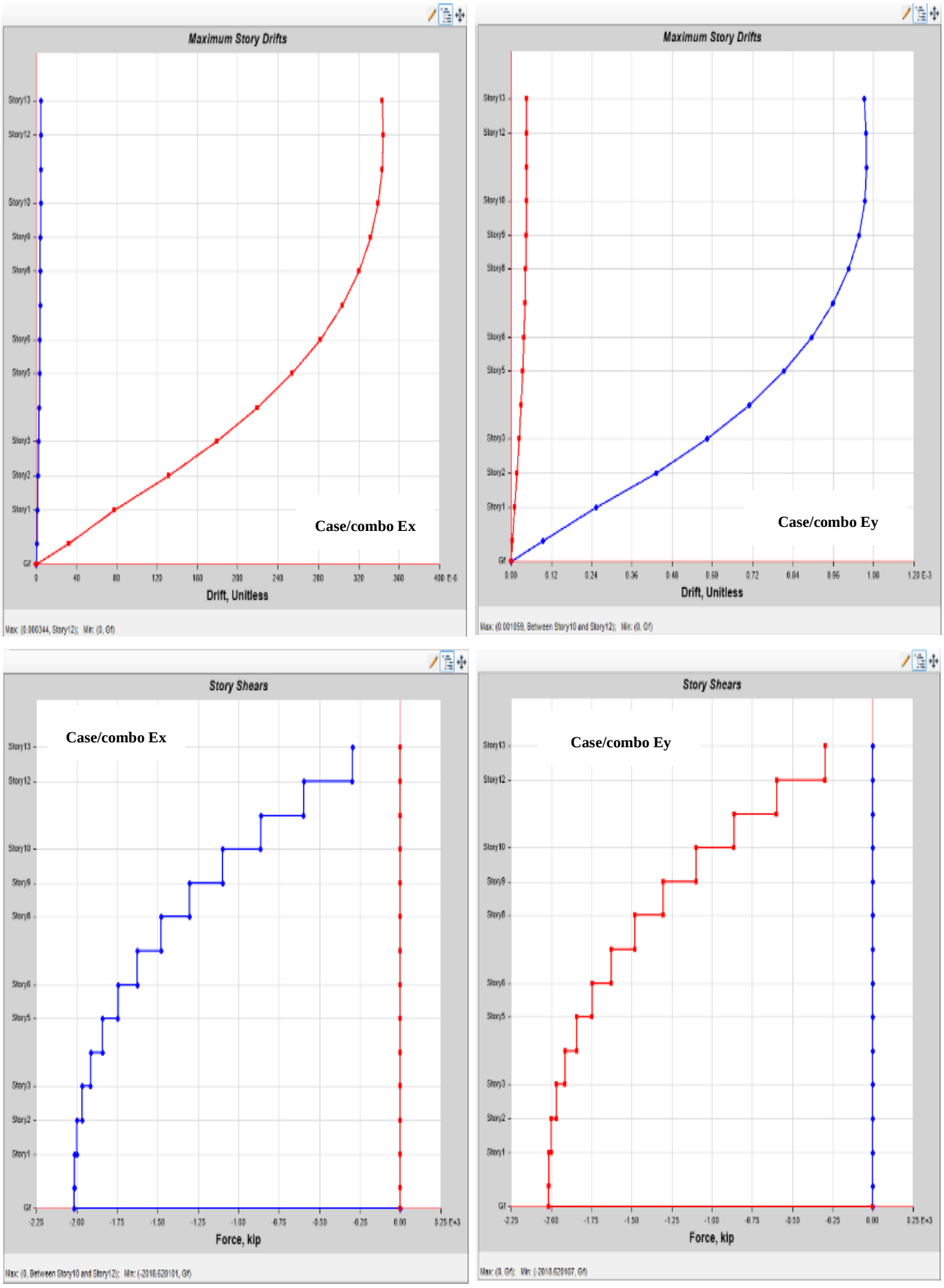

Figure 4.12: Maximum story drift and story shear due to earthquake load zone II (Case F)

4.11 Zone III: Case A (Story response plot)

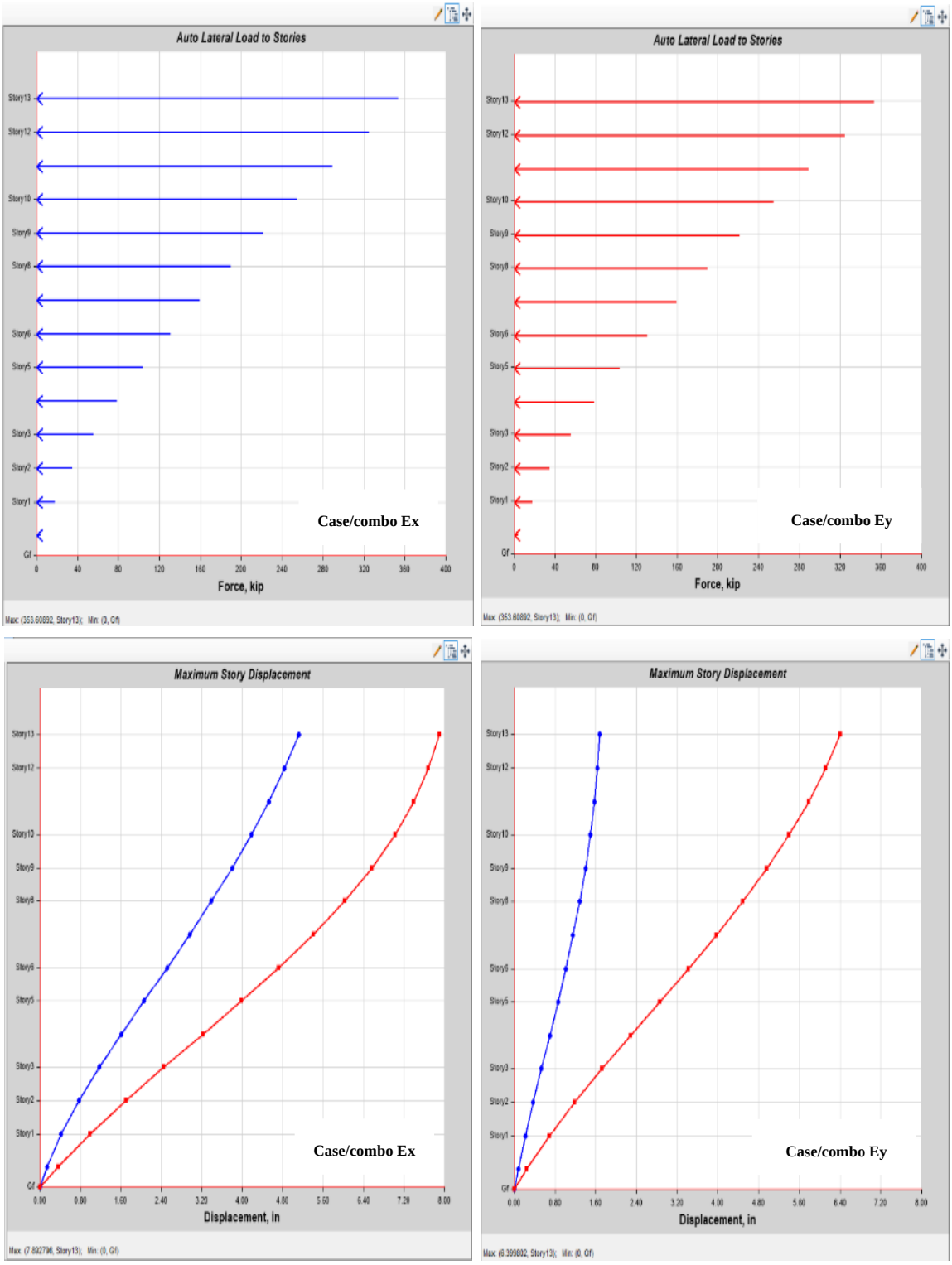

Figure 4.13: Lateral load, maximum story displacement due to earthquake load zone III (Case A)

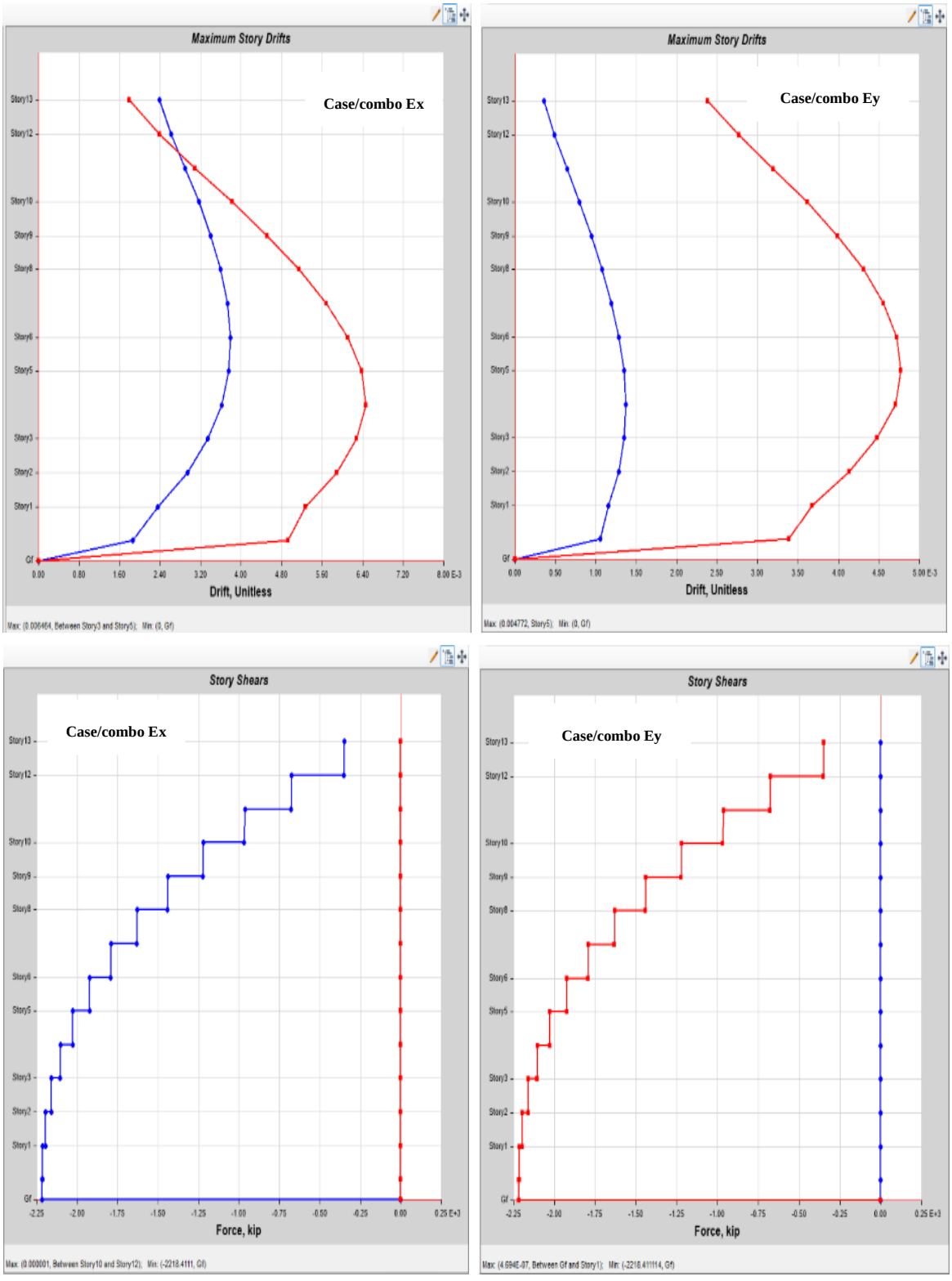

Figure 4.14: Maximum story drift and story shear due to earthquake load zone III (Case A)

4.12 Zone III: Case F (Story response plot)

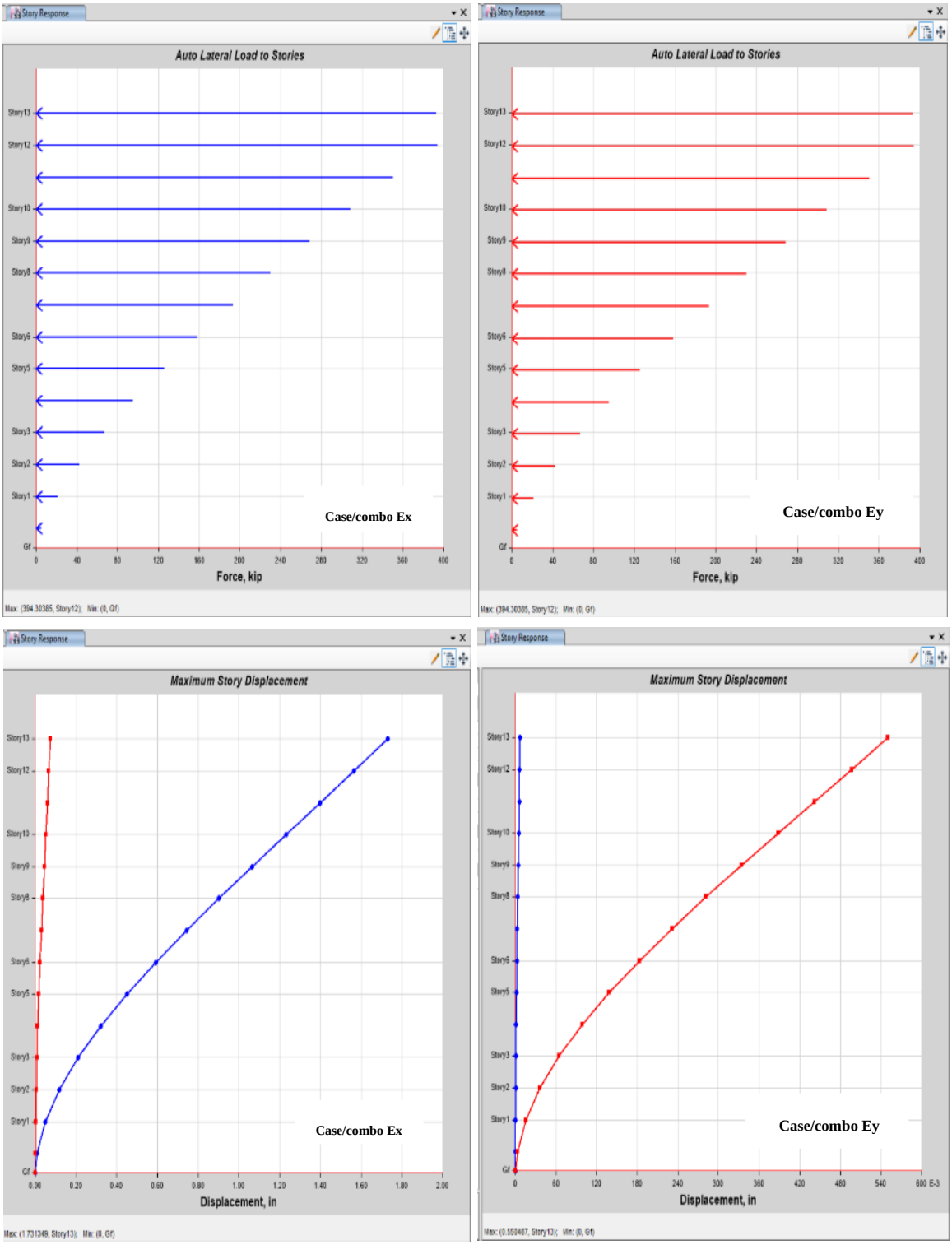

Figure 4.15: Lateral load, maximum story displacement due to earthquake load zone III (Case F)

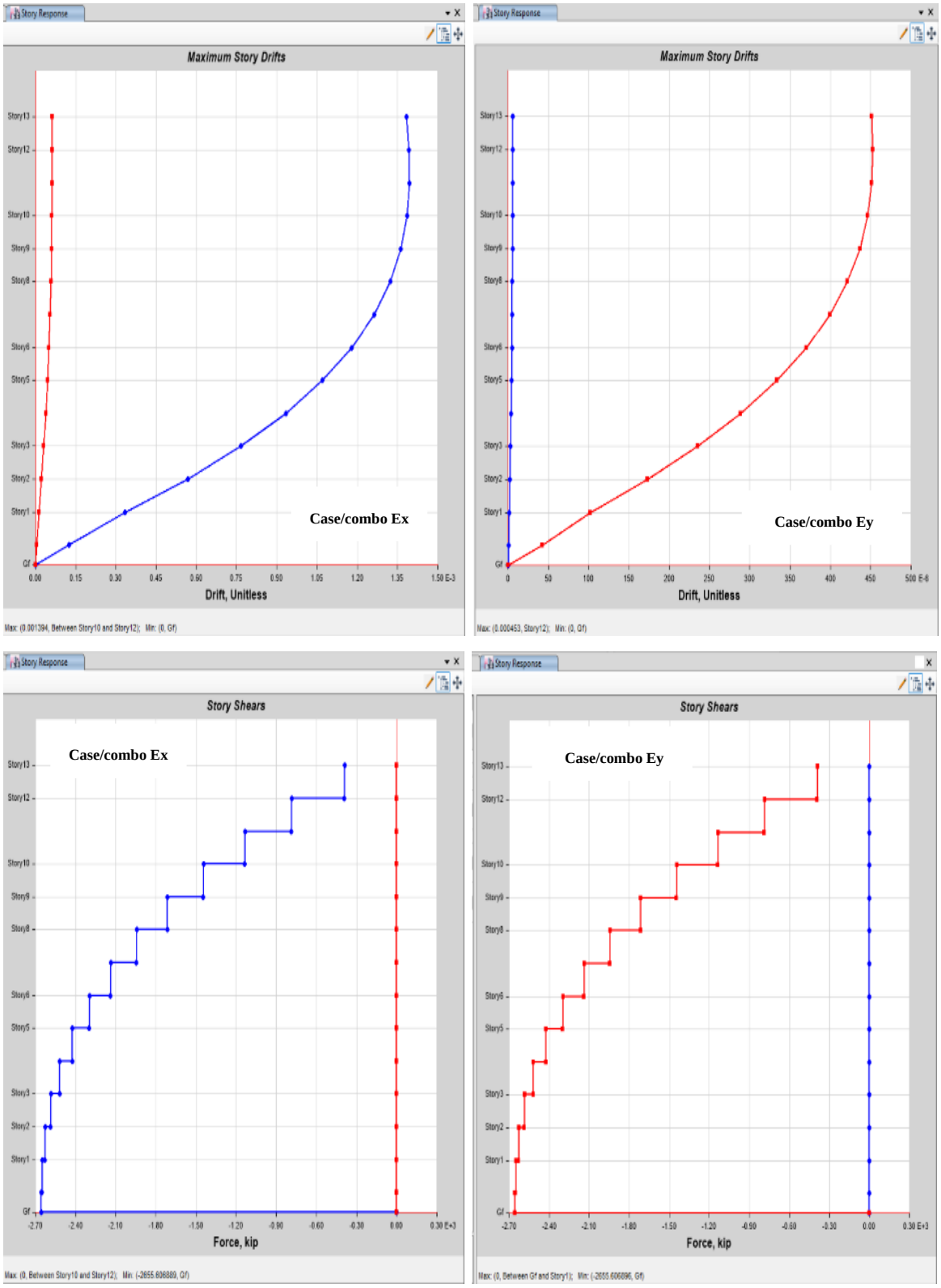

Figure 4.16: Maximum story drift and story shear due to earthquake load zone III (Case F)

4.13 Zone IV: Case A (Story response plot)

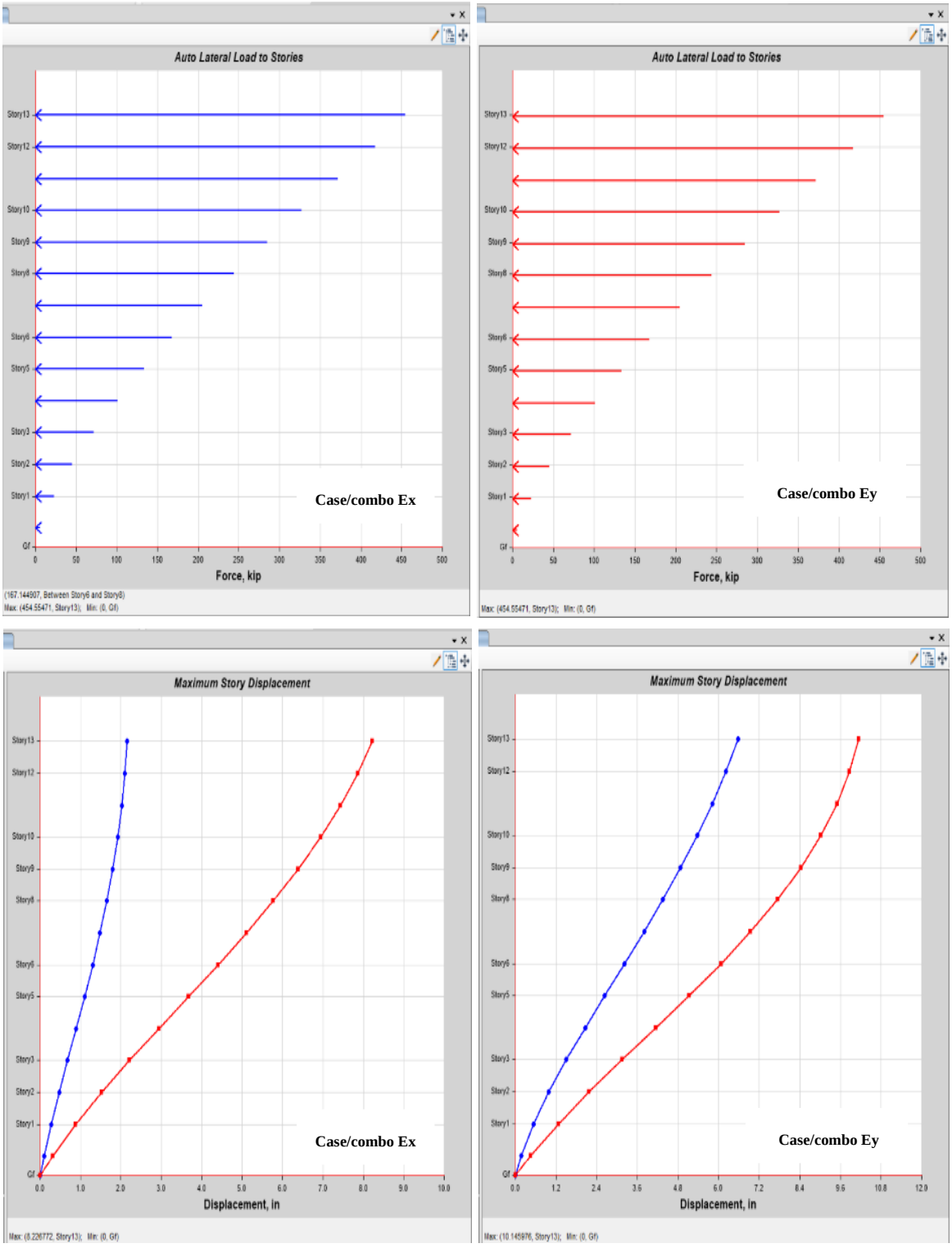

Figure 4.17: Lateral load, maximum story displacement due to earthquake load zone IV (Case A)

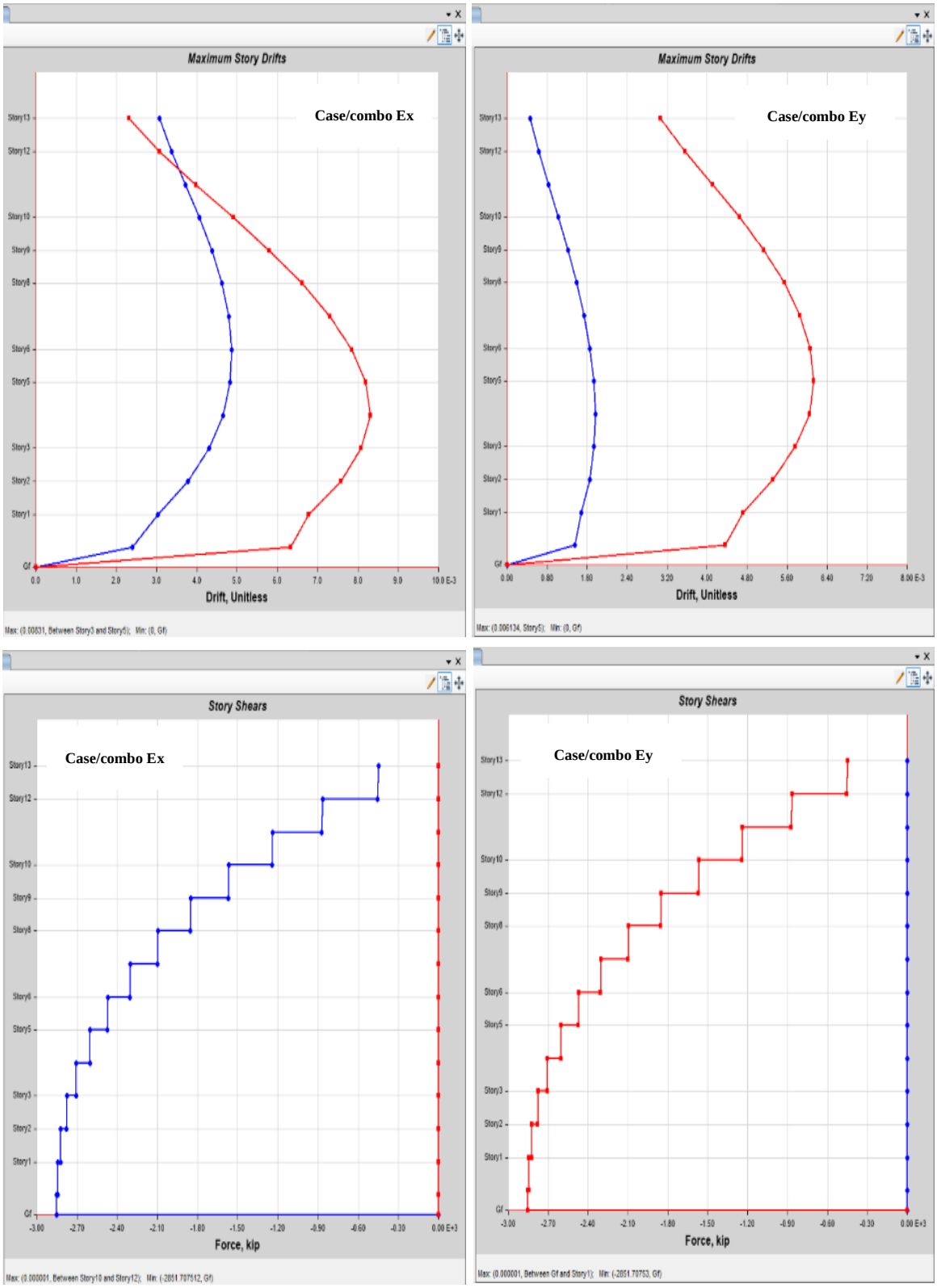

Figure 4.18: Maximum story drift and story shear due to earthquake load zone IV (Case A)

4.14 Zone IV: Case F (Story response plot)

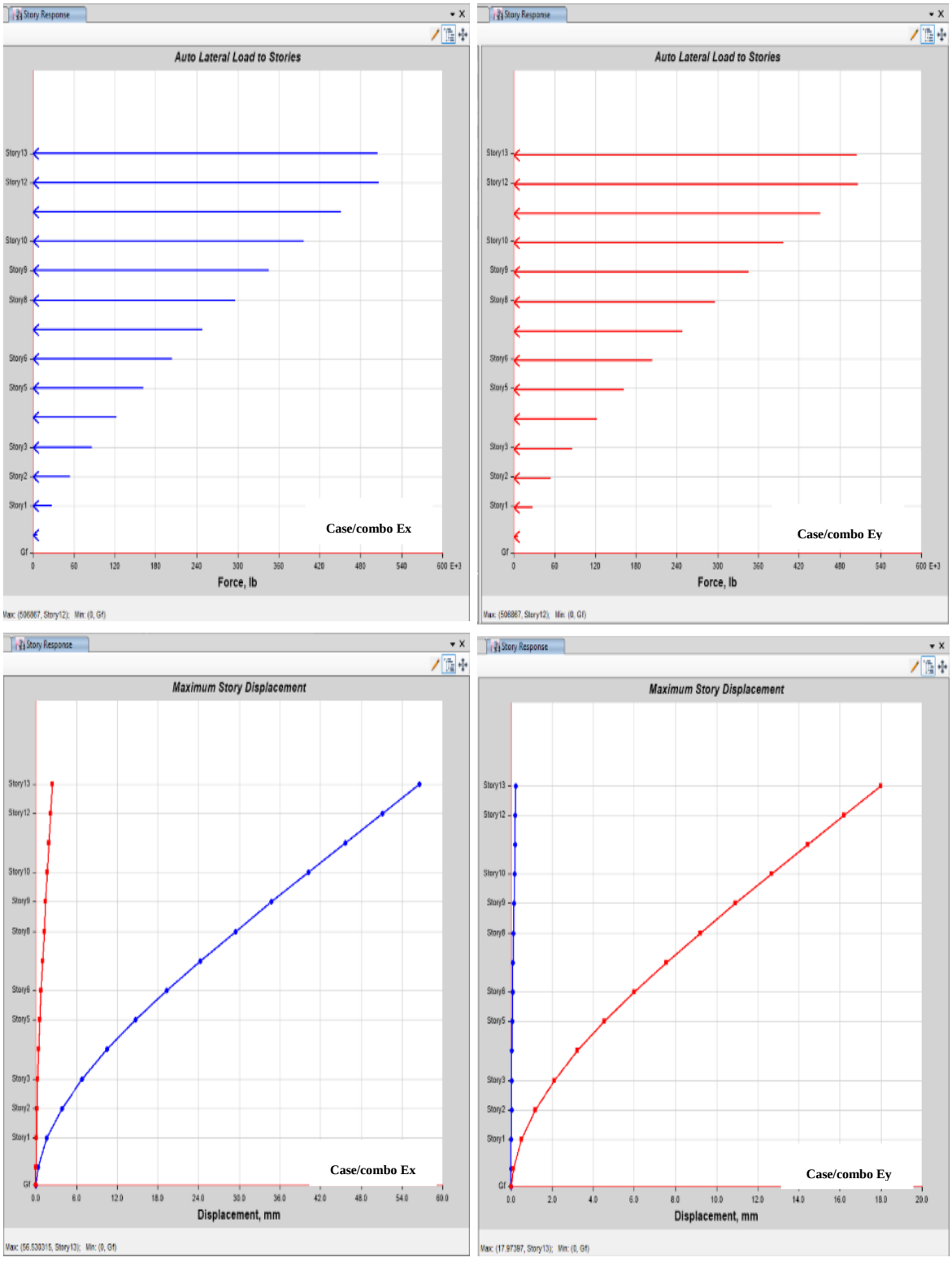

Figure 4.19: Lateral load, maximum story displacement due to earthquake load zone IV (Case F)

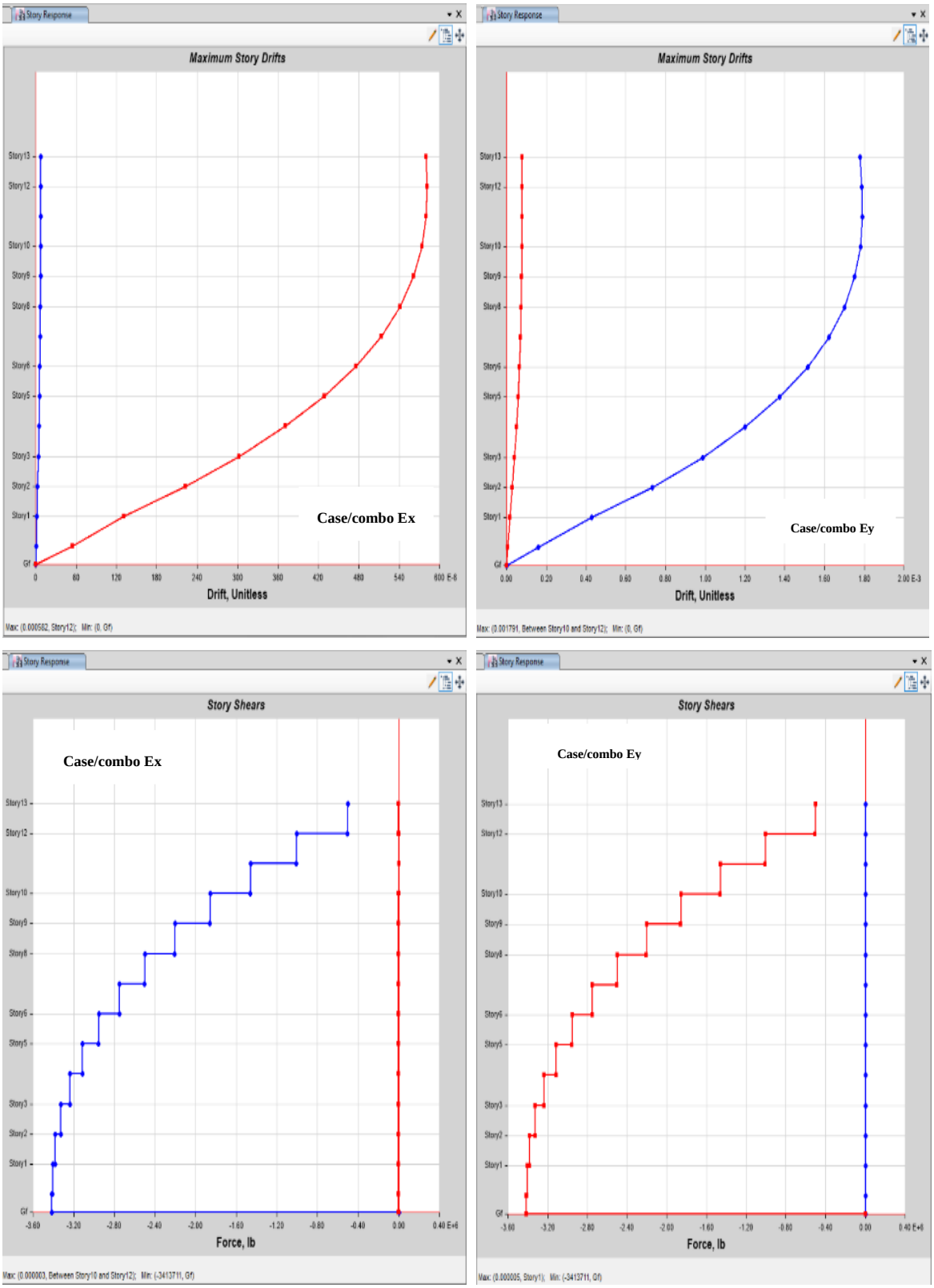

Figure 4.20: Maximum story drift and story shear due to earthquake load zone IV (Case F)

4.15 Results

The maximum story displacements for a G+13 multi storied building for all the cases (Case A, B, C, D, E and F) and for three seismic zones of Bangladesh (II, III, IV) along global X and Y directions has presented in the tables of 4.2-4.8.In zone II Case A (Building without shear wall) the maximum displacement is 3.659 inch along X direction and 4.5717 inch along Y direction. This is the maximum displacement among all the case (B, C, D, E and F). In zone II for other case (B, C, D, E and F) maximum displacement values are respectively 1.5094 inch, 1.7917 inch, 1.5150 inch, 1.5324 inch and 1.2278 inch at X direction and 0.534067 inch, 0.591028 inch, 0.588595 inch, 0.626205 inch and 1.718778 inch at Y direction. In zone III the maximum displacement is 5.122756 inch along X direction and 6.399802 inch along Y direction. In zone IV the maximum displacement is 6.585164 inch along X direction and 8.226772 inch along Y direction. From table 4.3 and 4.4 for zone II and table 4.5 and 4.6 for zone IV get the same result that case A (Building without shear wall) shows maximum displacement among all the six cases.

Response spectrum analysis is carried out and the number of mode shapes taken for analysis is ‘’14”, so that the modal mass participation exceeds 90%. The fundamental time period and frequency of the building for all the cases shown at the time period and frequency table 4.24, 4.25 and 4.26.In zone II for modal ‘’14” the time period and frequency for all the cases (A, B, C, D, E and F) are respectively 0.036 sec, 0.018 sec, 0.017 sec, 0.018 sec, 0.018 sec and 0.015 sec. The frequency values are respectively 27.794 cyc/sec, 56.288 cyc/sec, 57.513 cyc/sec56.713 cyc/sec, 55.844 cyc/sec and 68.385 cyc/sec. In zone III and IV the time period and frequency values for all the cases are same as zone II.

The maximum story drifts of the building for all the cases (A, B, C, D, E and F) along Global X and Y directions had presented in the following figures of 4.9-4.14. In seismic zone II the maximum story drifts along X and Y direction is 0.454118inch and 0.572606 inch. In seismic zone III the maximum story drifts along X and Y direction is 0.454118 inch and 0.572606 inch. In seismic zone IV the maximum story drifts along X and Y direction is 0.583756 inch and 0.727753 inch.

Buildings are checked for sway limitation as per as BNBC 2020 the overall sway at the top level of the building will not exceed 1/500 times of the total height of the building above ground (BNBC, 2020).Table 4.15-4.20 represent the sway maximum and average value for the seismic zone II, III, IV and for all the cases(A, B, C, D, E and F). In zone II the maximum sway value is 3.048739 inch along X direction and 8.264112 inch along Y direction among all the cases (A, B, C, D, E and F). In zone III and IV the maximum sway values are respectively 3.048739 inch and 3.048739 inch along X direction and 8.01095 inch and 8.264112 inch along Y direction.

Buildings are checked for base reaction that has calculated from the response spectrum function (RSX, RSY) must be at least 85% of the calculated static base reaction (Ex1, Ex2, Ey1, Ey2). Table 4.27, 4.28 and 4.29 represent the base reaction values for seismic zone II, III, IV and for all the cases (A, B, C, D, E and F).The maximum values of RSX of zone II, III and IV are 2339.199 kip, 2339.199 kip and 2339.199 kip and RXY maximum values are 3751.888 kip, 3751.888 kip and 3751.888 kip for all the six cases. The maximum value of Ex for seismic zone II, III, IV are 1897.05 kip, 2437.01 kip and 3132.71 kip for all the six cases. The maximum value of Ex for seismic zone II, III, IV are 1897.05 kips, 2655.61 kips and 3413.71 kips for all the cases (A, B, C, D, E and F).

Buildings are checked for torsional irregularities by using the formulae D max/D avg.
If D max/D avg > 1.2, Torsional Irregularity exit.
If D max/D avg > 1.4, Extreme Torsional Irregularity exit.
The D max/D avg ratio for a G+13 multi storied building for all the cases (Case A, B, C, D, E and F) and for three seismic zones of Bangladesh (II, III, IV) along global X and Y directions has presented in the tables of 4.1 and 4.2.Case A value is 1.7 along X direction and 6.81 for Y direction. For the other cases (B, C, D, E and F) torsional value are 1.02, 1.05, 1.01, 1.01 and 1 along X direction and 1.1, 1.11, 1.08, 1.12 and 1.05 along Y direction.

Base shear for all the six cases (A, B, C, D, E and F) and for seismic zone II, III, IV of Bangladesh are presented in the tables 4.21, 4.22 and 4.23. The maximum base shear in zone II, III and IV are 1897.054 kip, 2655.607 kip and 3413.711 kip.

By story response plot we also get the value of lateral load, maximum story displacement, maximum story drifts, story shear, story overturning moment. Figures 4.9 to 4.20 shows the value for story response plot for all the cases (Case A and F) and for all the three zones (II, III and IV) of Bangladesh. The maximum Lateral load, maximum story displacement, story drifts, story shear, story overturning moment due to earthquake load zone II and among for all the cases (Case A, B, C, D, E and F) are respectively 299.72 lb, 5.99 inch, 1.316 inch, 3.56 kip and 16758 kip-ft. The maximum Lateral load, maximum story displacement, story drifts, story shear, story overturning moment due to earthquake load zone III and among for all the cases (Case A, B, C, D, E and F) are respectively 394.30 lb, 7.899 inch, 0.0064 inch, 4.69 kip and 220377 kip-ft. The maximum Lateral load, maximum story displacement, story drifts, story shear, story overturning moment due to earthquake load zone III and among for all the cases (Case A, B, C, D, E and F) are respectively 506.86 lb, 10.14 inch and 283289 kip-ft.

CHAPTER 5
CONCLUSION

The following conclusions are drawn from the analysis.

It is studied that maximum displacement values are found to be higher in seismic zone IV for all the cases (A, B, C, D, E and F) when correlated to the seismic zones II and III. Figure 4.1 and 4.2 represent the maximum displacement for zone II, III and IV for all the cases (A, B, C, D, E and F). The Case F (shear wall at four ends) giving better result for all the zone II, III and IV. The maximum displacement value of Case F are 1.24 inch, 1.73 inch and 2.23 inch along X direction and 0.39 inch, 0.55 inch and 0.71 inch along Y direction. Case A have the maximum displacement and Case F have minimum displacement among all the cases. Which indicates that displacement can be reduced by making the structure with uniform stiffness and case B, C and case D, E are giving same results for displacements.

It is also studied that story drift values are found to be higher in seismic zone IV for all the cases (A, B, C, D, E and F) when correlated to zones II and III. Figure 4.5 and 4.6 represents the value of story drifts. Zone IV giving the higher story drifts for all the cases but case F have the minimum story drift among all the cases and case F (Shear wall at four ends) giving better result. Case F story drifts value is minimum among all the cases for the zone of II, III and IV. The story drifts value for Case F for zone II, III and IV are 3.03 mm, 4.25 mm and 5.46 mm along X direction and 0.98 mm, 1.38 mm and 1.77 mm along Y direction. Which indicates that story drifts also can reduce by making the structure with uniform stiffness.

Story drift are checked and for case F and get the results Ex and Ey direction all story are safe. So, here also case F gives better result than the other cases (A, B, C, D, E and E). So that it is concluded that building with uniform stiffness proven better results.

From the figure of maximum base shear 4.3 and 4.4 it is observed that the minimum base shear value in Zone II is 1584.74 kip for Case A. The maximum base shear value in Zone IV, 3413.711 kip for case F. The base shear values for the building increase with the seismic zone, reflecting the higher seismic demand in zones III and IV compared to zone II. Case F consistently has the highest base shear value among all zones and correlated with other cases (A, B, C, D, E and E). Case (B, C, D and E) base shear is same for all the three seismic zones II, III and IV.

Sway limits is observed due to load case Wx in global X direction and Wy global Y direction for case F and for the remaining five cases A, B, C, D, and E. The building remains safe with sway limits for case F for seismic zones II, III and IV.

As the static base reaction the base reaction is not verified 85% for all the case. Case F gives better results in zone II and III. For zone IV need to scale the base reaction value. To get 85% base reaction we need to scale the value.

Torsional irregularity is observed due to load case Ex in global X and Y direction for all the cases (A, B, C, D, E and F). For Case A the torsional value is more than 1.2 that's mean the building is not safe for torsional irregularity. But for the other cases the torsional value is under 1.2 that's mean the building is safe for the cases (B, C, D, E and F). The building remains safe with torsional irregularity which indicates that the building for the present study needs further stiffness in order to reduce displacements in all the seismic zones of Bangladesh.

The time period of the building as per BNBC 2020 is given by the formulae of building time period, Ta=1.33s which doesn't match with any of the time periods of Modal 14 which was shown in time period and frequency table, its indicates that the building is safe from resonance effect.

The displacement of building models by story response plot increases with the seismic zones. The displacement is very high at roof and very low at the base. The displacement occur at the zone II case F is 1.24 inch, zone III case F is 1.73 inch and zone IV case F is 2.23 inch. The story drift is mainly occurred at the middle of the building structure. From figure 4.5 and 4.6 it is concluded that the story drift increases with the increasing of seismic zone factor and the maximum story drift is available at zone IV and case F.

It is observed that the building with shear walls placed at four ends, Case F, had given better results in terms of maximum displacement, story drift, building time period and base shear. So that it is concluded that building with uniform stiffness proven better results.

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