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Institute of Graduate Studies

Civil Engineering

COMPARISON OF THE EFFECT OF THE POSITION OF SHEAR WALLS İN HIGH-RISE BUILDINGS ON THE HORIZONTAL STIFFNESS OF THE BUILDING UNDER THE EFFECT OF HORIZONTAL EARTHQUAKE LOADS

Aymen ZIGHECHE

Master’s Thesis

Supervisor

Prof. Dr Zeki HASGUR

Istanbul, 2022

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I hereby declare that this thesis meets all format and submission requirements of a Master of Science.

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I hereby declare that all information/data presented in this graduation project has been obtained in full accordance with academic rules and ethical conduct. I also declare all unoriginal materials and conclusions have been cited in the text and all references mentioned in the Reference List have been cited in the text, and vice versa as required by the abovementioned rules and conduct.

Aymen ZIGHECHE

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ABSTRACT

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The earthquake has turned into a menace to our lives and the infrastructure of countries. Several earthquakes have struck the world in recent years, causing extensive damage such as building destruction and material and human losses in various parts of the world. To reduce the number of casualties, we must make building construction structures more rigid so that they can withstand the force of an earthquake while it is occurring, as well as increase the thickness of the shear walls, which play an important role in resisting lateral forces because they are stiff and strong. In this PAPER, I will address the effect of shear wall position in buildings of 5 stories and 15 stories under seismic load in (zone c) as per code provision TSC 2018, which includes changes in base shear, storey displacement, and storey drift, as well as other data related to shear wall effect. The study was carried out to determine the effectiveness of the shear wall in a building by changing the position of the shear walls as a result of the analysis completed using ETABS software.

Keywords: Seismic Load, Shear Wall Location, Etabs, Base Shear, Displacement

TABLE OF CONTENTS

Pages

LIST OF TABLES

Pages

LIST OF FIGURES

Pages

ABBREVIATIONS

CM	:	Centre Of Mass
CR	:	Centre Of Rigidity
SW	:	Shear Wall
ECC	:	Eccentricity

LIST OF SYMBOLS

VtE	:	(X) total equivalent earthquake load (base shear force) acting on the whole building in the earthquake direction (KN
mt	:	Total mass of the upper part of the building above the basements (t)
SAR	:	Reduced design spectral acceleration [g]
Tp(x)	:	(X) the dominant natural vibration period of the building in the direction of the earthquake [s]
SDS	:	Short period design spectral acceleration coefficient [dimensionless]
g	:	Gravitational acceleration [m/s2]
I	:	BUILDING IMPORTANCE FACTOR
D	:	displacement component
nbi	:	Torsionally Irregularity Factor defined at i’th storey of building
Δi	:	Storey drift of i’th storey of building
Di and di-1	:	lateral displacements obtained from the analysis according to reduced seismic loads at the ends of any column or structural wall at stories I and (i-1)

1. INTRODUCTION

Buildings with shear walls that have been properly built and detailed have performed admirably in previous earthquakes. In seismically active areas, shear walls demand special attention. Even buildings with a sufficient number of walls that were not carefully specified for seismic performance (but had enough well-distributed reinforcing) were rescued from collapse in previous earthquakes. Shear wall structures are common in earthquake-prone countries such as Chile, New Zealand, and the United States. Shear walls are simple to construct since wall reinforcement detailing is straightforward and hence simple to execute on site. Shear walls are effective in minimizing earthquake damage to structural and non-structural elements, both in terms of construction cost and effectiveness (like glass windows and building contents)[1].

1.1 THE IMPACT OF EARTHQUAKE ON BUILDING

An earthquake is a natural occurrence that is full of unknowns. During an earthquake, ground motions occur at random in all directions radiating from the epicenter, both horizontally and vertically, causing structures to vibrate and inducing inertia forces on them [2]. it has become more deadly without forgetting the collapse of the buildings that happen due to its power. But in the fact, the earthquake don t causes this destruction directly, most collapses occurring during an earthquake are not caused by the earthquake itself instead. when the ground moves beneath a building it displaces the foundation and lower level sending a shock wave through the rest of the structure and causing it to uprate back and forth. A building endures dynamic motion when an earthquake occurs; this is due to inertia forces acting in the opposite direction as the acceleration of seismic excitations on the structure. These inertia forces, also known as seismic loads, are normally addressed by assuming external forces. As a result, in addition to gravity loads, the structure will be subjected to significant lateral forces during earthquake shaking. In order to construct a structure that can withstand an earthquake, these lateral forces must be estimated and specified [3].

If we talk more about waves and deeply that caused by vibration that occurs in the first shock of the earthquake to structure, we must go through these steps which are:

Ground motion is caused by seismic waves, particularly surface waves, propagating through surface rock strata and regolith. Buildings can be damaged and, in rare cases, completely destroyed by such motion. If a structure, such as a building or a road, is built on top of a fault, the ground movement caused by an earthquake will severely damage or destroy it. Earthquake vibrations in areas with hills and steep slopes can trigger landslides, mudslides, and cliff collapses, which can damage buildings and result in fatalities. Soil vibration can cause a building's foundation to crumble, change its supports, or shake it off its foundation; In areas with highly moist ground-infilled land, near the ocean, or in situations with a high-water table, ground shaking may exacerbate the problem. Liquefaction is the term for this condition. When moist sandy soil is shaken by an earthquake, the soil particles may be jolted apart, allowing water to flow in between them. The friction between soil particles, which is responsible for soil strength, is considerably reduced as a result of this. Because of the abrupt fall in shear resistance induced by the temporary increase in pore fluid pressure, wet saturated soils lose their bearing capacity and become fluid. The earth then behaves in a similar manner to quicksand. When this occurs, buildings begin to lean and can simply tumble over or partially sink into the liquefied earth, as the soil is unable to hold them. However, as the land settles following the earthquake, subsequent settlements and sand soil eruptions may cause severe damage to buildings (water and sediment bursts from the pressure-charged liquefied sand). Liquefaction can also increase the lateral pressure on retaining walls, causing them to shift; Large volumes of soil can be shifted laterally as a result of liquefaction, a process known as lateral spreading, which can have significant implications. Cracks, rifting, and buckling appear on the displaced earth. Lateral spreading causes bridges to buckle and service pipelines to burst, disrupting the foundations of buildings placed across the fault. Strong surface seismic waves cause the ground to heave and lurch, causing structural damage [4].

1.2 BUILDING RESIST SESMIC

Buildings designed to withstand earthquakes should have at least some lateral rigidity, so that they do not sway excessively during minor tremors [5].

After the vibration of the building that occurred due to the shock wave that the earthquake caused that, the strength of this oscillation is determined by two factor:

i. Mass of building that combined with the acceleration of ground

ii. Stiffness that affected by the height of the building

iii. shorter buildings tend to be stiffer and motionless while taller buildings are more flexible

The resistance of the buildings come back to its rigidity that limits the displacement. if the rigidity is high the displacement is low.

We should utilize columns with enormous dimensions to improve the seismic performance of structures, however this would limit the interior accessible area. As a result, huge columns are eliminated in favor of shear walls in both orientations of the construction. The shear walls contribute not only to the building's compressive strength, but also to its structural stiffness, minimizing displacements and, as a result, deformations caused by seismic events [6].

1.3 SOME DEFINITIONS OF SHEAR WALLS

The first time of the earthquake, the columns of the building structure are unable to withstand it, so to avoid the direct collapse of the building and reduce the number of damages the shear wall is required. Shear walls are vertically oriented features that, in addition to bearing vertical loads, limit the structural frame's horizontal deformations. Because they usually transport gravity loads, their great size isn't really necessary. On the other side, their massive bulk is required in order for them to withstand horizontal seismic forces. Shear walls are subjected to strong flexural and shear loads as a result of ground earthquake events. Only a robust and well positioned reinforcement can carry these stresses across their full mass [6]. Shear wall is one of the best structure elements for the multi-story building to resist the lateral force from wind and earthquake. Shear wall are usually placed in the stairs, between column lines, lift wells, shafts, and so on. It works by distributing the lateral force (wind and earthquake load) to the foundation. Shear wall make the structure of the building become more rigid/stiff and increase the strength of the structure [7].

1.4 SHORT SUMMARY ABOUT THE STUDY OF THE THEME

Nowadays the buildings with the shear walls are the most popular in the construction field regarding their importance to protecting the buildings from lateral loads and making the structure more resistant when an earthquake occurs. in this project (G+5) and (G+15), I'm going to analyse the structure of this building for (zone c) and suitable load combination according to Turkish code for getting the best location for shear walls and its effectiveness. as I have assumed some positions in the structure and I analysed that, with each place I supposed I noted the change set and the values that I got which include the stiffness, displacement, and base shear with some data and I compared the results.

2. LITERATURE REVIEW

The rush to new heights and architecture has not been without its difficulties; as a building's height increases, the structure's rigidity becomes more critical. Due to dominating lateral loads, tall constructions have continued to soar higher and higher, encountering unexpected loading effects and extremely high loading values. The effects of lateral loads like as wind loads and earthquake forces are becoming increasingly important, and practically every designer is faced with the dilemma of providing suitable protection. strength and stability against lateral loads; Alpa Sheth, (2008) studied three concrete towers with concrete flat slabs and shear walls, with and without a perimeter framing beam, and one of the models was also studied with the addition of an outrigger system; Anshuman. S et al., (2011) studied the location of shear walls in multi-story buildings. The top deflection was reduced and reached within the permissible deflection after providing the shear wall after an earthquake load was calculated and applied to a fifteen-story building located in zone IV; it was observed that the top deflection was reduced and reached within the permissible deflection after providing the shear wall; Dr. B. Kameshwari et al. (2011) investigated the impact of various shear wall layouts on high-rise structures. The structure's drift and inter-storey drift in the following configurations of shear wall panels were investigated and compared to those of a bare frame; For structures in earthquake-prone areas, a diagonal shear wall configuration has been demonstrated to be beneficial. T. Fatima and colleagues (2011) investigated lateral motions in composite high-rise buildings subjected to seismic action. This research sheds light on how buildings behave when subjected to seismic forces. Earthquake Analysis of High-Rise Buildings with and Without Infilled Walls was studied by Wakchaure M.R et al. (2012). The major goal of this project was to use the linear dynamic analysis approach to investigate the effect of masonry infill walls on the seismic behavior of a R.C.C. high-rise building. Top story displacement was decreased in the High Rise Building due to infill walls. A. Rahman et al., (2012) examined drift analysis due to seismic load on tall structures; regular shaped structures were considered in this study. For rigid frame structures, coupled shear wall structures, and wall frame structures, drift estimation was performed [8]. Concrete is an ideal building material in many ways, combining economy, form and function adaptability, and notable resilience to fire and the ravages of time. Cement is made from raw elements that are available in almost every country, and the process is quite easy. It's no surprise that it's become a universal building material in our century. Tall buildings are the most difficult to construct because to the numerous conflicting requirements and complicated building systems that must be integrated. In comparison to prior high-rise buildings, today's tall buildings are getting increasingly slim, allowing for more sway. Thus, the effect of wind and seismic forces on them becomes a critical design consideration. Tall structures' structural systems can be improved to regulate their dynamic response. The maximum height of concrete buildings has risen dramatically in recent decades, thanks to more appropriate structural forms such as shear walls and tube structures, as well as enhanced material qualities. As a result, the time dependency of concrete has become another key component to include in studies in order to come up with a more fair and cost-effective design [9].

Shear walls are one of the best ways to make multistory reinforced concrete buildings earthquake resistant. During earthquakes, the structure is still harmed for several reasons. The distribution of weight, stiffness, and strength in both horizontal and vertical planes of the building determines how the structure behaves during an earthquake. The structure uses reinforced concrete shear walls to lessen the effects of earthquakes. These can be utilized to improve a building's seismic response. Building structural design for seismic loading is primarily concerned with structural safety during significant earthquakes; however, particularly tall buildings, enough lateral stiffness to resist lateral load is critical. The use of a shear wall in a structure to achieve stiffness has been proven to be both effective and cost-efficient. When structures are tall, the beam and column sizes are relatively huge, and the amount of steel required is considerable. As a result, there is a great deal of congestion at these joints, making it difficult to insert and vibrate concrete, and displacement is fairly substantial. Shear walls are commonly employed in tall buildings to prevent collapse. When shear walls are placed in strategic locations across a structure, they can form an effective lateral force resisting system [10].

Shear walls are straight-up elements during the sideways power resist arrangement. They send out sideways services commencing the diaphragm over in the direction of the diaphragm underneath or towards the groundwork. The shear stress distribution is proportional to the time of inertia of the wall cross-sections. The displacements in every floor or level square measure the results of the flexural deformations within the walls. Investigation on different sturdy ground movements discovered that nicely designed laterally restrained buildings performed well in past disasters. However, previous investigations' observed that the buildings that have high shear wall area to floor area ratios with walls that don't have any particular seismic design remained when high magnitude earthquakes occurred. Providing shear walls can reduce the drifts and improve structural stability. This in fact drew the attention of educational researchers to shear wall frame buildings. Engineers would like sensible and straightforward ways to predict the structural behavior before testing various analyses. The shear wall area to floor area magnitude relation is additionally recognized as an important specification moving the world achievement of building. within the gift study, totally different shear wall area to floor area magnitude relations area unit accustomed recommend comfortable shear wall ratio to be used at the preliminary style stage of buildings [11].

2.1 THE ROLE OF SHEAR WALLS IN THE BUILDINGS

The addition of a shear wall considerably improves the building's lateral load carrying capacity [12]. And gives it a great performance seismic. And among the functions that contains it we have as follow.

2.1.1 Giving Building Lateral Strength

Shear Wall should provide parallel shear solidarity to the structure to withstand even seismic tremor powers, wind powers, and move these forces to the foundation [13].

2.1.2 Giving Lateral Stiffness to building

Shear Walls give enormous firmness to working toward their direction, which lessens horizontal influence of the structure and consequently decreases harm to structure [13].

Without forgetting that the shear walls contribute to the stability of buildings and minimizing the consequences of earthquakes to structure and non-structure elements

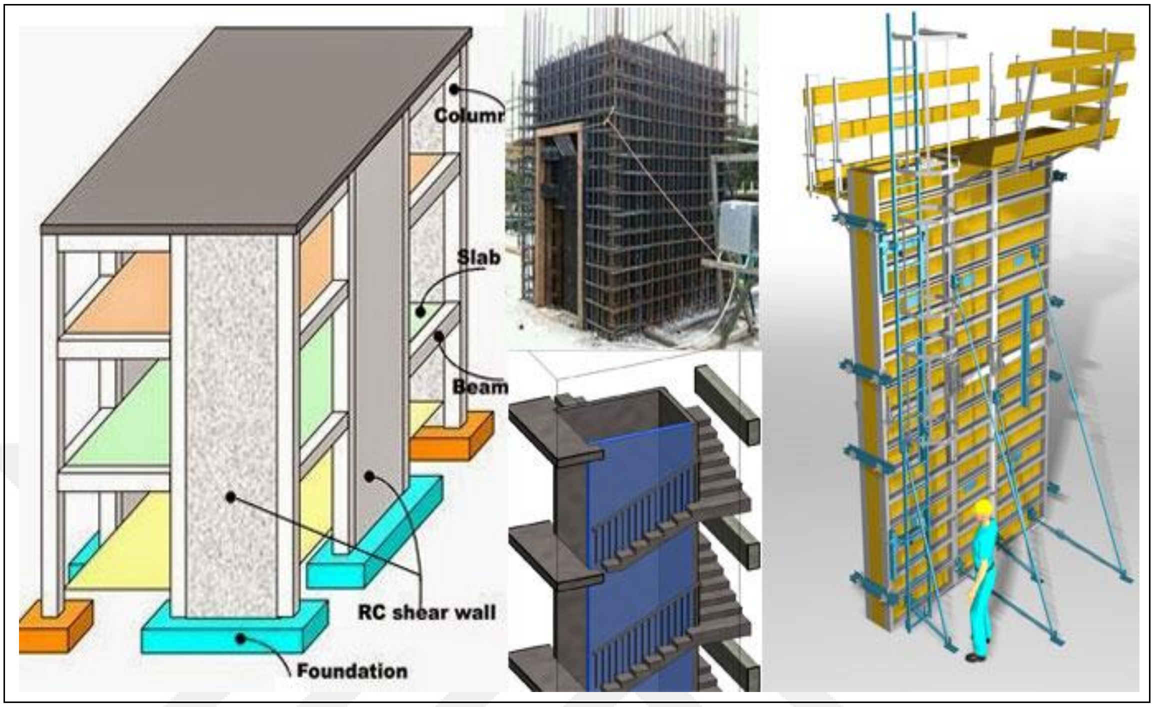

Figure 2.1 a: Shear Wall Caste in the Construction Site (https://www.quantity-takeoff.com/load-transfer-system-in-shear-walls.htm)

Figure 2.1b: Shear Wall Caste in the Construction Site (https://structville.com/2020/10/bracing-systems-in-a-high-rise-building.html)

2.2 SHEAR WALL BEHAVIOUR

During a seismic event, the wall is subjected to flexural and, in particular, shear loads. As a result, stresses emerge along the diagonal axis across the entire element's surface. With the change in earthquake shaking, the diagonal shear strains change direction. These stresses are efficiently handled by the well-confined border columns, while they are carried by the double reinforcement mesh in the main body of the shear wall (horizontal and vertical rebars) [6]. Furthermore, shear wall may be behaved as slender wall a squat wall or combination of two. In slender wall the basic mode of deformation is bending. Shear deformation are small and can be neglect. In comparison to bending deformation, a squat wall appears to have a substantial degree of shear deformation. The design of such a wall is dictated by its shear strength. Typically, they are subjected to high nominal shear stress.

2.3 DIFFERENCE BETWEEN SHEAR WALL AND COLUMN

Because of its high in-plane stiffness, shear walls are useful in resisting seismic loads in high seismic zones. The gravity loads are carried by the columns, while the lateral loads are carried by the shear walls. Through a stiff floor diaphragm, a central core or dispersed shear walls interact with the frame structure [14].

i. When opposed to shear walls, concrete columns are less seismically resistant

ii. Shear walls are far more earthquake resistant than columns

iii. As per the structural plan, concrete columns are usually supplied at the room's end.

iv. Shear wall run along the full length of walls.

v. Concrete pillars Square, rectangular, circular, L shape, and I shape cross-sections are all possible.

vi. Shear wall cross-section is like vertical oriented wide beam

vii. Lateral load of columns resisted by flexure deformation

viii. Lateral load of shear walls resisted by shear deformation

ix. When opposed to a shear wall system, the consumption of concrete in columns is typically lower.

x. Normally consumption of concrete is more in shear wall when compared to beam column system

xi. Beam column system is more efficient and preferred for low rise building

xii. System of shear walls are the most appropriate for high rise building

2.4 KINDS OF SHEAR WALLS

The process of development in the field of construction increases day by day in terms of designs and construction methods and as I said already that the shear walls consider as an important structural element to protect the buildings from several natural factors and disasters like earthquakes and make it steadfast against the seismic. The shear walls have many kinds that are utilized according to the type of construction that is used in building as steel or concrete. And among these kinds we have as follow.

2.4.1 CONCRETE SHEAR WALLS

Concrete shear walls are one of the most reliable shear wall materials. Many earthquake-prone countries and regions have buildings with cast-in-place reinforced concrete shear walls. This form of construction has been used in urban areas for medium to high-rise structures since the 1960s [15].

Figure 2.2: Concrete Shear Wall (https://www.thestructuralworld.com/2018/09/08/concrete-shear-wall-design/)

2.4.2 STEEL SHEAR WALL

Steel infill plates are surrounded by boundary elements in a steel plate shear wall (SPSW). They make up an SPSW. It behaves like a vertical plate girder that is cantilevered from its base. The SPSW system, like plate girders, takes advantage of the steel infill panels' post-buckling behavior to improve component performance. An SPSW frame can be thought of as a vertical cantilever plate girder, with steel plates acting as the web, columns acting as flanges, and cross beams acting as transverse stiffeners [15].

Figure 2.3: Steel Shear Wall (https://www.canadianconsultingengineer.com/features/steel-plate-shear-walls/)

2.4.3 WOODEN FRAME WITH VERTICAL STUDS AND SHEATHING

Considered as traditional type walls and the most peripheral form of shear walls among its feature that they’re subject to deformation, collapse with vertical studs alone and covered in sheathing.

Figure 2.4: Wooden Frame (https://theconstructor.org/structural-engg/shear-wall-types-efficiency/6820/)

2.5 CLASSIFICATION OF SHEAR WALL

Reinforced concrete shear walls come in a variety of shapes and sizes, as shown below:

2.5.1 Simple Rectangular Type and Flanged Wall

i. Bar bell type with boundary element placed between columns

ii. Bar bell type walls are stronger and more ductility than the simple rectangular type of uniform section and they never fail in shear but only by yielding of steel in bending

iii. Bar bell type: minimum steel in web part and remaining steel in boundary elements

iv. Simple shear wall: steel in uniform distributed

v. Among the disadvantage of this type of shear wall is that like these walls during the seismic are rigid they attract and dissipate much of energy by cracking so repair become so hard

vi. Resist in plane vertical and horizontal shear forces and they are subjected to bending and shear

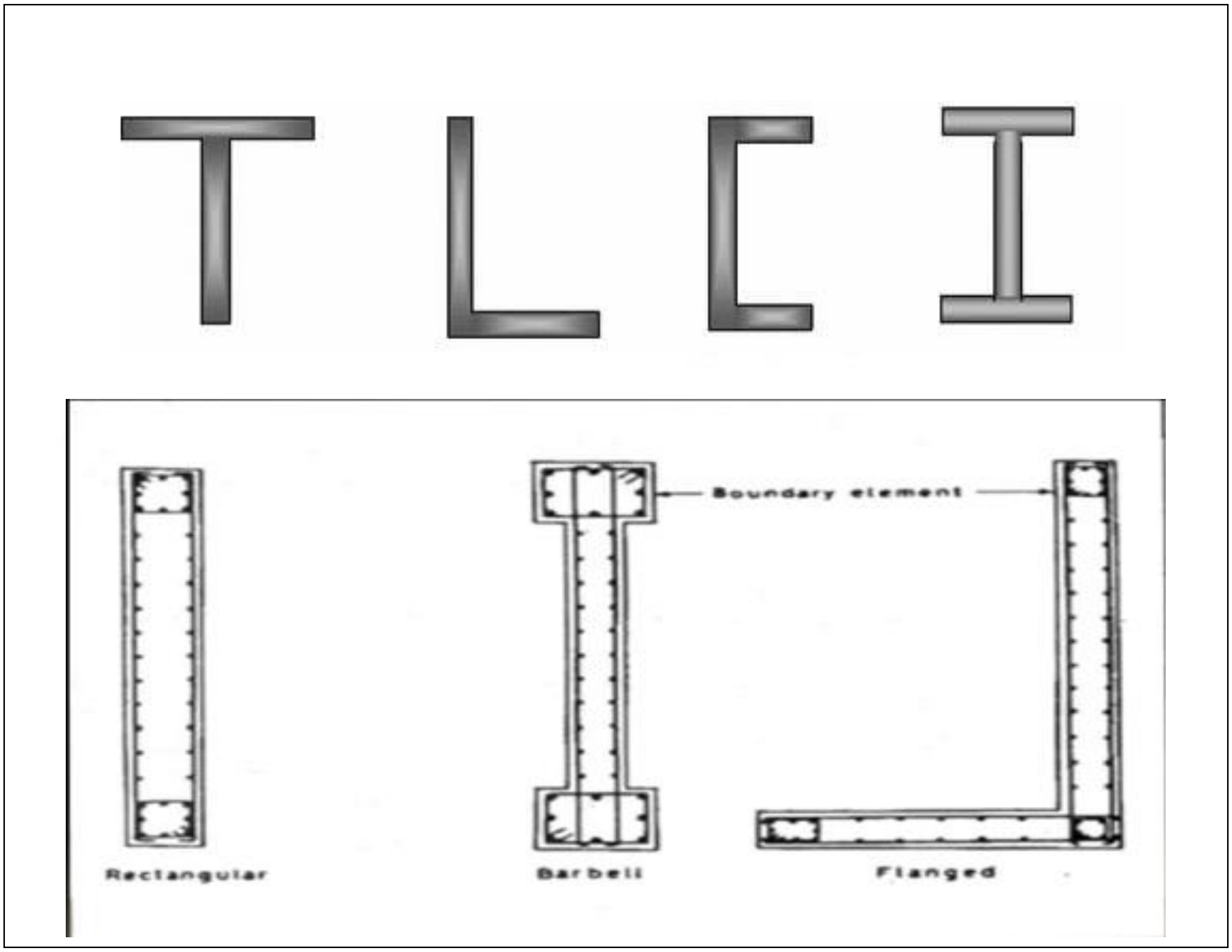

Figure 2.5: Rectangular Type and Flanged Wall (https://wrengineers.in/what-is-shear-wall-classification-of-shear-walls-advantages-of-shear-wall-functions-of-shear-wall/)

2.5.2 Coupled Wall Type

i. Two shear walls are tied together comparatively by spandrel beams, increasing stiffness, while the structure dissipates energy by yielding coupled beams with little damage to the main wall.

ii. Walls are more difficult to repair than coupling beams.

iii. Coupling beams designed to get a great energy dissipation characteristic and to develop hinges in the beam before shear failure.

iv. beams are moved vertically, bend in double curvature under lateral load

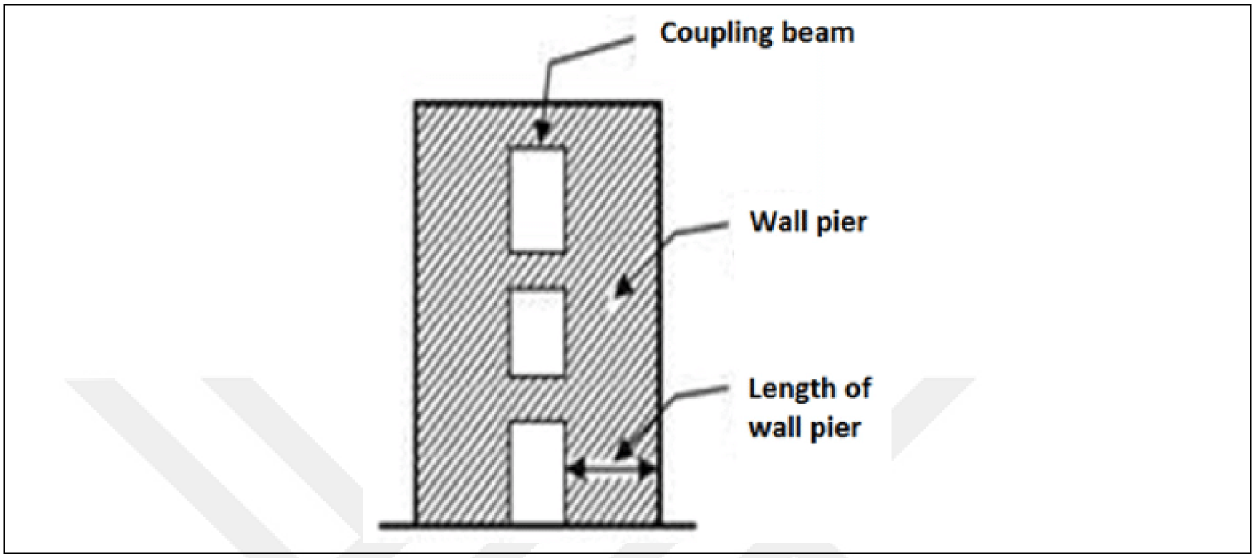

Figure 2.6: Coupled Wall (https://www.researchgate.net/publication/308665929_Structural_Shear_Wall_Systems_with_Metal_Energy_Dissipation_Mechanism/figures?lo=1)

2.5.3 Frame Walls with Infilled Frame

Framed walls are cast monolithically while infilled frames are constructed by casting frame first and in filling it with masonry or concrete block later.

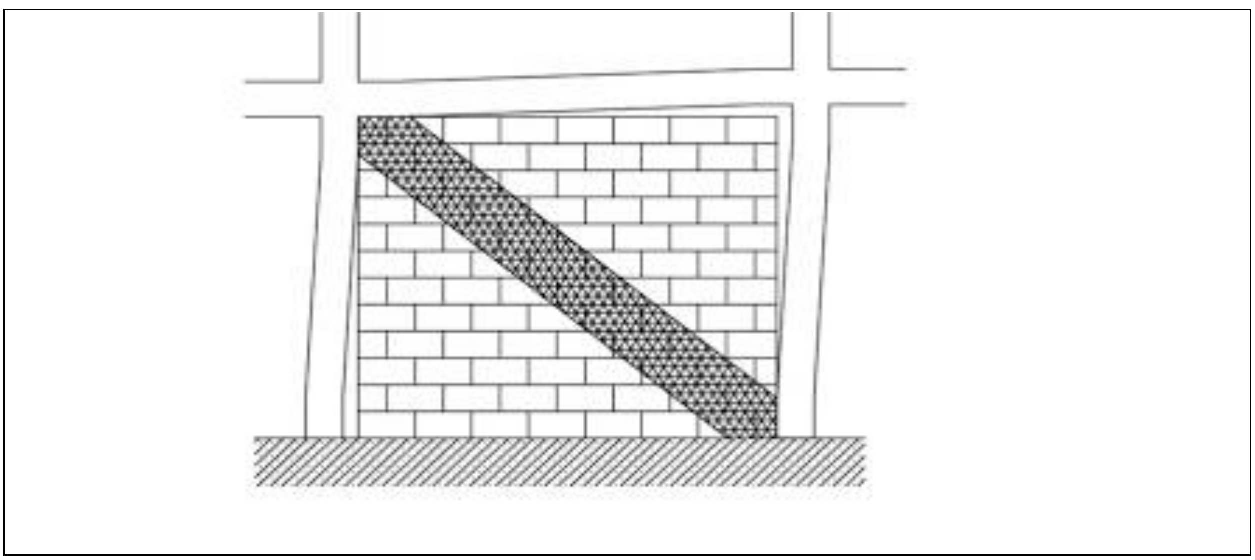

Figure 2.7: Frame Wall with Infilled Frame (https://www.structuremag.org/?p=13122)

2.5.4 Column Supported Shear Walls

Walls may be removed from the floor level for architectural purposes. A widely spread column carries the wall to the ground. The discontinuity in geometry at that level should be carefully considered in the design and detailing of such a column-supported shear wall.

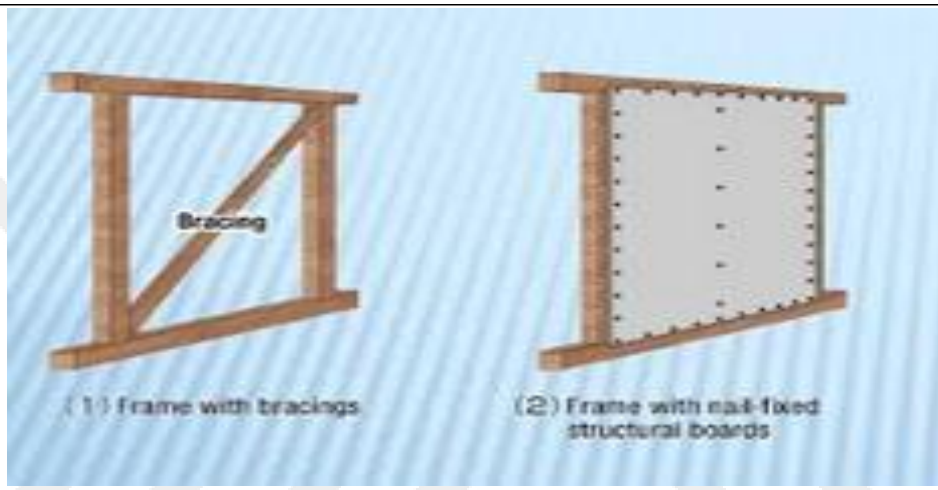

Figure 2.8: Columns Supported Shear Walls (https://www.slideshare.net/rajatrmr/shear-walls-87240979)

2.5.5 Core Type Shear Walls

Like this type is spreading in some buildings that have a lift and other services areas, the shear walls can be assembled in a vertical core and may serve against lateral forces.

i. The asymmetric position results in torsion and if torsion is absent it acts as a simple shear wall.

ii. core with designed lintels at regular intervals has good resistance to torsion example lift shaft

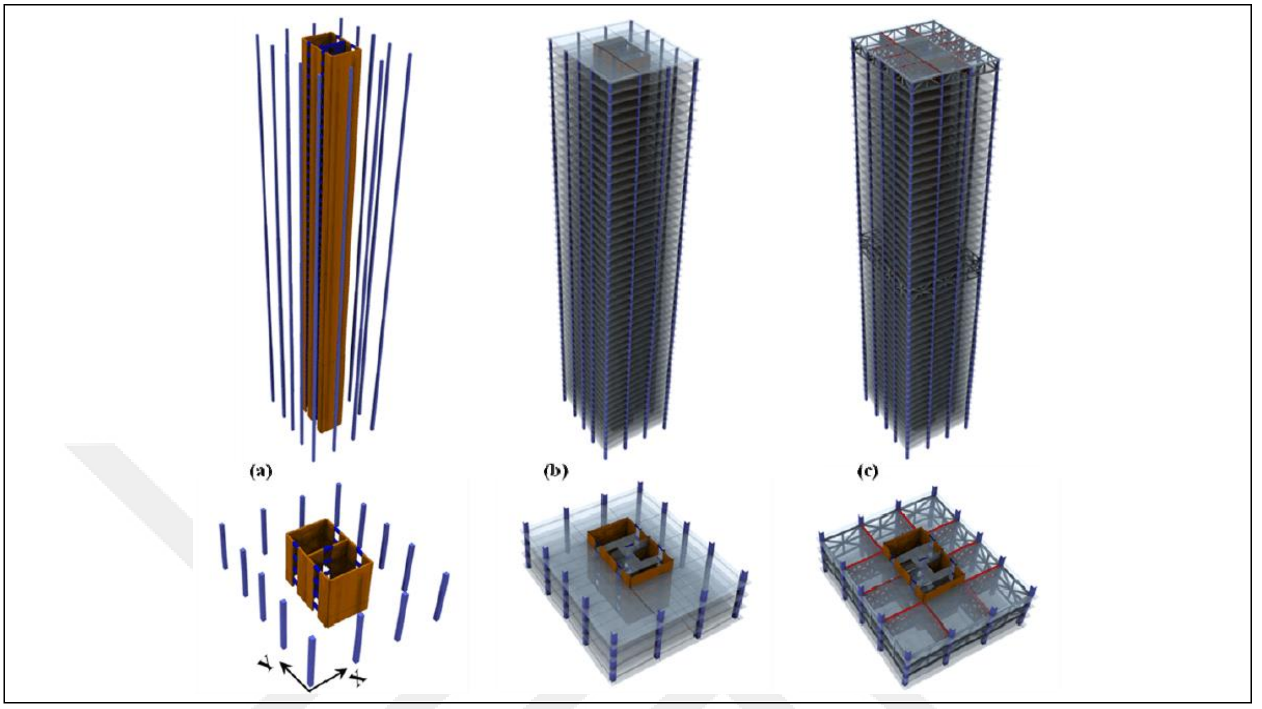

Figure2.9: Core Type

(https://www.researchgate.net/publication/272089387_Effects_of_Modeling_RC_Flat_Slabs_on_Nonlinear_Response_of_High-Rise_Building_Systems/figures?lo=1)

2.6 OPENING OF SHEAR WALL

Cantilever shear walls, which have apertures and are connected by coupling beams, always behave as coupled shear walls. In both internal and external walls of multistory buildings, openings in rows are required for doors, ventilations, openings, and windows. The opening has provided from an architectural standpoint. From the standpoint of structural engineering, the aperture must be kept to a minimum in order to protect the structural resisting components from undesirable seismic effects. In high-rise buildings subjected to lateral wind and seismic stresses, shear walls are extremely critical. Shear walls are typically planar or flanged in form, whereas core walls are made up of channel sections. Shear wall openings can be found in: structures with any sort of shear wall, structures with any type of shear wall, structures with any type of shear wall, structures with any type of shear wall, structures with any Shear walls are typically placed around lift areas in most structures. Components of shear walls in Dual System structures [16].

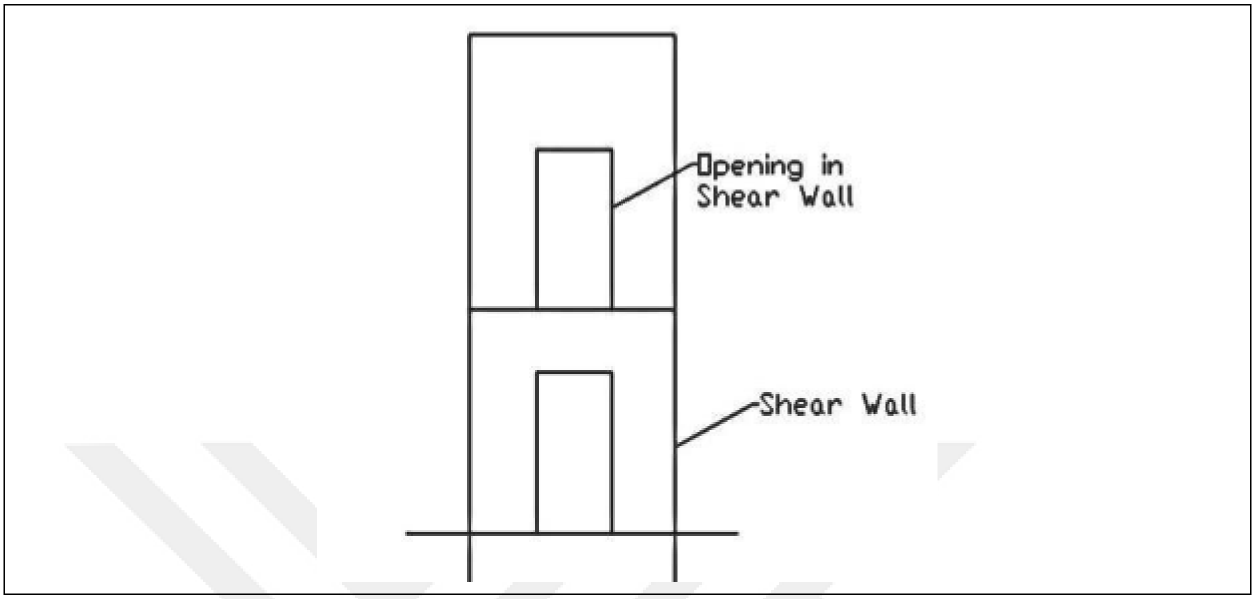

Figure 2.10: Opening Shear Wall

(https://www.sciencedirect.com/science/article/pii/B978008011692150016X)

Shear walls with openings are not recommended because they are unable to adequately transfer the load to the ground and hence fail [17] .

2.7 THE ROLE OF LIFT CORE SHEAR WALL

The ideal approach is to use a lift core, which is required in multi-story buildings and is usually used as a core type shear wall. Lift cores are generally given for the convenience of consumers [18].

2.8 THE EFFECT OF SHEAR WALL TO THE SOFT STORY IN BUILDING

It is well known that RC frame structures with an open first story perform badly during intense earthquake shaking. The stiffness caused by the wide opening on the lowest floor is very mild in comparison to the stiffness caused by the huge opening on the story above; The stiffness of the bottom level is 70% less than the stiffness of the story above it, resulting in the soft story. The stiffness of a structure is related to its lateral strength. A building's lateral strength is the total of all the stiffness from columns and shear walls applied at each story. So, for a building that does not have any lateral load resisting components such as bracing or shear wall, the low strength at the lowest floor causes failure, especially during earthquakes. The strength is considered to be quite poor and susceptible to failure during an earthquake [19].

So, the adding of shear walls in various arrangement in building contribute to reduce the soft story effect on structural seismic response and considering as an important factor for soft story structure to displace while the earthquake occurs.

2.9 CLASSIFICATION ACCORDING TO BEHAVIOR

2.9.1 Squat Structural Walls

i. deflection and strength are controlled by shear

ii. low rise shear walls

2.9.2 Slender Walls

They behave like a vertical slender cantilever beam. And usually have a height to length ratio is more than 2.

2.9.3 Ordinary Moment Shear Walls

i. Deflection and strength are controlled by flexure

ii. High rise shear walls which used to withstand high cyclones and wind

2.9.4 Ductile Moment Shear Walls

Special walls used in the earthquake zones and which have a great energy dissipation characteristic under reversal loads.

3. THE DIFFERENCE AND THE EFFECT OF THE LOCATION SHEAR WALL IN THE BUILDING

The analyses of any structure for controlling the extent of the building resistance are the desired target. For this purpose, my studies were about a comparison between buildings of (G+5) and (G+15) after analyzing it's with and without shear walls, as I was changing the position of shear walls from one building to another and noticing the output that resulted from that. These results were about the changeset of the values of base shear, displacement, and drift story with other data. These analyses have been carrying out utilizing ETABS software according to the Turkish code.

3.1 BASE SHEAR

Base shear is a calculation of the greatest predicted lateral force on the structure's base as a result of seismic activity.[17] this force after the earthquake happen distribute its strength along the height of the building and this latter increases the higher the building.

$$V_{tE}^{(x)} = m_t \, S_{aR} \, (T_P^{(x)}) \geq 0.04 m_t \, I \, S_{DS} \, g \tag{3.1}$$

3.2 STOREY DISPLACMENT

The displacement of story was appropriately named, but the displacement of base was not overlooked.

$$D = (\eta_{bi}/1.2)^2 \tag{3.2}$$

3.3 STORY DRIFT

Story drift any floor is the displacement of the floor with respect displacement just down to the floor and it's considered else as kind of displacement. Example the story drift in such floor it's not the same the story displacement.

$$\Delta_i = d_i - d_{i-1} \tag{3.3}$$

3.4 TIME PERIOD OF BUILDING

Considered as a feature property of building controlled by stiffness and mass inversely proportional with stiffness.

3.5 TORSION

Or twist, it's occurred due to the eccentricity which we got it from the difference between center of mass and center of rigidity, and caused to the severe damage or destruction of the buildings during the earthquake.

$$\eta bi = \Delta i_{,\, maks} / \Delta i_{,\, ave} \quad (3.4)$$

$$ecc = |cm - cr| \quad (3.5)$$

3.6 DESIGN DATA

ZONE	Zc (According to Turkish code tsc2018)
Number of stories	G+5 and G+15
Imposed load	$4.79kN/m^2$
thickness of slab	300mm
Materials	C30/S420
Unit weight of RRC	$25KN/m^3$
Total height of building frame	15.6m for (G+5) and 44.6m for (G+15)
Beams	25*50
Intern columns	30*40
Extern columns	30*50
Thickness of wall exterior	200mm
Thickness of wall interior	150mm
Thickness of shear wall	300mm
Height of storey	2.9m

Combination according to the turkish code	**Seismic coef**
0.9G+Ex	ZONE:C
0.9G+Ey	SS:0.348 (0.2 sec spectral accel)
0.9G-Ex	S1:0.098 (1 sec spectral accel)
0.9G-Ey	TL:8(long period transition period)
1.4G+1.6Q	Fa:1.3 (site coef)
G+1.3Q	Fv:1.5 (site coef)
G+Q+EX	R:8 (response modification)
G+Q+EY	D:3 (system overstrength)
G+Q-EX	I:1 (occupancy importance)
G+Q-EY	

Name	Type	Self Weight Multiplier	Auto Load
Dead	Dead	1	
Live	Live	0	
EX	Seismic	0	TSC-2018
EY	Seismic	0	TSC-2018
MASONRY	Superimposed Dead	0	

3.7 CASE 1 OF THE STUDIES (G+5)

3.8 DETAILS RESULT OF STUDIES

3.8.1 Building without shear walls (model1)

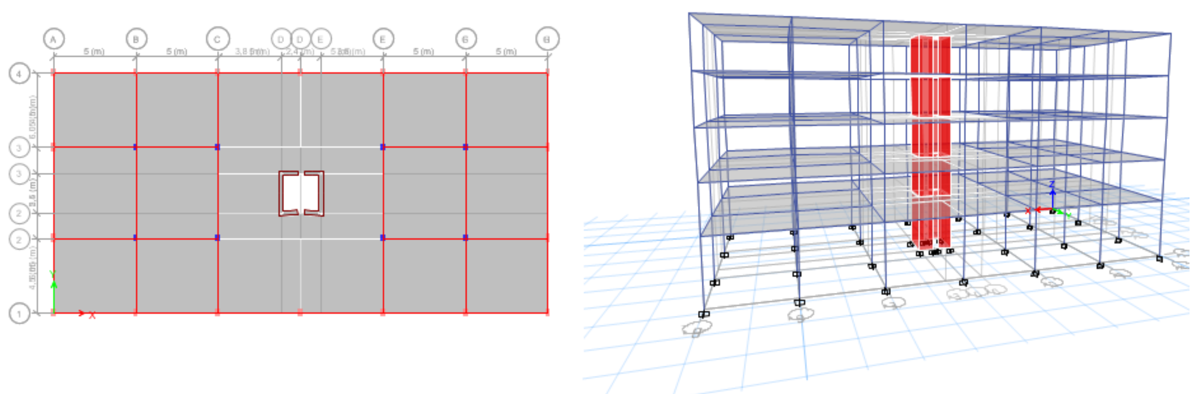

Figure 3.1: building without shear wall

- I took a-a axis belonging to the x-axis
- kind of case that I choose is : Ex

Bending Moment:

Table 3.1 a: Bending moment values of columns

stories	Vertical frame moment (column) (KN.M)							
	Top				Bottom			
Story 5	-3.72	-4	-3.90	-3.42	4.63	5.26	5.14	4.30
Story 4	-4.05	-4.49	-4.29	-3.57	5.73	6.53	6.26	5.15
Story3	-4.82	-5.32	-5.01	-4.14	6.95	7.85	7.40	6.04
Story 2	-5.39	-5.98	-5.59	-4.68	8.43	9.37	8.75	7.14
Story1	-4.32	-4.74	-4.52	-3.89	7.91	7.97	7.61	7.03

Table 3.1 b: Bending moment values of beams

stories	Horizontal frame moment (beam) (KN.M)					
Story 5	-0.52	0.15	-0.68	0.27	-0.51	0.22
Story 4	-1.15	0.42	-1.30	0.52	-1.15	0.57
Story 3	-1.8	0.76	-1.78	0.73	-1.72	1.11
Story 2	-2.44	1.20	-2.24	1	-2.26	1.63
Story 1	-2.33	1.1	-1.97	0.86	-2.08	1.52

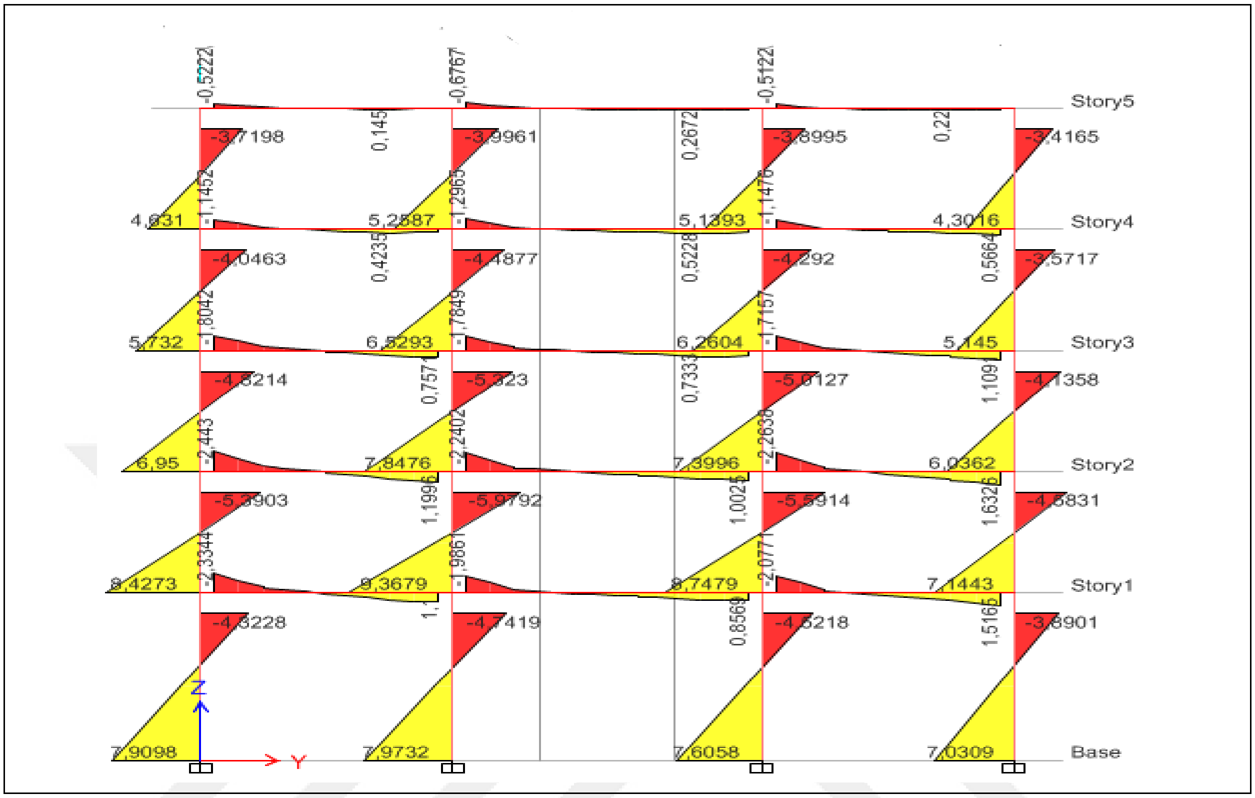

Figure 3.2: Bending Moment Diagram

Shear Force:

Table 3.2 a : Shear Force Values of Columns

stories	Vertical frame shear force (column) (KN.M)			
Story 5	3.48	3.86	3.77	3.22
Story 4	4.07	4.59	4.40	3.63
Story 3	4.90	5.49	5.17	4.24
Story 2	5.76	6.39	5.97	4.89
Story 1	3.50	3.63	3.47	3.12

Table 3.2 b: Shear Force Values of Beams

stories	Horizontal frame (beam) (KN.M)					
Story 5	-0.46	0.16	-0.64	0.17	-0.57	0.02
Story 4	-0.97	0.13	-1.23	0.21	-1.17	
Story 3	-1.44	-1.62	0.06	-1.61		
Story 2	-1.89	-1.99	-2.04			
Story 1	-1.80	-1.79	-1.88			

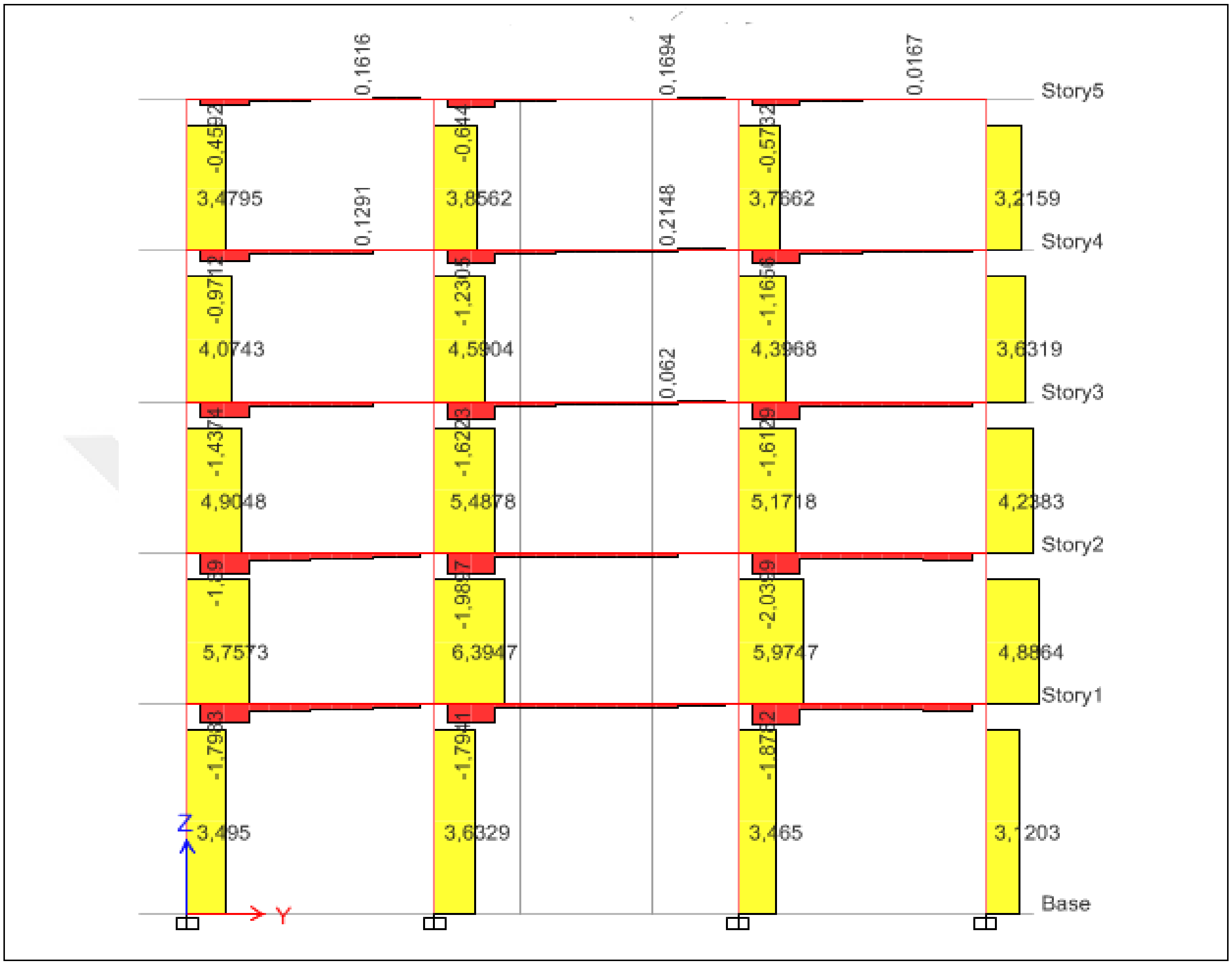

Figure 3.3: Shear Force Diagram

Table 3.3 : Center of Mass And Center of Rigidity

Story	Diaphragm	Mass X	Mass Y	XCM	YCM	Cumulative X	Cumulative Y	XCCM	YCCM	XCR	YCR
		kg	kg	m	m	kg	kg	m	m	m	m
Story5	D1	112930,48	112930,48	15	7,2501	112930,48	112930,48	15	7,2501	14,9999	8,0697
Story4	D1	128793,99	128793,99	15	7,2501	241724,47	241724,47	15	7,2501	15	8,0314
Story3	D1	128793,99	128793,99	15	7,2501	370518,46	370518,46	15	7,2501	15,0001	7,9931
Story2	D1	222906,66	222906,66	15	7,2501	593425,13	593425,13	15	7,2501	15,0001	7,8569
Story1	D1	228118,88	228118,88	15	7,2501	821544,01	821544,01	15	7,2501	15,0001	7,5404

Ecc: along x = 0 and along y = 0.82m the centers are not coincide therefore The building is subjected to a torsion

Torssion: (x direction)

Δi, ave= (0,000135+0,000221)/2 =1.78.10^{-4}

ηbi= 1.24≥1.2 so there is an irregularity torsion in the system bearing

y direction:

Δi, ave= (0.000145+0.000088)/2=1.17.10^{-4}

ηbi= 1.24≥1.20

Story Stiffness:

Stiffness along x in load case ex: storey1/(average (storey2+3+4)/3)

736768,286/1931042.939=0.38≤0.80 irregular

Storey2/(average (storey 3+4+5)/3

749704,716/520168.557=1.44≥0.8 regular

EY:

Stiffness along y in load case EY: storey1/(average(storey2+3+4)/3)

1686622,412/3022419.173=0.56≤0.80 irregular

Storey2/average (storey 3+4+5)/3

1311945,457/727851.84=1.80≥0.8 regular

Table 3.4 : Story Stiffness

Story	Load Case	Shear X kN	Drift X mm	Stiffness X kN/m	Shear Y kN	Drift Y mm	Stiffness Y kN/m
Story5	EX	142,1083	0,375	379167,448	0	0,016	0
Story4	EX	255,6914	0,467	547695,681	0	0,028	0
Story3	EX	343,3383	0,542	633642,542	0	0,041	0
Story2	EX	444,791	0,593	749704,716	0	0,049	0
Story1	EX	506,8732	0,688	736768,286	0	0,044	0
Story5	Ey	0	0,0000472	0	167,0424	0,353	473081,799
Story4	Ey	0	0,00001464	0	300,5547	0,4	750465,538
Story3	Ey	0	0,00003855	0	403,5799	0,42	960008,178
Story2	Ey	0	0,00007742	0	522,8334	0,399	1311945,457
Story1	Ey	0	0,00006995	0	595,8085	0,353	1686622,412

Table 3.5 : Response Spectrum Function

Name	Period	Acceleration	Damping	Ss	S1	TL	Site Class	Fa	Fv	SDS	SD1
	sec					sec					
TSC2018.responce spectrum	0	0,18096	5	0,348	0,098	6	ZC	1,3	1,5	0,3016	0,098
TSC2018.responce spectrum	0,065	0,4524									
TSC2018.responce spectrum	0,325	0,4524									
TSC2018.responce spectrum	0,6	0,245									
TSC2018.responce spectrum	0,8	0,18375									
TSC2018.responce spectrum	1	0,147									
TSC2018.responce spectrum	1,2	0,1225									
TSC2018.responce spectrum	1,4	0,105									
TSC2018.responce spectrum	1,6	0,091875									
TSC2018.responce spectrum	1,8	0,081667									
TSC2018.responce spectrum	2	0,0735									
TSC2018.responce spectrum	2,5	0,0588									
TSC2018.responce spectrum	3	0,049									
TSC2018.responce spectrum	3,5	0,042									
TSC2018.responce spectrum	4	0,03675									
TSC2018.responce spectrum	4,5	0,032667									
TSC2018.responce spectrum	5	0,0294									
TSC2018.responce spectrum	5,5	0,026727									
TSC2018.responce spectrum	6	0,0245									
TSC2018.responce spectrum	6,5	0,020876									
TSC2018.responce spectrum	7	0,018									
TSC2018.responce spectrum	7,5	0,01568									
TSC2018.responce spectrum	8	0,013781									
TSC2018.responce spectrum	8,5	0,012208									
TSC2018.responce spectrum	9	0,010889									
TSC2018.responce spectrum	9,5	0,009773									
TSC2018.responce spectrum	10	0,00882									

Displacement:

Load case: Ex

Table 3.6: Displacement

Story	Elevation	Location	X-Dir	Y-Dir
	m		mm	mm
Story5	15,6	Top	2,836	0,355
Story4	12,7	Top	2,446	0,323
Story3	9,8	Top	1,953	0,268
Story2	6,9	Top	1,371	0,186
Story1	4	Top	0,731	0,088
Base	0	Top	0	0

Load case: Ey

Table 3.7 : Displacement

Story	Elevation	Location	X-Dir	Y-Dir
	m		mm	mm
Story5	15,6	Top	1,704E-04	1,926
Story4	12,7	Top	2,024E-04	1,573
Story3	9,8	Top	1,916E-04	1,172
Story2	6,9	Top	1,555E-04	0,752
Story1	4	Top	7,387E-05	0,353
Base	0	Top	0	0

Story Drift:

Load case: Ex

Table 3.8 : Story Drift

Story	Elevation	Location	X-Dir	Y-Dir
	m			
Story5	15,6	Top	0,000135	0,000011
Story4	12,7	Top	0,00017	0,000019
Story3	9,8	Top	0,0002	0,000028
Story2	6,9	Top	0,000221	0,000034
Story1	4	Top	0,000183	0,000022
Base	0	Top	0	0

Load case: EY

Table 3.9: Story Drift

Story	Elevation	Location	X-Dir	Y-Dir
	m			
Story5	15,6	Top	2,152E-08	0,000122
Story4	12,7	Top	7,631E-09	0,000138
Story3	9,8	Top	1,414E-08	0,000145
Story2	6,9	Top	2,813E-08	0,000137
Story1	4	Top	1,847E-08	0,000088
Base	0	Top	0	0

Base Shear:

Table 3.10: Base Shear: According To The Turkish Code Tsc2018

Load Pattern	Type	Direction	Eccentricity	Ct (m), x	Period Used	Coeff Used	Weight Use	Base Shear
			%		sec		kN	kN
EX	Seismic	X		0.10m, 0.75	0,325	0,056485	8973,667	506,8732
EX	Seismic	X + Ecc. Y	5	0.10m, 0.75	0,325	0,056485	8973,667	506,8732
EX	Seismic	X - Ecc. Y	5	0.10m, 0.75	0,325	0,056485	8973,667	506,8732
Ey	Seismic	Y		0.10m, 0.75	0,248	0,066395	8973,667	595,8085
Ey	Seismic	Y + Ecc. X	5	0.10m, 0.75	0,248	0,066395	8973,667	595,8085
Ey	Seismic	Y - Ecc. X	5	0.10m, 0.75	0,248	0,066395	8973,667	595,8085

3.8.2 Building With Shear Wall In The Corners: (model2)

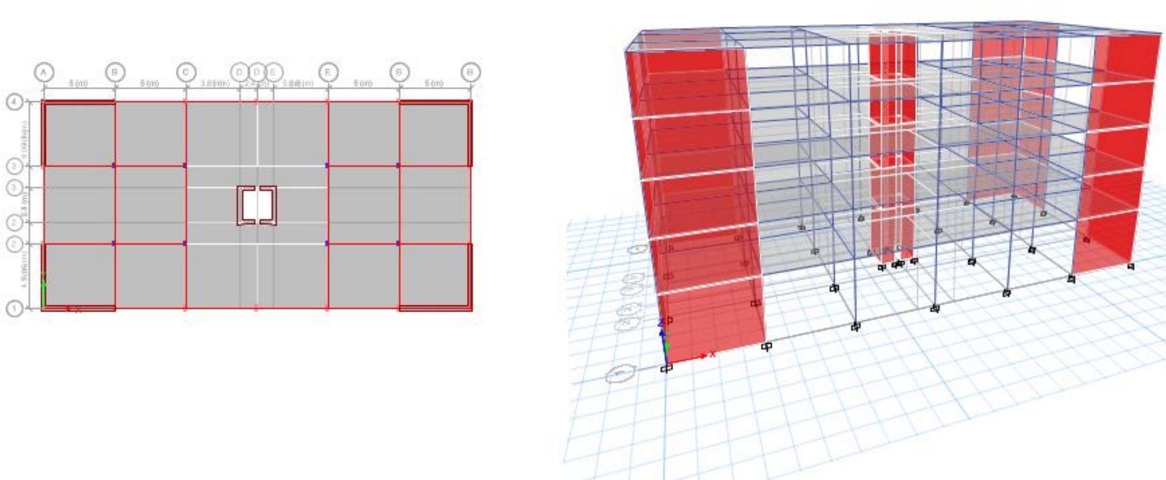

Figure 3.4: Building with Shear Walls in the Corners

- I took a-a axis belonging to the x-axis
- kind of case that I choose is : Ex

Bending Moment :

Table 3.11.a: Bending Moment Values of Columns

STORIES	VERTICAL FRAME VALUES (KN.M)							
	Top				Bottom			
STORY 5	-0.28	-0.35	-0.36	-0.27	0.34	0.64	0.66	0.33
STORY 4	-0.54	-0.30	-0.31	-0.54	0.77	0.69	0.70	0.76
STORY 3	-0.73	-0.35	-0.36	-0.72	1.14	0.79	0.80	1.13
STORY 2	-0.90	-0.35	-0.36	-0.90	1.53	0.90	0.91	1.52
STORY 1	-0.1	-0.23	-0.24	-0.1	2.27	1.06	1.06	2.27

Table 3.11.b: Bending Moment Values of Beams

Stories	Horizontal frame values (KN.M)					
Story 5	-0.22	0.14	-0.07	0.10	0.14	-0.21
Story 4	-0.24	0.25	-0.11	0.13	0.24	-0.23
Story 3	-0.32	0.36	-0.1	0.14	0.36	-0.31
Story 2	-0.37	0.46	-0.08	0.15	0.45	-0.36
Story 1	-0.29	0.5	-0.05	0.14	0.45	-0.28

Table 3.11.c: Bending Moment Values of Shear Walls

stories	Shear walls values (KN.M)			
	Top		Bottom	
Story 5	12.34	-11.65	-40.32	39.18
Story 4	2.32	-2.18	-54.18	51.78
Story 3	11.72	-12.58	-55.64	51.63
Story 2	29.82	-32.16	-33.12	27.18
Story 1	63	-67.44	90.59	-96.84

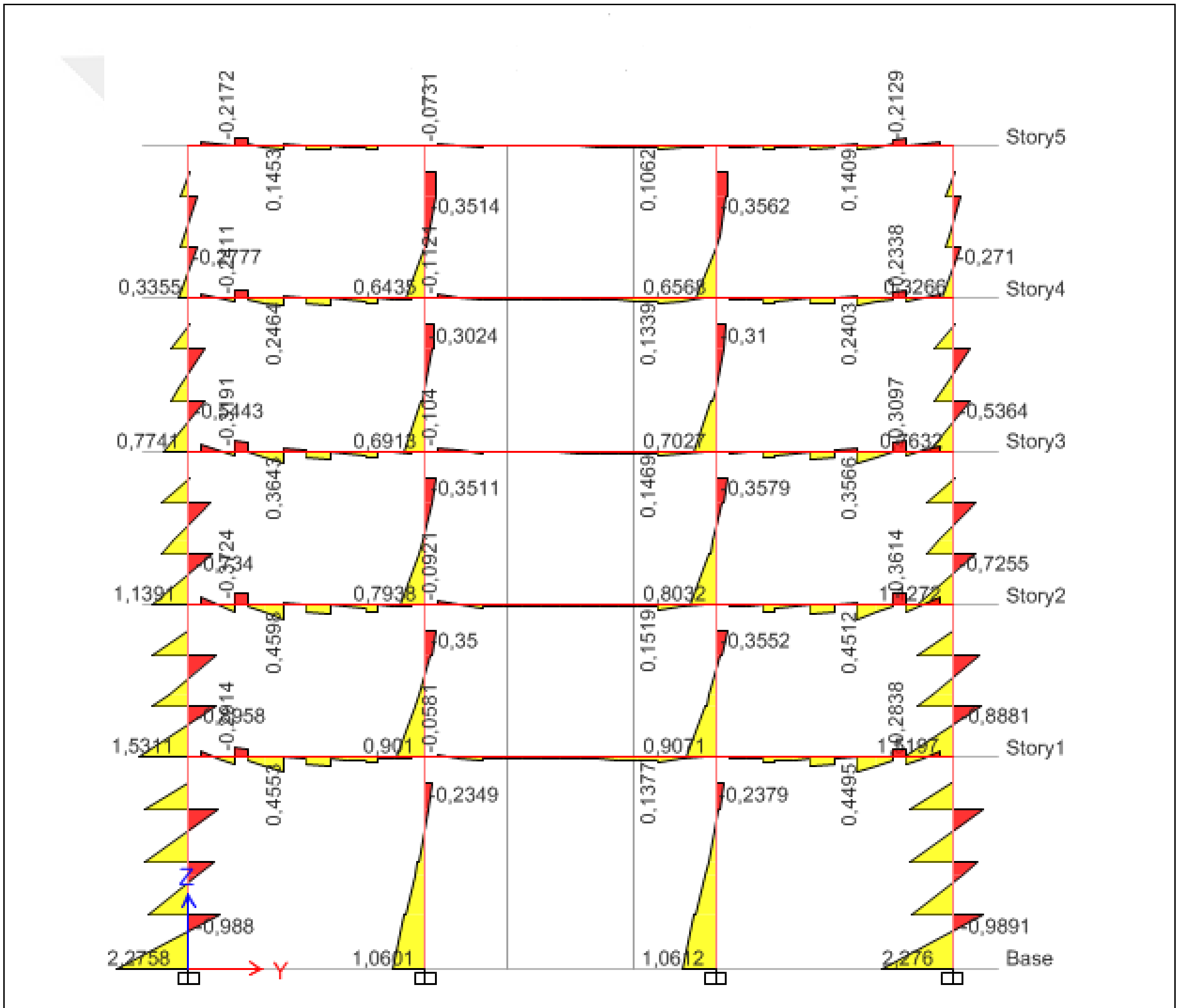

Figure 3.5: Bending Moment Diagram of Frame

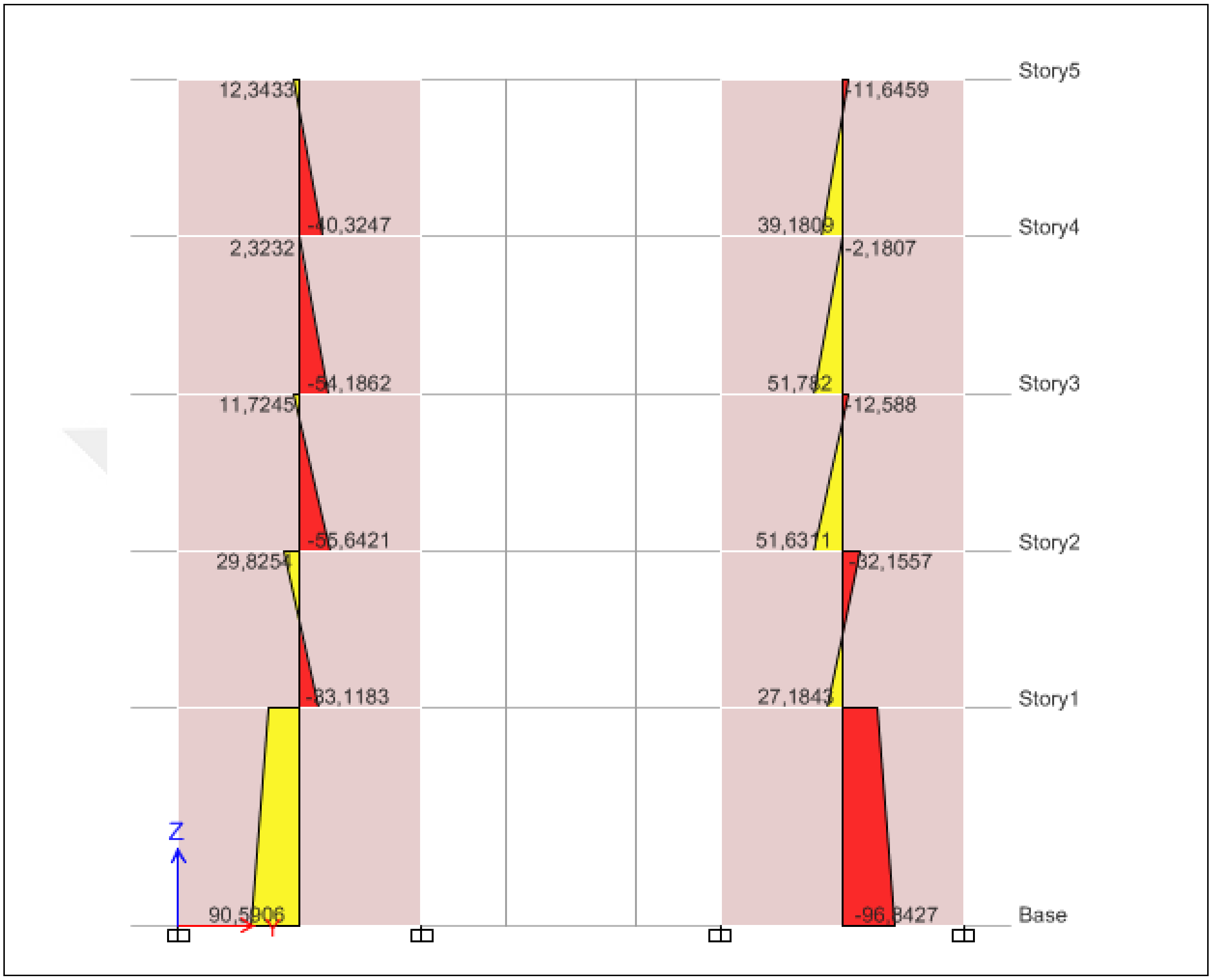

Figure 3.6: Bending Moment Diagram of Shear Wall

Shear Force:

Table3.12.a: Shear Force Values of Columns

stories	Vertical frame values (columns) (KN.M)							
	Top				Bottom			
Story 5	0.67	0.02	0.01	0.65	0.63	0.67	0.68	0.62
Story 4	1.38	0.24	0.33	1.36	1.96	0.58	0.59	1.94
Story 3	1.97	0.23	0.24	1.94	2.5	0.59	0.6	2.47
Story 2	2.49	0.35	0.47	2.47	2.51	0.57	0.58	2.5
Story 1	2.63	0.25	0.30	2.62	3.26	0.4	0.4	3.26

Table 3.12.b: Shear force Values of Beams

stories	Horizontal frame values (beam) (KN.M)			
Story 5	-0.26	-0.13	0.08	0.26
Story 4	-0.35	-0.20	0.15	0.34
Story 3	-0.53	-0.21	0.17	0.52
Story 2	-0.67	-0.22	0.18	0.66
Story 1	-0.69	-0.19	0.16	0.69

Table 3.12.c: Shear Force Values of Shear Walls

stories	shear walls values (KN.M)	
Story 5	-38.08	36.73
Story 4	-55.20	53.49
Story 3	-72.10	70.12
Story 2	-79.72	77.65
Story 1	-52.10	51.23

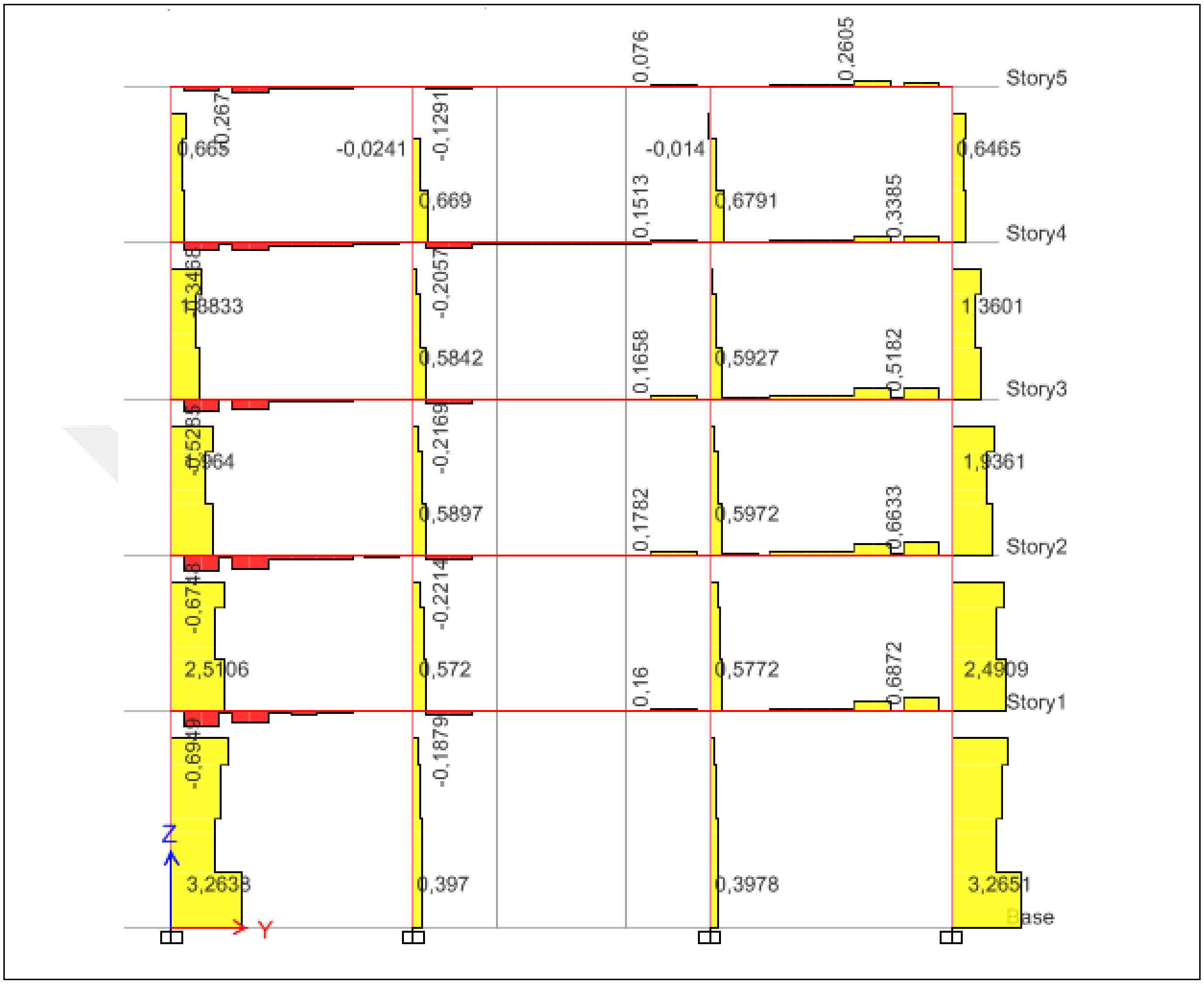

Figure 3.7: Shear Force Diagram of Frame

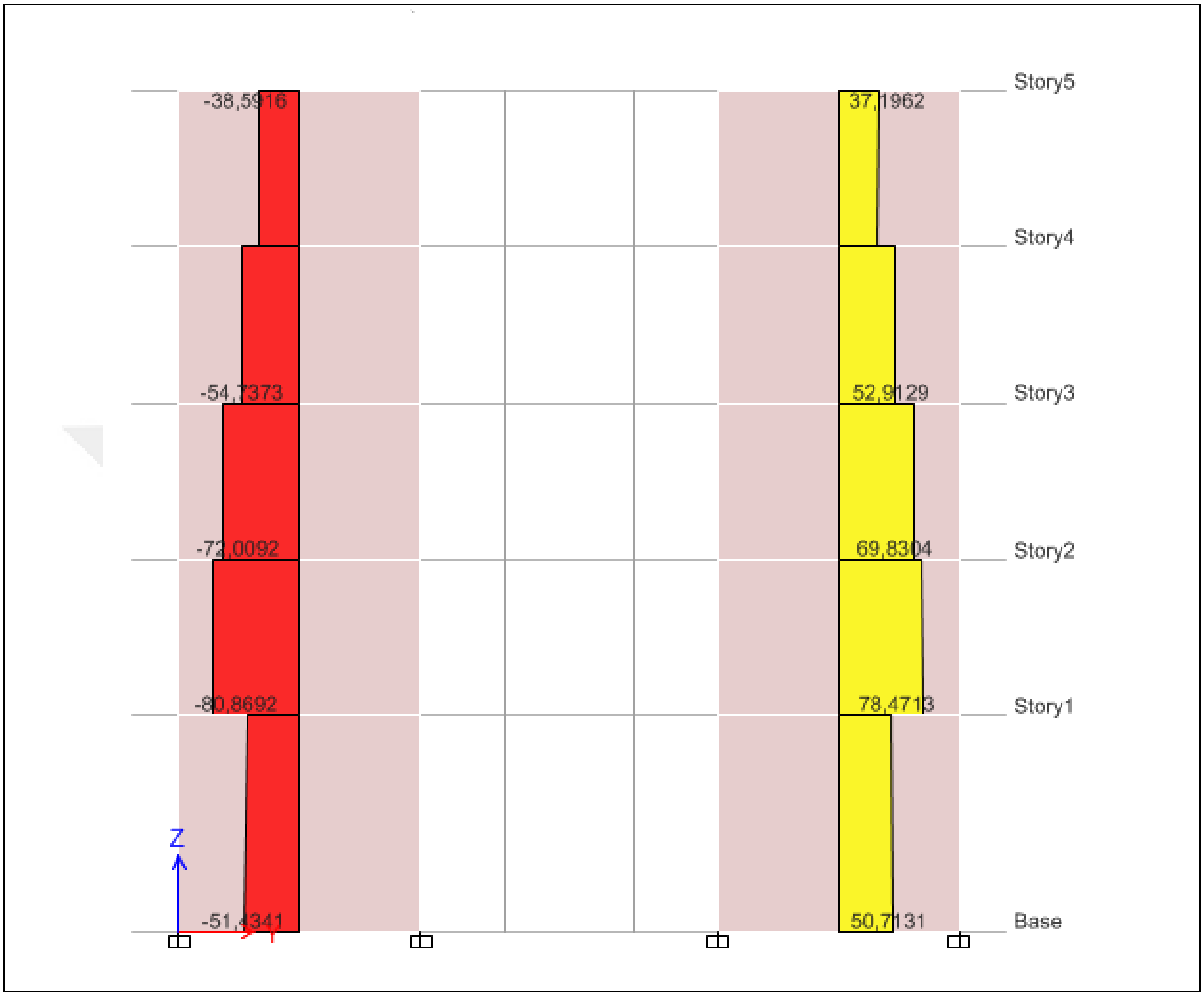

Figure 3.8: Shear Force Diagram of Shear Wall

Center of mass and center of rigidity:

Table 3.13: Center of Mass And Center of Rigidity

Story	Diaphragm	Mass X	Mass Y	XCM	YCM	Cumulative X	Cumulative Y	XCCM	YCCM	XCR	YCR
		kg	kg	m	m	kg	kg	m	m	m	m
Story5	D1	115191,76	115191,76	15	7,2501	115191,76	115191,76	15	7,2501	15	7,3594
Story4	D1	133864,6	133864,6	15	7,2501	249056,35	249056,35	15	7,2501	15	7,3482
Story3	D1	133864,6	133864,6	15	7,2501	382920,95	382920,95	15	7,2501	15	7,3322
Story2	D1	227977,26	227977,26	15	7,2501	610898,21	610898,21	15	7,2501	15	7,3085
Story1	D1	233286,36	233286,36	15	7,2501	844184,57	844184,57	15	7,2501	15	7,2722

Ecc: along x axis =0

Along y axis =0.1

Δi, ave= (0,000052+0,00003)/2 =4.1.10^{-5}

ηbi= 1.27≥1.2 so there is a torsion irregularity in the bearing system

y direction:

Δi, ave= (0.000056+0.000031)/2=4.35.10^{-5}

ηbi= 1.29≥1.20 there is a torsion irregularity in the bearing system

Story Stiffness:

Stiffness along x in load case ex: storey1/(average (storey2+3+4)/3

10275099.17/17903813.83=0.57≤0.80

Storey2/(average (storey 3+4+5)/3

7987848.849/12367942.37=0.65≤0.80

EY:

Stiffness along y in load case EY: storey1/(average(storey2+3+4)/3)

9728276.179/16307769.14=0.60≤0.80 irregular

Storey2/average (storey 3+4+5)/3)

7294454.289/11246884.95=0.65≤0.80 irregular

Table 3.14: Story Stiffness

Story	Load Case	Shear X kN	Drift X mm	Stiffness X kN/m	Shear Y kN	Drift Y mm	Stiffness Y kN/m
Story5	EX	349,0627	0,142	2451977,386	0	0,0004502	0
Story4	EX	634,8779	0,151	4195316,695	0	0,0004458	0
Story3	EX	855,4283	0,15	5720648,286	0	0,0004107	0
Story2	EX	1074,291	0,134	7987848,849	0	0,0003341	0
Story1	EX	1218,7273	0,119	10275099,17	0	0,0001851	0
Story5	Ey	0	0,000001988	0	343,3037	0,154	2233570,094
Story4	Ey	0	3,04E-08	0	624,4033	0,164	3816860,666
Story3	Ey	0	2,317E-07	0	841,3148	0,162	5196454,187
Story2	Ey	0	0,000001272	0	1056,5666	0,145	7294454,289
Story1	Ey	0	9,973E-07	0	1198,6199	0,123	9728276,179

Table 3.15: Response Spectrum Function

Name	Period	Acceleration	Damping	Ss	S1	TL	Site Class	Fa	Fv	SDS	SD1
	sec					sec					
TSC2018.responce spectrum	0	0,18096	5	0,348	0,098	6	ZC	1,3	1,5	0,3016	0,098
TSC2018.responce spectrum	0,065	0,4524									
TSC2018.responce spectrum	0,325	0,4524									
TSC2018.responce spectrum	0,6	0,245									
TSC2018.responce spectrum	0,8	0,18375									
TSC2018.responce spectrum	1	0,147									
TSC2018.responce spectrum	1,2	0,1225									
TSC2018.responce spectrum	1,4	0,105									
TSC2018.responce spectrum	1,6	0,091875									
TSC2018.responce spectrum	1,8	0,081667									
TSC2018.responce spectrum	2	0,0735									
TSC2018.responce spectrum	2,5	0,0588									
TSC2018.responce spectrum	3	0,049									
TSC2018.responce spectrum	3,5	0,042									
TSC2018.responce spectrum	4	0,03675									
TSC2018.responce spectrum	4,5	0,032667									
TSC2018.responce spectrum	5	0,0294									
TSC2018.responce spectrum	5,5	0,026727									
TSC2018.responce spectrum	6	0,0245									
TSC2018.responce spectrum	6,5	0,020876									
TSC2018.responce spectrum	7	0,018									
TSC2018.responce spectrum	7,5	0,01568									
TSC2018.responce spectrum	8	0,013781									
TSC2018.responce spectrum	8,5	0,012208									
TSC2018.responce spectrum	9	0,010889									
TSC2018.responce spectrum	9,5	0,009773									
TSC2018.responce spectrum	10	0,00882									

Displacement:

Load Case: Ex

Table 3.16: Displacement

Load Case : Ex				
Story	**Elevation**	**Location**	**X-Dir**	**Y-Dir**
	m		**mm**	**mm**
Story5	15,6	Top	0,698	0,004
Story4	12,7	Top	0,555	0,003
Story3	9,8	Top	0,404	0,002
Story2	6,9	Top	0,254	0,001
Story1	4	Top	0,119	3,734E-04
Base	0	Top	0	0

Load case: EY

Table 3.17: DISPLACEMENT

Story	Elevation	Location	X-Dir	Y-Dir
	m		mm	mm
Story5	15,6	Top	6,543E-07	0,747
Story4	12,7	Top	2,521E-06	0,594
Story3	9,8	Top	2,568E-06	0,43
Story2	6,9	Top	2,343E-06	0,268
Story1	4	Top	1,026E-06	0,123
Base	0	Top	0	0

Story Drift:

Load case : EX

Table 3.18: Story Drift

Story	Elevation	Location	X-Dir	Y-Dir
	m			
Story5	15,6	Top	0,000049	3,069E-07
Story4	12,7	Top	0,000052	3,074E-07
Story3	9,8	Top	0,000052	2,832E-07
Story2	6,9	Top	0,000046	2,298E-07
Story1	4	Top	0,00003	9,243E-08
Base	0	Top	0	0

Load case: EY

Table 3.19: Story Drift

Story	Elevation	Location	X-Dir	Y-Dir
	m			
Story5	15,6	Top	0	0,000053
Story4	12,7	Top	0	0,000056
Story3	9,8	Top	0	0,000056
Story2	6,9	Top	0	0,00005
Story1	4	Top	0	0,000031
Base	0	Top	0	0

Base Shear:

Table 3.20: Base Shear

Load Pattern	Type	Direction	Eccentricity	Ct (m), x	Period Used	Coeff Used	Weight Used	Base Shear
			%		sec		kN	kN
EX	Seismic	X		0.10m, 0.75	0,125	0,091977	13250,3	1218,7273
EX	Seismic	X + Ecc. Y	5	0.10m, 0.75	0,125	0,091977	13250,3	1218,7273
EX	Seismic	X - Ecc. Y	5	0.10m, 0.75	0,125	0,091977	13250,3	1218,7273
Ey	Seismic	Y		0.10m, 0.75	0,13	0,09046	13250,3	1198,6199
Ey	Seismic	Y + Ecc. X	5	0.10m, 0.75	0,13	0,09046	13250,3	1198,6199
Ey	Seismic	Y - Ecc. X	5	0.10m, 0.75	0,13	0,09046	13250,3	1198,6199

3.8.3 Shear Walls Along The Perimeter Of Building: (model 3)

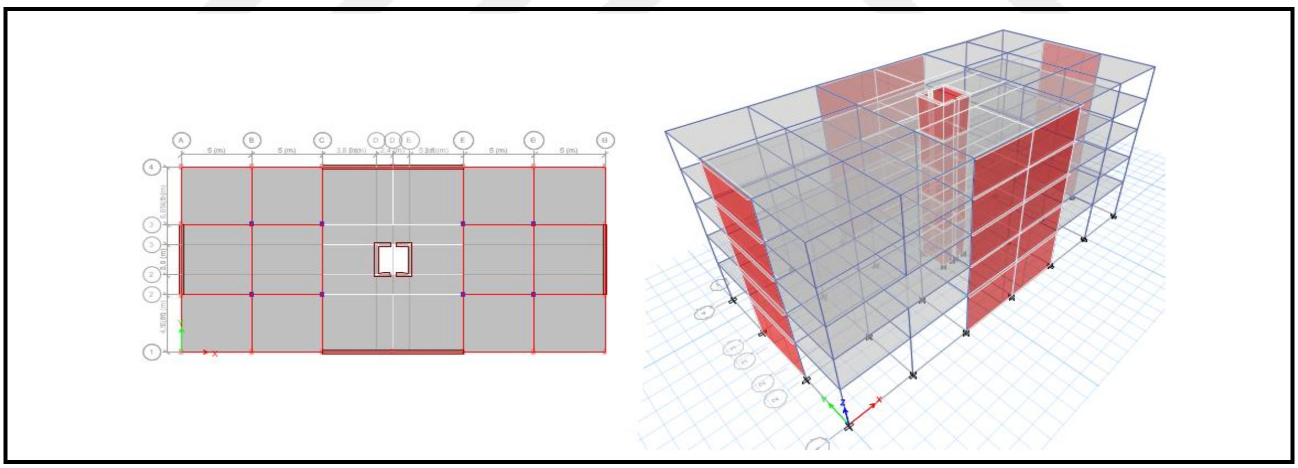

Figure 3.9: Shear Walls Along The Perimeter of Building

- I took a-a axis belonging to the x-axis
- kind of case that I choose is : Ex

Bending Moment:

Table 3.21 a: Bending Moment Values of Columns

STORIES	VERTICAL FRAME VALUES (KN.M)							
	Top				Bottom			
STORY 5	-0.86	-0.61	-0.60	-0.68	1.16	0.87	0.86	1.15
STORY 4	-0.80	-0.34	-0.33	-0.79	1.20	0.76	0.74	1.19
STORY 3	-0.80	-0.40	-0.39	-0.79	1.23	0.78	0.77	1.21
STORY 2	-0.73	-0.35	-0.35	-0.72	1.20	0.76	0.75	1.19
STORY 1	-0.48	-0.25	-0.24	-0.48	0.98	0.92	0.92	0.98

Table 3.21 b: Bending Moment Values of Beams

Stories	Horizontal frame values (KN.M)					
Story 5	-0.12	0.09	0.007	-0.01	-0.1	0.07
Story 4	-0.19	0.15	-0.01	0.01	-0.15	0.1
Story 3	-0.17	0.14	-0.01	0.01	-0.15	0.09
Story 2	-0.16	0.13	-0.01	0.01	-0.14	0.09
Story 1	-0.12	0.11	-0.01	0.01	-0.12	0.08

Table 3.21.c: Bending Moment Values of Shear Walls

stories	Shear walls values (KN.m)
Story 5	-0.55
Story 4	-1.67
Story 3	-3.29
Story 2	-5.29
Story 1	-6.47

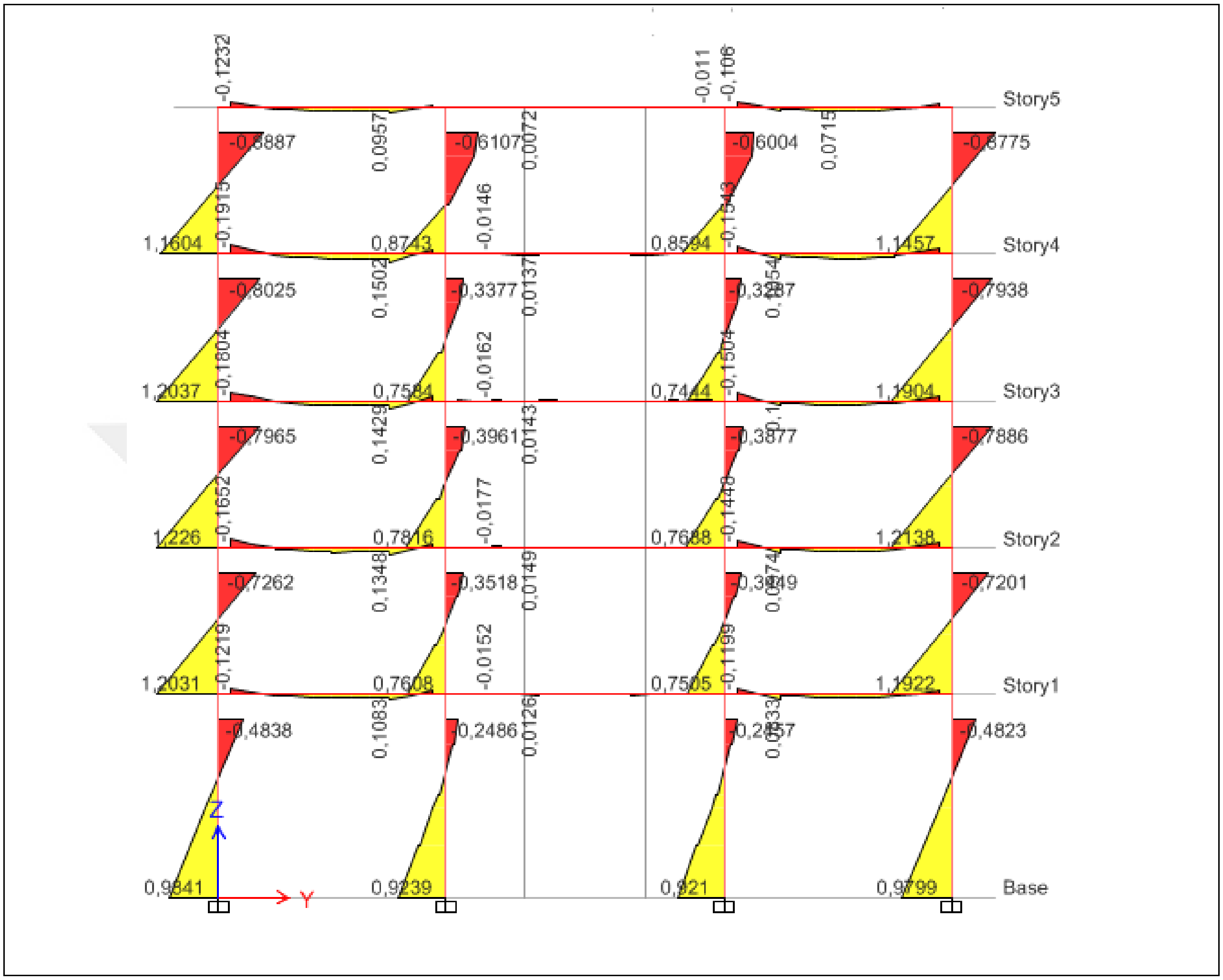

Figure 3.10: Bending Moment Diagram of Frame

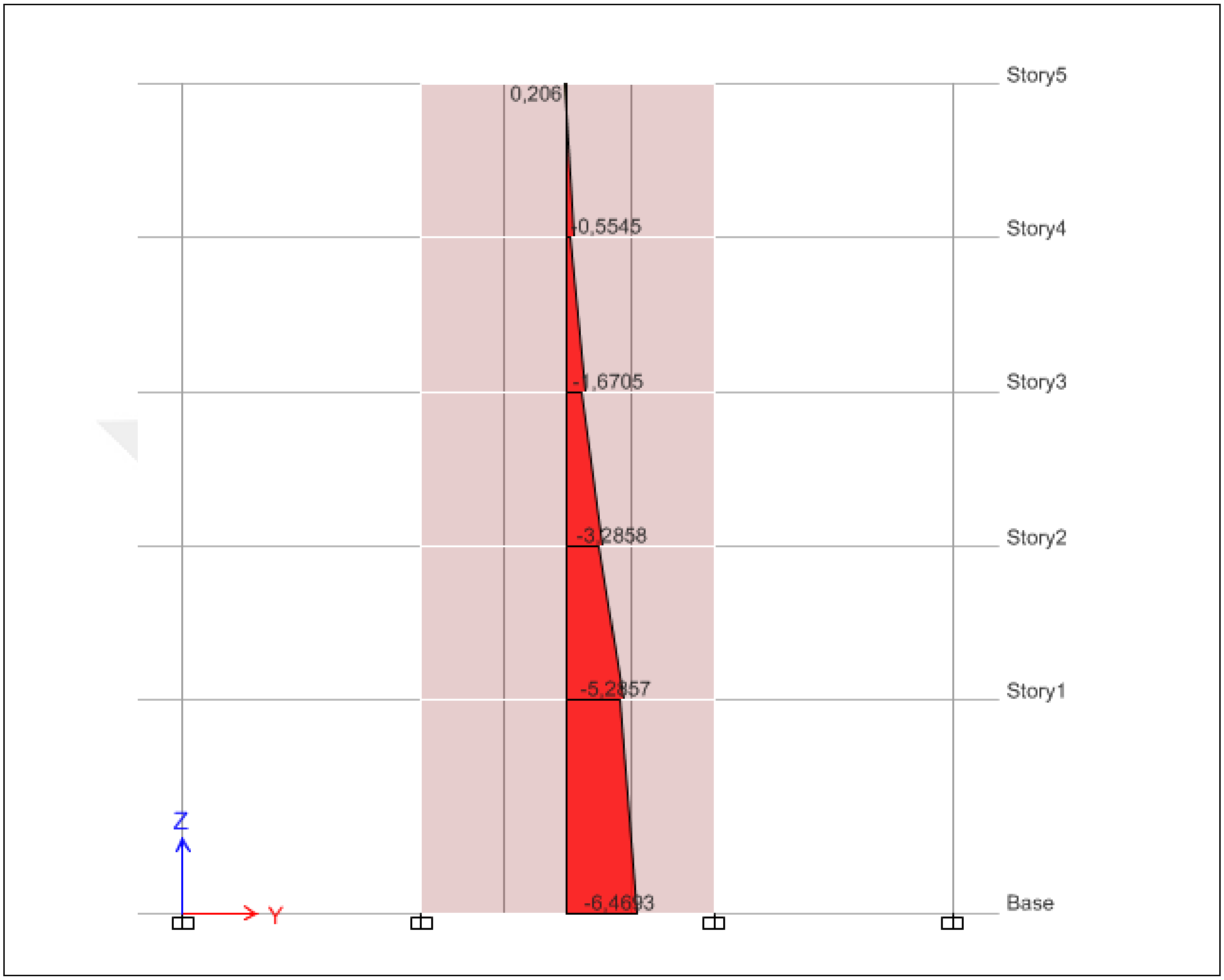

Figure 3.11: Bending Moment Diagram of Shear Wall

Shear Force:

Table 3.22.a: Shear Force Values of Columns

stories	Vertical frame values (columns) (KN.M)			
Story 5	0.85	0.89	0.88	0.84
Story 4	0.84	0.64	0.63	0.83
Story 3	0.84	0.62	0.61	0.83
Story 2	0.80	0.54	0.53	0.80
Story 1	0.42	0.37	0.37	0.42

Table 3.22.b: Shear Force Values of Beams

stories	Horizontal frame values (beam) (KN.M)					
Story 5	-0.16	0.15	-0.009	0.01	-0.17	0.12
Story 4	-0.22	0.25	-0.02	0.02	-0.29	0.16
Story 3	-0.21	0.24	-0.02	0.02	-0.28	0.16
Story 2	-0.19	0.24	-0.02	0.02	-0.27	0.15
Story 1	-0.15	0.21	-0.02	0.01	-0.23	0.12

Table 3.22.c: Shear Force Values of Shear Walls

stories	shear walls values (KN.M)
Story 5	-0.45
Story 4	-0.74
Story 3	-0.99
Story 2	-1.20
Story 1	-0.56

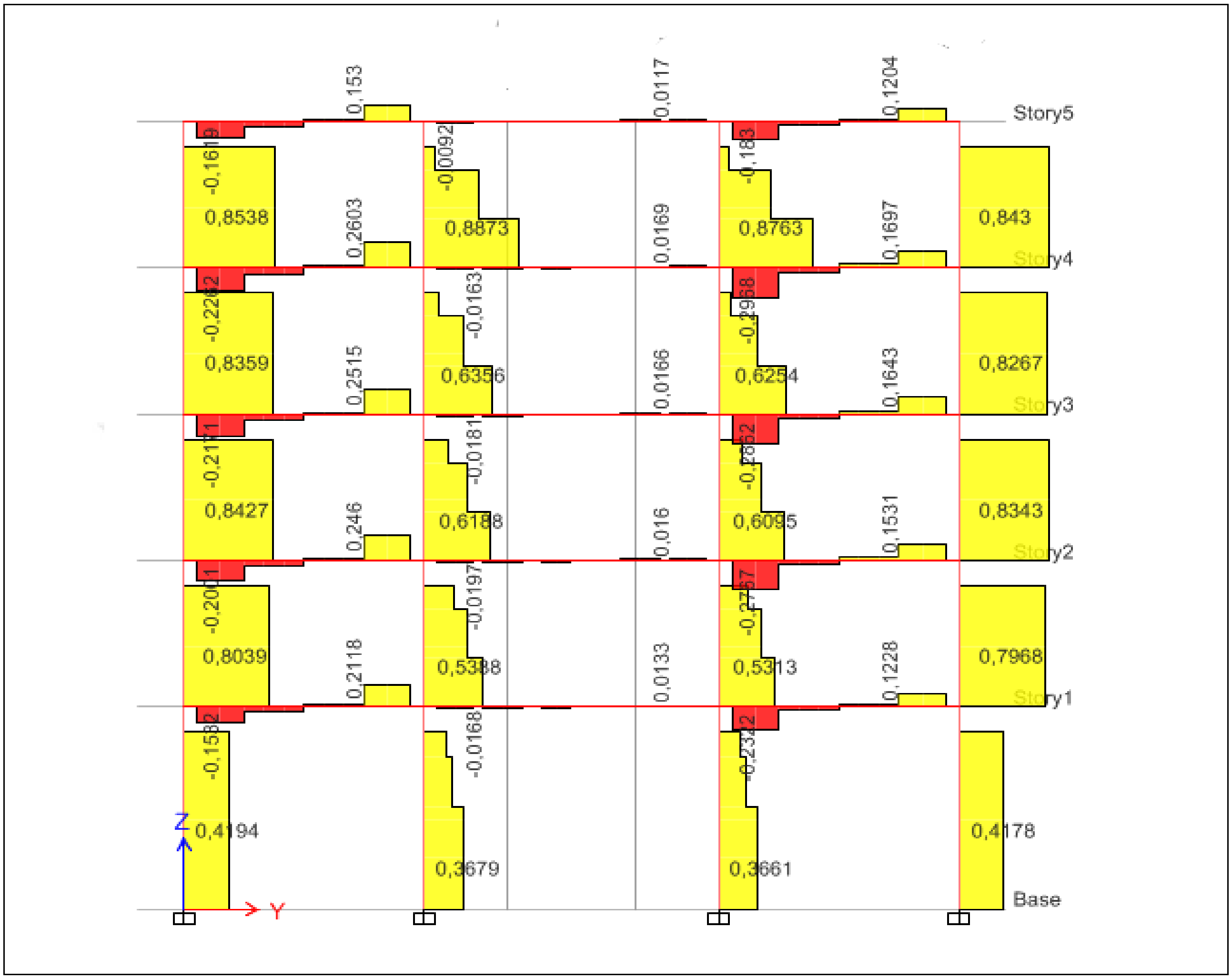

Figure 3.12: Shear Force Diagram of Frame

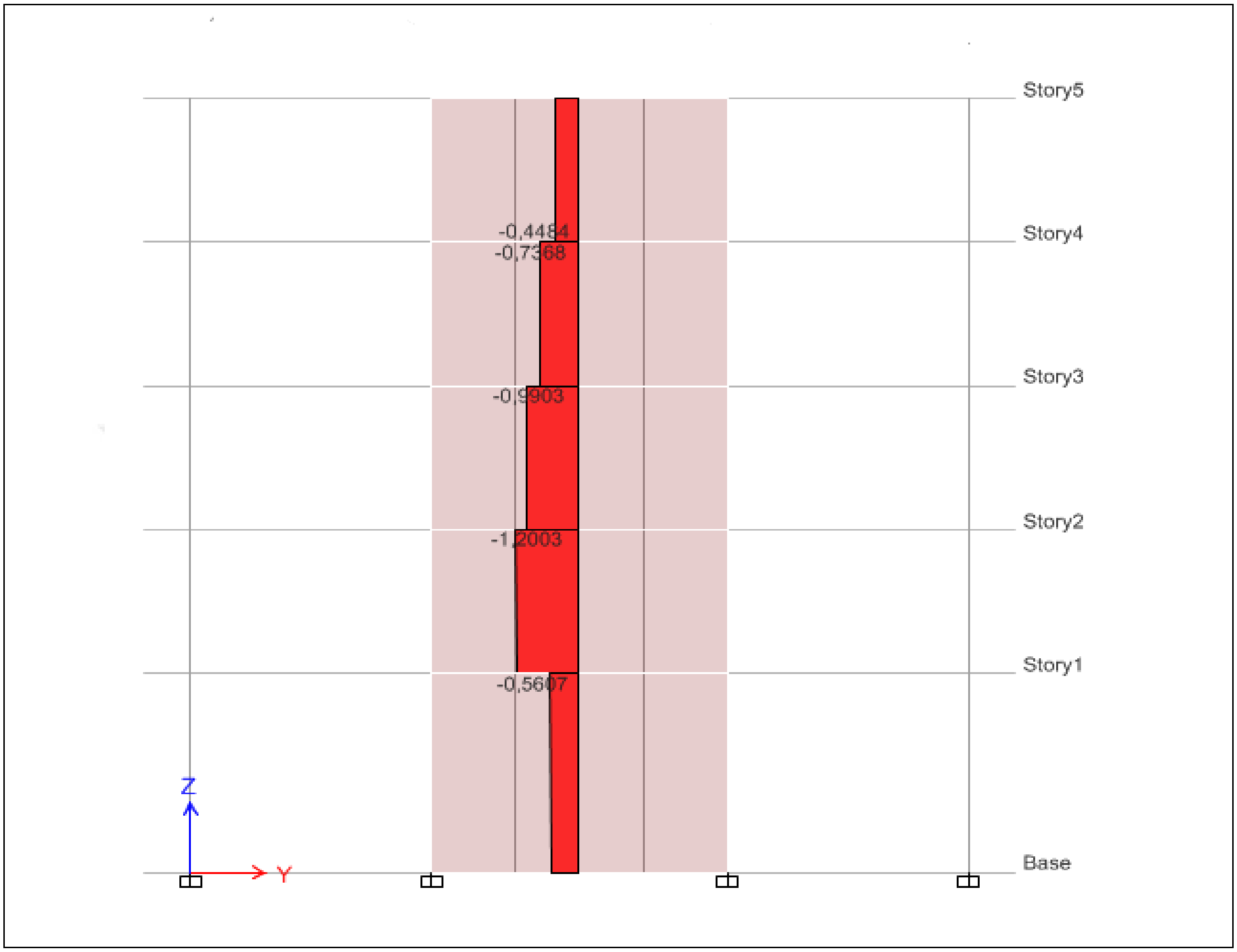

Figure 3.13: Shear Force Diagram of Shear Wall

Center of mass and center of gravity:

Table 3.23: Center of Mass and Center of Rigidity

Story	Diaphragm	Mass X kg	Mass Y kg	XCM m	YCM m	Cumulative X kg	Cumulative Y kg	XCCM m	YCCM m	XCR m	YCR m
Story5	D1	105849,66	105849,66	15	7,2495	105849,66	105849,66	15	7,2495	14,9995	7,3197
Story4	D1	123869,46	123869,46	15	7,2496	229719,12	229719,12	15	7,2495	14,9996	7,3145
Story3	D1	123869,46	123869,46	15	7,2496	353588,58	353588,58	15	7,2495	14,9997	7,3068
Story2	D1	217982,12	217982,12	15	7,2498	571570,7	571570,7	15	7,2496	14,9998	7,2938
Story1	D1	223268,7	223268,7	15	7,2498	794839,4	794839,4	15	7,2497	15	7,2682

Ecc: x direction =0 and y direction =0.07 so the centers are almost locating in same

Δi, ave= (0,000035+0,000023)/2 =2.9.10^{-5}

ηbi= 1.21≥1.2 so there is a torsion irregularity in the bearing system

:y direction

Δi, ave= (0.000075+0.000041)/2=5.8.10^{-5}

ηbi= 1.29≥1.20 there is a torsion irregularity in the bearing system

Story Stiffness:

Stiffness along x in load case Ex: storey1/average(storey2+3+4)/3

12931727.29/25496749.34=0.51≤0.80 irregular

Storey2/average (storey 3+4+5)/3

11114585.47/18095524.92=0.61≤0.80 irregular

EY

Stiffness along y in load case EY:

storey1/average(storey2+3+4)/3

6209719.122/31712489.94=0.20≤0.80 irregular

Storey2/average(storey3+4+5)/3

4579077.247/7042232.92=0.65≤0.80 irregular

Table 3.24: Story Stiffness

Story	Load Case	Shear X kN	Drift X mm	Stiffness X kN/m	Shear Y kN	Drift Y mm	Stiffness Y kN/m
Story5	EX	351,6513	0,095	3713361,049	0	0,001	0
Story4	EX	638,7018	0,104	6159600,21	0	0,001	0
Story3	EX	860,2054	0,105	8222563,657	0	0,0004904	0
Story2	EX	1084,6004	0,098	11114585,47	0	0,0004047	0
Story1	EX	1231,1414	0,095	12931727,29	0	0,0002301	0
Story5	Ey	0	0,00000679	0	295,7692	0,21	1409848,224
Story4	Ey	0	0,000004888	0	537,2036	0,225	2388414,714
Story3	Ey	0	0,000004311	0	723,5074	0,223	3243969,982
Story2	Ey	0	0,000002914	0	912,2429	0,199	4579077,247
Story1	Ey	0	0,000001358	0	1035,4966	0,167	6209719,122

Response Spectrum:

Table 3.25: Responce Spectrum

Name	Period	Acceleration	Damping	Ss	S1	TL	Site Class	Fa	Fv	SDS	SD1
	sec					sec					
TSC2018.responce spectrum	0	0,18096	5	0,348	0,098	6	ZC	1,3	1,5	0,3016	0,098
TSC2018.responce spectrum	0,065	0,4524									
TSC2018.responce spectrum	0,325	0,4524									
TSC2018.responce spectrum	0,6	0,245									
TSC2018.responce spectrum	0,8	0,18375									
TSC2018.responce spectrum	1	0,147									
TSC2018.responce spectrum	1,2	0,1225									
TSC2018.responce spectrum	1,4	0,105									
TSC2018.responce spectrum	1,6	0,091875									
TSC2018.responce spectrum	1,8	0,081667									
TSC2018.responce spectrum	2	0,0735									
TSC2018.responce spectrum	2,5	0,0588									
TSC2018.responce spectrum	3	0,049									
TSC2018.responce spectrum	3,5	0,042									
TSC2018.responce spectrum	4	0,03675									
TSC2018.responce spectrum	4,5	0,032667									
TSC2018.responce spectrum	5	0,0294									
TSC2018.responce spectrum	5,5	0,026727									
TSC2018.responce spectrum	6	0,0245									
TSC2018.responce spectrum	6,5	0,020876									
TSC2018.responce spectrum	7	0,018									
TSC2018.responce spectrum	7,5	0,01568									
TSC2018.responce spectrum	8	0,013781									
TSC2018.responce spectrum	8,5	0,012208									
TSC2018.responce spectrum	9	0,010889									
TSC2018.responce spectrum	9,5	0,009773									
TSC2018.responce spectrum	10	0,00882									

Displacement:

Load case: EX

Table 3.26: Displacement

Story	Elevation	Location	X-Dir	Y-Dir
	m		mm	mm
Story5	15,6	Top	0,482	0,004
Story4	12,7	Top	0,39	0,003
Story3	9,8	Top	0,289	0,002
Story2	6,9	Top	0,188	0,001
Story1	4	Top	0,093	4,61E-04
Base	0	Top	0	0

Load case:EY

Table 3.27: Displacement

Story	Elevation	Location	X-Dir	Y-Dir
	m		mm	mm
Story5	15,6	Top	4,203E-05	0,993
Story4	12,7	Top	2,819E-05	0,79
Story3	9,8	Top	1,753E-05	0,572
Story2	6,9	Top	8,39E-06	0,356
Story1	4	Top	2,721E-06	0,162
Base	0	Top	0	0

Story Drift:

Load case: EX

Table 3.28: Story Drift

Story	Elevation	Location	X-Dir	Y-Dir
	m			
Story5	15,6	Top	0,000032	3,426E-07
Story4	12,7	Top	0,000035	3,475E-07
Story3	9,8	Top	0,000035	3,274E-07
Story2	6,9	Top	0,000033	2,717E-07
Story1	4	Top	0,000023	1,141E-07
Base	0	Top	0	0

Load case: EY

Table 3.29: story drift

Story	Elevation	Location	X-Dir	Y-Dir
	m			
Story5	15,6	Top	0	0,00007
Story4	12,7	Top	0	0,000075
Story3	9,8	Top	0	0,000075
Story2	6,9	Top	0	0,000067
Story1	4	Top	0	0,000041
Base	0	Top	0	0

Base Shear:

Table 3.30: Base Shear

Load Pattern	Type	Direction	Eccentricity	Ct (m), x	Period Used	Coeff Used	Weight Used	Base Shear
			%		sec		kN	kN
EX	Seismic	X		0.10m, 0.75	0,103	0,09878	12463,49	1231,1414
EX	Seismic	X + Ecc. Y	5	0.10m, 0.75	0,103	0,09878	12463,49	1231,1414
EX	Seismic	X - Ecc. Y	5	0.10m, 0.75	0,103	0,09878	12463,49	1231,1414
Ey	Seismic	Y		0.10m, 0.75	0,159	0,083082	12463,49	1035,4966
Ey	Seismic	Y + Ecc. X	5	0.10m, 0.75	0,159	0,083082	12463,49	1035,4966
Ey	Seismic	Y - Ecc. X	5	0.10m, 0.75	0,159	0,083082	12463,49	1035,4966

3.8.4 Shear wall in some part of building: (model 4)

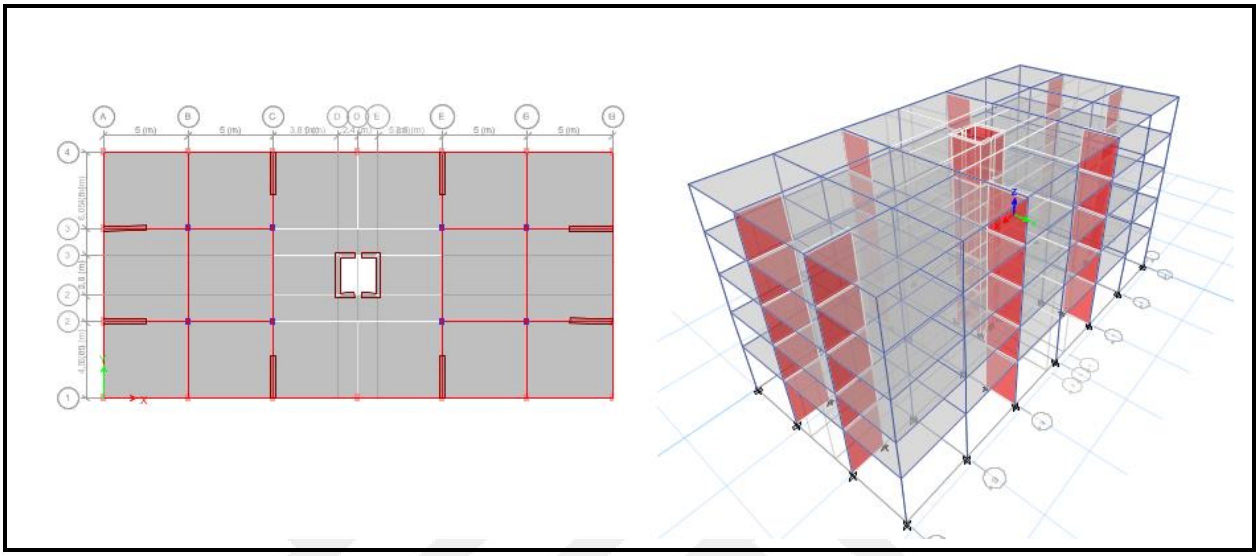

Figure3.14: Shear Wall in Different Part of Building

- I took c-c axis belonging to the x-axis
- kind of case that I choose is : Ex

Bending Moment:

Table 3.31.a: Bending Moment Values of Columns

STORIES	VERTICAL FRAME VALUES (KN.M)							
	Top				Bottom			
STORY 5	-3.13	-4.15	-4.10	-3.07	3.70	5.78	5.74	3.68
STORY 4	-2.72	-4.20	-4.15	-2.66	3.86	6.24	6.20	3.81
STORY 3	-3.07	-4.50	-4.45	-2.98	4.36	6.68	6.64	4.25
STORY 2	-2.96	-4.31	-4.38	-2.90	4.82	6.65	6.58	4.66
STORY 1	-1.56	-2.29	-2.28	-1.58	3.52	3.45	3.40	3.37

Table 3.31.b: Bending Moment Values of Beams

Stories	Horizontal frame values (KN.M)					
Story 5	0.57	-0.07	-0.61	0.35	-0.15	1.09
Story 4	0.50	-0.12	-0.70	0.70	-0.35	1.25
Story 3	-0.02	0.33	-0.78	0.83	-0.28	1.31
Story 2	-0.02	0.31	-0.81	0.91	-0.19	1.25
Story 1	-0.06	0.35	-0.70	0.76	0.12	0.90

Table 3.31.c: Bending Moment Values of Shear Walls

stories	Shear walls values (KN.M)			
	Top		bottom	
Story 5	-2.01	4.32	2.96	-1.12
Story 4	1.29	4.85	1.79	-1.72
Story 3	1.41	4.91	-0.49	-3.48
Story 2	0.34	3.27	-3.67	-6.02
Story 1	-2.89	-1.49	-7.19	-7.56

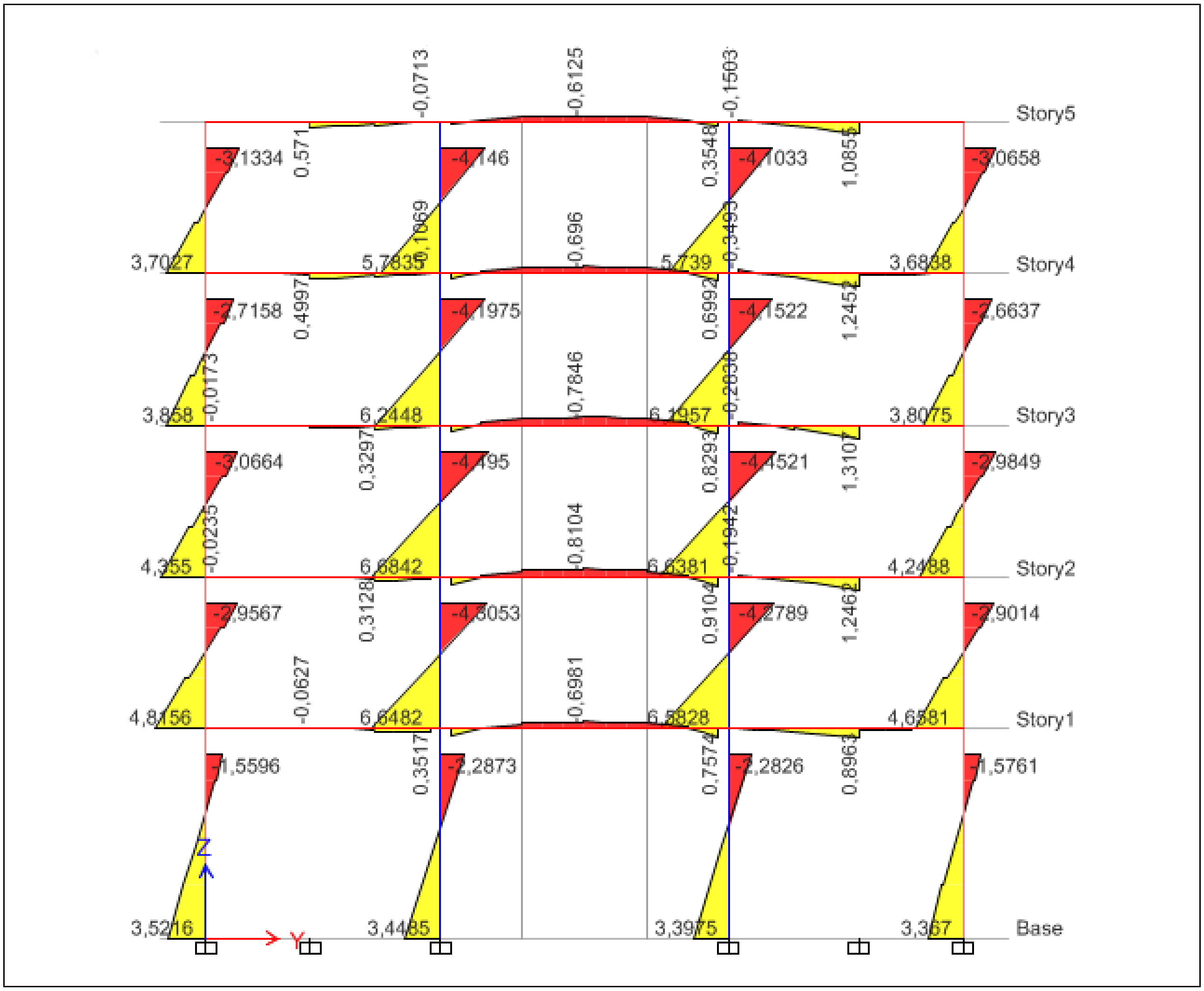

Figure 3.15: Bending Moment Diagram of Frame

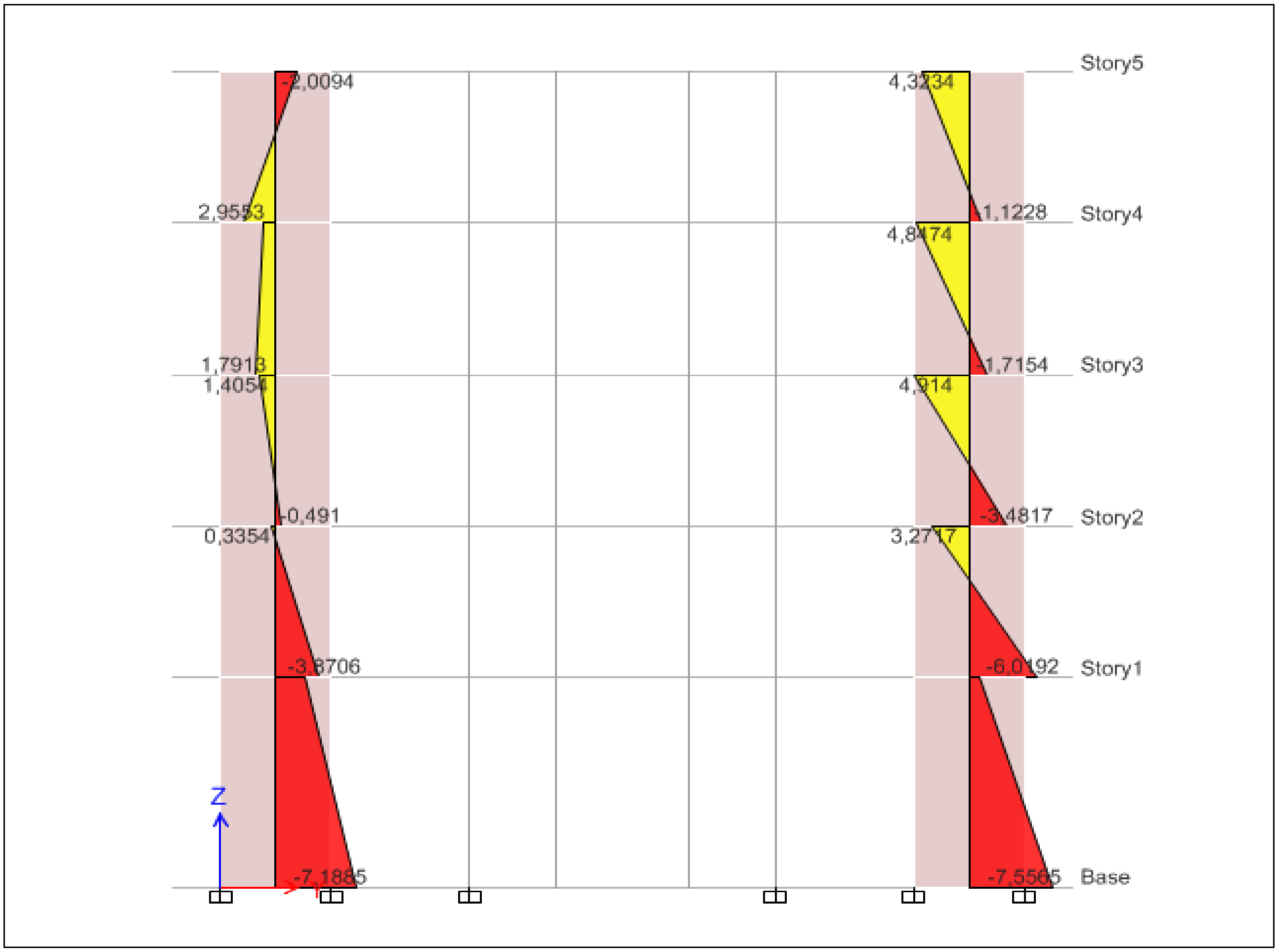

Figure 3.16: Bending Moment of Shear Wall

Shear Force:

Table 3.32.a: Shear Force Values of Columns

stories	Vertical frame values (columns) (KN.M)			
Story 5	2.74	4.14	4.10	2.73
Story 4	2.65	4.35	4.31	2.64
Story 3	3.00	4.66	4.62	2.96
Story 2	3.15	4.56	4.53	3.10
Story 1	1.46	1.64	1.62	1.44

Table 3.32.b: Shear Force Values of Beams

stories	Horizontal frame values (beam) (KN.M)					
Story 5	-0.02	0.33	0.70	-0.84	-0.62	0.04
Story 4	-0.03	0.42	1.07	-1.30	-0.74	0.03
Story 3	-0.04	0.24	1.24	-1.51	-0.79	0.03
Story 2	-0.03	0.07	1.32	-1.62	-0.76	0.02
Story 1	-0.02	-0.11	1.16	-1.33	-0.54	0.01

Table 3.32.c: Shear Force Values of Shear Walls

stories	shear walls values (KN.M)	
Story 5	2.11	-2.07
Story 4	0.3	-2.57
Story 3	-0.83	-3.39
Story 2	-1.81	-3.86
Story 1	-1.50	-2.21

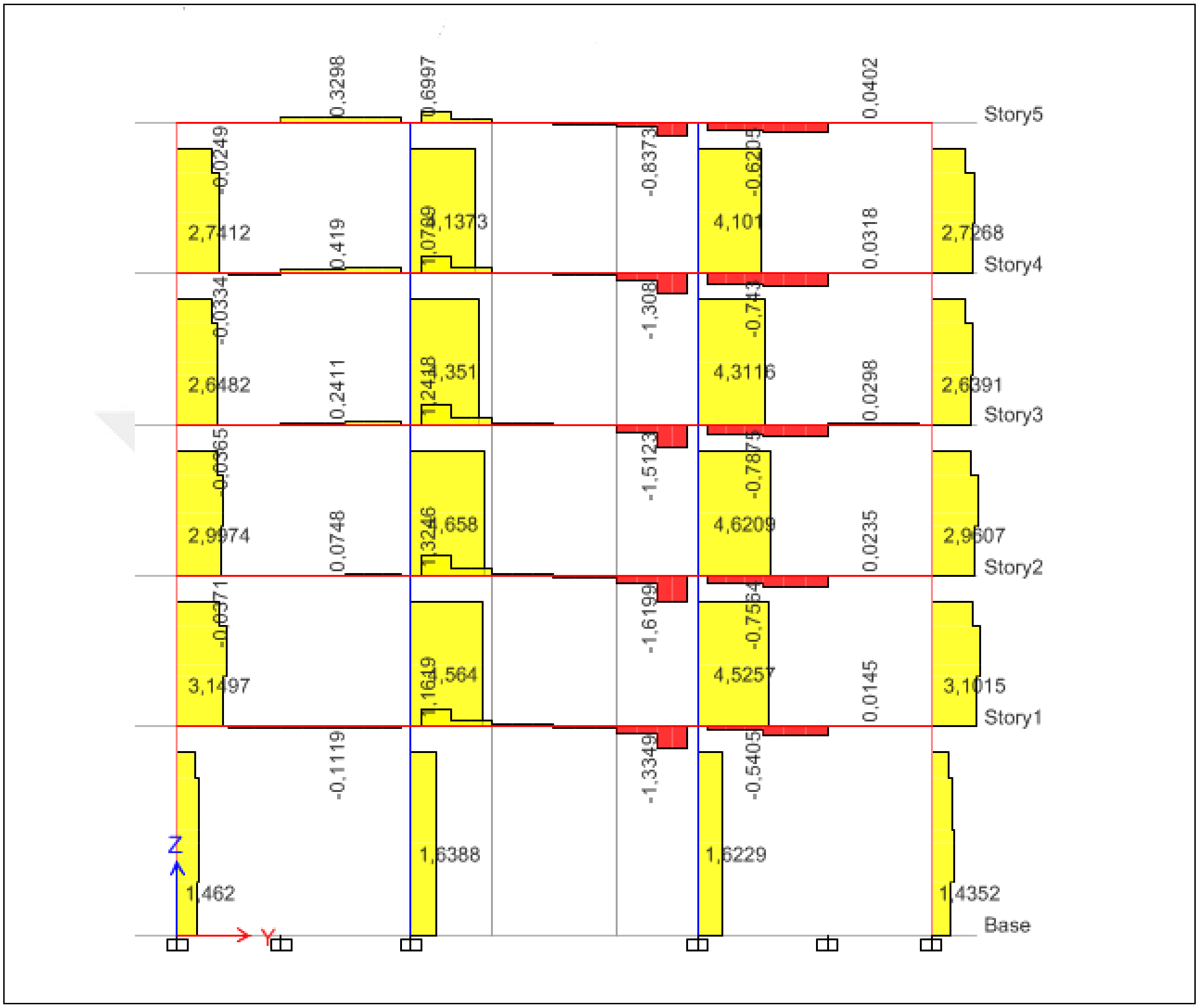

Figure 3.17: Shear Force of Frame

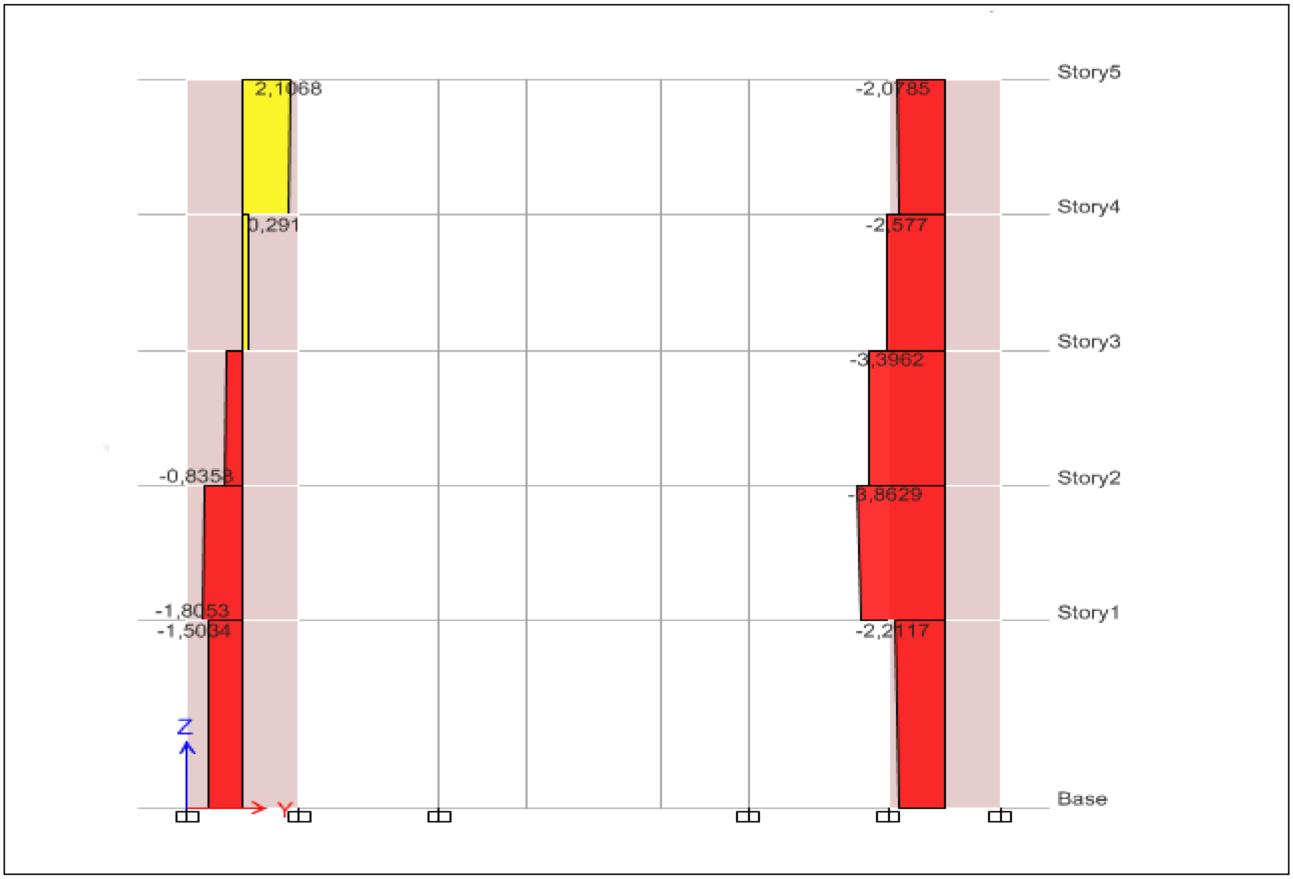

Figure 3.18: Shear Force Of Shear Wall

Center of mass and center of rigidity:

Table 3.33: Center of Mass and Center of Rigidity

Story	Diaphragm	Mass X	Mass Y	XCM	YCM	Cumulative X	Cumulative Y	XCCM	YCCM	XCR	YCR
		kg	kg	m	m	kg	kg	m	m	m	m
Story5	D1	116462,12	116462,12	15,044	7,3004	116462,12	116462,12	15,044	7,3004	15,1109	7,9534
Story4	D1	136280,86	136280,86	15,0642	7,3257	252742,97	252742,97	15,0549	7,314	15,0897	7,9404
Story3	D1	136280,86	136280,86	15,0642	7,3257	389023,83	389023,83	15,0581	7,3181	15,0641	7,9207
Story2	D1	230393,53	230393,53	15,038	7,2948	619417,36	619417,36	15,0506	7,3094	15,0357	7,8636
Story1	D1	235742,13	235742,13	15,0376	7,2944	855159,49	855159,49	15,047	7,3053	15,0038	7,7436

Ecc: along x=0.07 and along y= 0.653

Δi, ave= (0,000151+0,000098)/2 =1.25.10^{-4}

ηbi= 1.21$\geq$1.2 so the torsion is not irregularity

:y direction

Δi, ave= (0.000113+0.000066)/2=8.95.10^{-05}

ηbi= 1.26$\geq$1.20

Story Stiffness:

Stiffness along x in load case Ex: storey1/average(storey2+3+4)/3

1963075.528/3748211.81=0.52$\leq$0.80

Storey2/average (storey 3+4+5)/3

1539019.551/2863239.736=0.53$\leq$0.80

EY

Stiffness along y in load case EY:

Storey1/average (storey2+3+4)/3

3022545.23/5325919.662=0.58$\leq$0.80

Storey2/average (storey3+4+5)/3

2265652.297/3922426.099=0.58$\leq$0.80

Table 3.34: Story Stiffness

Story	Load Case	Shear X kN	Drift X mm	Stiffness X kN/m	Shear Y kN	Drift Y mm	Stiffness Y kN/m
Story5	EX	204,4702	0,313	653936,477	0	0,013	0
Story4	EX	370,0358	0,37	1001286,385	0	0,019	0
Story3	EX	497,7951	0,412	1207905,874	0	0,025	0
Story2	EX	634,4118	0,412	1539019,551	0	0,027	0
Story1	EX	721,2824	0,367	1963075,528	0	0,028	0
Story5	Ey	0	0,002	0	224,7988	0,261	862158,734
Story4	Ey	0	0,003	0	406,8252	0,3	1357258,64
Story3	Ey	0	0,002	0	547,2865	0,321	1703008,725
Story2	Ey	0	0,002	0	697,4857	0,308	2265652,297
Story1	Ey	0	0,0003212	0	792,9931	0,262	3022545,23

Displacement:

Load case: EX

Table 3.35: Displacement

Story	Elevation	Location	X-Dir	Y-Dir
	m		mm	mm
Story5	15,6	Top	1,978	0,22
Story4	12,7	Top	1,654	0,195
Story3	9,8	Top	1,267	0,158
Story2	6,9	Top	0,832	0,11
Story1	4	Top	0,394	0,055
Base	0	Top	0	0

Load case: EY

Table 3.36: Displacement

Story	Elevation	Location	X-Dir	Y-Dir
	m		**mm**	**mm**
Story5	15,6	Top	0,018	1,479
Story4	12,7	Top	0,014	1,212
Story3	9,8	Top	0,009	0,905
Story2	6,9	Top	0,004	0,576
Story1	4	Top	4,025E-04	0,263
Base	0	Top	0	0

Story Drift:

Load case: EX

Table 3.37: Story drift

Story	Elevation	Location	X-Dir	Y-Dir
	m			
Story5	15,6	Top	0,000112	0,000009
Story4	12,7	Top	0,000133	0,000013
Story3	9,8	Top	0,00015	0,000017
Story2	6,9	Top	0,000151	0,000019
Story1	4	Top	0,000098	0,000014
Base	0	Top	0	0

Load case: EY

Table 3.38: Story Drift

Story	Elevation	Location	X-Dir	Y-Dir
	m			
Story5	15,6	Top	0,000002	0,000092
Story4	12,7	Top	0,000002	0,000106
Story3	9,8	Top	0,000002	0,000113
Story2	6,9	Top	0,000001	0,000108
Story1	4	Top	1,006E-07	0,000066
Base	0	Top	0	0

Base shear:

Table 3.39: Base Shear

Load Pattern	Type	Direction	Eccentricity %	Ct (m), x	Period Used sec	Coeff Used	Veight Use kN	Base Shear kN
EX	Seismic	X		0.10m, 0.75	0,244	0,066933	10776,22	721,2824
EX	Seismic	X + Ecc. Y	5	0.10m, 0.75	0,244	0,066933	10776,22	721,2824
EX	Seismic	X - Ecc. Y	5	0.10m, 0.75	0,244	0,066933	10776,22	721,2824
Ey	Seismic	Y		0.10m, 0.75	0,205	0,073587	10776,22	792,9931
Ey	Seismic	Y + Ecc. X	5	0.10m, 0.75	0,205	0,073587	10776,22	792,9931
Ey	Seismic	Y - Ecc. X	5	0.10m, 0.75	0,205	0,073587	10776,22	792,9931

3.8.5 Shear Wall as (U) Form: (model5)

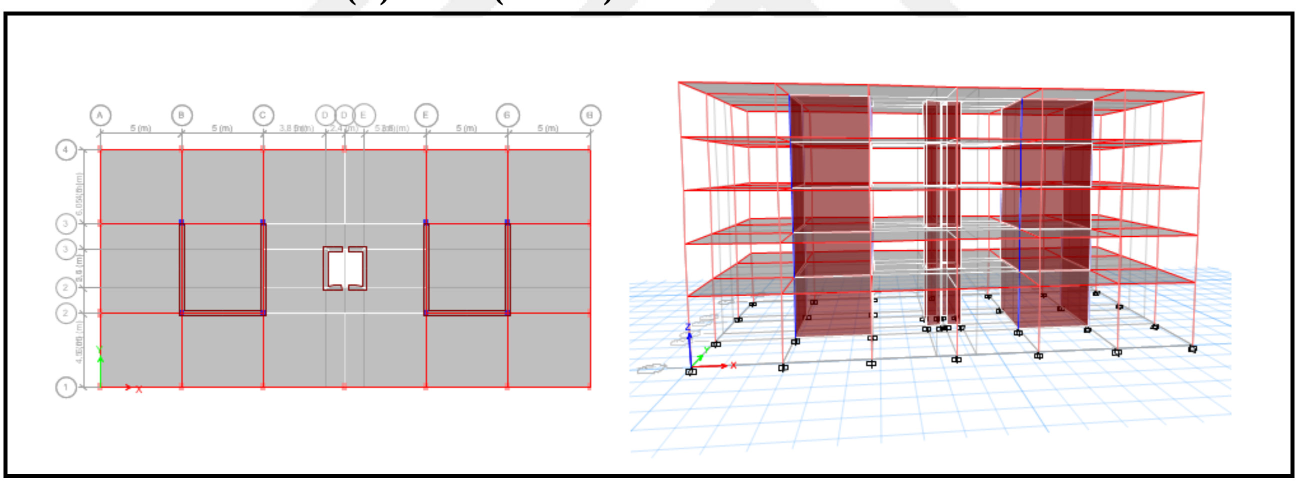

Figure 3.19: Shear Walls As (U) Form

- I took B-B axis belonging to the x-axis
- kind of case that I choose is : Ex

Bending Moment:

Table 3.40 a: Bending Moment Values of Columns

STORIES	VERTICAL FRAME VALUES (KN.M)							
	Top				Bottom			
STORY 5	-0.94	-0.29	-0.79	-2.07	1.33	0.48	1.27	2.90
STORY 4	-1.13	-0.67	-0.88	-2.20	1.68	1.07	1.46	3.32
STORY 3	-1.26	-0.96	-1	-2.35	1.92	1.54	1.63	3.59
STORY 2	-1.34	-1.28	-1.04	-2.34	2.12	2.11	1.78	3.72
STORY 1	-1.03	-1.68	-0.78	-1.58	1.64	3.28	1.60	2.49

Table 3.40 b: Bending Moment Values of Beams

Stories	Horizontal frame values (KN.M)					
Story 5	1.79	-3.18	-0.42	0.19	1.07	-0.75
Story 4	2.90	-3.77	-0.43	0.25	1.30	-1.30
Story 3	2.94	-4.02	-0.48	0.37	1.48	-1.41
Story 2	2.90	-3.98	-0.49	0.47	1.56	-1.48
Story 1	2.20	-3.31	-0.40	0.48	1.37	-1.21

Table 3.40 c: Bending Moment Values of Shear Walls

stories	Shear walls values (KN.M)
Story 5	-75.96
Story 4	-40.28
Story 3	66.54
Story 2	271.24
Story 1	797.02

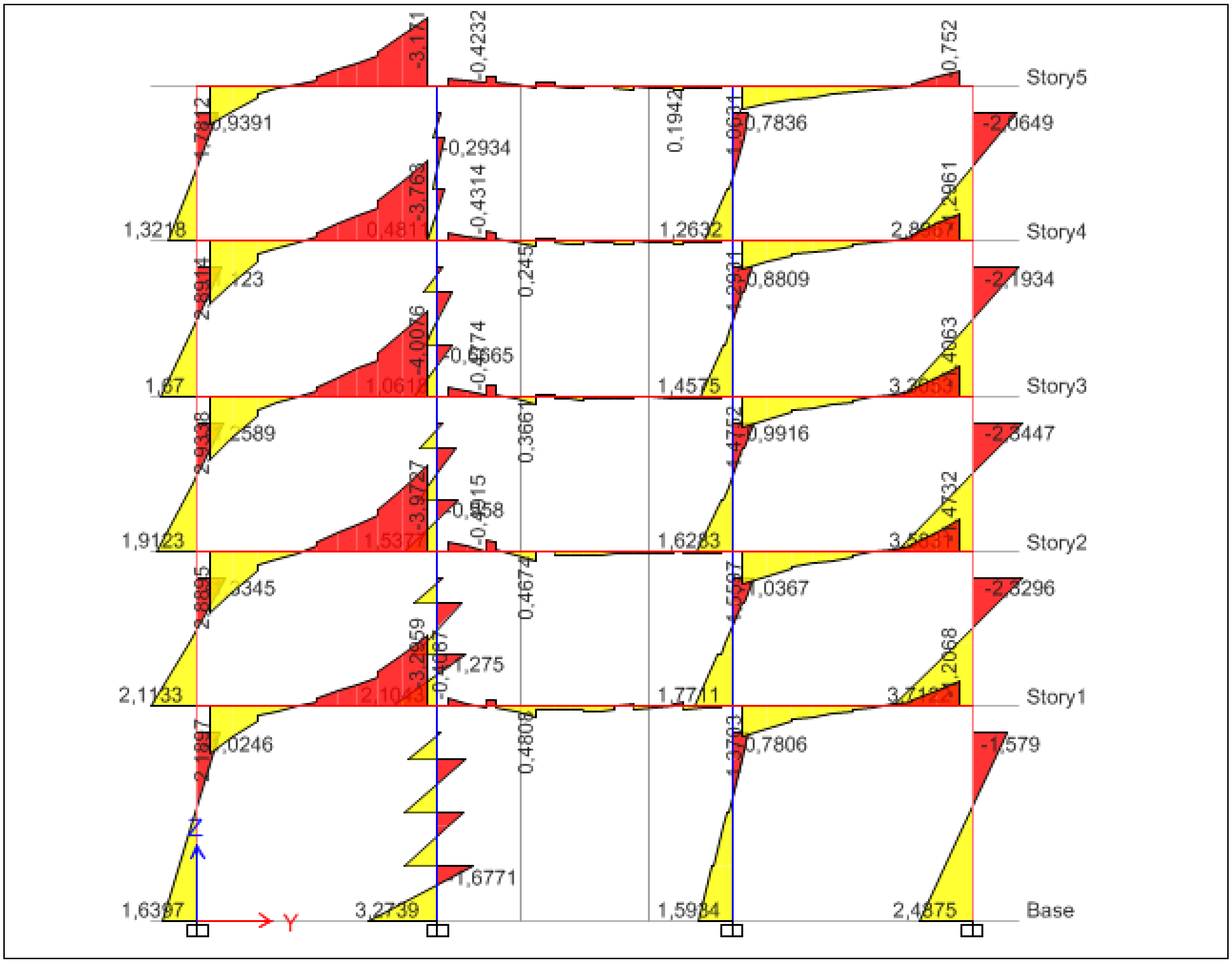

Figure 3.20: Bending Moment Diagram Of Frame

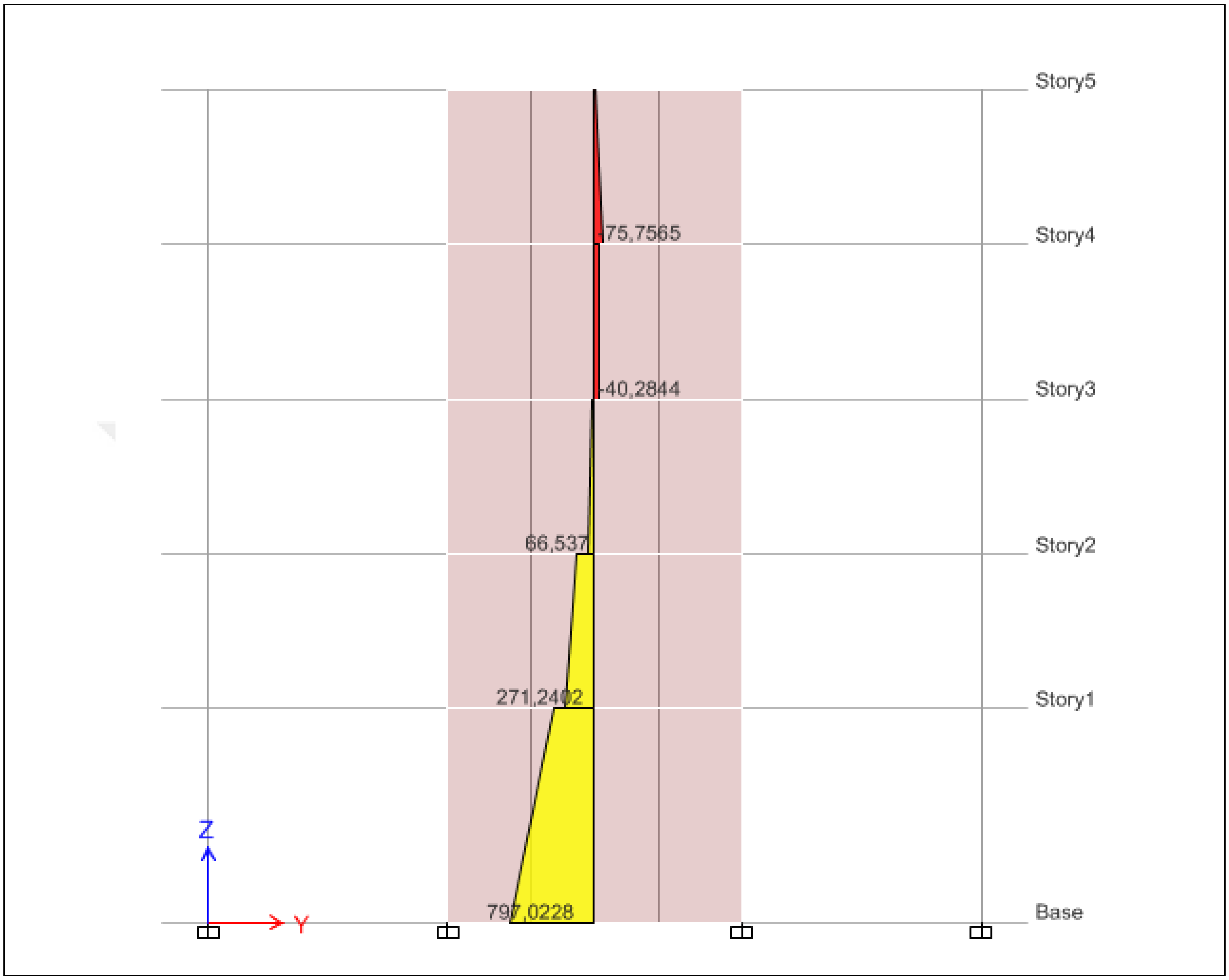

Figure 3.21: Bending Moment Diagram Of Shear Wall

Shear Force:

Table 3.41 a: Shear Force Values of Columns

stories	Vertical frame values (columns) (KN.M)			
Story 5	0.95	0.93	1.06	2.07
Story 4	1.17	1.79	1.09	2.30
Story 3	1.32	2.59	1.15	2.48
Story 2	1.44	3.50	1.17	2.53
Story 1	0.76	4.95	0.68	1.17

Table 3.41.b: Shear Force Values of Beams

stories	Horizontal frame values (beam) (KN.M)		
Story 5	1.67	-0.42	0.73
Story 4	2.26	-0.51	1.12
Story 3	2.31	-0.63	1.21
Story 2	2.28	-0.71	1.25
Story 1	1.83	-0.71	1.02

Table 3.41.c: Shear Force Values of Shear Walls

stories	shear walls values (KN.M)
Story 5	-46.09
Story 4	-37.46
Story 3	-37.66
Story 2	-26
Story 1	36.84

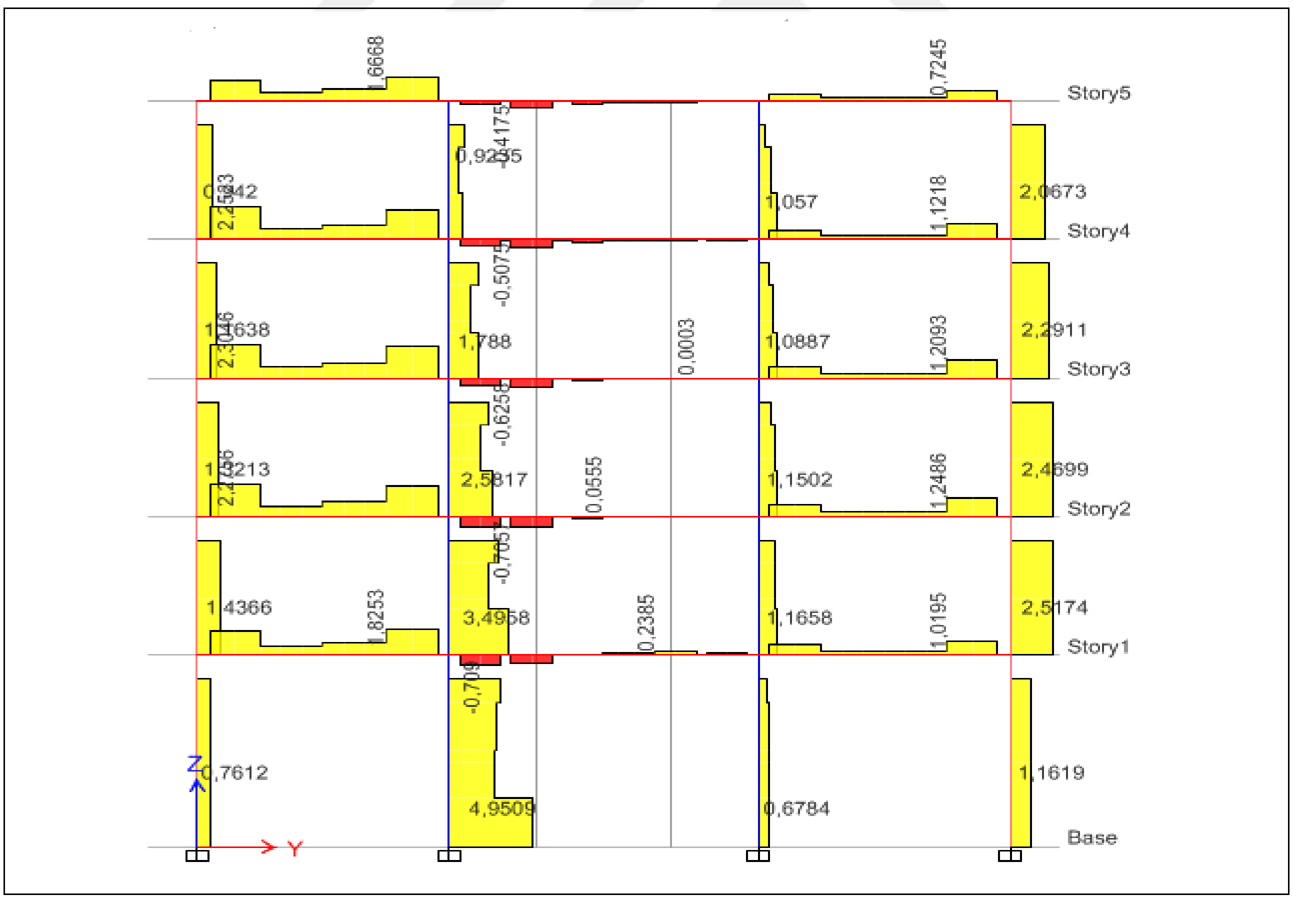

Figure 3.22: Shear Force Diagram Of Frame

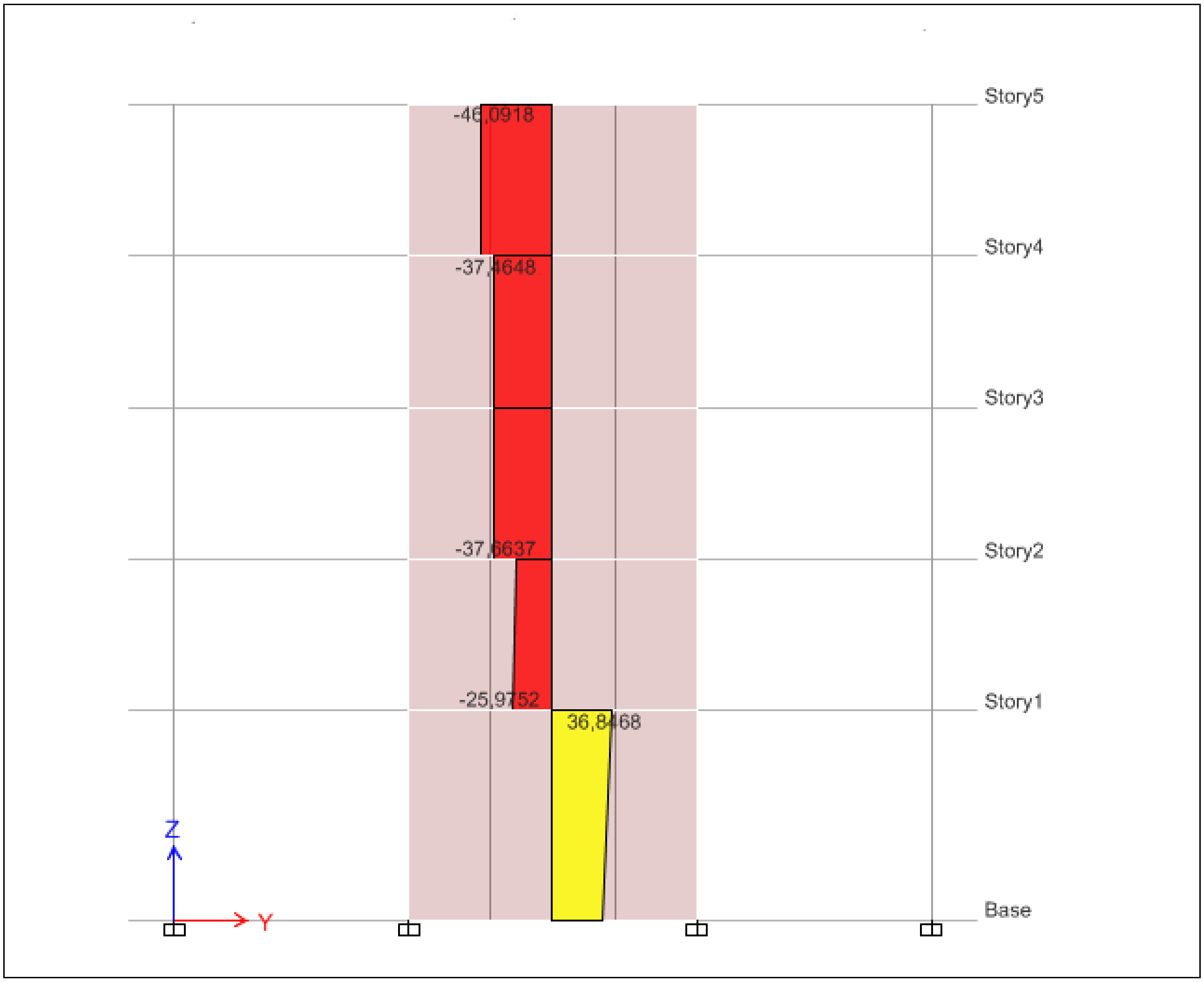

Figure 3.23: Shear Force Diagram Of Shear Wall

Center of mass and center of rigidity:

Table3.42: Center of Mass And Center of Rigidity

Story	Diaphragm	Mass X	Mass Y	XCM	YCM	Cumulative X	Cumulative Y	XCCM	YCCM	XCR	YCR
		kg	kg	m	m	kg	kg	m	m	m	m
Story5	D1	115702,83	115702,83	15	7,2325	115702,83	115702,83	15	7,2325	15,0016	3,6311
Story4	D1	134338,7	134338,7	15	7,2198	250041,53	250041,53	15	7,2257	15,0014	3,6859
Story3	D1	134338,7	134338,7	15	7,2198	384380,23	384380,23	15	7,2236	15,001	3,7812
Story2	D1	228451,37	228451,37	15	7,2323	612831,6	612831,6	15	7,2269	15,0006	3,9653
Story1	D1	233759,19	233759,19	15	7,2324	846590,79	846590,79	15	7,2284	15,0002	4,3024

Ecc: along x: 0.0016   alongy: 3.60

Δi, ave= (0,000073+0,000053)/2 =6.3.10^{-5}

ηbi= 1.15$\leq$1.2

:y direction

Δi, ave= (0.000044+0.000025)/2=3.45.10^{-5}

ηbi= 1.28$\geq$1.20 There is a torsion irregularity in the bearing system

Story Stiffness:

Stiffness along x in load case Ex: storey1/average(storey2+3+4)/3

6907085.685/15660013.89=0.44$\leq$0.80

Storey2/average (storey 3+4+5)/3

6461920.329/11850464.97=0.54$\leq$0.55

EY

Stiffness along y in load case EY:

storey1/average(storey2+3+4)/3

12296122.49/21103663.21=0.58$\leq$0.80

Storey2/average(storey3+4+5)/3

9452954.448/14536465.52=0.65$\leq$0.8

Table 3.43: Story Stiffness

Story	Load Case	Shear X kN	Drift X mm	Stiffness X kN/m	Shear Y kN	Drift Y mm	Stiffness Y kN/m
Story5	EX	348,5102	0,131	2652371,404	0	0,043	0
Story4	EX	633,0559	0,155	4086991,356	0	0,046	0
Story3	EX	852,6266	0,167	5111102,208	0	0,047	0
Story2	EX	1074,237	0,166	6461920,329	0	0,042	0
Story1	EX	1219,1634	0,177	6907085,685	0	0,037	0
Story5	Ey	0	0,00002458	0	345,2061	0,12	2885756,759
Story4	Ey	0	0,00002308	0	627,0541	0,127	4926890,908
Story3	Ey	0	0,00002014	0	844,5431	0,126	6723817,851
Story2	Ey	0	0,00001496	0	1064,0525	0,113	9452954,448
Story1	Ey	0	0,000008001	0	1207,6049	0,098	12296122,49
Story5	rs	901,1372	0,503	1790112,934	1260,4696	0,653	1929428,673
Story4	rs	1729,233	0,579	2988039,905	2350,8097	0,706	3328390,86
Story3	rs	2342,7149	0,609	3844684,321	3108,7456	0,704	4417007,581
Story2	rs	2964,6706	0,593	4997645,668	3826,3331	0,64	5982395,175
Story1	rs	3331,0104	0,604	5511132,446	4215,3029	0,574	7347251,679

Displacement:

Load case : EX

Table 3.44: Displacement

Story	Elevation	Location	X-Dir	Y-Dir
	m		mm	mm
Story5	15,6	Top	1,003	0,43
Story4	12,7	Top	0,831	0,344
Story3	9,8	Top	0,631	0,251
Story2	6,9	Top	0,419	0,158
Story1	4	Top	0,212	0,073
Base	0	Top	0	0

Load case: EY

Table 3.45: Displacement

Story	Elevation	Location	X-Dir	Y-Dir
	m		**mm**	**mm**
Story5	15,6	Top	1,589E-04	0,583
Story4	12,7	Top	1,165E-04	0,464
Story3	9,8	Top	7,695E-05	0,336
Story2	6,9	Top	4,251E-05	0,211
Story1	4	Top	1,521E-05	0,098
Base	0	Top	0	0

Story Drift:

Load case: EX

Table3.46: Story Stiffness

Story	Elevation	Location	X-Dir	Y-Dir
	m			
Story5	15,6	Top	0,00006	0,00003
Story4	12,7	Top	0,000069	0,000032
Story3	9,8	Top	0,000073	0,000032
Story2	6,9	Top	0,000071	0,000029
Story1	4	Top	0,000053	0,000018
Base	0	Top	0	0

Load case: EY

Table 3.47: Story Stiffness

Story	Elevation	Location	X-Dir	Y-Dir
	m			
Story5	15,6	Top	1,46E-08	0,000041
Story4	12,7	Top	1,366E-08	0,000044
Story3	9,8	Top	1,187E-08	0,000043
Story2	6,9	Top	9,413E-09	0,000039
Story1	4	Top	0	0,000025
Base	0	Top	0	0

Base Shear:

Table3.48: Base Shear

Load Pattern	Type	Direction	Ct (m), x	Period Used sec	Coeff Used	Weight Used kN	Base Shear kN
EX	Seismic	X	0.10m, 0.75	0,109	0,096777	12597,6674	1219,163
EX	Seismic	X + Ecc. Y	0.10m, 0.75	0,109	0,096777	12597,6674	1219,163
EX	Seismic	X - Ecc. Y	0.10m, 0.75	0,109	0,096777	12597,6674	1219,163
Ey	Seismic	Y	0.10m, 0.75	0,112	0,095859	12597,6674	1207,605
Ey	Seismic	Y + Ecc. X	0.10m, 0.75	0,112	0,095859	12597,6674	1207,605
Ey	Seismic	Y - Ecc. X	0.10m, 0.75	0,112	0,095859	12597,6674	1207,605

3.9 GENERAL RESULT FOR FIRST CASE

Displacement: approved unit is (mm)

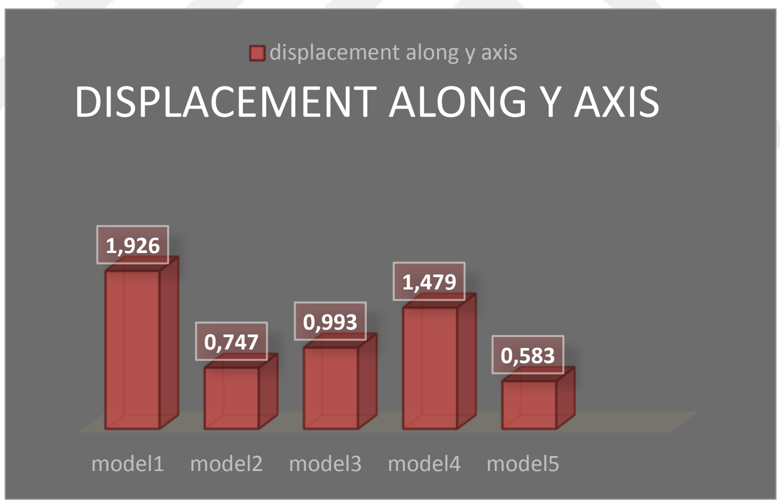

Figure 3.9.a: Diagram Bar of Displacement

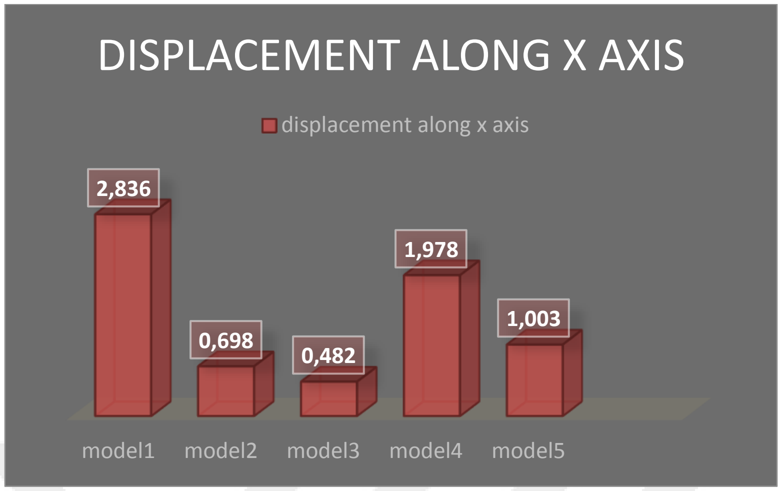

Figure 3.9.b: Diagram Bar of Displacement

Story drift: approved unit (mm)

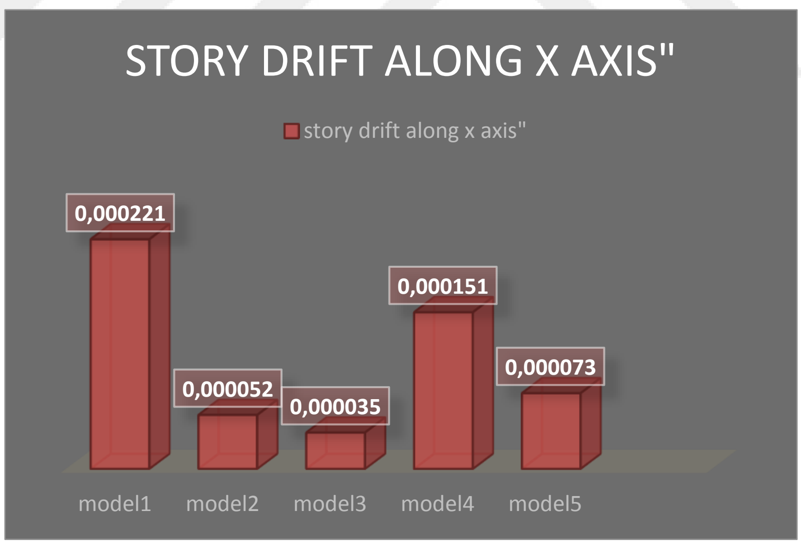

Figure 3.9.c: Diagram Bar of Story Drift

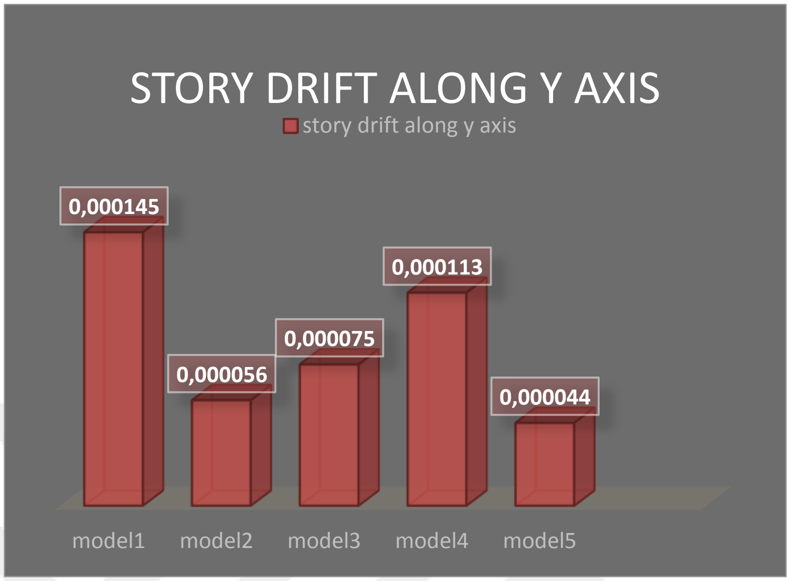

Figure 3.9.d: Diagram Bar of Story Drift

Base shear: KN

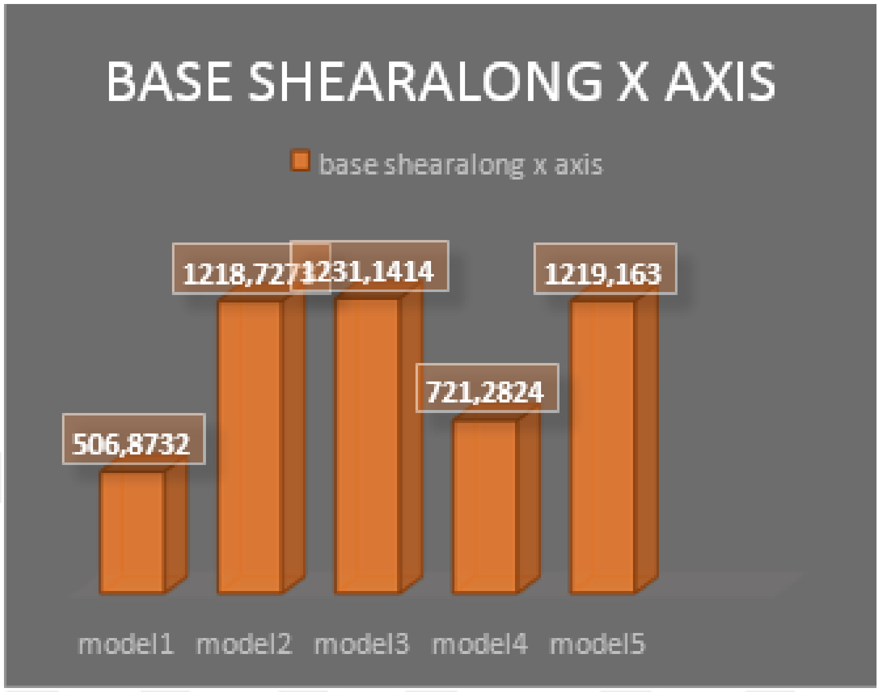

Figure 3.9.e: Diagram Bar of Base Shear

Figure 3.9.f: Diagram Bar of Base Shear

3.10 DISCUSSING THE RESULTS

i. The impact of earthquake for the whole models was noticed that bending moment of the vertical frame is more in the bottom level for each story as compared as with the top-level whereas it has been different for beams in such level of each story for all models either with or without shear walls however the values of bending moment of the frame are reduced in the addition of shear walls.

ii. For the shear force of columns, it was observed that each model has had its values. As example in 2^{nd} and 3^{rd} and 4^{th} for each model the shear force of columns value was more in the middle to each storey than in the stories 1and 5. on the contrary when the addition of SW. the shear force value of columns has changed as it's became more in the column's sides of building than in the middle. the same for shear force values of beams were oscillatory in each storey for all models.

iii. In the models 1,2,3,4 it was noted that the center of mass and center of rigidity are almost equal. The matter is changed in the 5^{th} model as there a difference in the cr and cm along y axis. In another side the torsion has been recorded in all models due to the ± 5% of eccentricity that has been added.

iv. Also, the maximum displacement value along x axis observed without shear walls was 2.8mm while with shear walls was 0.7mm in model 2 that's mean the reduction up to 75% and 0.5mm (83%),2mm (30%) and 1mm (65%) for the rest models respectively

v. In the y axis the maximum displacement value was noted without shear walls 1.9mm without shear walls whilst it' was 0.75mm with shear wall in model 2 i.e. 61% of reducing and 1 (48 %), 1.5mm (23%) and 0.6mm (70%) for the others models respectively.

vi. Storey drift value noted in the axis (x) 0.0002mm at the top without shear walls while it's got to 0.00005mm at the top with shear walls in model 2 that s means a reduction up to 76% and 0.00004mm (84%), 0.002mm(32%) and0.00007mm (67%) respectively for the rest models.

vii. The same observations were noted in y axis the storey drift at the top value was 0.00015mm without shear walls, and 0.00006mm with shear wall equivalent to 61%, 0.00008mm (48%),0.0001mm (22%) and 0.00004mm (70%) of reductions in the models (2,3,4,5) respectively.

viii. We got the base shear values from the whole models 1 to 5. They're compared with each other. So, it's can be said that the base shear of building without shear walls is high. With the addition of shear walls, I noted that the base shear of building increased it was without SW 507KN and with SW it's became 1219KN in model 2 that's means it's increase up to 58% and 1231KN (59%) ,721 KN(30%) and1219KN (58%) for the others models respectively in the X direction.

ix. The same thing in the Y direction, the value of building base shear without SW was 596KN after that it's became 1199KN with shear walls (model2); the increase up to 50% and 1036KN (42%),793KN (25%),1208KN (51%) for models 3,4,5 respectively.

x. The period used has decreased with the additions of SW as it was 0.35sec without sw after it's became 0.13sec ,0.1sec ,0.2sec and 0.1sec respectively along x direction. In the y-axis it has been noted 0.25sec without SW and 0.13sec,0.16sec ,0.2sec and 0.1sec respectively for the others model with shear walls.

3.11 CASE 2 (G+15):

3.11.1 Building Without Shear Walls: (model1)

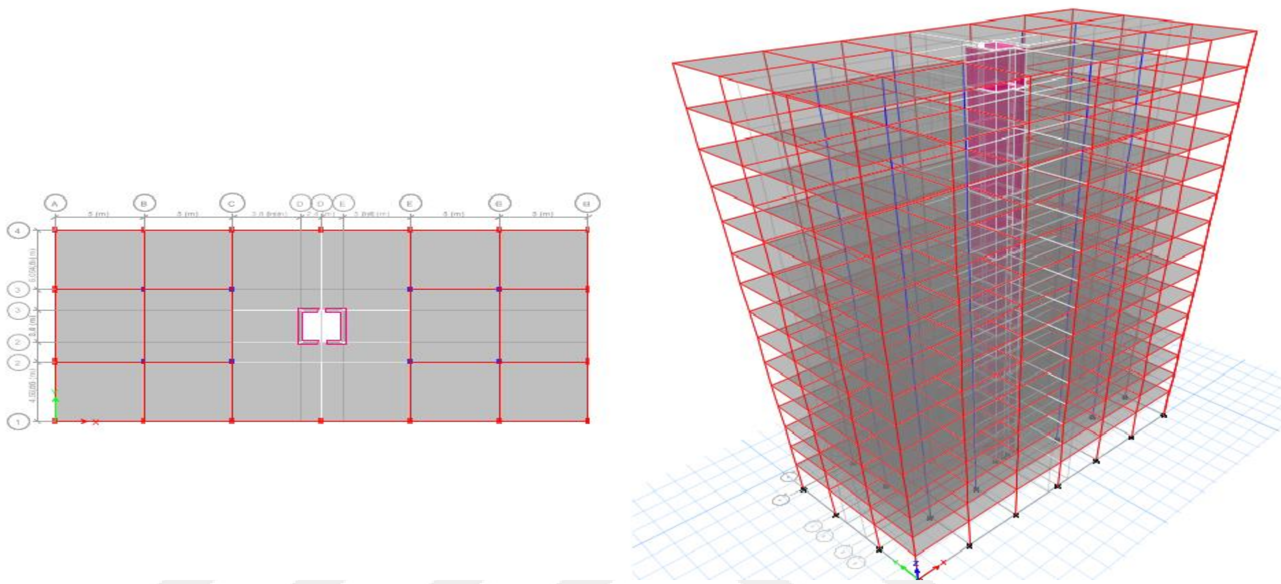

Figure 3.24: Building Without Shear Walls

- Axis a-a belonging x-axis
- Load Pattern: EX

Bending Moment:

Tables3.49.a: Bending Moment Values of Columns

stories	Column force (KN.M)							
	TOP				BOTTOM			
Story15	-15,4167	-18,6739	-18,1943	-14,9074	19,7408	24,9483	24,2938	19,1842
Story14	-15,0595	-18,7701	-18,5243	-15,1809	21,6787	27,484	27,0655	21,7371
Story13	-17,8951	-22,0353	-21,9596	-18,433	25,6703	32,1863	32,0159	25,6703
Story12	-20,3727	-24,9964	-25,0753	-21,2521	29,5354	36,7702	36,8389	30,7089
Story11	-22,7457	-27,8097	-28,0293	-23,949	33,287	41,1781	41,4655	34,9703
Story10	-24,907	-30,3693	-30,7184	-26,4104	36,7846	45,2569	45,7467	38,9386
Story9	-26,7992	-32,6066	-33,0804	-28,5881	39,9311	48,8948	49,5796	42,527
Story8	-28,3621	-34,4537	-35,054	-30,4296	42,6344	51,9873	52,8695	45,6544
Story7	-29,5313	-35,8385	-36,5738	-31,8787	44,799	54,4274	55,5197	48,2374
Story6	-30,2303	-36,6769	-37,5632	-32,8679	46,3163	56,0941	57,4204	50,1804
Story5	-30,3616	-36,8631	-37,9235	-33,3076	47,0467	56,8356	58,431	51,3569
Story4	-29,8069	-36,2643	-37,5249	-33,079	46,8489	56,4836	58,3921	51,6426
Story3	-28,3564	-34,6428	-36,1066	-31,9118	45,1701	54,5019	56,7456	50,4299
Story2	-26,5255	-32,4849	-34,0301	-30,0895	44,3328	53,382	55,9618	50,3971
Story1	-20,0555	-23,3337	-24,0297	-21,6077	38,0422	40,6598	41,8482	41,0036

Table 3.49.b: Bending Moment Values of Beams

Stories	Beam force (KN.M)					
Story15	0,6944	-1,6924	0,5416	-2,0002	-2,6394	0,7984
Story14	1.0038	-2.8556	0.94	-2.9127	-3.432	1.0467
Story13	1.232	-3.721	1.215	-3.8462	-2.9479	0.931
Story12	1.6366	-4.7633	1.6458	-4.9351	-2.4773	1.0367
Story11	2.0052	-5.7192	2.0588	-5.9763	1.3089	-3.3157
Story10	2.3447	-6.5793	2.4446	-6.9416	1.6425	-4.3096
Story9	2.6603	-7.3517	2.8012	-7.8253	1.9709	-5.2331
Story8	2.9518	-8.0534	3.1301	-8.6299	2.3004	-6.11
Story7	3.2312	-8.704	3.4584	-9.36	2.6231	-6.967
Story6	3.5118	-9.325	3.7179	-10.0205	2.9255	-7.8338
Story5	3.9828	-9.9391	4.0033	-10.6155	3.2931	-8.7422
Story4	4.7941	-10.5638	4.202	-11.1405	3.6608	-9.721
Story3	5.7513	-11.1497	4.5084	-11.5304	4.0384	-10.7241
Story2	6.6265	-11.4973	4.6018	-11.5952	4.3483	-11.5313
Story1	5.0936	-9.0082	3.5177	-8.8939	3.4697	-9.4809

Figure 3.25: Bending Moment Diagram of Frame

Shear Force:

Figure 3.26: Shear Force Diagram of Frame

Center of mass and center of rigidity:

Table3.50: Center of Mass and Center of Rigidity

Story	Diaphragm	Mass X kg	Mass Y kg	XCM m	YCM m	Cumulative X kg	Cumulative Y kg	XCCM m	YCCM m	XCR m	YCR m
Story15	D1	841003,79	841003,79	15,0234	7,2388	841003,79	841003,79	15,0234	7,2388	15,0953	6,8076
Story14	D1	873507,94	873507,94	15,0374	7,2329	1714511,74	1714511,74	15,0305	7,2358	15,0863	6,7886
Story13	D1	873777,75	873777,75	15,0413	7,2311	2588289,49	2588289,49	15,0342	7,2342	15,0787	6,7574
Story12	D1	873777,75	873777,75	15,0413	7,2311	3462067,25	3462067,25	15,036	7,2334	15,0715	6,7295
Story11	D1	873777,75	873777,75	15,0413	7,2311	4335845	4335845	15,037	7,233	15,0646	6,7045
Story10	D1	873777,75	873777,75	15,0413	7,2311	5209622,75	5209622,75	15,0378	7,2327	15,058	6,6813
Story9	D1	873777,75	873777,75	15,0413	7,2311	6083400,51	6083400,51	15,0383	7,2324	15,0515	6,6596
Story8	D1	873777,75	873777,75	15,0413	7,2311	6957178,26	6957178,26	15,0386	7,2323	15,0451	6,6394
Story7	D1	873777,75	873777,75	15,0413	7,2311	7830956,01	7830956,01	15,0389	7,2321	15,0387	6,6217
Story6	D1	873777,75	873777,75	15,0413	7,2311	8704733,77	8704733,77	15,0392	7,232	15,0324	6,6087
Story5	D1	873777,75	873777,75	15,0413	7,2311	9578511,52	9578511,52	15,0394	7,232	15,0258	6,605
Story4	D1	873777,75	873777,75	15,0413	7,2311	10452289,27	10452289,27	15,0395	7,2319	15,0191	6,6196
Story3	D1	873777,75	873777,75	15,0413	7,2311	11326067,03	11326067,03	15,0397	7,2318	15,0121	6,6718
Story2	D1	873777,75	873777,75	15,0413	7,2311	12199844,78	12199844,78	15,0398	7,2318	15,0053	6,8025
Story1	D1	884481,93	884481,93	15,0445	7,2297	13084326,71	13084326,71	15,0401	7,2316	15,0025	7,0675

Ecc: along x: 0.0072   alongy: 0.4312

Δi, ave= (0.001531+0,000373)/2 =9.52.10^{-4}

ηbi= 1.61$\geq$1.2   There is a torsion irregularity in the bearing system

y direction:

Δi, ave= (0.001247+0.000458)/2=8.525.10^{-4}

ηbi= 1.46$\geq$1.20 There is a torsion irregularity in the bearing system

Story Stiffness:

Stiffness along x in load case EX:

storey1/(average (storey2+3+4)/3)

647437.476/1784410.27=0.36$\leq$0.80

Storey2/(average (storey 3+4+5)/3

656911.818/1638615.25=0.40$\leq$0.80

Storey3/(average (storey 4+5+6)/3

585687,193/1541471,071=0.38≤0.80

Storey4/(average (storey 5+6+7)/3

541811,259/1470774,234=0.37≤0.80

Storey5/(average (storey 6+7+8)/3

511116,795/1415877,612=0.36≤0.80

Storey6/(average (storey 7+8+9)/3

488543,017/1369548,498=0.35≤0.80

Storey7/(average (storey 8+9+10)/3

471114,422/1325971,772=0,35≤0.80

Storey8/(average (storey 9+10+11)/3

=0,36≤0.80

Storey9/(average (storey 10+11+12)/3

=0,36≤0.80

Storey10=0.37≤0.80

Storey11=0.39≤0.80

Storey12=0.43≤0.80

The storey stiffness is this case is ireegular

EY: by the same method I check the irregularity of storey stiffness in this case

Storey 1=0,54

Storey2=0,48

Storey3=0,42

Storey4=0,39

Storey5=0,38

Storey6=0,37 ≤ 0.80

Storey7=0,36

Storey8=0,36

Storey9=0,37

Storey10=0,38

Storey11=0,41

Storey12=0,46

The story stiffness for EY load is irregular

Table 3.51: Story Stiffness

Story	Load Case	Shear X	Drift X	Stiffness X	Shear Y	Drift Y	Stiffness Y
		kN	mm	kN/m	kN	mm	kN/m
Story15	EX	512,3951	2,13	240546,967	1,5854	0,025	0
Story14	EX	757,1677	2,431	311449,878	1,5217	0,023	0
Story13	EX	983,3472	2,752	357384,83	2,0587	0,044	0
Story12	EX	1192,7447	3,072	388259,767	2,4158	0,063	0
Story11	EX	1385,1216	3,375	410379,581	2,7484	0,084	0
Story10	EX	1560,5837	3,65	427537,696	3,0331	0,098	0
Story9	EX	1719,168	3,888	442213,903	3,2822	0,111	0
Story8	EX	1860,9195	4,079	456220,173	3,5016	0,123	0
Story7	EX	1985,884	4,215	471114,422	3,6984	0,137	0
Story6	EX	2094,1126	4,286	488543,017	3,8823	0,155	0
Story5	EX	2185,6822	4,276	511116,795	4,0577	0,173	0
Story4	EX	2260,6162	4,172	541811,259	4,2701	0,19	0
Story3	EX	2319,399	3,96	585687,193	4,3887	0,207	0
Story2	EX	2360,1265	3,593	656911,818	5,3212	0,207	0
Story1	EX	2405,1523	3,715	647437,476	0	0,156	0
Story15	EY	2,5303	0,025	0	510,3899	2,292	222666,456
Story14	EY	2,1531	0,026	0	756,4409	2,469	306347,8
Story13	EY	2,2517	0,026	0	982,541	2,669	368190,737
Story12	EY	2,2617	0,025	0	1191,8616	2,88	413859,591
Story11	EY	2,2709	0,024	0	1384,0936	3,084	448866,034
Story10	EY	2,2581	0,023	0	1559,393	3,266	477450,759
Story9	EY	2,2215	0,021	0	1717,814	3,417	502771,788
Story8	EY	2,1567	0,019	0	1859,4177	3,527	527184,118
Story7	EY	2,0596	0,017	0	1984,2688	3,587	553238,092
Story6	EY	1,9256	0,015	0	2092,4515	3,576	585108,22
Story5	EY	1,7479	0,012	0	2184,0965	3,479	627782,64
Story4	EY	1,5204	0,01	0	2259,3567	3,269	691146,297
Story3	EY	1,2142	0,009	0	2318,7281	2,906	797794,033
Story2	EY	0,9061	0,01	0	2361,48	2,314	1020727,41
Story1	EY	0	0,02	0	2405,1523	1,789	1344134,27

Response Spectrum:

Table 3.52: Responce Spectrum

Name	Period	Acceleration	Damping	Ss	S1	TL	Site Class	Fa	Fv	SDS	SD1
	sec					sec					
responce spectrum	0	0,18096	5	0,348	0,098	6	ZC	1,3	1,5	0,3016	0,098
responce spectrum	0,065	0,4524									
responce spectrum	0,325	0,4524									
responce spectrum	0,6	0,245									
responce spectrum	0,8	0,18375									
responce spectrum	1	0,147									
responce spectrum	1,2	0,1225									
responce spectrum	1,4	0,105									
responce spectrum	1,6	0,091875									
responce spectrum	1,8	0,081667									
responce spectrum	2	0,0735									
responce spectrum	2,5	0,0588									
responce spectrum	3	0,049									
responce spectrum	3,5	0,042									
responce spectrum	4	0,03675									
responce spectrum	4,5	0,032667									
responce spectrum	5	0,0294									
responce spectrum	5,5	0,026727									
responce spectrum	6	0,0245									
responce spectrum	6,5	0,020876									
responce spectrum	7	0,018									
responce spectrum	7,5	0,01568									
responce spectrum	8	0,013781									
responce spectrum	8,5	0,012208									
responce spectrum	9	0,010889									
responce spectrum	9,5	0,009773									
responce spectrum	10	0,00882									

Base Shear:

Table 3.53 : Base Shear

Load Pattern	Type	Direction	Eccentricity	Ecc. Overridden	Period Method	Ct (m), x	Top Story	Bottom Story	Period Used	Coeff Used	Weight Used	Base Shear
			%						sec		kN	kN
EX	Seismic	X			Program Calculated	0.10m, 0.75	Story15	Base	1,726	0,018096	132910,7151	2405,1523
EX	Seismic	X + Ecc. Y	5	No	Program Calculated	0.10m, 0.75	Story15	Base	1,726	0,018096	132910,7151	2405,1523
EX	Seismic	X - Ecc. Y	5	No	Program Calculated	0.10m, 0.75	Story15	Base	1,726	0,018096	132910,7151	2405,1523
EY	Seismic	Y			Program Calculated	0.10m, 0.75	Story15	Base	1,726	0,018096	132910,7151	2405,1523
EY	Seismic	Y + Ecc. X	5	No	Program Calculated	0.10m, 0.75	Story15	Base	1,726	0,018096	132910,7151	2405,1523
EY	Seismic	Y - Ecc. X	5	No	Program Calculated	0.10m, 0.75	Story15	Base	1,726	0,018096	132910,7151	2405,1523

Displacement:

load case: EX

Table3.54 : Displacement

Story	Elevation	Location	X-Dir	Y-Dir
	m		mm	mm
Story15	44,6	Top	55,156	3,481
Story14	41,7	Top	53,032	3,468
Story13	38,8	Top	50,608	3,427
Story12	35,9	Top	47,843	3,347
Story11	33	Top	44,738	3,227
Story10	30,1	Top	41,311	3,072
Story9	27,2	Top	37,592	2,885
Story8	24,3	Top	33,618	2,668
Story7	21,4	Top	29,436	2,422
Story6	18,5	Top	25,1	2,147
Story5	15,6	Top	20,675	1,842
Story4	12,7	Top	16,234	1,503
Story3	9,8	Top	11,87	1,127
Story2	6,9	Top	7,697	0,716
Story1	4	Top	3,854	0,306
Base	0	Top	0	0

Load case : EY

Table 3.55: Displacement

Story	Elevation	Location	X-Dir	Y-Dir
	m		mm	mm
Story15	44,6	Top	0,455	45,003
Story14	41,7	Top	0,408	42,668
Story13	38,8	Top	0,364	40,164
Story12	35,9	Top	0,32	37,465
Story11	33	Top	0,277	34,554
Story10	30,1	Top	0,236	31,44
Story9	27,2	Top	0,196	28,143
Story8	24,3	Top	0,158	24,695
Story7	21,4	Top	0,124	21,136
Story6	18,5	Top	0,092	17,521
Story5	15,6	Top	0,065	13,914
Story4	12,7	Top	0,052	10,423
Story3	9,8	Top	0,05	7,146
Story2	6,9	Top	0,045	4,211
Story1	4	Top	0,036	1,831
Base	0	Top	0	0

Story Drift:

Load case: EX

Table 3.56: Story Drift

Story	Elevation	Location	X-Dir	Y-Dir
	m			
Story15	44,6	Top	0,000737	0,000013
Story14	41,7	Top	0,000836	0,000014
Story13	38,8	Top	0,000953	0,000028
Story12	35,9	Top	0,001071	0,000041
Story11	33	Top	0,001182	0,000053
Story10	30,1	Top	0,001283	0,000065
Story9	27,2	Top	0,00137	0,000075
Story8	24,3	Top	0,001442	0,000085
Story7	21,4	Top	0,001495	0,000095
Story6	18,5	Top	0,001526	0,000105
Story5	15,6	Top	0,001531	0,000117
Story4	12,7	Top	0,001505	0,00013
Story3	9,8	Top	0,001439	0,000142
Story2	6,9	Top	0,001325	0,000142
Story1	4	Top	0,000964	0,000076
Base	0	Top	0	0

Load case: EY

Table 3.57: Story Drift

Story	Elevation	Location	X-Dir	Y-Dir
	m			
Story15	44,6	Top	0,000016	0,000805
Story14	41,7	Top	0,000015	0,000863
Story13	38,8	Top	0,000015	0,000931
Story12	35,9	Top	0,000015	0,001004
Story11	33	Top	0,000014	0,001074
Story10	30,1	Top	0,000014	0,001137
Story9	27,2	Top	0,000013	0,001189
Story8	24,3	Top	0,000012	0,001227
Story7	21,4	Top	0,000011	0,001247
Story6	18,5	Top	0,00001	0,001244
Story5	15,6	Top	0,000008	0,001212
Story4	12,7	Top	0,000007	0,001142
Story3	9,8	Top	0,000005	0,001019
Story2	6,9	Top	0,000004	0,000822
Story1	4	Top	0,000009	0,000458
Base	0	Top	0	0

3.11.2 Building With Shear Walls In The Corners: (model2)

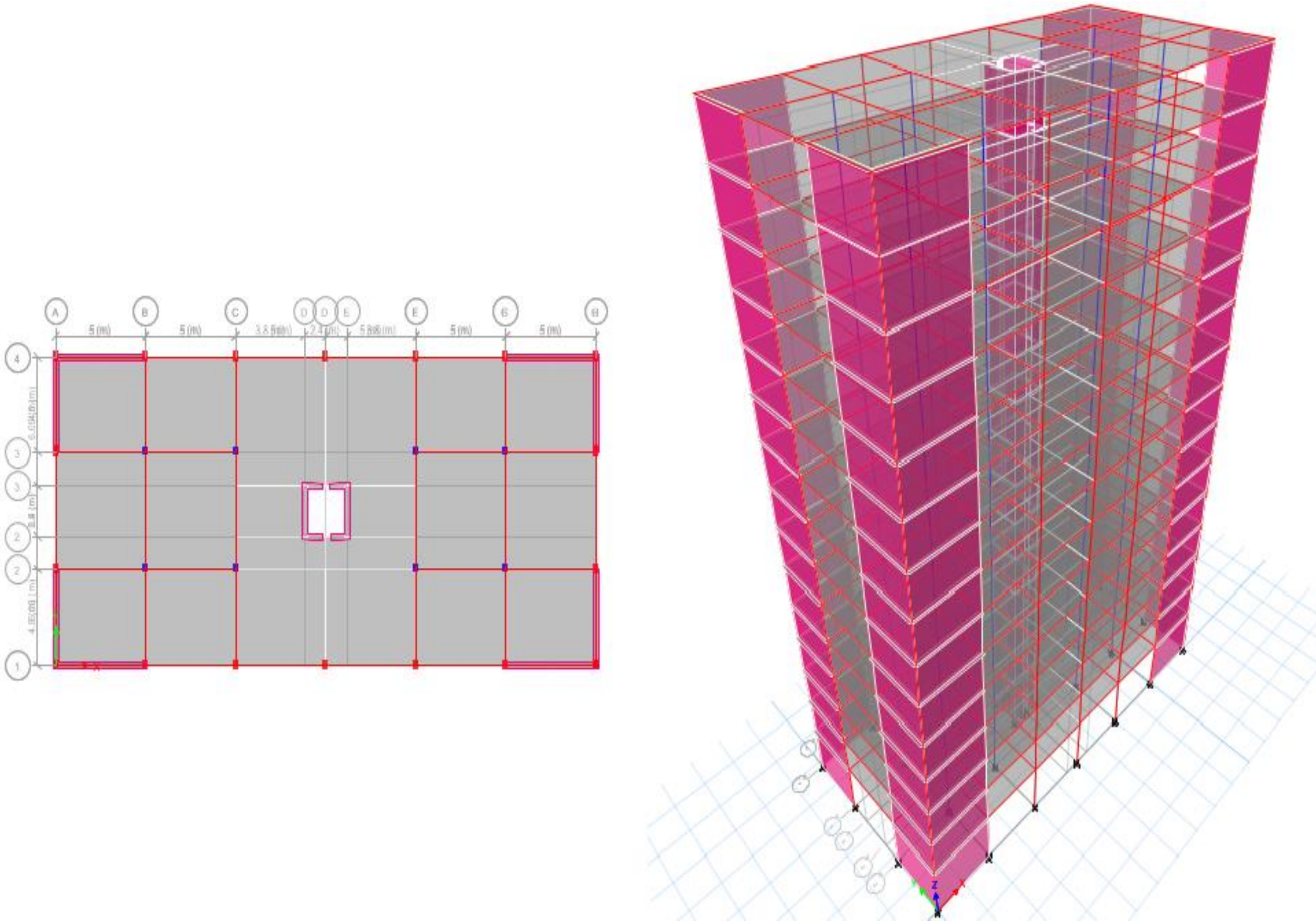

Figure 3.27: Shear Walls in the Corners of Building

- Along a-a axis belonging x direction
- Load case EX

Bending Moment:

Tables3.58.a: Bending Moment Values of Columns

STORIES	COLUMN FORCES (KN.M)							
	Top				Bottom			
Storey15	0,2813	-1,298	-1,1424	0,2697	-0,4022	1,8055	1,5893	-0,3891
Storey14	-0,2827	-1.2313	-1.102	-0.19	0,1902	1,8429	1,6404	0,2076
Storey13	-0.4805	-1.3962	-1.2647	-0.5	0.608	2.058	1.8765	0.6305
Storey12	-0.7418	-1.5015	-1.3727	-0.7646	1.017	2.2637	2. 0672	1.044
Storey11	-0.9666	-1.5867	-1.4612	-0.9921	1.418	2.2714	2.2811	1.4489
Storey10	-1.1594	-1.6437	-1.5228	-1.1872	1.8137	2.6712	2.489	1.8481
Storey9	-1.3233	-1.6696	-1.5545	-1.3531	2.058	2.8561	2.6843	2.2433
Storey8	-1.4613	-1.661	-1.5532	-1.4927	2.5959	3.0196	2.8605	2.6364
Storey7	-1.5757	-1.6142	-1.5153	-1.6083	2.986	3.1549	3.011	3.029
Storey6	-1.6685	-1.5249	-1.4366	-1.702	3.3777	3.2548	3.1287	3.4228
Storey5	-1.7407	-1.3879	-1.3118	-1.7748	3.7721	3.3109	3.2052	3.8191
Storey4	-1.7917	-1.1957	-1.1336	-1.826	4.1697	3.3125	3.2299	4.2182
Storey3	-1.8144	-0.9355	-0.8891	-1.8487	4.5617	3.2383	3.1812	4.6111
Storey2	-1.7793	-0.5924	-0.5625	-1.8103	4.919	3.0992	3.0671	4.9588
Storey1	-1.7875	-0.1321	-0.1188	-1.7698	6.2983	2.9038	2.8979	6.2763

Table 3.58.b: Bending Moment Values of Beams

Stories	Beam forces (KN.M)					
Storey15	-0.5533	0.0272	0.7556	-1.6684	0.0038	-0.5374
Storey14	-0.2181	0.0173	0.834	-1.7244	0.0063	-0.1918
Storey13	-0.2874	0.1365	0.8647	-1.7191	0.1523	-0.2674
Storey12	-0.3496	0.2844	0.8982	-1.7084	0.3029	-0.3331
Storey11	-0.418	0.4231	0.9261	-1.6862	0.4442	-0.4392
Storey10	-0.5334	0.5525	0.9465	-1.6504	0.5761	-0.5571
Storey9	-0.6416	0.6741	0.9573	-1.5982	0.7	-0.6676
Storey8	-0.7432	0.789	0.9568	-1.5269	0.817	-0.7713
Storey7	-0.839	0.8984	0.9434	-1.4339	0.9282	-0.869
Storey6	-0.9292	1.0031	0.9151	-1.3168	1.0344	-0.9608
Storey5	-1.0124	1.1029	0.87	-1.1739	1.1355	-1.0452
Storey4	-1.0835	1.1954	0.8053	-1.0042	1.2286	-1.1167
Storey3	-1.1273	1.2712	0.7166	-0.8086	1.3038	-1.1591
Storey2	-1.0985	1.2968	0.5967	-0.5927	1.3252	-1.1236
Storey1	-0.8069	1.1141	0.4606	-0.3037	1.1183	-0.7976

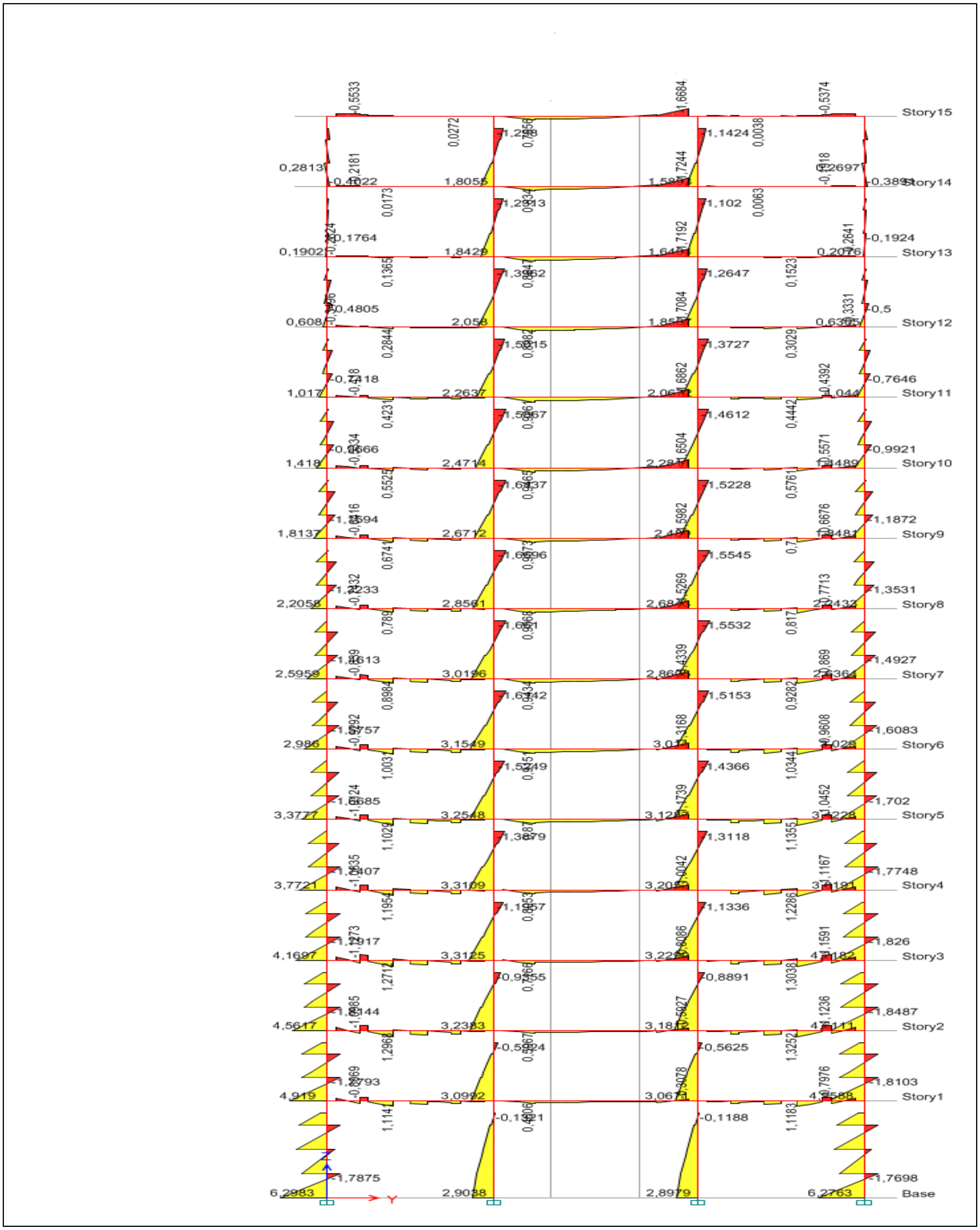

Figure 3.28: Bending Moment Diagram of Frame

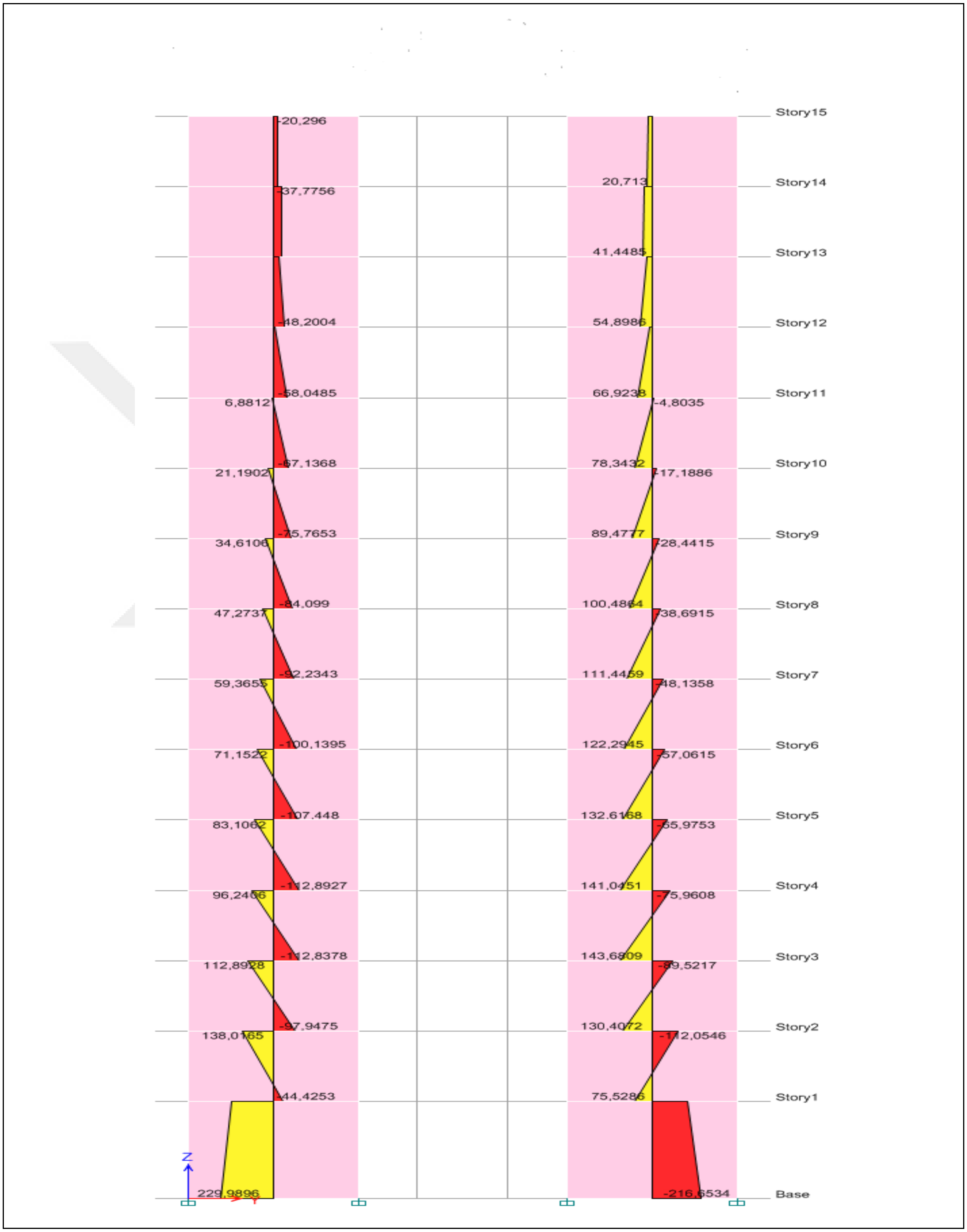

Figure 3.29: Bending Moment of Shear Wall

Shear force of frame and shear wall:

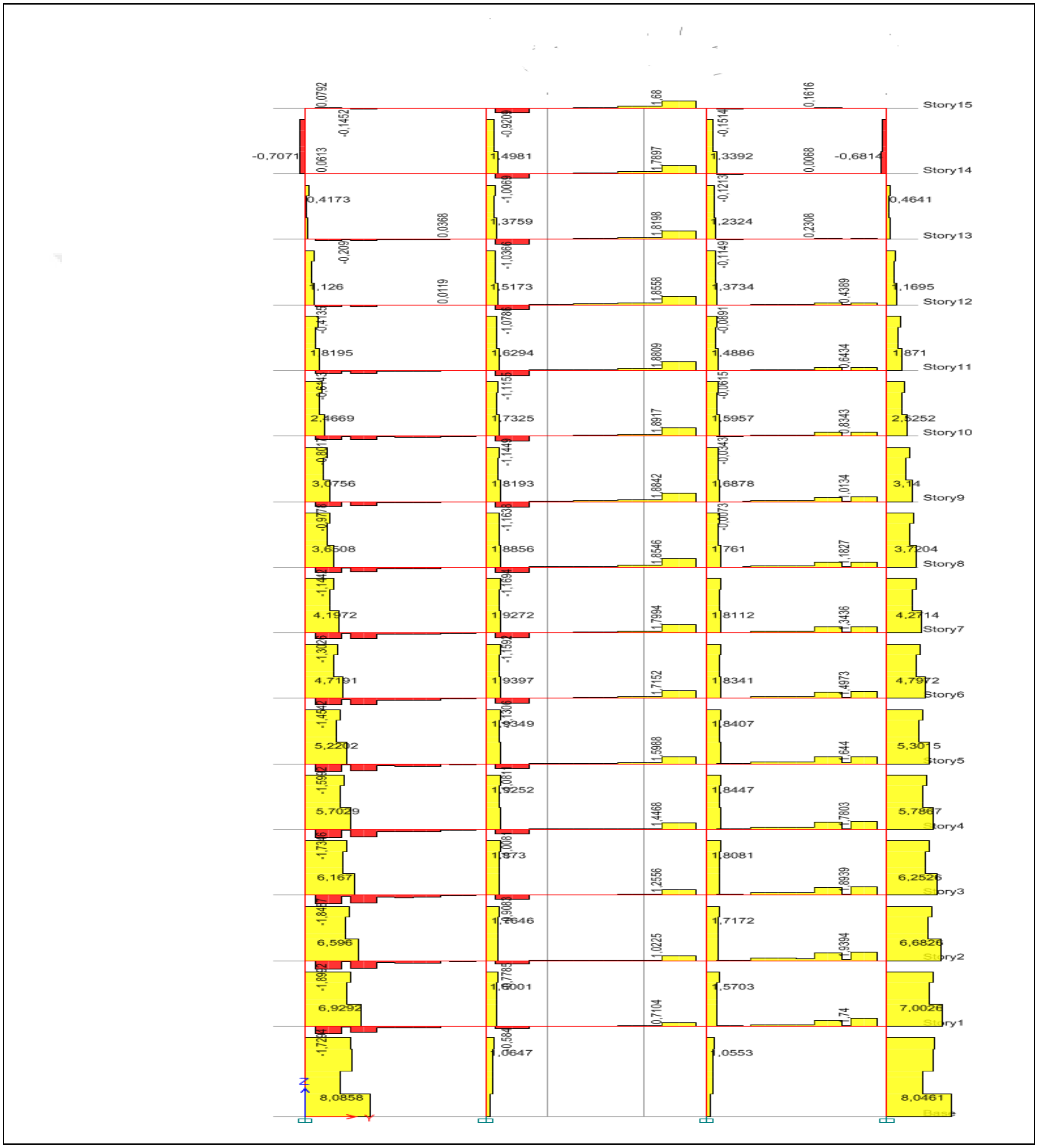

Figure 3.30: Shear Force Diagram of Frame

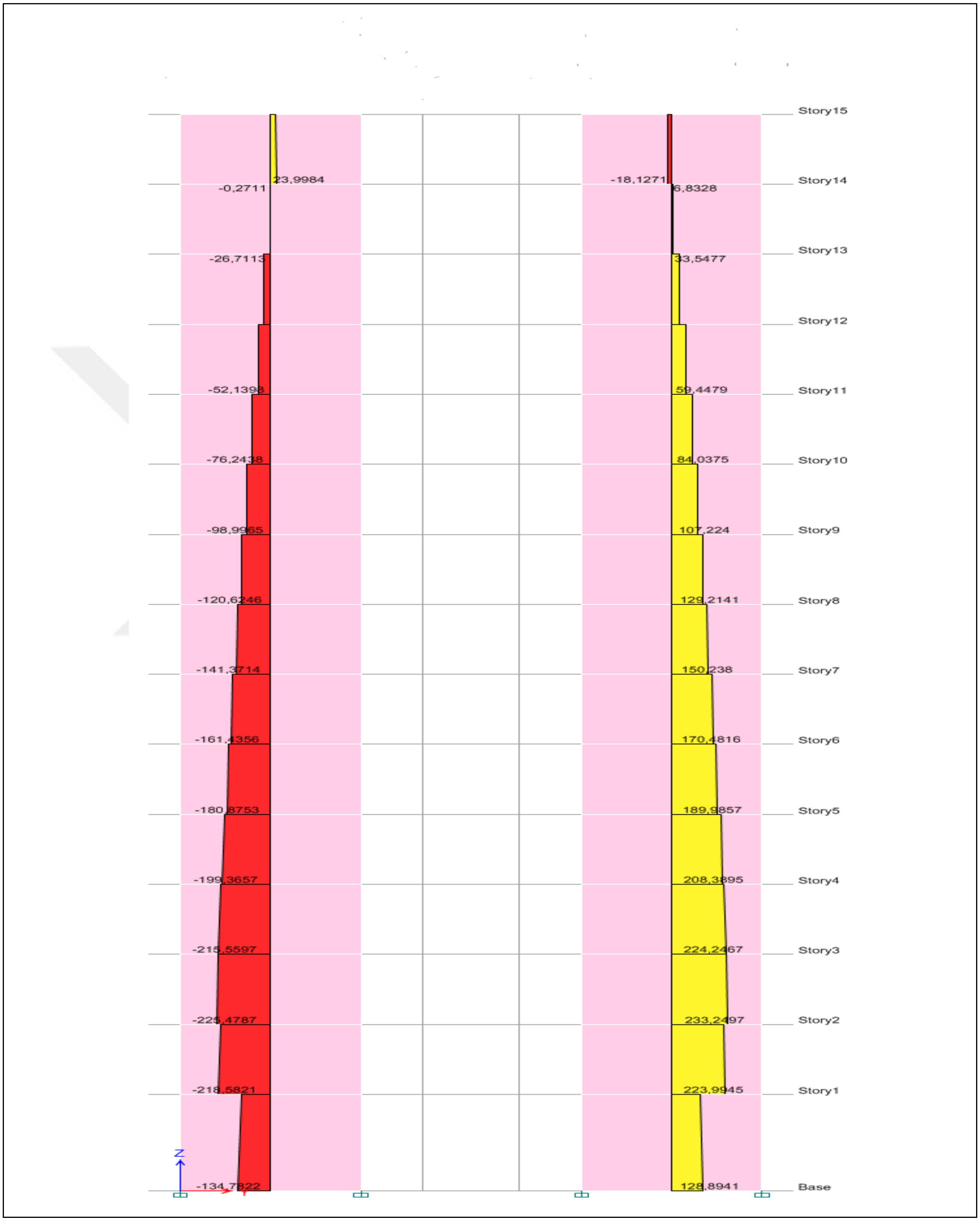

Figure 3.31: Shear Force Diagram of Shear Wall

Center of mass and center of rigidity:

Table3.59: Center of Mass and Center of Rigidity

Story	Diaphragm	Mass X kg	Mass Y kg	XCM m	YCM m	Cumulative X kg	Cumulative Y kg	XCCM m	YCCM m	XCR m	YCR m
Story15	D1	846074,4	846074,4	15,0233	7,2389	846074,4	846074,4	15,0233	7,2389	15,0243	7,1389
Story14	D1	884197,18	884197,18	15,0369	7,2331	1730271,58	1730271,58	15,0303	7,2359	15,0244	7,1434
Story13	D1	884466,99	884466,99	15,0408	7,2313	2614738,57	2614738,57	15,0338	7,2344	15,0244	7,1491
Story12	D1	884466,99	884466,99	15,0408	7,2313	3499205,56	3499205,56	15,0356	7,2336	15,0244	7,1558
Story11	D1	884466,99	884466,99	15,0408	7,2313	4383672,55	4383672,55	15,0366	7,2332	15,0243	7,1636
Story10	D1	884466,99	884466,99	15,0408	7,2313	5268139,54	5268139,54	15,0373	7,2328	15,0243	7,1722
Story9	D1	884466,99	884466,99	15,0408	7,2313	6152606,53	6152606,53	15,0378	7,2326	15,0245	7,1817
Story8	D1	884466,99	884466,99	15,0408	7,2313	7037073,52	7037073,52	15,0382	7,2325	15,0249	7,1918
Story7	D1	884466,99	884466,99	15,0408	7,2313	7921540,52	7921540,52	15,0385	7,2323	15,0258	7,2028
Story6	D1	884466,99	884466,99	15,0408	7,2313	8806007,51	8806007,51	15,0387	7,2322	15,0272	7,2144
Story5	D1	884466,99	884466,99	15,0408	7,2313	9690474,5	9690474,5	15,0389	7,2322	15,0296	7,2269
Story4	D1	884466,99	884466,99	15,0408	7,2313	10574941,49	10574941,49	15,0391	7,2321	15,0331	7,24
Story3	D1	884466,99	884466,99	15,0408	7,2313	11459408,48	11459408,48	15,0392	7,232	15,0377	7,2536
Story2	D1	884466,99	884466,99	15,0408	7,2313	12343875,47	12343875,47	15,0393	7,232	15,0419	7,2669
Story1	D1	895364,91	895364,91	15,044	7,2299	13239240,38	13239240,38	15,0396	7,2318	15,0397	7,2797

Ecc: along x: 0.0001   alongy: 0.1

Δi, ave= (0.000493+0,000108)/2 =3.005.10^{-4}

ηbi= 1.64≥1.2   There is a torsion irregularity in the bearing system

y direction:

Δi, ave= (0.000478+0.000112)/2=2.95.10^{-4}

ηbi= 1.62≥1.20 There is a torsion irregularity in the bearing system

Story Stiffness:

Checking the irregularity of storey stiffness for EX and EY along the both axis

EX:

Storey1/average (storey2+3+4/3) =0,614231583

Storey2=0,55

Storey3=0,48

Storey4=0,44

Storey5=0,42

Storey6=0,41 **≤0.80**

Storey7=0,40

Storey8=0,41

Storey9=0,42

Storey10=0,43

Storey11=0,46

Storey12=0,51

EY:

Storey1=0,62

Storey2=0,55

Storey3=0,47

Storey4=0,43

Storey5=0,41

Storey6=0,41 **≤0.80**

Storey7=0,40

Storey8=0,40

Storey9=0,41

Storey10=0,42

Storey11=0,45

Storey12=0,50

Table3.60: Story Stiffness

Story	Load Case	Shear X kN	Drift X mm	Stiffness X kN/m	Shear Y kN	Drift Y mm	Stiffness Y kN/m
Story15	EX	616,2528	1,341	459419,263	0,8913	0,007	0
Story14	EX	907,273	1,37	662421,364	0,2049	0,007	0
Story13	EX	1178,3773	1,393	845845,762	0,3149	0,007	0
Story12	EX	1429,2216	1,413	1011470,173	0,6963	0,007	0
Story11	EX	1659,796	1,425	1164740,163	0,9509	0,007	0
Story10	EX	1870,0931	1,426	1311748,767	1,091	0,006	0
Story9	EX	2060,1078	1,411	1460293,463	1,1285	0,006	0
Story8	EX	2229,8355	1,377	1618922,793	1,0742	0,006	0
Story7	EX	2379,2724	1,322	1799421,635	0,9378	0,005	0
Story6	EX	2508,4149	1,242	2019294,798	0,7261	0,005	0
Story5	EX	2617,2603	1,134	2307802,858	0,4408	0,004	0
Story4	EX	2705,8078	0,994	2720778,305	0,0693	0,003	0
Story3	EX	2774,0704	0,82	3384301,948	0,4329	0,003	0
Story2	EX	2822,0883	0,605	4663581,982	1,2772	0,002	0
Story1	EX	2858,5726	0,432	6614452,452	0	0,0001564	0
Story15	EY	0,7276	0,004	0	616,8045	1,246	495214,293
Story14	EY	0,2444	0,004	0	906,8982	1,283	707068,154
Story13	EY	0,1212	0,004	0	1177,4977	1,317	894310,892
Story12	EY	0,3969	0,004	0	1427,9029	1,348	1058990,292
Story11	EY	0,598	0,004	0	1658,0844	1,373	1207502,549
Story10	EY	0,7355	0,005	0	1868,0233	1,387	1346906,326
Story9	EY	0,8187	0,005	0	2057,7084	1,386	1484668,615
Story8	EY	0,8556	0,004	0	2227,1297	1,366	1630316,371
Story7	EY	0,8527	0,004	0	2376,2782	1,324	1795119,746
Story6	EY	0,8138	0,004	0	2505,1457	1,255	1995758,094
Story5	EY	0,7375	0,004	0	2613,7255	1,157	2259816,451
Story4	EY	0,609	0,003	0	2702,0143	1,024	2639838,586
Story3	EY	0,3835	0,002	0	2770,0201	0,851	3255003,254
Story2	EY	0,0992	0,001	0	2817,7857	0,632	4457022,145
Story1	EY	0	0,0004147	0	2858,5726	0,448	6387479,234

Response Spectrum:

Table 3.61: RESPONCE Spectrum

Name	Period	Acceleration	Damping	Ss	S1	TL	Site Class	Fa	Fv	SDS	SD1
	sec					sec					
responce spectrum	0	0,18096	5	0,348	0,098	6	ZC	1,3	1,5	0,3016	0,098
responce spectrum	0,065	0,4524									
responce spectrum	0,325	0,4524									
responce spectrum	0,6	0,245									
responce spectrum	0,8	0,18375									
responce spectrum	1	0,147									
responce spectrum	1,2	0,1225									
responce spectrum	1,4	0,105									
responce spectrum	1,6	0,091875									
responce spectrum	1,8	0,081667									
responce spectrum	2	0,0735									
responce spectrum	2,5	0,0588									
responce spectrum	3	0,049									
responce spectrum	3,5	0,042									
responce spectrum	4	0,03675									
responce spectrum	4,5	0,032667									
responce spectrum	5	0,0294									
responce spectrum	5,5	0,026727									
responce spectrum	6	0,0245									
responce spectrum	6,5	0,020876									
responce spectrum	7	0,018									
responce spectrum	7,5	0,01568									
responce spectrum	8	0,013781									
responce spectrum	8,5	0,012208									
responce spectrum	9	0,010889									
responce spectrum	9,5	0,009773									
responce spectrum	10	0,00882									

Base Shear:

Table3.62: Base Shear

Load Pattern	Type	Direction	Eccentricity	Ecc. Overridden	Period Method	Ct (m), x	Top Story	Bottom Story	Period Used	Coeff Used	Weight Used	Base Shear
			%						sec		kN	kN
EX	Seismic	X			Program Calculated	0.10m, 0.75	Story15	Base	1,364	0,018096	157967,0994	2858,5726
EX	Seismic	X + Ecc. Y	5	No	Program Calculated	0.10m, 0.75	Story15	Base	1,364	0,018096	157967,0994	2858,5726
EX	Seismic	X - Ecc. Y	5	No	Program Calculated	0.10m, 0.75	Story15	Base	1,364	0,018096	157967,0994	2858,5726
EY	Seismic	Y			Program Calculated	0.10m, 0.75	Story15	Base	1,359	0,018096	157967,0994	2858,5726
EY	Seismic	Y + Ecc. X	5	No	Program Calculated	0.10m, 0.75	Story15	Base	1,359	0,018096	157967,0994	2858,5726
EY	Seismic	Y - Ecc. X	5	No	Program Calculated	0.10m, 0.75	Story15	Base	1,359	0,018096	157967,0994	2858,5726

Displacement:

Load case: EX

Table3.63: Displacement

Story	Elevation	Location	X-Dir	Y-Dir
	m		mm	mm
Story15	44,6	Top	17,832	0,14
Story14	41,7	Top	16,486	0,127
Story13	38,8	Top	15,114	0,114
Story12	35,9	Top	13,718	0,101
Story11	33	Top	12,302	0,088
Story10	30,1	Top	10,873	0,075
Story9	27,2	Top	9,443	0,063
Story8	24,3	Top	8,026	0,052
Story7	21,4	Top	6,642	0,041
Story6	18,5	Top	5,311	0,031
Story5	15,6	Top	4,057	0,022
Story4	12,7	Top	2,91	0,014
Story3	9,8	Top	1,899	0,008
Story2	6,9	Top	1,06	0,007
Story1	4	Top	0,432	0,007
Base	0	Top	0	0

Load case: EY

Table 3.64: Displacement

Story	Elevation	Location	X-Dir	Y-Dir
	m		**mm**	**mm**
Story15	44,6	Top	0,057	17,471
Story14	41,7	Top	0,053	16,225
Story13	38,8	Top	0,048	14,945
Story12	35,9	Top	0,044	13,631
Story11	33	Top	0,04	12,285
Story10	30,1	Top	0,035	10,913
Story9	27,2	Top	0,03	9,526
Story8	24,3	Top	0,025	8,139
Story7	21,4	Top	0,021	6,77
Story6	18,5	Top	0,016	5,441
Story5	15,6	Top	0,013	4,178
Story4	12,7	Top	0,01	3,011
Story3	9,8	Top	0,008	1,973
Story2	6,9	Top	0,007	1,104
Story1	4	Top	0,013	0,448
Base	0	Top	0	0

Story Drift:

Load case: EX

Table3.65: Story Drift

Story	Elevation	Location	X-Dir	Y-Dir
	m			
Story15	44,6	Top	0,000464	0,000004
Story14	41,7	Top	0,000473	0,000004
Story13	38,8	Top	0,000481	0,000004
Story12	35,9	Top	0,000488	0,000004
Story11	33	Top	0,000493	0,000004
Story10	30,1	Top	0,000493	0,000004
Story9	27,2	Top	0,000488	0,000004
Story8	24,3	Top	0,000477	0,000004
Story7	21,4	Top	0,000459	0,000003
Story6	18,5	Top	0,000432	0,000003
Story5	15,6	Top	0,000396	0,000003
Story4	12,7	Top	0,000348	0,000002
Story3	9,8	Top	0,000289	0,000002
Story2	6,9	Top	0,000217	0,000001
Story1	4	Top	0,000108	7,61E-08
Base	0	Top	0	0

Load case: EY

Table3.66: Story Drift

Story	Elevation	Location	X-Dir	Y-Dir
	m			
Story15	44,6	Top	0,000001	0,00043
Story14	41,7	Top	0,000001	0,000441
Story13	38,8	Top	0,000001	0,000453
Story12	35,9	Top	0,000002	0,000464
Story11	33	Top	0,000002	0,000473
Story10	30,1	Top	0,000002	0,000478
Story9	27,2	Top	0,000002	0,000478
Story8	24,3	Top	0,000002	0,000472
Story7	21,4	Top	0,000002	0,000458
Story6	18,5	Top	0,000001	0,000436
Story5	15,6	Top	0,000001	0,000403
Story4	12,7	Top	0,000001	0,000358
Story3	9,8	Top	0,000001	0,0003
Story2	6,9	Top	0,000001	0,000226
Story1	4	Top	2,048E-07	0,000112
Base	0	Top	0	0

3.11.3 Shear Walls Along The Perimeter Of Building: (model 3)

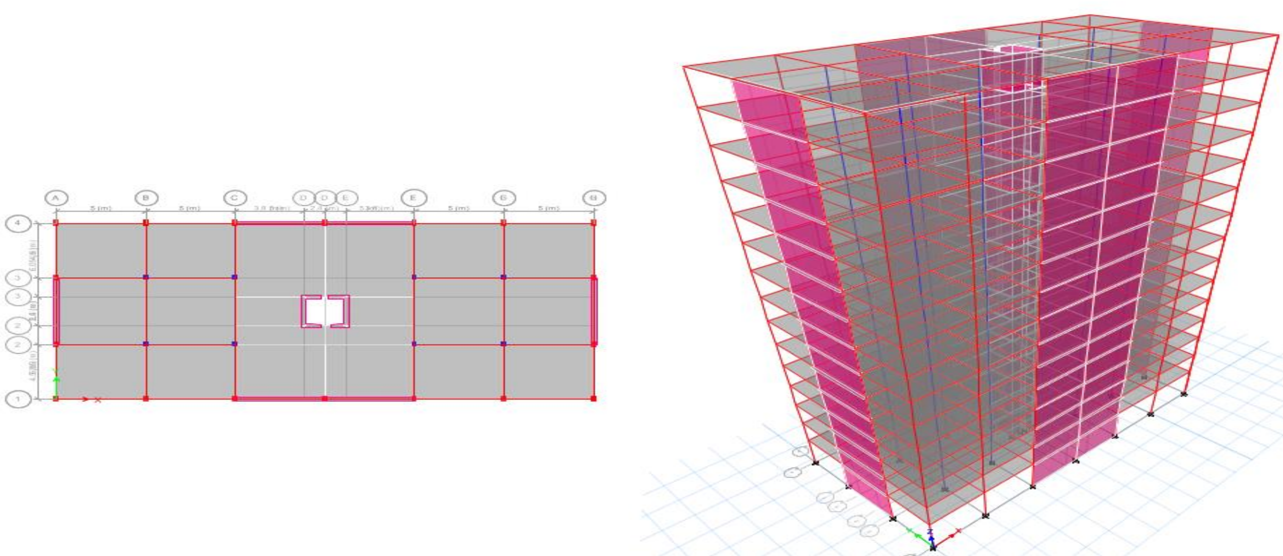

Figure 3.32: Shear Walls Along the Perimeter of Building

- Along a-a axis in the x- axis
- Load case: EX

Bending moment of frame and shear walls:

Tables 3.67.a: Bending Moment Values of Columns

Stories	Column forces (KN.M)							
	Top				Bottom			
Storey15	-11.1632	-6.7171	-6.7369	-11.029	14.8662	7.932	7.971	14.9267
Storey14	-9.0017	-4.3702	-4.3981	-9.0684	13.8071	6.8452	6.8921	13.94
Storey13	-9.2629	-4.8336	-4.8701	-9.3649	13.9964	7.1036	7.1531	14.1451
Storey12	-9.2448	-4.7695	-4.8018	-9.3415	14.0129	7.1018	7.1529	14.161
Storey11	-9.1887	-4.7485	-4.7822	-9.2885	13.9582	7.1003	7.1531	14.1092
Storey10	-9.0488	-4.6653	-4.6999	-9.1496	13.7919	7.039	7.0932	13.944
Storey9	-8.8127	-4.5299	-4.5652	-8.9135	13.4909	6.914	6.969	13.6422
Storey8	-8.4651	-4.3324	-4.3679	-8.5641	13.0317	6.7131	6.7679	13.1794
Storey7	-7.992	-4.0668	-4.1017	-8.087	12.3927	6.4261	6.4798	12.5334
Storey6	-7.3702	-3.7267	-3.7602	-7.4686	11.5541	6.0435	6.0946	11.6835
Storey5	-6.6174	-3.3058	-3.3369	-6.696	10.4976	5.5556	5.6025	10.6107
Storey4	-5.6927	-2.7983	-2.8258	-5.7575	9.2082	4.9555	4.9962	9.2984
Storey3	-4.593	-2.1959	-2.2183	-4.6393	7.6578	4.2233	4.2558	7.719
Storey2	-3.3387	-1.4998	-1.5159	-3.3611	6.0029	3.4096	3.432	6.0223
Storey1	-1.5003	-0.6682	-0.6736	-1.4955	3.2567	2.5237	2.5282	3.2581

Table 3.67.b: Bending Moment Values of Beams

Stories	Beam forces (KN.M)					
Storey15	-2.7617	2.3756	-0.0206	0.1326	2.6026	-3.0725
Storey14	-4.1122	2.8105	-0.063	0.1442	3.0648	-4.5485
Storey13	-3.8974	2.7396	-0.0566	0.1343	2.9987	-4.3181
Storey12	-3.8781	2.7227	-0.059	0.1359	2.9866	-4.311
Storey11	-3.7899	2.6698	-0.0617	0.1362	2.9376	-4.2291
Storey10	-3.6699	2.5939	-0.0645	0.1357	2.864	-4.1135
Storey9	-3.5106	2.4911	-0.0667	0.1339	2.7609	-3.9544
Storey8	-3.3114	2.3602	-0.0683	0.1306	2.6265	-3.75
Storey7	-3.0713	2.2001	-0.0688	0.1258	2.4586	-3.4978
Storey6	-2.7898	2.0099	-0.068	0.119	2.2557	-3.196
Storey5	-2.4668	1.7893	-0.0656	0.1103	2.0156	-2.8432
Storey4	-2.1031	1.5381	0.0993	-0.063	1.7404	-2.4391
Storey3	-1.6987	1.2566	0.0858	-0.0588	1.4265	-1.9818
Storey2	-¨1.2657	0.9474	0.0677	-0.0498	1.0772	-1.4847
Storey1	-0.7524	0.6102	0.0415	-0.0437	0.6884	-0.8799

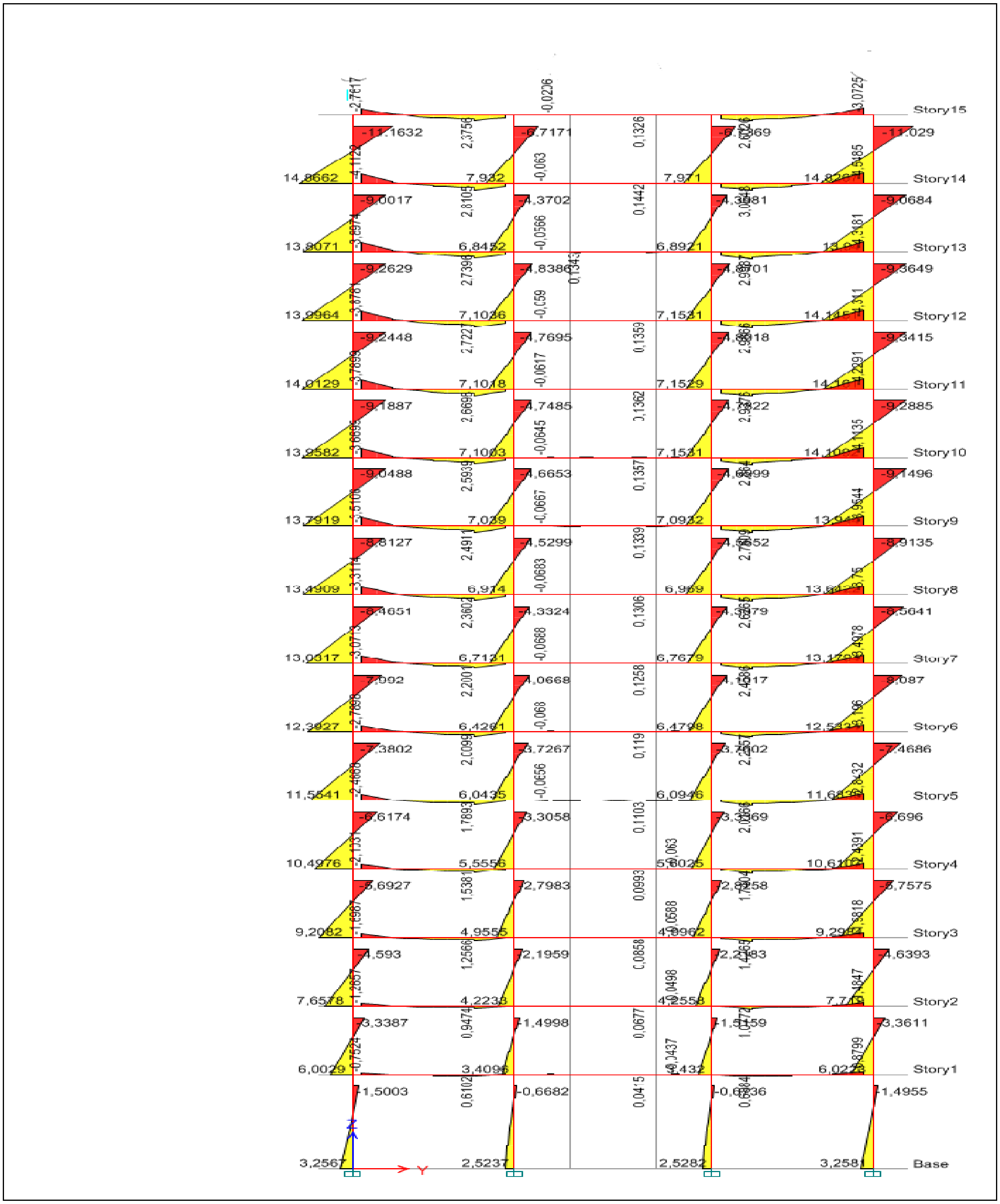

Figure 3.33: Bending Moment Diagram of Frame

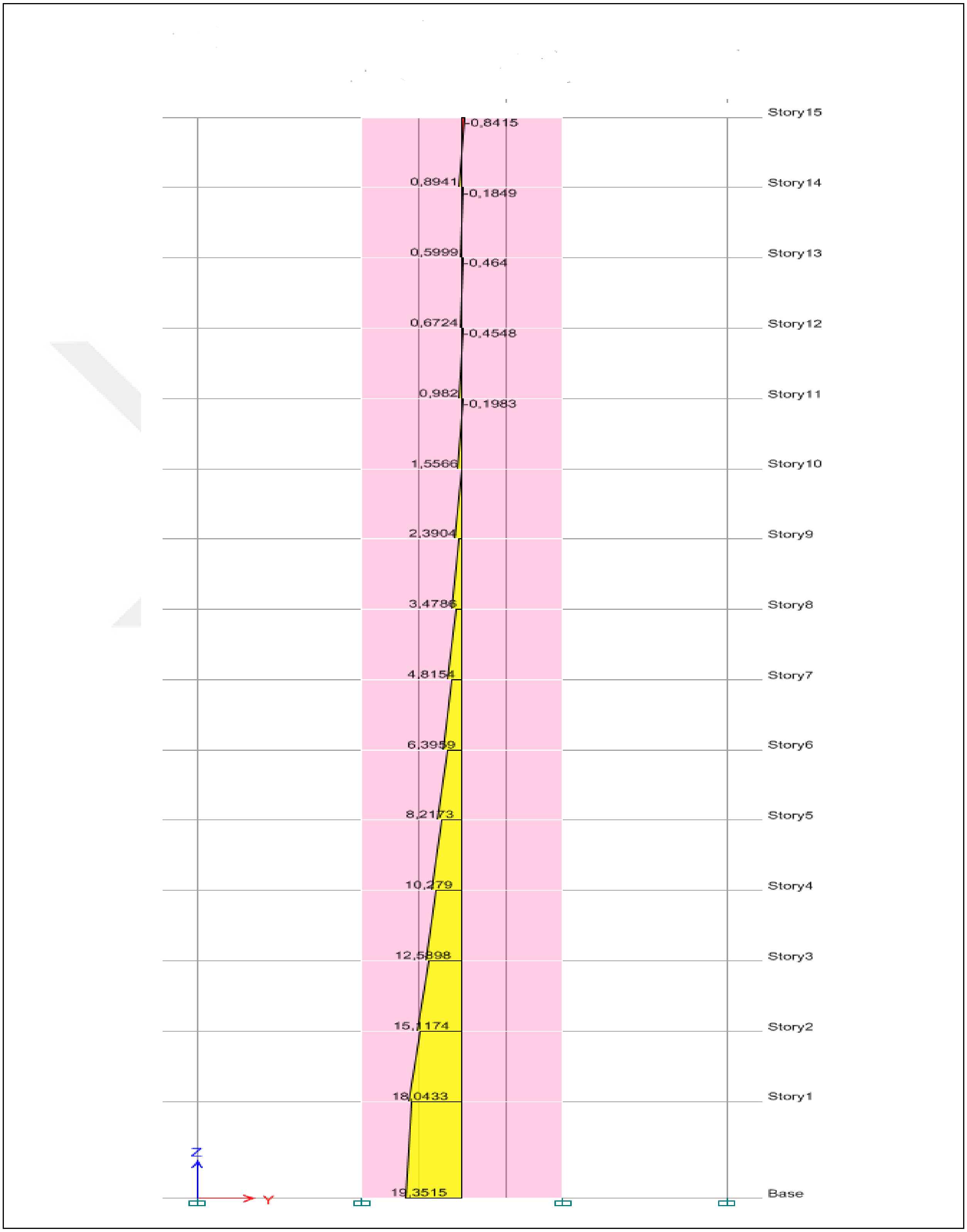

Figure 3.34: Bending Moment Diagram of Shear Wall

Shear force of frame and shear wall:

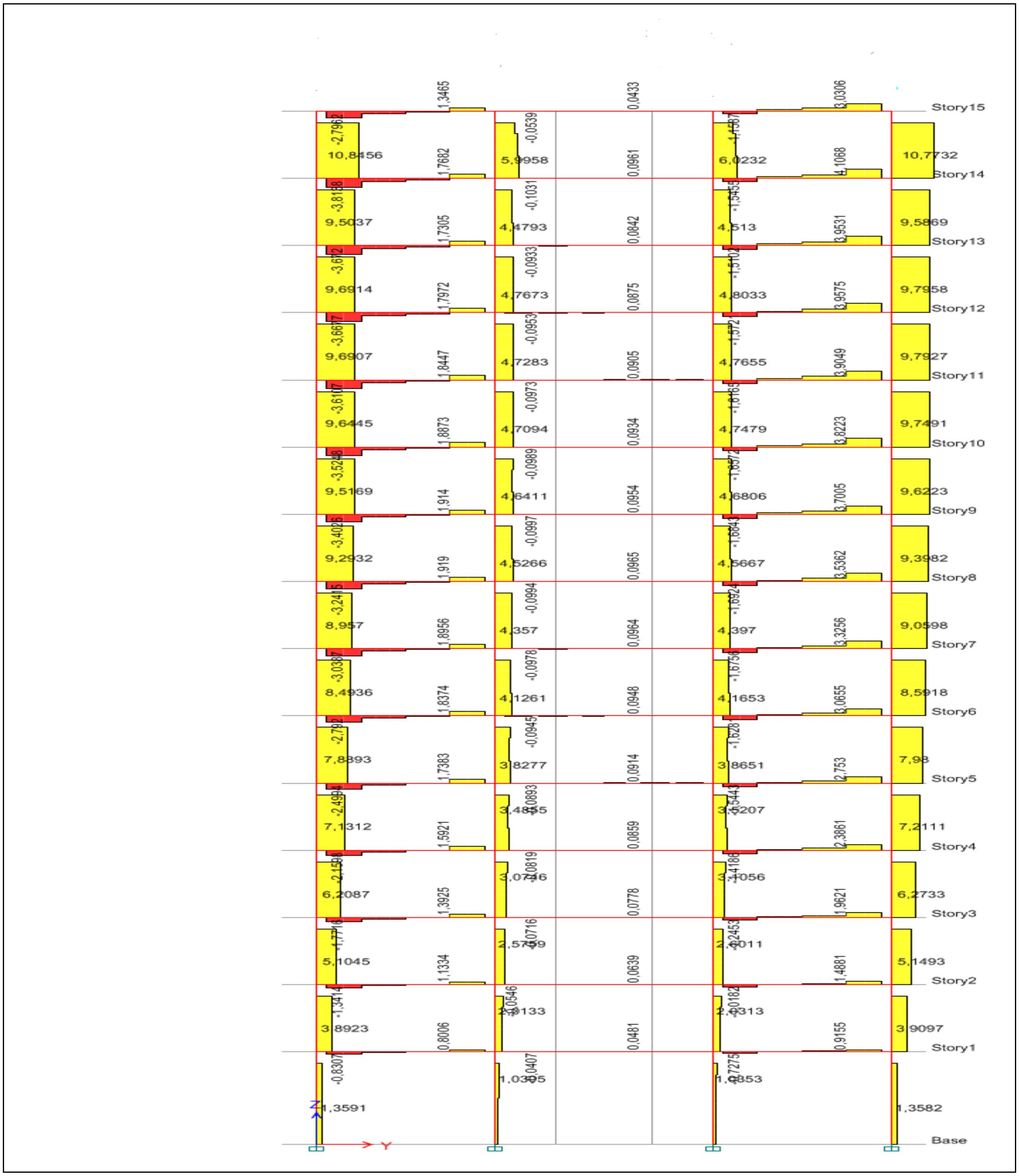

Figure 3.35: Shear Force Diagram of Frame

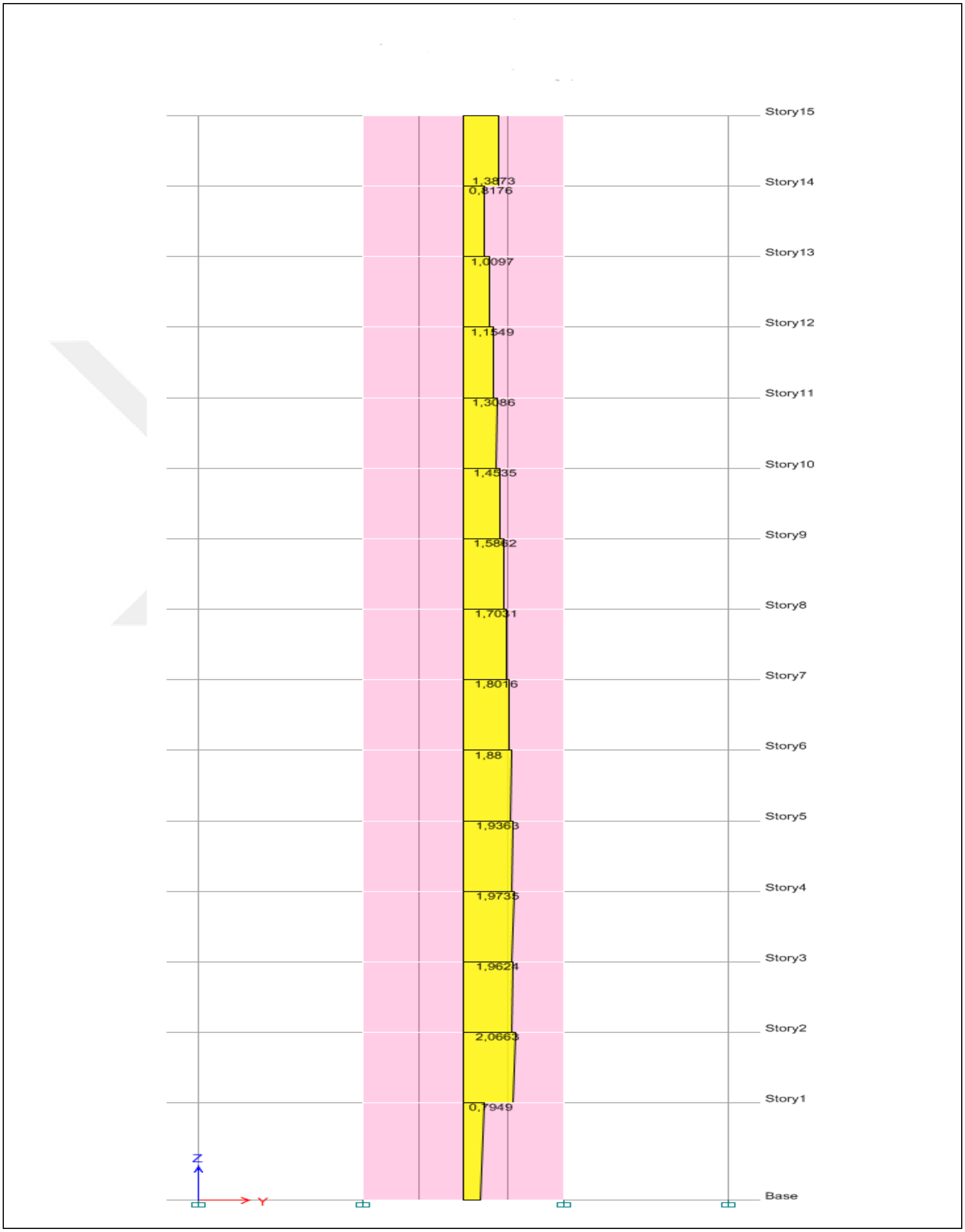

Figure 3.36: Shear Force Diagram of Shear Wall

Center of mass and center of rigidity:

Table 3.68: Center of Mass and Center of Rigidity

Story	Diaphragm	Mass X kg	Mass Y kg	XCM m	YCM m	Cumulative X kg	Cumulative Y kg	XCCM m	YCCM m	XCR m	YCR m
Story15	D1	844862,09	844862,09	15,0233	7,2388	844862,09	844862,09	15,0233	7,2388	15,2544	7,2169
Story14	D1	881678,79	881678,79	15,037	7,2331	1726540,88	1726540,88	15,0303	7,2359	15,2446	7,2167
Story13	D1	881948,6	881948,6	15,0409	7,2313	2608489,48	2608489,48	15,0339	7,2343	15,2328	7,2156
Story12	D1	881948,6	881948,6	15,0409	7,2313	3490438,08	3490438,08	15,0357	7,2336	15,2189	7,2142
Story11	D1	881948,6	881948,6	15,0409	7,2313	4372386,68	4372386,68	15,0367	7,2331	15,2036	7,2126
Story10	D1	881948,6	881948,6	15,0409	7,2313	5254335,28	5254335,28	15,0374	7,2328	15,187	7,2108
Story9	D1	881948,6	881948,6	15,0409	7,2313	6136283,88	6136283,88	15,0379	7,2326	15,1694	7,2091
Story8	D1	881948,6	881948,6	15,0409	7,2313	7018232,48	7018232,48	15,0383	7,2324	15,1509	7,2076
Story7	D1	881948,6	881948,6	15,0409	7,2313	7900181,08	7900181,08	15,0386	7,2323	15,1316	7,2065
Story6	D1	881948,6	881948,6	15,0409	7,2313	8782129,68	8782129,68	15,0388	7,2322	15,1114	7,2059
Story5	D1	881948,6	881948,6	15,0409	7,2313	9664078,28	9664078,28	15,039	7,2321	15,0905	7,2064
Story4	D1	881948,6	881948,6	15,0409	7,2313	10546026,88	10546026,88	15,0392	7,232	15,069	7,2083
Story3	D1	881948,6	881948,6	15,0409	7,2313	11427975,48	11427975,48	15,0393	7,232	15,047	7,2127
Story2	D1	881948,6	881948,6	15,0409	7,2313	12309924,08	12309924,08	15,0394	7,2319	15,0258	7,2214
Story1	D1	892801,48	892801,48	15,0441	7,2299	13202725,56	13202725,56	15,0397	7,2318	15,0076	7,2402

Ecc: along x: 0.231 alongy: 0.022

Δi, ave= (0.000351+0,000031)/2 =1.91.10^{-4}

ηbi= 1.83≥1.2 There is a torsion irregularity in the bearing system

y direction:

Δi, ave= (0.000591+0.000159)/2=3.75.10^{-4}

ηbi= 1.57≥1.20 There is a torsion irregularity in the bearing system

Story Stiffness:

Checking the irregularity

EX:

Storey1/ave (storey2+3+4)/3

=0,57

Storey2=0,55

Storey3=0,48

Storey4=0,44

Storey5=0,43

Storey6=0,41 **≤0.80**

Storey7=0,41

Storey8=0,41

Storey9=0,42

Storey10=0,44

Storey11=0,46

Storey12=0,52

EY:

Storey1/ave (storey2+3+4)/3

=0,60

Storey2=0,53

Storey3=0,45

Storey4=0,42

Storey5=0,40

Storey6=0,39 **≤0.80**

Storey7=0,38

Storey8=0,38

Storey9=0,39

Storey10=0,41

Storey11=0,44

Storey12=0,4

Table 3.69: Story Stiffness

Story	Load Case	Shear X	Drift X	Stiffness X	Shear Y	Drift Y	Stiffness Y
		kN	mm	kN/m	kN	mm	kN/m
Story15	EX	590,9912	0,968	610335,714	0,9473	0,005	0
Story14	EX	875,4267	0,988	885809,986	0,5744	0,004	0
Story13	EX	1138,9624	1,003	1136076,426	0,6426	0,005	0
Story12	EX	1383,0259	1,013	1365183,842	0,6099	0,004	0
Story11	EX	1607,3832	1,018	1578921,439	0,5901	0,004	0
Story10	EX	1812,0878	1,014	1786864,463	0,5605	0,004	0
Story9	EX	1997,1442	0,999	1998475,564	0,5258	0,004	0
Story8	EX	2162,5642	0,972	2225323,169	0,4855	0,003	0
Story7	EX	2308,3578	0,93	2483335,455	0,44	0,003	0
Story6	EX	2434,5342	0,871	2796251,977	0,3899	0,003	0
Story5	EX	2541,1027	0,793	3203447,769	0,3352	0,002	0
Story4	EX	2628,0666	0,695	3779466,331	0,2785	0,002	0
Story3	EX	2695,4603	0,576	4682861,393	0,2132	0,002	0
Story2	EX	2743,1168	0,428	6408926,394	0,1737	0,001	0
Story1	EX	2775,0287	0,325	8549986,213	0	0,001	0
Story15	EY	0,8307	0,01	0	584,3053	1,343	435160,706
Story14	EY	0,6475	0,01	0	870,8871	1,404	620215,143
Story13	EY	0,599	0,01	0	1132,7006	1,467	772241,424
Story12	EY	0,5104	0,009	0	1375,6399	1,533	897074,961
Story11	EY	0,4193	0,009	0	1598,6607	1,595	1001991,948
Story10	EY	0,3225	0,009	0	1802,0859	1,647	1094428,009
Story9	EY	0,2253	0,009	0	1985,9603	1,681	1181529,243
Story8	EY	0,1309	0,008	0	2150,3787	1,692	1271148,787
Story7	EY	0,0435	0,008	0	2295,429	1,672	1372597,287
Story6	EY	0,0323	0,008	0	2421,2074	1,618	1496639,149
Story5	EY	0,0911	0,007	0	2527,8384	1,521	1661999,344
Story4	EY	0,1256	0,006	0	2615,4035	1,373	1904776,844
Story3	EY	0,1294	0,006	0	2684,3389	1,166	2301801,559
Story2	EY	0,0866	0,004	0	2733,5232	0,876	3121096,276
Story1	EY	0	0,001	0	2775,0287	0,632	4392583,115

Response Spectrum:

Table 3.70: Responce Spectrum

Name	Period	Acceleration	Damping	Ss	S1	TL	Site Class	Fa	Fv	SDS	SD1
	sec					sec					
responce spectrum	0	0,18096	5	0,348	0,098	6	ZC	1,3	1,5	0,3016	0,098
responce spectrum	0,065	0,4524									
responce spectrum	0,325	0,4524									
responce spectrum	0,6	0,245									
responce spectrum	0,8	0,18375									
responce spectrum	1	0,147									
responce spectrum	1,2	0,1225									
responce spectrum	1,4	0,105									
responce spectrum	1,6	0,091875									
responce spectrum	1,8	0,081667									
responce spectrum	2	0,0735									
responce spectrum	2,5	0,0588									
responce spectrum	3	0,049									
responce spectrum	3,5	0,042									
responce spectrum	4	0,03675									
responce spectrum	4,5	0,032667									
responce spectrum	5	0,0294									
responce spectrum	5,5	0,026727									
responce spectrum	6	0,0245									
responce spectrum	6,5	0,020876									
responce spectrum	7	0,018									
responce spectrum	7,5	0,01568									
responce spectrum	8	0,013781									
responce spectrum	8,5	0,012208									
responce spectrum	9	0,010889									
responce spectrum	9,5	0,009773									
responce spectrum	10	0,00882									

Base Shear:

Table 3.71: Base Shear

Type	Direction	Eccentricity %	Ecc. Overridden	Period Method	Ct (m), x	Top Story	Bottom Story	Period Used sec	Coeff Used	Weight Used kN	Base Shear kN
Seismic	X			Program Calculated	0.10m, 0.75	Story15	Base	1,147	0,018096	153350,3946	2775,0287
Seismic	X + Ecc. Y	5	No	Program Calculated	0.10m, 0.75	Story15	Base	1,147	0,018096	153350,3946	2775,0287
Seismic	X - Ecc. Y	5	No	Program Calculated	0.10m, 0.75	Story15	Base	1,147	0,018096	153350,3946	2775,0287
Seismic	Y			Program Calculated	0.10m, 0.75	Story15	Base	1,529	0,018096	153350,3946	2775,0287
Seismic	Y + Ecc. X	5	No	Program Calculated	0.10m, 0.75	Story15	Base	1,529	0,018096	153350,3946	2775,0287
Seismic	Y - Ecc. X	5	No	Program Calculated	0.10m, 0.75	Story15	Base	1,529	0,018096	153350,3946	2775,0287

Displacement:

Load case: EX

Table3.72: Displacement

Story	Elevation	Location	X-Dir	Y-Dir
	m		mm	mm
Story15	44,6	Top	12,657	0,074
Story14	41,7	Top	11,688	0,068
Story13	38,8	Top	10,7	0,062
Story12	35,9	Top	9,698	0,056
Story11	33	Top	8,684	0,05
Story10	30,1	Top	7,665	0,044
Story9	27,2	Top	6,649	0,038
Story8	24,3	Top	5,647	0,033
Story7	21,4	Top	4,672	0,027
Story6	18,5	Top	3,737	0,022
Story5	15,6	Top	2,86	0,017
Story4	12,7	Top	2,059	0,013
Story3	9,8	Top	1,354	0,008
Story2	6,9	Top	0,768	0,005
Story1	4	Top	0,325	0,002
Base	0	Top	0	0

Load case: EY

Table3.73: Displacement

Story	Elevation	Location	X-Dir	Y-Dir
	m		mm	mm
Story15	44,6	Top	0,192	21,606
Story14	41,7	Top	0,212	20,233
Story13	38,8	Top	0,193	18,8
Story12	35,9	Top	0,174	17,304
Story11	33	Top	0,156	15,743
Story10	30,1	Top	0,138	14,12
Story9	27,2	Top	0,121	12,448
Story8	24,3	Top	0,104	10,743
Story7	21,4	Top	0,088	9,028
Story6	18,5	Top	0,073	7,332
Story5	15,6	Top	0,058	5,69
Story4	12,7	Top	0,045	4,143
Story3	9,8	Top	0,033	2,743
Story2	6,9	Top	0,021	1,549
Story1	4	Top	0,014	0,634
Base	0	Top	0	0

Story Drift:

Load case: EX

Table 3.74: Story Drift

Story	Elevation	Location	X-Dir	Y-Dir
	m			
Story15	44,6	Top	0,000334	0,000002
Story14	41,7	Top	0,000341	0,000002
Story13	38,8	Top	0,000346	0,000002
Story12	35,9	Top	0,00035	0,000002
Story11	33	Top	0,000351	0,000002
Story10	30,1	Top	0,00035	0,000002
Story9	27,2	Top	0,000345	0,000002
Story8	24,3	Top	0,000336	0,000002
Story7	21,4	Top	0,000322	0,000002
Story6	18,5	Top	0,000302	0,000002
Story5	15,6	Top	0,000276	0,000002
Story4	12,7	Top	0,000243	0,000001
Story3	9,8	Top	0,000202	0,000001
Story2	6,9	Top	0,000153	0,000001
Story1	4	Top	0,000081	3,145E-07
Base	0	Top	0	0

Table3.75: Story Drift

Load case: EY

Story	Elevation	Location	X-Dir	Y-Dir
	m			
Story15	44,6	Top	0,000007	0,000473
Story14	41,7	Top	0,000006	0,000494
Story13	38,8	Top	0,000006	0,000516
Story12	35,9	Top	0,000006	0,000538
Story11	33	Top	0,000006	0,000559
Story10	30,1	Top	0,000006	0,000577
Story9	27,2	Top	0,000005	0,000588
Story8	24,3	Top	0,000005	0,000591
Story7	21,4	Top	0,000004	0,000585
Story6	18,5	Top	0,000004	0,000566
Story5	15,6	Top	0,000003	0,000533
Story4	12,7	Top	0,000003	0,000483
Story3	9,8	Top	0,000002	0,000412
Story2	6,9	Top	0,000001	0,000315
Story1	4	Top	4,696E-07	0,000159
Base	0	Top	0	0

3.11.4 Building with Different Position Of Shear Walls: (model 4)

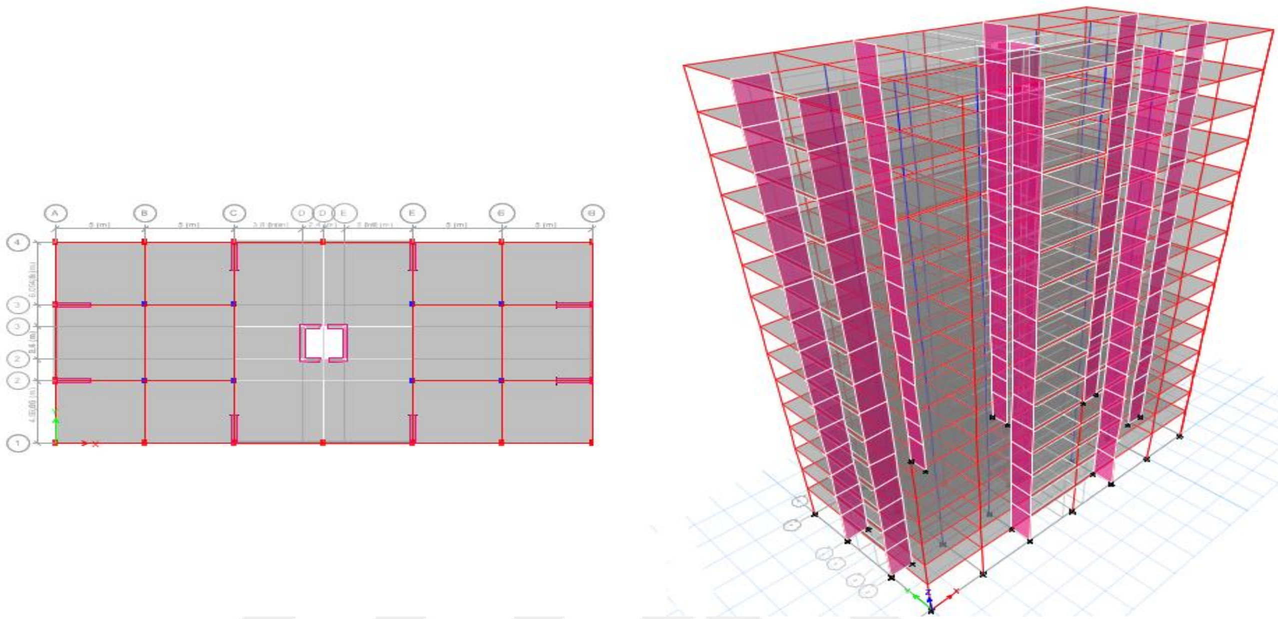

Figure 3.37: Shear Walls In Different Part of Building

- Axis c-c in x- direction
- Load case: EX

Bending moment of frame and shear wall:

Tables3.76.a: Bending Moment Values of Columns

Stories	Column forces (KN.M)							
	Top				Bottom			
Storey15	-13.6152	-19.0921	-18.9	-13.8958	15.9136	27.0056	26.7427	16.5091
Storey14	-10.8598	-18.4406	-18.2704	-11.3581	15.3504	28.0854	27.8366	16.089
Storey13	-12.6568	-20.484	-20.3135	-13.1764	17.3374	31.0737	30.8269	18.1467
Storey12	-13.8795	-22.5083	-22.3412	-14.4734	19.1662	34.2011	33.9594	20.0729
Storey11	-15.1273	-24.5271	-24.365	-15.7906	21.0144	37.3016	37.0672	22.0115
Storey10	-16.2455	-26.3952	-26.24	-16.978	22.7311	40.1648	39.9434	23.8227
Storey9	-17.1889	-28.0038	-27.8572	-17.9843	24.2332	42.6299	42.4183	25.4035
Storey8	-17.899	-29.2466	-29.1105	-18.7475	25.4382	44.5262	44.3299	26.6696
Storey7	-18.3176	-30.0129	-29.8889	-19.2024	26.263	45.5875	45.5092	27.5311
Storey6	-18.3698	-30.1756	-30.0564	-19.272	26.6143	45.9211	45.7631	27.8972
Storey5	-17.9628	-29.5773	-29.4823	-18.8575	26.3749	44.9902	44.8537	27.612
Storey4	-16.9699	-28.0093	-27.931	-17.8276	25.41.79	42.5898	42.475	26.5653
Storey3	-15.1641	-15.1634	-25.1044	-15.9544	23.3574	38.2421	38.1472	24.3599
Storey2	-12.4184	-20.705	-20.67	-13.1284	21.2752	32.0956	32.0081	22.0719
Storey1	-5.9242	-9.8535	-9.8553	-6.3474	13.3053	14.1752	14.1275	13.3896

Table 3.76.b: Bending Moment Values of Beams

Stories	Beam forces (KN.M)					
Storey15	7.1521	-1.6813	-3.8797	0.9466	-1.9011	8.1045
Storey14	8.1319	-2.8717	-4.3148	2.7442	-3.1542	9.493
Storey13	8.4864	-2.6746	-4.8929	3.2469	-3.0155	10.0306
Storey12	9.0533	-2.6092	-5.5619	3.8814	-3.0068	10.8241
Storey11	9.716	-2.5928	-6.2495	4.5055	-3.045	11.7066
Storey10	10.3937	-2.6027	-6.9125	5.0977	-3.1045	12.5904
Storey9	11.0108	-2.6074	-7.5193	5.6415	-3.1531	13.3921
Storey8	11.4941	-2.5742	-8.4033	6.1272	-3.1577	14.0335
Storey7	11.769	-2.4693	-8.458	6.5454	-3.0845	14.4358
Storey6	11.755	-2.2583	-8.7324	6.8827	-2.899	14.5129
Storey5	11.3621	-1.9078	-8.8249	7.1154	-2.5661	14.1657
Storey4	10.4928	-1.392	-8.6744	7.1999	-2.0543	13.2766
Storey3	9.0527	-0.7074	-8.1865	7.0524	-1.3431	11.703
Storey2	-0.0088	6.9881	-7.2117	6.5395	-0.4593	9.2849
Storey1	-0.0139	4.2307	-5.4204	4.8604	0.8141	5.6813

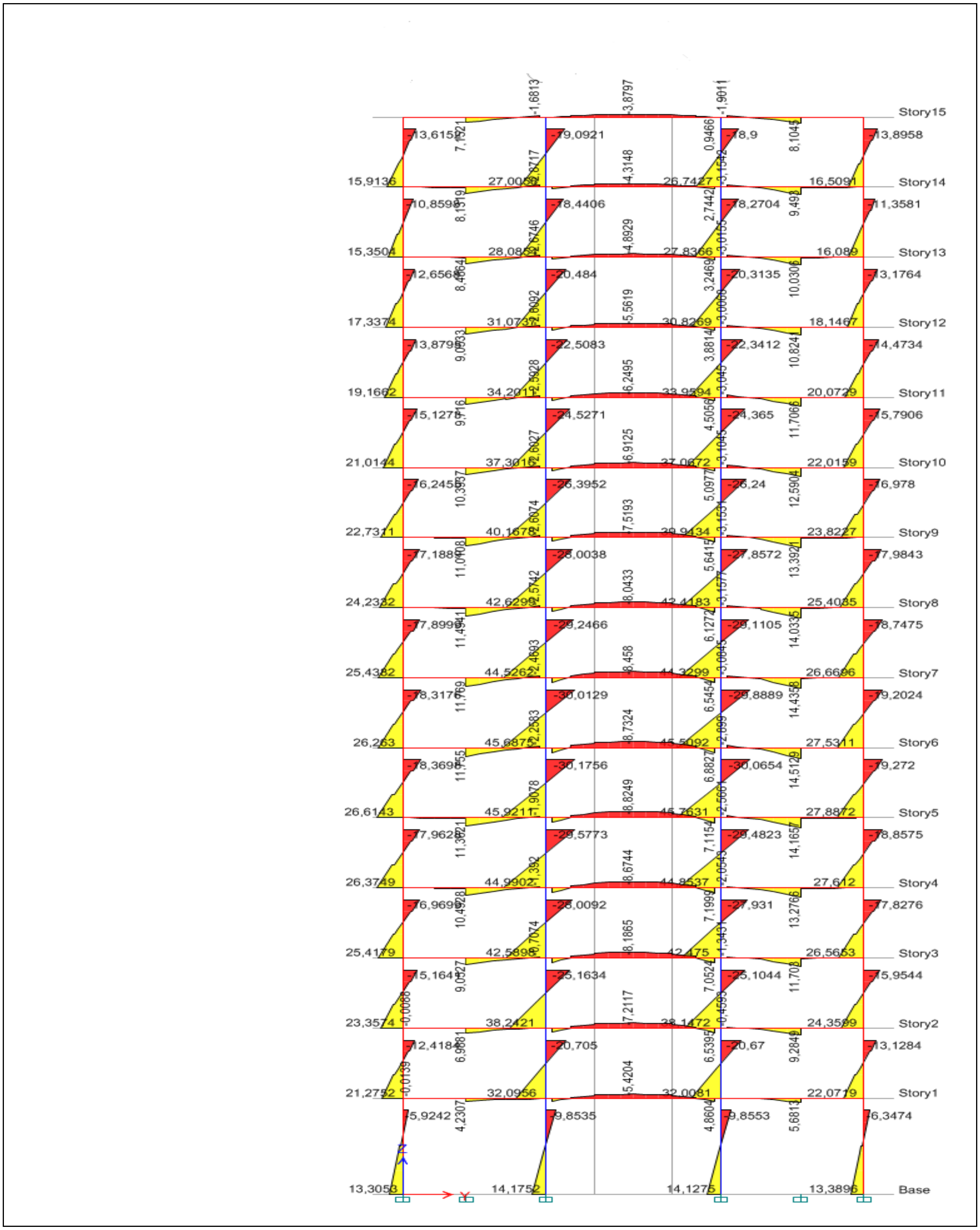

Figure 3.38: Bending Moment Diagram of Frame

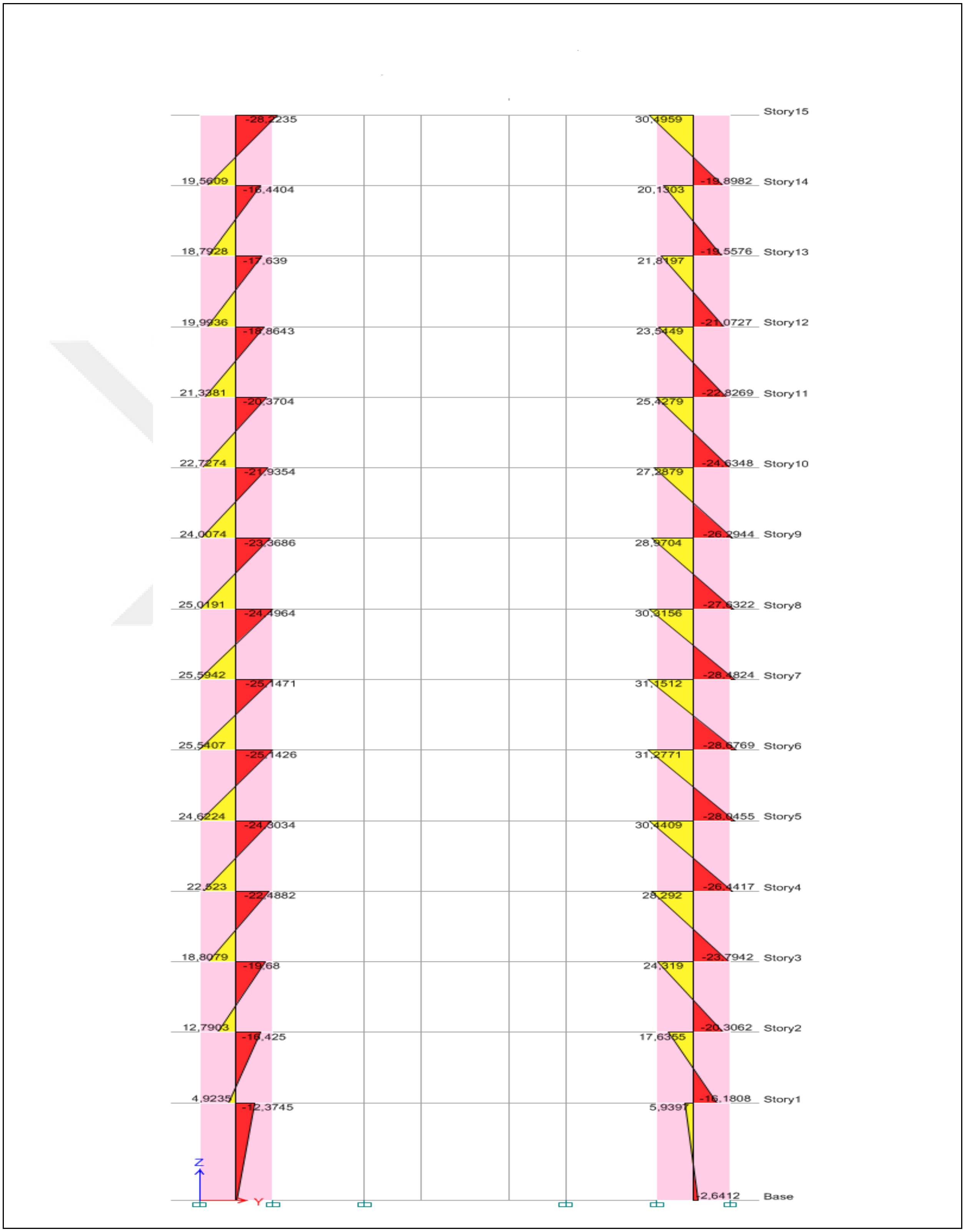

Figure 3.39: Bending Moment Diagram of Shear Wall

Shear force of frame and shear walls:

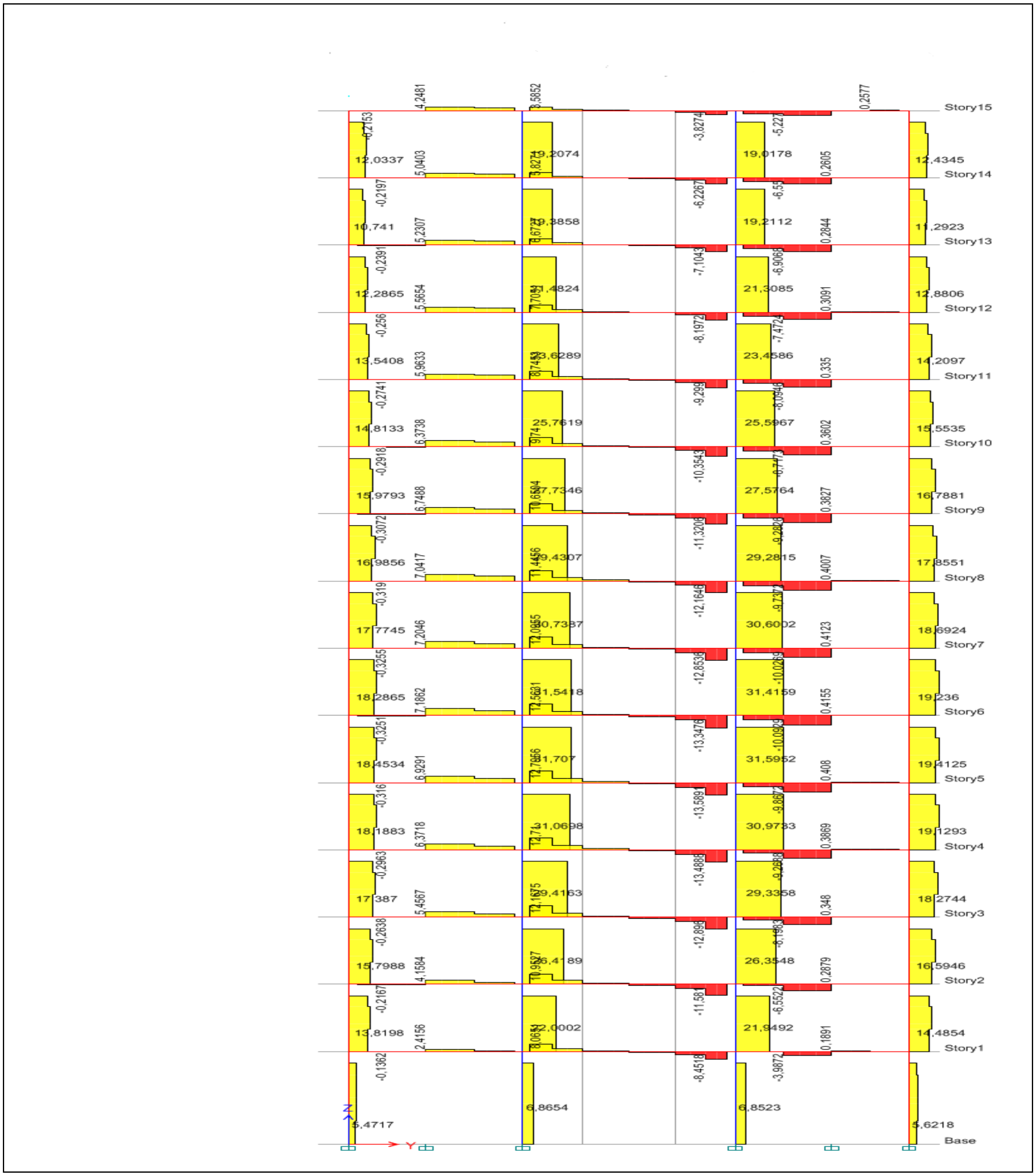

Figure 3.40: Shear Force Diagram of Frame

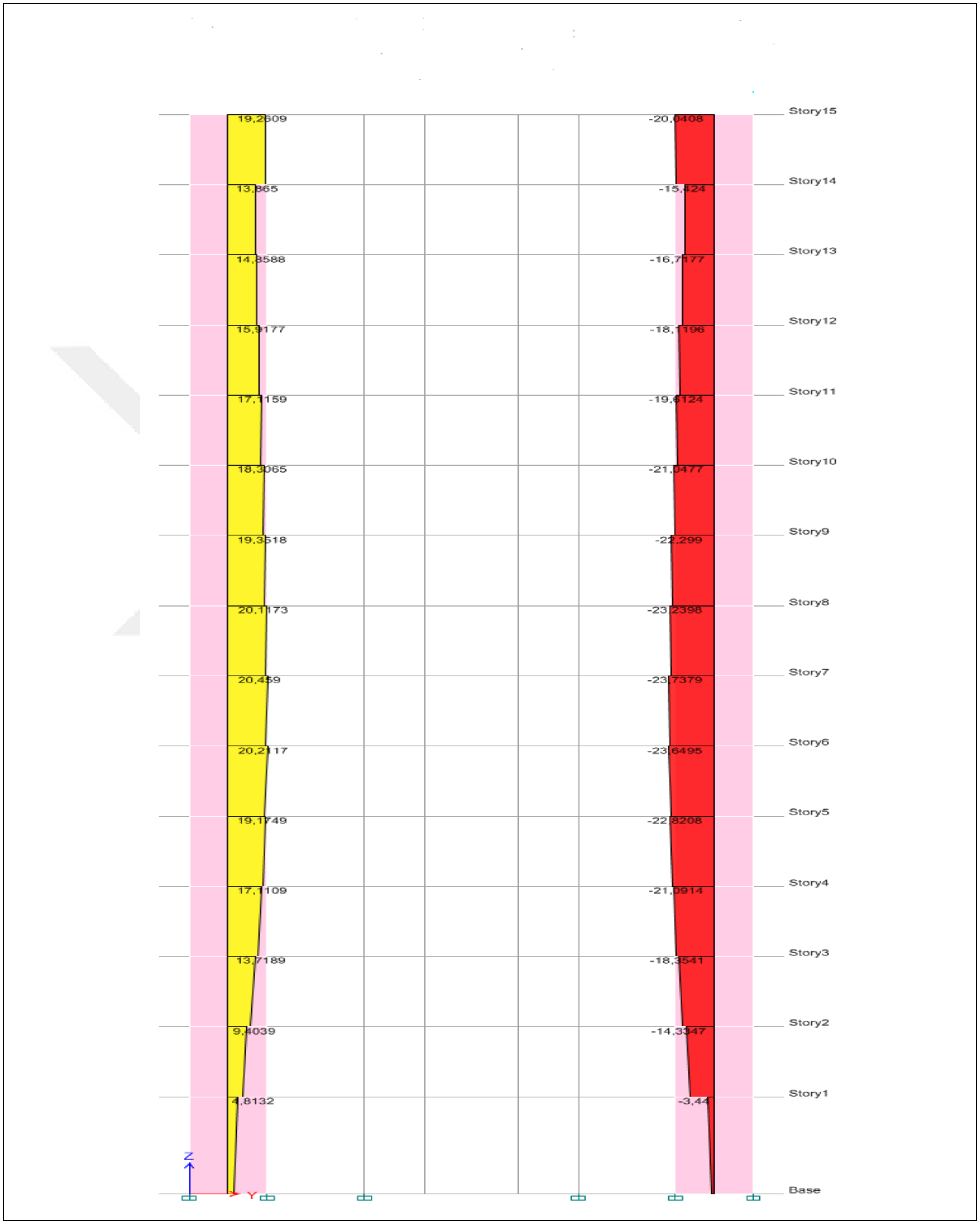

Figure 3.41: Shear Force Diagram of Shear Wall

Center of mass and center of rigidity:

Table 3.77: Center of Mass and Center of Rigidity

Story	Diaphragm	Mass X	Mass Y	XCM	YCM	Cumulative X	Cumulative Y	XCCM	YCCM	XCR	YCR
		kg	kg	m	m	kg	kg	m	m	m	m
Story15	D1	842665,34	842665,34	15,0287	7,2407	842665,34	842665,34	15,0287	7,2407	15,0811	7,3975
Story14	D1	886998,2	886998,2	15,0418	7,235	1729663,54	1729663,54	15,0354	7,2378	15,0741	7,3928
Story13	D1	887268,01	887268,01	15,0457	7,2332	2616931,55	2616931,55	15,0389	7,2362	15,0674	7,3873
Story12	D1	887268,01	887268,01	15,0457	7,2332	3504199,56	3504199,56	15,0406	7,2354	15,0609	7,3819
Story11	D1	887268,01	887268,01	15,0457	7,2332	4391467,57	4391467,57	15,0416	7,235	15,0548	7,3765
Story10	D1	887268,01	887268,01	15,0457	7,2332	5278735,58	5278735,58	15,0423	7,2347	15,0488	7,3713
Story9	D1	887268,01	887268,01	15,0457	7,2332	6166003,59	6166003,59	15,0428	7,2345	15,0429	7,366
Story8	D1	887268,01	887268,01	15,0457	7,2332	7053271,6	7053271,6	15,0432	7,2343	15,037	7,3608
Story7	D1	887268,01	887268,01	15,0457	7,2332	7940539,61	7940539,61	15,0434	7,2342	15,0312	7,3555
Story6	D1	887268,01	887268,01	15,0457	7,2332	8827807,62	8827807,62	15,0437	7,2341	15,0254	7,3496
Story5	D1	887268,01	887268,01	15,0457	7,2332	9715075,63	9715075,63	15,0439	7,234	15,0194	7,3425
Story4	D1	887268,01	887268,01	15,0457	7,2332	10602343,64	10602343,64	15,044	7,2339	15,0134	7,3328
Story3	D1	887268,01	887268,01	15,0457	7,2332	11489611,65	11489611,65	15,0441	7,2339	15,0072	7,3177
Story2	D1	887268,01	887268,01	15,0457	7,2332	12376879,66	12376879,66	15,0442	7,2338	15,0012	7,292
Story1	D1	898380,07	898380,07	15,0488	7,2318	13275259,73	13275259,73	15,0446	7,2337	14,9949	7,25

Ecc: along x: 0.052   alongy: 0.157

Δi, ave= (0.00086+0,000356)/2 =6.08.10^{-4}

ηbi= 1.41≥1.2   There is a torsion irregularity in the bearing system

y direction:

Δi, ave= (0.000747+0.00027)/2=5.085.10^{-4}

ηbi= 1.47≥1.20 There is a torsion irregularity in the bearing system

Story Stiffness:

Checking the irregularity

EX-X

Storey1/ave(storey2+3+4)/3

=0,50

Storey2=0,45

Storey3=0,40

Storey4=0,38

Storey5=0,37

Storey6=0,36 **≤0.80**

Storey7=0,36

Storey8=0,36

Storey9=0,36

Storey10=0,37

Storey11=0,39

Storey12=0,44

EY-Y:

Storey1/ave(storey2+3+4)/3

=0,55

Storey2=0,48

Storey3=0,41

Storey4=0,39

Storey5=0,37

Storey6=0,37 **≤0.80**

Storey7=0,36

Storey8=0,37

Storey9=0,37

Storey10=0,38

Storey11=0,41

Storey12=0,45

Table 3.78: Story Displacement

Story	Load Case	Shear X	Drift X	Stiffness X	Shear Y	Drift Y	Stiffness Y
		kN	mm	kN/m	kN	mm	kN/m
Story15	EX 1	552,1084	1,317	419371,101	1,7179	0,022	0
Story14	EX 1	813,97	1,468	554518,142	1,3859	0,024	0
Story13	EX 1	1057,0835	1,636	646091,873	1,7012	0,026	0
Story12	EX 1	1281,9932	1,811	707738,089	1,9162	0,028	0
Story11	EX 1	1488,6578	1,982	751176,225	2,1616	0,03	0
Story10	EX 1	1677,1315	2,138	784471,189	2,3914	0,032	0
Story9	EX 1	1847,4418	2,272	813068,532	2,5984	0,033	0
Story8	EX 1	1999,6176	2,377	841111,608	2,7688	0,034	0
Story7	EX 1	2133,6899	2,446	872407,089	2,8892	0,034	0
Story6	EX 1	2249,6962	2,468	911487,331	2,944	0,034	0
Story5	EX 1	2347,691	2,436	963677,842	2,9112	0,033	0
Story4	EX 1	2427,7255	2,331	1041438,455	2,7765	0,031	0
Story3	EX 1	2490,0441	2,129	1169682,749	2,4476	0,029	0
Story2	EX 1	2533,9925	1,769	1432502,054	2,1775	0,024	0
Story1	EX 1	2569,6162	1,411	1820848,797	0	0,015	0
Story15	EY 1	1,0025	0,012	0	549,1709	1,324	414764,3
Story14	EY 1	1,0174	0,013	0	811,2587	1,439	563843,723
Story13	EY 1	1,1188	0,013	0	1053,8294	1,568	672041,376
Story12	EY 1	1,2263	0,013	0	1278,2376	1,703	750645,065
Story11	EY 1	1,331	0,013	0	1484,4049	1,832	810368,454
Story10	EY 1	1,4266	0,012	0	1672,4124	1,947	858885,641
Story9	EY 1	1,5064	0,012	0	1842,3024	2,043	901762,591
Story8	EY 1	1,5644	0,011	0	1994,1156	2,114	943463,165
Story7	EY 1	1,5939	0,011	0	2127,8977	2,155	987526,252
Story6	EY 1	1,5873	0,01	0	2243,7063	2,155	1041119,444
Story5	EY 1	1,5347	0,009	0	2341,6402	2,104	1113037,937
Story4	EY 1	1,4223	0,008	0	2421,7796	1,985	1220029,673
Story3	EY 1	1,2276	0,006	0	2484,6313	1,775	1399856,651
Story2	EY 1	0,9701	0,006	0	2528,9892	1,422	1778577,573
Story1	EY 1	0	0,006	0	2569,6162	1,065	2411967,161

Response Spectrum:

Table3.79: Responce spectrum

Name	Period	Acceleration	Damping	Ss	S1	TL	Site Class	Fa	Fv	SDS	SD1
	sec					sec					
responce spectrum	0	0,18096	5	0,348	0,098	6	ZC	1,3	1,5	0,3016	0,098
responce spectrum	0,065	0,4524									
responce spectrum	0,325	0,4524									
responce spectrum	0,6	0,245									
responce spectrum	0,8	0,18375									
responce spectrum	1	0,147									
responce spectrum	1,2	0,1225									
responce spectrum	1,4	0,105									
responce spectrum	1,6	0,091875									
responce spectrum	1,8	0,081667									
responce spectrum	2	0,0735									
responce spectrum	2,5	0,0588									
responce spectrum	3	0,049									
responce spectrum	3,5	0,042									
responce spectrum	4	0,03675									
responce spectrum	4,5	0,032667									
responce spectrum	5	0,0294									
responce spectrum	5,5	0,026727									
responce spectrum	6	0,0245									
responce spectrum	6,5	0,020876									
responce spectrum	7	0,018									
responce spectrum	7,5	0,01568									
responce spectrum	8	0,013781									
responce spectrum	8,5	0,012208									
responce spectrum	9	0,010889									
responce spectrum	9,5	0,009773									
responce spectrum	10	0,00882									

Base Shear:

Table 3.80: Base Shear

Load Pattern	Type	Direction	Eccentricity	Ecc. Overridden	Period Method	Ct (m), x	Top Story	Bottom Story	Period Used	Coeff Used	Weight Used	Base Shear
			%						sec		kN	kN
EX	Seismic	X			Program Calculated	0.10m, 0.75	Story15	Base	1,726	0,018096	141999,1286	2569,6162
EX	Seismic	X + Ecc. Y	5	No	Program Calculated	0.10m, 0.75	Story15	Base	1,726	0,018096	141999,1286	2569,6162
EX	Seismic	X - Ecc. Y	5	No	Program Calculated	0.10m, 0.75	Story15	Base	1,726	0,018096	141999,1286	2569,6162
EY	Seismic	Y			Program Calculated	0.10m, 0.75	Story15	Base	1,726	0,018096	141999,1286	2569,6162
EY	Seismic	Y + Ecc. X	5	No	Program Calculated	0.10m, 0.75	Story15	Base	1,726	0,018096	141999,1286	2569,6162
EY	Seismic	Y - Ecc. X	5	No	Program Calculated	0.10m, 0.75	Story15	Base	1,726	0,018096	141999,1286	2569,6162

Displacement:

Load case: EX

Table 3.81: Displacement

Story	Elevation	Location	X-Dir	Y-Dir
	m		mm	mm
Story15	44,6	Top	30,279	0,805
Story14	41,7	Top	28,947	0,762
Story13	38,8	Top	27,475	0,716
Story12	35,9	Top	25,835	0,666
Story11	33	Top	24,017	0,612
Story10	30,1	Top	22,027	0,555
Story9	27,2	Top	19,878	0,496
Story8	24,3	Top	17,591	0,435
Story7	21,4	Top	15,196	0,373
Story6	18,5	Top	12,728	0,311
Story5	15,6	Top	10,233	0,248
Story4	12,7	Top	7,768	0,187
Story3	9,8	Top	5,405	0,128
Story2	6,9	Top	3,242	0,074
Story1	4	Top	1,422	0,028
Base	0	Top	0	0

Table 3.82: Displacement

Load case: EY

Story	Elevation	Location	X-Dir	Y-Dir
	m		mm	mm
Story15	44,6	Top	0,228	26,846
Story14	41,7	Top	0,205	25,501
Story13	38,8	Top	0,184	24,048
Story12	35,9	Top	0,162	22,466
Story11	33	Top	0,141	20,75
Story10	30,1	Top	0,12	18,906
Story9	27,2	Top	0,101	16,946
Story8	24,3	Top	0,081	14,891
Story7	21,4	Top	0,064	12,764
Story6	18,5	Top	0,047	10,597
Story5	15,6	Top	0,038	8,442
Story4	12,7	Top	0,033	6,338
Story3	9,8	Top	0,027	4,343
Story2	6,9	Top	0,02	2,547
Story1	4	Top	0,012	1,08
Base	0	Top	0	0

Story Drift:

Load case: EX

Table 3.83: Story Drift

Story	Elevation	Location	X-Dir	Y-Dir
	m			
Story15	44,6	Top	0,000459	0,000015
Story14	41,7	Top	0,000508	0,000016
Story13	38,8	Top	0,000566	0,000017
Story12	35,9	Top	0,000627	0,000019
Story11	33	Top	0,000686	0,00002
Story10	30,1	Top	0,000741	0,00002
Story9	27,2	Top	0,000789	0,000021
Story8	24,3	Top	0,000826	0,000021
Story7	21,4	Top	0,000851	0,000022
Story6	18,5	Top	0,00086	0,000021
Story5	15,6	Top	0,00085	0,000021
Story4	12,7	Top	0,000815	0,00002
Story3	9,8	Top	0,000746	0,000019
Story2	6,9	Top	0,000627	0,000016
Story1	4	Top	0,000356	0,000007
Base	0	Top	0	0

Load case: EY

Table 3.84: Story Drift

Story	Elevation	Location	X-Dir	Y-Dir
	m			
Story15	44,6	Top	0,000008	0,000464
Story14	41,7	Top	0,000008	0,000501
Story13	38,8	Top	0,000007	0,000545
Story12	35,9	Top	0,000007	0,000592
Story11	33	Top	0,000007	0,000636
Story10	30,1	Top	0,000007	0,000676
Story9	27,2	Top	0,000007	0,000709
Story8	24,3	Top	0,000006	0,000733
Story7	21,4	Top	0,000006	0,000747
Story6	18,5	Top	0,000005	0,000747
Story5	15,6	Top	0,000004	0,00073
Story4	12,7	Top	0,000003	0,000691
Story3	9,8	Top	0,000002	0,00062
Story2	6,9	Top	0,000003	0,000506
Story1	4	Top	0,000003	0,00027
Base	0	Top	0	0

3.11.5 Building with Shear Wall as (U) Form: (model5)

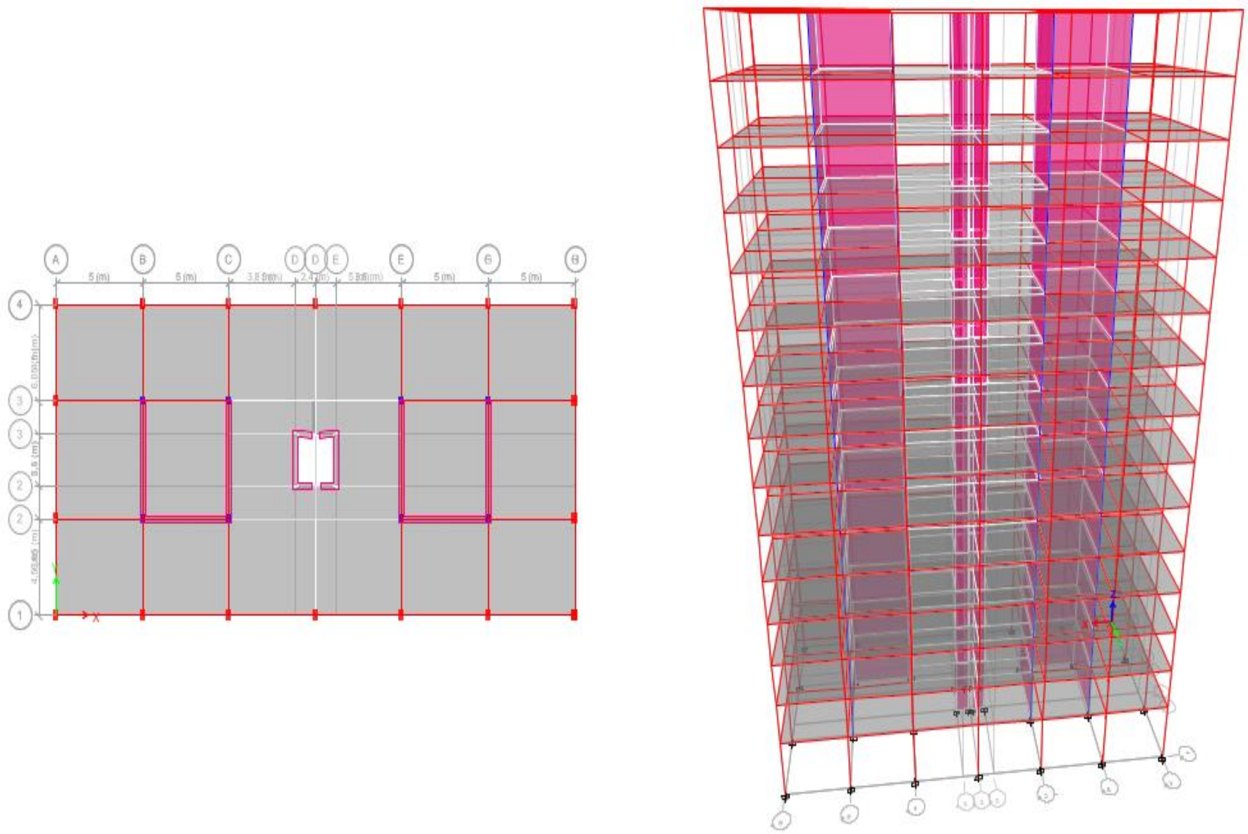

Figure 3.42: Building with Shear Wall Under Form of (U)

- Axis B-B in the x- axis
- Load case: EX

Bending moment of frame and shear walls:

Table 3.85.a: Bending Moment Values of Columns

Stories	Column forces (KN.M)							
	Top				Bottom			
Storey15	-5.2708	-7.4781	-7.0016	-6.542	6.7999	10.1953	9.5326	8.5001
Storey14	-4.4065	-6.8016	-6.4596	-5.6977	6.735	10.528	9.8054	8.5602
Storey13	-4.8804	-7.6237	-7.1268	-6.3363	7.3666	11.7323	10.7558	9.3817
Storey12	-5.2384	-8.3923	-7.7309	-6.8282	7.9522	12.9504	11.7078	10.1669
Storey11	-5.5924	-9.1614	-8.3176	-7.3079	8.5219	14.1536	12.6381	10.9402
Storey10	-5.9038	-9.8715	-8.842	-7.726	9.0303	15.2626	13.4839	11.643
Storey9	-6.1514	-10.4794	-9.2702	-8.0568	9.4432	16.211	14.1915	12.2324
Storey8	-6.3128	-10.9429	-9.568	-8.2732	9.7263	16.9339	14.7087	12.6666
Storey7	-6.3659	-11.2189	-9.7007	-8.3464	9.8458	17.3646	14.9824	12.9032
Storey6	-6.2877	-11.2608	-9.6308	-8.2469	9.7669	17.43	14.9561	12.8968
Storey5	-6.0535	-11.0145	-9.3158	-7.9374	9.4527	17.045	14.567	12.5954
Storey4	-5.6359	-10.4146	-8.7059	-7.3743	8.8658	16.1088	13.7439	11.9403
Storey3	-4.9954	-9.3672	-7.4334	-6.4944	7.9281	14.4439	12.3738	10.8213
Storey2	-4.1243	-7.83	-6.3689	-5.2624	6.8544	12.3424	10.683	9.4624
Storey1	-2.5716	-4.4676	-3.6701	-3.0729	4.3913	6.0481	6.1813	6.3239

Table 3.85.b: Bending Moment Values of Beams

Stories	Beam forces (KN.M)					
Storey15	6.7664	-5.3275	2.6338	-2.4804	-0.4586	-0.3855
Storey14	10.3405	-8.7919	4.7203	-3.7807	0.1447	-0.9555
Storey13	10.4813	-8.9229	5.0182	-4.0959	0.6273	-1.6211
Storey12	11.2195	-9.4956	5.584	-4.5585	1.2098	-2.393
Storey11	11.9212	-10.0525	6.1685	-5.0408	1.858	-3.2451
Storey10	12.5935	-10.5779	6.74	-5.5117	2.5232	-4.1154
Storey9	13.164	-11.0178	7.2594	-5.94	3.1799	-4.9637
Storey8	13.5769	-11.3257	7.6909	-6.2972	3.7968	-5.751
Storey7	13.775	-11.4554	7.9989	-6.5551	4.3437	-6.438
Storey6	13.699	-11.3586	8.1447	-6.6825	4.7864	-6.9803
Storey5	13.2833	-10.983	8.0835	-6.6435	5.0833	-7.3235
Storey4	12.4536	-10.2696	7.7611	-6.3937	5.1817	-7.3987
Storey3	11.1135	-9.1437	7.1051	-5.8741	5.0107	-7.1127
Storey2	9.1983	-7.5721	6.052	-5.0347	4.4943	-6.3581
Storey1	6.1851	-4.9255	4.1706	-3.4524	3.3261	-4.774

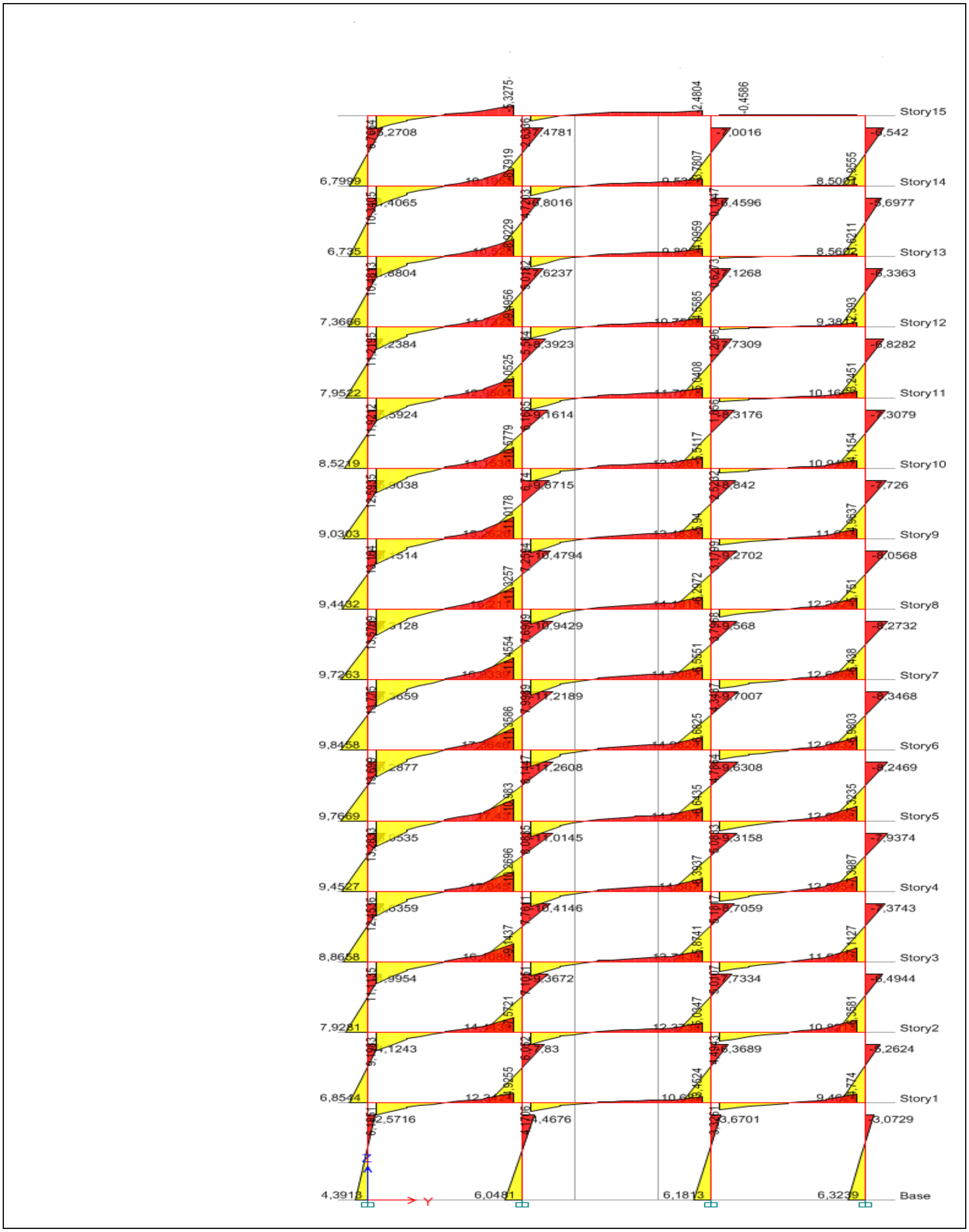

Figure 3.43: Bending Moment Diagram of Frame

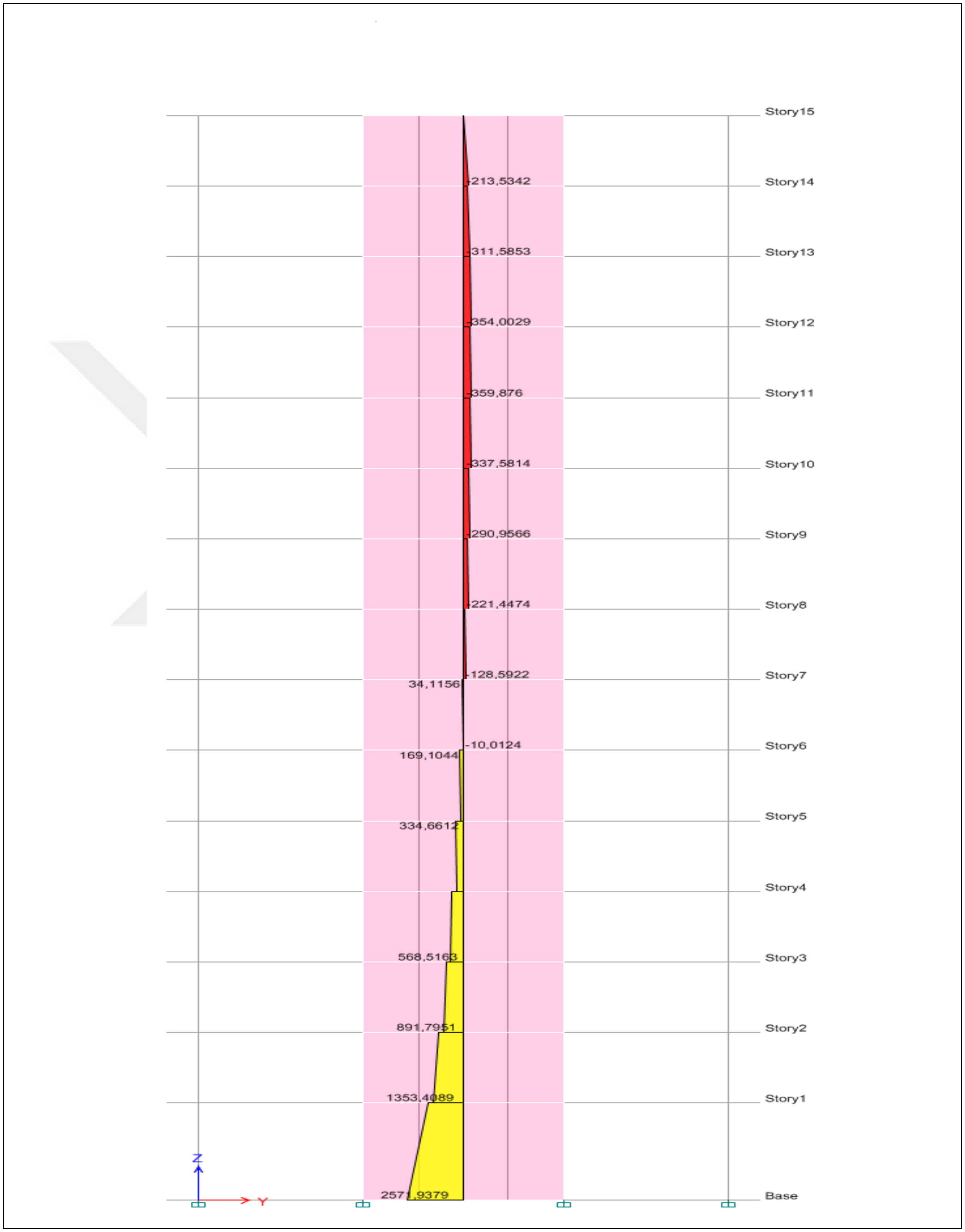

Figure 3.44: Bending Moment Diagram of Shear Wall

Shear force of frame and shear walls:

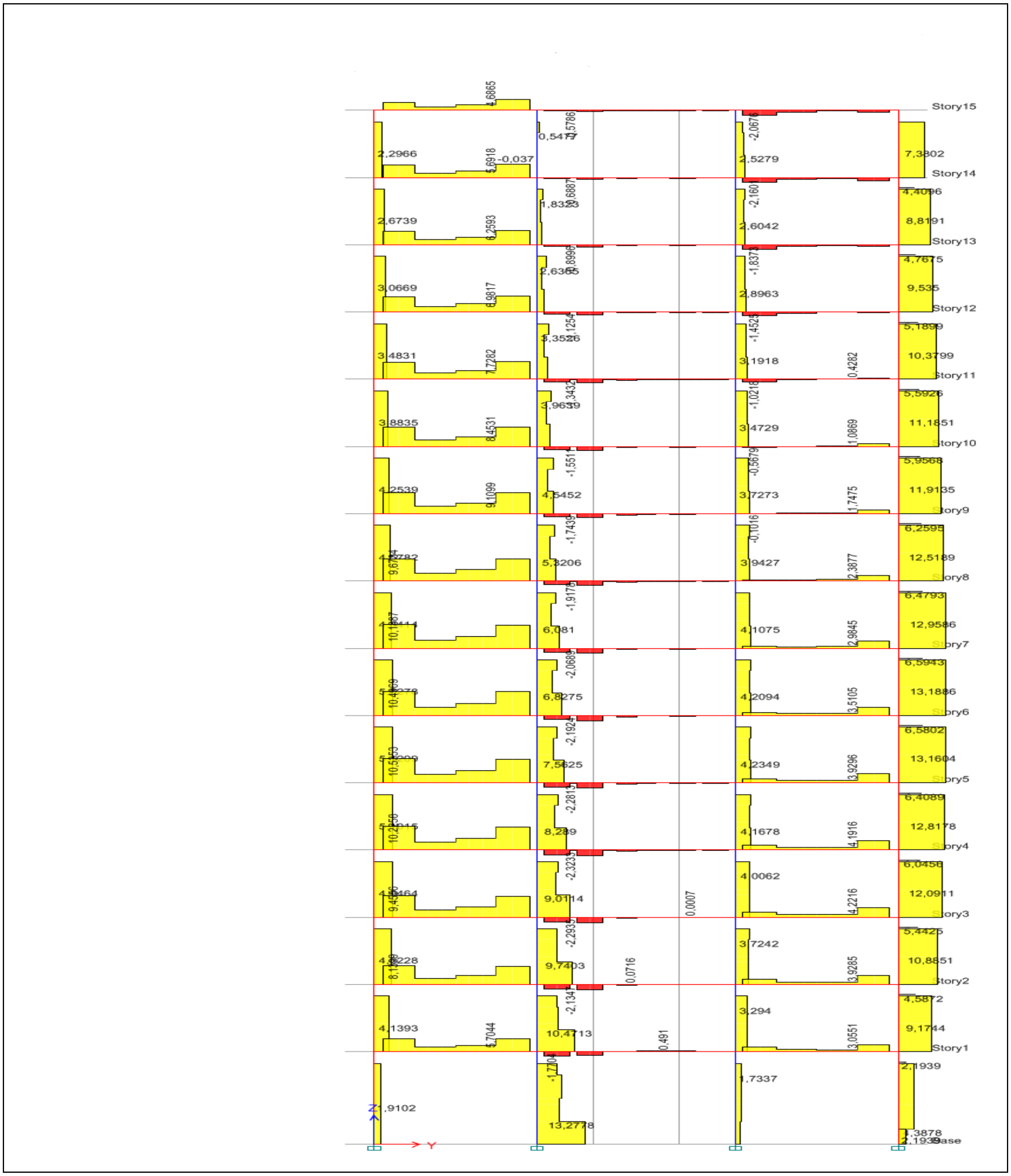

Figure 3.45: Shear Force Diagram of Frame

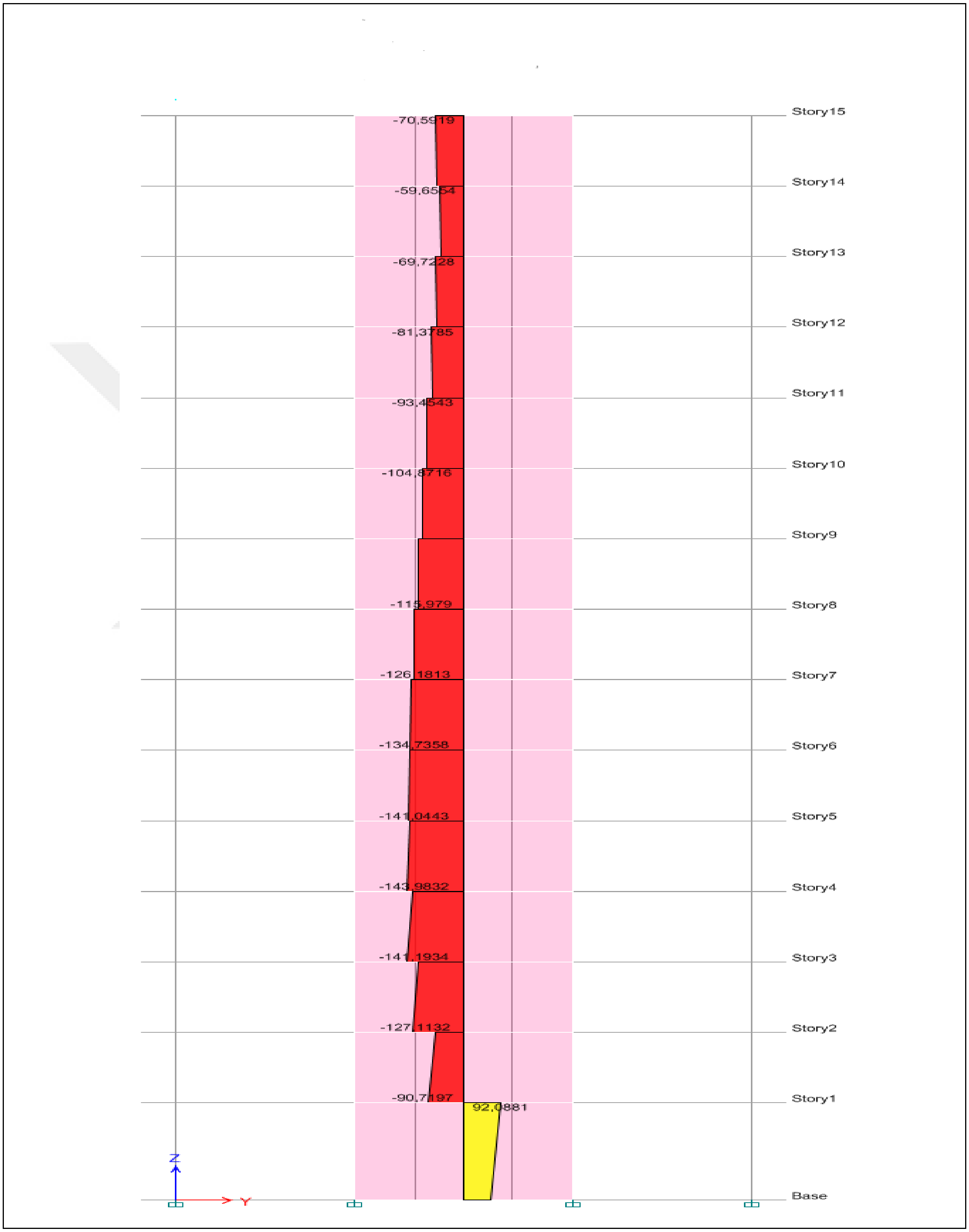

Figure 3.46: Shear Force Diagram of Shear Wall

Center of mass and center of rigidity:

Table 3.86: Center of Mass and Center of Rigidity

Storey	Diaphragm	Mass X	Mass Y	XCM	YCM	Cumulative X	Cumulative Y	XCCM	YCCM	XCR	YCR
		kg	kg	m	m	kg	kg	m	m	m	m
Story15	D1	836852,32	836852,32	14,9938	7,1961	836852,32	836852,32	14,9938	7,1961	15,0142	4,4785
Story14	D1	874223,49	874223,49	15,005	7,1875	1711075,81	1711075,81	14,9996	7,1917	15,0115	4,4356
Story13	D1	874493,3	874493,3	15,0089	7,1857	2585569,12	2585569,12	15,0027	7,1897	15,0085	4,3781
Story12	D1	874493,3	874493,3	15,0089	7,1857	3460062,42	3460062,42	15,0043	7,1887	15,0049	4,3099
Story11	D1	874493,3	874493,3	15,0089	7,1857	4334555,72	4334555,72	15,0052	7,1881	15,0011	4,2352
Story10	D1	874493,3	874493,3	15,0089	7,1857	5209049,02	5209049,02	15,0059	7,1877	14,9972	4,157
Story9	D1	874493,3	874493,3	15,0089	7,1857	6083542,32	6083542,32	15,0063	7,1874	14,9935	4,0778
Story8	D1	874493,3	874493,3	15,0089	7,1857	6958035,62	6958035,62	15,0066	7,1872	14,9904	4,0005
Story7	D1	874493,3	874493,3	15,0089	7,1857	7832528,92	7832528,92	15,0069	7,187	14,988	3,9285
Story6	D1	874493,3	874493,3	15,0089	7,1857	8707022,22	8707022,22	15,0071	7,1869	14,9865	3,8669
Story5	D1	874493,3	874493,3	15,0089	7,1857	9581515,52	9581515,52	15,0073	7,1868	14,9862	3,8242
Story4	D1	874493,3	874493,3	15,0089	7,1857	10456008,83	10456008,83	15,0074	7,1867	14,9872	3,8149
Story3	D1	874493,3	874493,3	15,0089	7,1857	11330502,13	11330502,13	15,0075	7,1866	14,9899	3,8648
Story2	D1	874493,3	874493,3	15,0089	7,1857	12204995,43	12204995,43	15,0076	7,1865	14,9943	4,0178
Story1	D1	885365,31	885365,31	15,0124	7,1847	13090360,73	13090360,73	15,008	7,1864	15,0001	4,319

Ecc: along x: 0.002   alongy: 2.72

Δi, ave= (0.000409+0,000154)/2 =2.82.10^{-4}

ηbi= 1.45≥1.2   There is a torsion irregularity in the bearing system

y direction:

Δi, ave= (0.000455+0.000093)/2=2.74.10^{-4}

ηbi= 1.66≥1.20 There is a torsion irregularity in the bearing system

Story Stiffness:

Checking the irregularity

EX-X

Storey1/ave(storey2+3+4)/3

=0,46

Storey2=0,48

Storey3=0,43

Storey4=0,40

Storey5=0,39

Storey6=0,385 **≤0.80**

Storey7=0,38

Storey8=0,38

Storey9=0,39

Storey10=0,40

Storey11=0,43

Storey12= 0,48

EY-Y

Storey1/ave(storey2+3+4)/3

=0,64

Storey2=0,56

Storey3=0,48

Storey4=0,45

Storey5=0,43

Storey6=0,42 **≤0.80**

Storey7=0,41

Storey8=0,41

Storey9=0,42

Storey10=0,45

Storey11=0,47

Storey12=0,52

Table 3.87: Story Stiffness

Story	Load Case	Shear X	Drift X	Stiffness X	Shear Y	Drift Y	Stiffness Y
		kN	mm	kN/m	kN	mm	kN/m
Story15	EX	614,2426	0,698	880516,6	6,3471	0,189	0
Story14	EX	907,9177	0,745	1217976,763	4,8574	0,2	0
Story13	EX	1180,3884	0,788	1498811,844	5,4719	0,212	0
Story12	EX	1432,6096	0,83	1726333,697	5,6973	0,226	0
Story11	EX	1664,4324	0,868	1917442,881	5,9897	0,239	0
Story10	EX	1875,9032	0,899	2085879,418	6,2259	0,251	0
Story9	EX	2067,0345	0,921	2244138,855	6,4013	0,261	0
Story8	EX	2237,844	0,931	2403907,827	6,4882	0,267	0
Story7	EX	2388,3481	0,926	2578551,801	6,4637	0,269	0
Story6	EX	2518,5636	0,904	2785018,247	6,3029	0,264	0
Story5	EX	2628,5089	0,862	3048676,511	5,9755	0,254	0
Story4	EX	2718,1975	0,796	3414694,85	5,4609	0,234	0
Story3	EX	2787,6876	0,702	3971855,598	4,6618	0,204	0
Story2	EX	2836,7944	0,568	4998255,748	3,8362	0,16	0
Story1	EX	2870,432	0,504	5698541,25	0	0,118	0
Story15	EY	4,6927	0,012	0	586,2012	1,263	464039,835
Story14	EY	3,8344	0,012	0	870,8917	1,283	678771,654
Story13	EY	3,9607	0,011	0	1132,8757	1,3	871495,751
Story12	EY	3,8924	0,011	0	1375,8435	1,313	1048200,878
Story11	EY	3,8261	0,01	0	1599,0849	1,317	1213881,356
Story10	EY	3,722	0,009	0	1802,7758	1,31	1375685,878
Story9	EY	3,5793	0,008	0	1986,9134	1,29	1540480,274
Story8	EY	3,3911	0,007	0	2151,5296	1,253	1717097,708
Story7	EY	3,1524	0,006	0	2296,649	1,198	1917846,051
Story6	EY	2,8586	0,005	0	2422,2974	1,12	2162347,237
Story5	EY	2,5061	0,004	0	2528,5052	1,018	2482829,763
Story4	EY	2,0951	0,003	0	2615,2859	0,889	2941887,356
Story3	EY	1,6115	0,002	0	2682,7526	0,729	3678103,25
Story2	EY	1,1408	0,002	0	2730,5291	0,532	5134281,121
Story1	EY	0,000002939	0,001	0	2764,2019	0,37	7464963,234

Response Spectrum:

Table 3.88: Responce Spectrum

Name	Period	Acceleration	Damping	Ss	S1	TL	Site Class	Fa	Fv	SDS	SD1
	sec					sec					
responce spectrum	0	0,18096	5	0,348	0,098	6	ZC	1,3	1,5	0,3016	0,098
responce spectrum	0,065	0,4524									
responce spectrum	0,325	0,4524									
responce spectrum	0,6	0,245									
responce spectrum	0,8	0,18375									
responce spectrum	1	0,147									
responce spectrum	1,2	0,1225									
responce spectrum	1,4	0,105									
responce spectrum	1,6	0,091875									
responce spectrum	1,8	0,081667									
responce spectrum	2	0,0735									
responce spectrum	2,5	0,0588									
responce spectrum	3	0,049									
responce spectrum	3,5	0,042									
responce spectrum	4	0,03675									
responce spectrum	4,5	0,032667									
responce spectrum	5	0,0294									
responce spectrum	5,5	0,026727									
responce spectrum	6	0,0245									
responce spectrum	6,5	0,020876									
responce spectrum	7	0,018									
responce spectrum	7,5	0,01568									
responce spectrum	8	0,013781									
responce spectrum	8,5	0,012208									
responce spectrum	9	0,010889									
responce spectrum	9,5	0,009773									
responce spectrum	10	0,00882									

Base Shear:

Table 3.89: Base *Shear*

Load Pattern	Type	Direction	Eccentricity	Ecc. Overridden	Period Method	Ct (m), x	Top Story	Bottom Story	Period Used	Coeff Used	Weight Used	Base Shear
			%						sec		kN	kN
EX	Seismic	X			Program Calculated	0.10m, 0.75	Story15	Base	0,978	0,018791	152752,097	2870,4324
EX	Seismic	X + Ecc. Y	5	No	Program Calculated	0.10m, 0.75	Story15	Base	0,978	0,018791	152752,097	2870,4324
EX	Seismic	X - Ecc. Y	5	No	Program Calculated	0.10m, 0.75	Story15	Base	0,978	0,018791	152752,097	2870,4324
EY	Seismic	Y			Program Calculated	0.10m, 0.75	Story15	Base	1,297	0,018096	152752,097	2764,2019
EY	Seismic	Y + Ecc. X	5	No	Program Calculated	0.10m, 0.75	Story15	Base	1,297	0,018096	152752,097	2764,2019
EY	Seismic	Y - Ecc. X	5	No	Program Calculated	0.10m, 0.75	Story15	Base	1,297	0,018096	152752,097	2764,2019

Displacement:

Load case: EX

Table 3.90: Displacement

Story	Elevation	Location	X-Dir	Y-Dir
	m		mm	mm
Story15	44,6	Top	15,125	6,67
Story14	41,7	Top	14,252	6,297
Story13	38,8	Top	13,324	5,901
Story12	35,9	Top	12,341	5,479
Story11	33	Top	11,301	5,03
Story10	30,1	Top	10,209	4,553
Story9	27,2	Top	9,074	4,052
Story8	24,3	Top	7,906	3,531
Story7	21,4	Top	6,721	2,998
Story6	18,5	Top	5,538	2,461
Story5	15,6	Top	4,38	1,933
Story4	12,7	Top	3,272	1,426
Story3	9,8	Top	2,249	0,959
Story2	6,9	Top	1,347	0,553
Story1	4	Top	0,616	0,234
Base	0	Top	0	0

Table 3.91: Displacement

Load case: EY

Story	Elevation	Location	X-Dir	Y-Dir
	m		mm	mm
Story15	44,6	Top	0,113	16,262
Story14	41,7	Top	0,099	14,994
Story13	38,8	Top	0,088	13,711
Story12	35,9	Top	0,078	12,415
Story11	33	Top	0,069	11,105
Story10	30,1	Top	0,06	9,789
Story9	27,2	Top	0,051	8,479
Story8	24,3	Top	0,042	7,187
Story7	21,4	Top	0,034	5,93
Story6	18,5	Top	0,026	4,726
Story5	15,6	Top	0,019	3,598
Story4	12,7	Top	0,013	2,57
Story3	9,8	Top	0,008	1,668
Story2	6,9	Top	0,005	0,924
Story1	4	Top	0,006	0,372
Base	0	Top	0	0

Story Drift:

Load case: EX

Table 3.92: Story Drift

Storey	Elevation	Location	X-Dir	Y-Dir
	m			
Story15	44,6	Top	0,000301	0,000129
Story14	41,7	Top	0,00032	0,000136
Story13	38,8	Top	0,000339	0,000145
Story12	35,9	Top	0,000358	0,000155
Story11	33	Top	0,000376	0,000164
Story10	30,1	Top	0,000392	0,000173
Story9	27,2	Top	0,000403	0,00018
Story8	24,3	Top	0,000409	0,000184
Story7	21,4	Top	0,000408	0,000185
Story6	18,5	Top	0,000399	0,000182
Story5	15,6	Top	0,000382	0,000175
Story4	12,7	Top	0,000353	0,000161
Story3	9,8	Top	0,000311	0,00014
Story2	6,9	Top	0,000252	0,00011
Story1	4	Top	0,000154	0,000059
Base	0	Top	0	0

Load case: EY

Table 3.93: Story Drift

Story	Elevation	Location	X-Dir	Y-Dir
	m			
Story15	44,6	Top	0,000005	0,000437
Story14	41,7	Top	0,000005	0,000444
Story13	38,8	Top	0,000004	0,000449
Story12	35,9	Top	0,000004	0,000454
Story11	33	Top	0,000004	0,000455
Story10	30,1	Top	0,000004	0,000453
Story9	27,2	Top	0,000003	0,000446
Story8	24,3	Top	0,000003	0,000433
Story7	21,4	Top	0,000003	0,000415
Story6	18,5	Top	0,000002	0,000389
Story5	15,6	Top	0,000002	0,000355
Story4	12,7	Top	0,000002	0,000311
Story3	9,8	Top	0,000001	0,000257
Story2	6,9	Top	0,000001	0,00019
Story1	4	Top	4,299E-07	0,000093
Base	0	Top	0	0

3.11.6 GENERAL RESULT

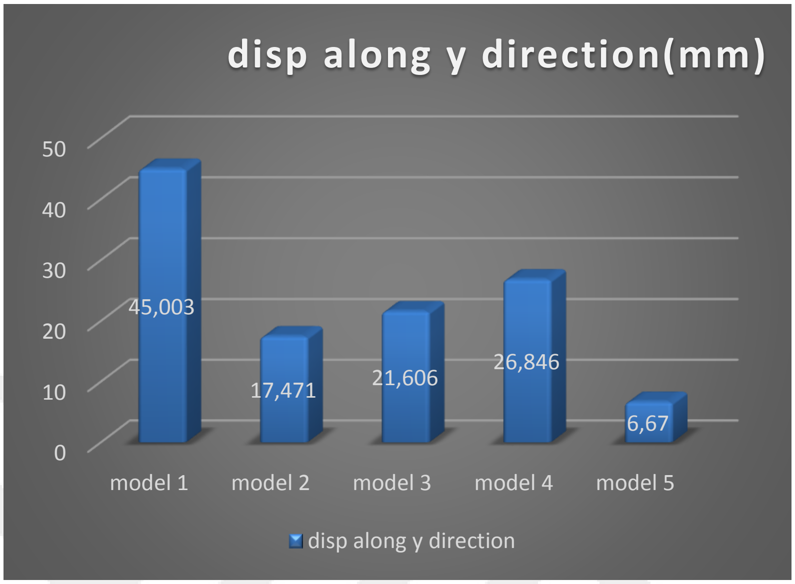

Figure 3.11.6 a: Diagram Bar of Displacement

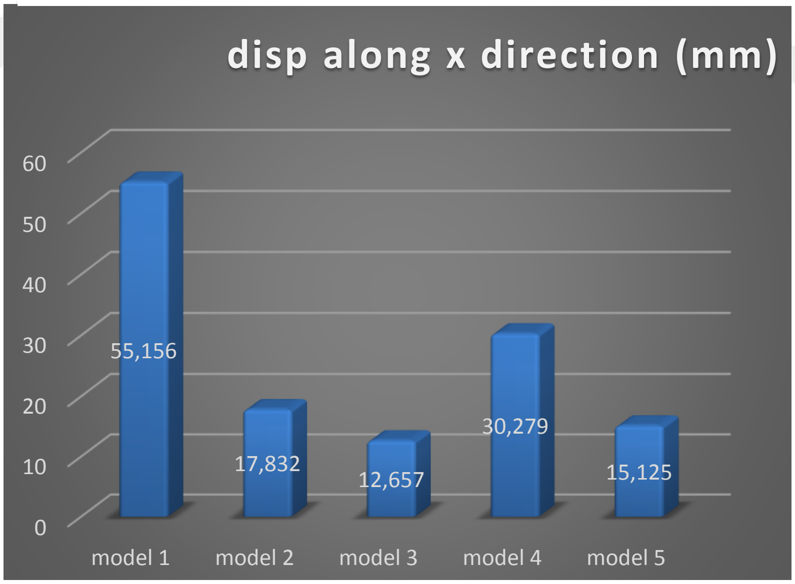

Figure 3.11.6 b: Diagram Bar of Displacement

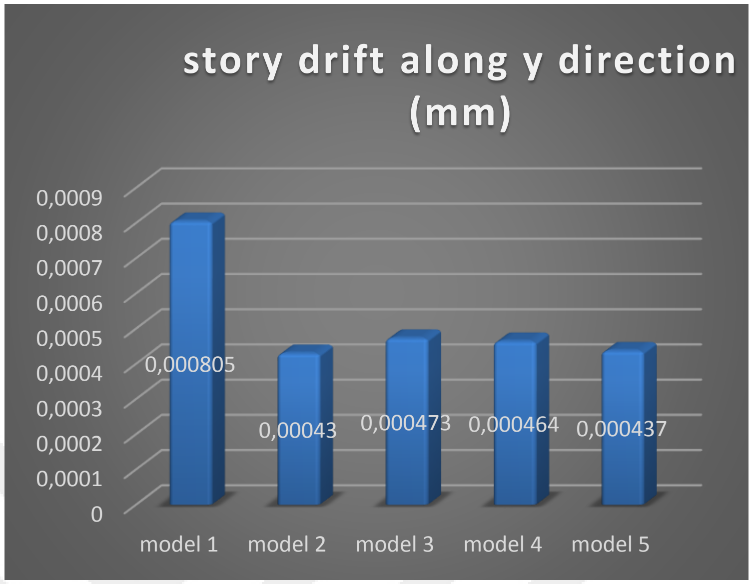

Figure 3.11.6 c: Diagram Bar of Story Drift

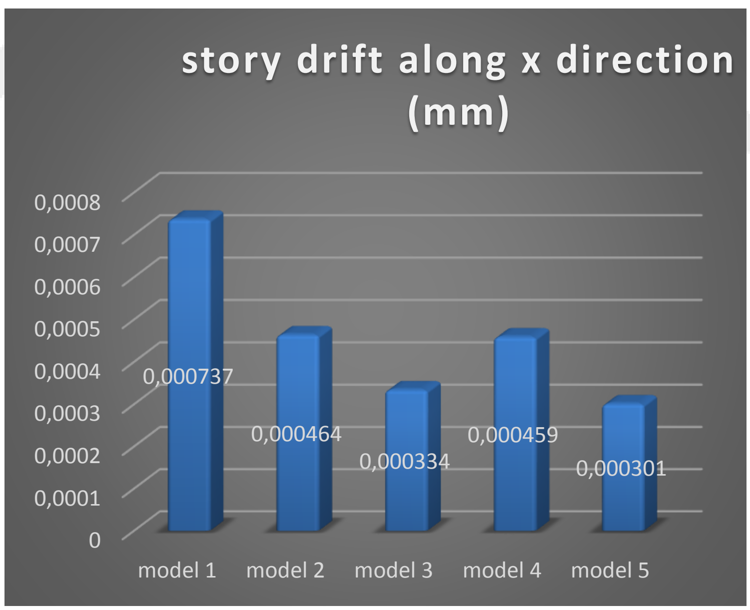

Figure 3.11.6 d: Diagram Bar of Story Drift

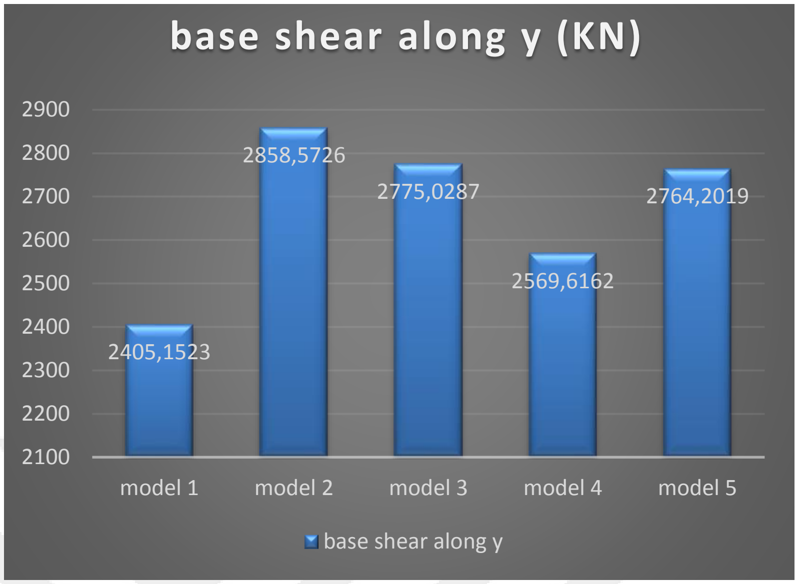

Figure 3.11.6 e: Diagram Bar of Base Shear

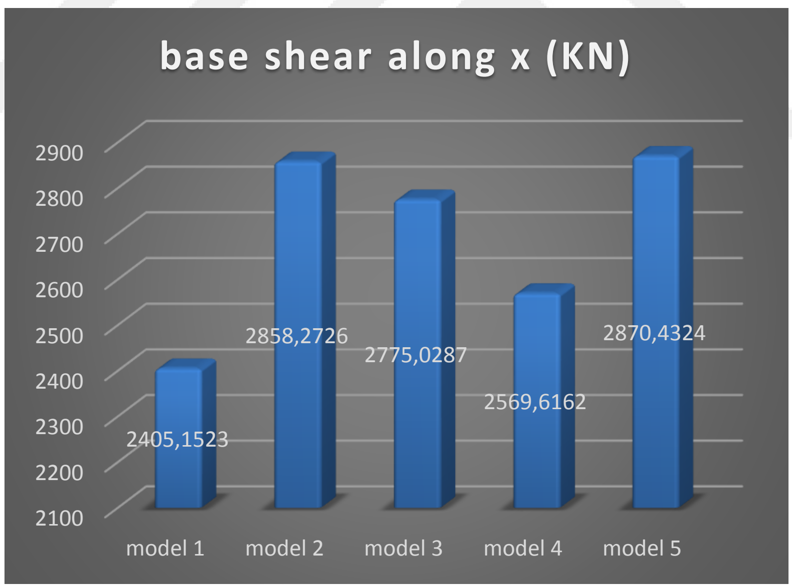

Figure 3.11.6 f: Diagram Bar of Base Shear

3.12 DISCUSSION THE RESULTS

i. The impact of earthquake for the whole models was noticed that bending moment of the vertical frame is more in the bottom level for each story as compared as with the top-level whereas it has been different for beams in such level of each story for all models either with or without shear walls however the values of bending moment of the frame are reduced in the addition of shear walls.

ii. For the shear force of columns, it was observed that each model has had its values. from 2 to 13 stories for all models the shear force of columns value was more in the middle to each storey than in the stories 1, 14 and 15. on the contrary when the addition of SW . the shear force value of columns has changed as it's became more in the column's sides of building. the same for shear force values of beams were oscillatory in each storey for all models.

iii. Basically, in the symmetrical building the eccentricity is as non-existed hence no twisting will be occurred, however by considering the ± 5% additional eccentricity effects. The building has been twisted with noting that there is torsion irregularity in the bearing system.

iv. Also, the maximum displacement value along x axis observed without shear walls was 55.2mm while with shear walls was 17.8mm in model 2 that's mean the reduction up to 68% and 12.7mm (70%), 30.3mm (45%) and 15.1mm (73%) for the rest models respectively

v. In the y axis the maximum displacement value was noted without shear walls 45mm without shear walls whilst it was 17.5mm with shear wall in model 2 i.e. 61% of reducing and 21.6mm (52%) , 26.8mm (40%) and 6.7mm (85%) for the others models respectively.

vi. Storey drift value noted in the axis (x) 0.0007mm at the top without shear walls while it's got to 0.0005mm at the top with shear walls in model 2 that s means a reduction up to 37% and 0.0003mm (55%), 0.0005mm(38%) and 0.0003mm (59%) respectively for the rest models

vii. The same observations were noted in y axis the storey drift at the top value was 0.0008mm without shear walls, and 0.0004mm with shear wall equivalent to

47%,0.0005mm (42%), 0.0005mm (42%) and 0.0004 (46%) of reductions in the models (2,3,4,5) respectively.

viii. We got the base shear values from the whole models 1 to 5. They're compared with each other. So, it's can be said that the base shear of building without shear walls is high. With the addition of shear walls, I noted that the base shear of building increased it was without SW 2405.2KN and with SW it's became 2858.3KN in model 2 that's means it's increase up to 16% and 2775KN (13.32%), 2569.6KN (6.40%)and 2870.4KN (16.21%) for the others models respectively in the X direction.

ix. The same results in the Y direction, but in the model 5 the increase was 13%

x. For the period used, without SW was 1.726sec along x axis after the addition of SW the period has decreased up tp 1.364, 1.147and 0.978sec for model 2 ,3 and 5 respectively while it was the same value for model 4.

xi. Along y axis, the period used without SW was 1.726sec after the addition of shear wall it's became 1.359sec, 1.529sec and1.297sec however I noticed the same value in the model 4.

4. CONCLUSIONS

i. first of all, after the analysis result that I got from ETABS it’s shown that the addition of shear walls gave the building an increment of resistance and make it stiffer than without shear walls

ii. in two cases after extract the cm and cr values, it has been specified an inherent irregularity torsional by considering ± 5% of eccentricity effect because there will not happen a torsion in a symmetrical building because in the symmetrical building the CM and CR are coincide in the middle of structure so that’s lead to the absence of eccentricity therefor no torsion.

iii. Poor designed of shear walls produces decreasing in efficiency of building.

iv. The provision of shear walls effects the seismic performance regarding the changes of strength and lateral displacement that occur.

v. By comparing between the entire five models, it’s found that the displacement with shear walls is less than without shear walls, as after the addition of shear walls the displacement value reduces up 75% in x-direction and to 61% in direction Y-axis for case 1 and 68% along x With 61. % along y in case 2

vi. The same thing happens for storey drift, when I added the shear walls the storey drift value reduces by 76% along the x-axis and 61% along the y-axis for 1st case and 37% in the x direction and 46% in 2nd case.

vii. The base shear in the building with shear walls is higher than without shear walls because the base shear is directly proportional with self-weight of building which means when we add the shear walls the self-weight of building increases lead that to increasing to base shear value as we noted in the analysis the addition of shear wall it increased the value of base shear by 58% in the x-axis and 50% in the y-axis in the case 1 and by 16% in the 2nd case

viii. These studies reveal that changing the position of shear walls influences base shear, displacement, and storey drift values.

ix. Period time and base shear have a reverse relation, the higher the base shear value , the less the period time of building.

x. Therefore, we conclude that the most appropriate of shear walls location is in model 2 mean in the corners of the building even 3rd model is acceptable.

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APPENDIX

The contents of this project were about demonstration of the effect of shear walls in high rise building under seismic load. For that, there were two case in this study which are tall building with 15 stories and building of 5 stories and such case had its special data regarding to the bending moment shear force and other items.

CASE1 (G+5):

Model 1: Building without shear walls

Bending moment values:

Table 1: Bending Moment Values of Columns

stories	Vertical frame moment (column) (KN.M)							
	Top				Bottom			
Story 5	-3.72	-4	-3.90	-3.42	4.63	5.26	5.14	4.30
Story 4	-4.05	-4.49	-4.29	-3.57	5.73	6.53	6.26	5.15
Story3	-4.82	-5.32	-5.01	-4.14	6.95	7.85	7.40	6.04
Story 2	-5.39	-5.98	-5.59	-4.68	8.43	9.37	8.75	7.14
Story1	-4.32	-4.74	-4.52	-3.89	7.91	7.97	7.61	7.03

Table 2: Bending Moment Values of Beams

stories	Horizontal frame moment (beam) (KN.M)					
Story 5	-0.52	0.15	-0.68	0.27	-0.51	0.22
Story 4	-1.15	0.42	-1.30	0.52	-1.15	0.57
Story 3	-1.8	0.76	-1.78	0.73	-1.72	1.11
Story 2	-2.44	1.20	-2.24	1	-2.26	1.63
Story 1	-2.33	1.1	-1.97	0.86	-2.08	1.52

Shear force values:

Table 3: Shear Force Values of Columns

stories	Vertical frame shear force (column) (KN.M)			
Story 5	3.48	3.86	3.77	3.22
Story 4	4.07	4.59	4.40	3.63
Story 3	4.90	5.49	5.17	4.24
Story 2	5.76	6.39	5.97	4.89
Story 1	3.50	3.63	3.47	3.12

Table 4: Shear Force Values of Beams

stories	Horizontal frame (beam) (KN.M)					
Story 5	-0.46	0.16	-0.64	0.17	-0.57	0.02
Story 4	-0.97	0.13	-1.23	0.21	-1.17	
Story 3	-1.44	-1.62	0.06	-1.61		
Story 2	-1.89	-1.99	-2.04			
Story 1	-1.80	-1.79	-1.88			

Displacement:

Load case: EX

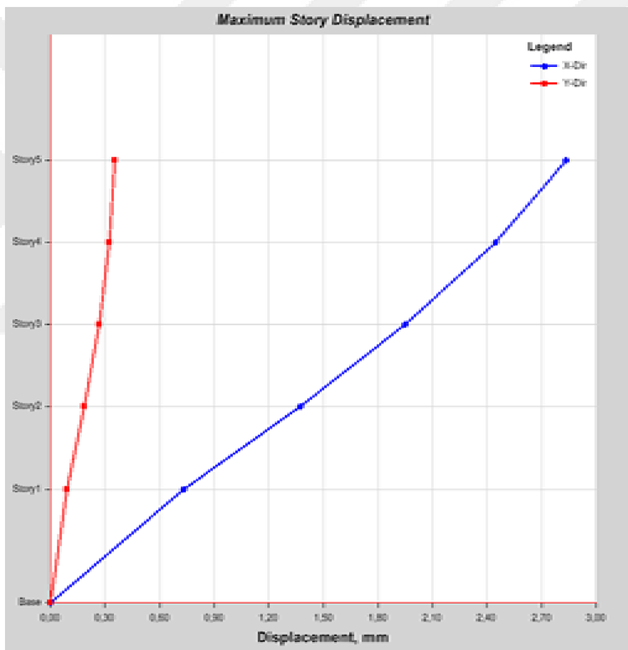

Figure 1: Diagram of displacement

Load case: EY

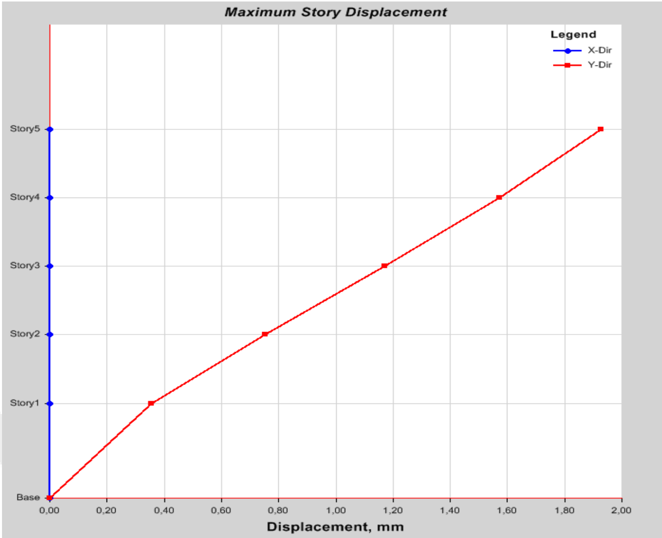

Figure 2: Diagram of Displacement

Story Drift:

Load case: EX

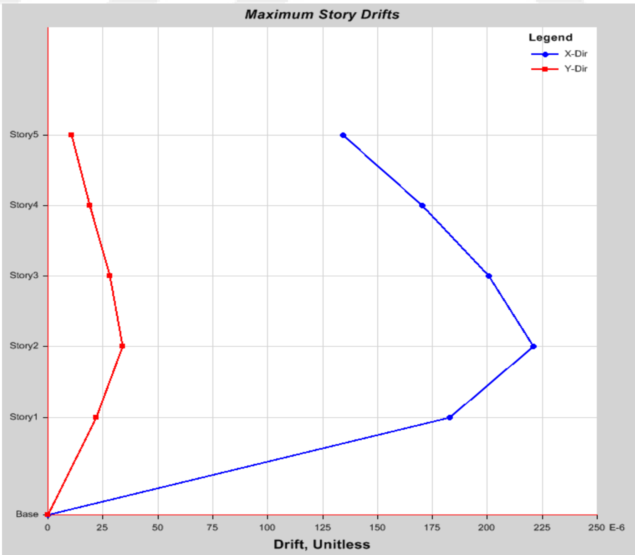

Figure 3: Diagram of Story Drift

Load case: EY

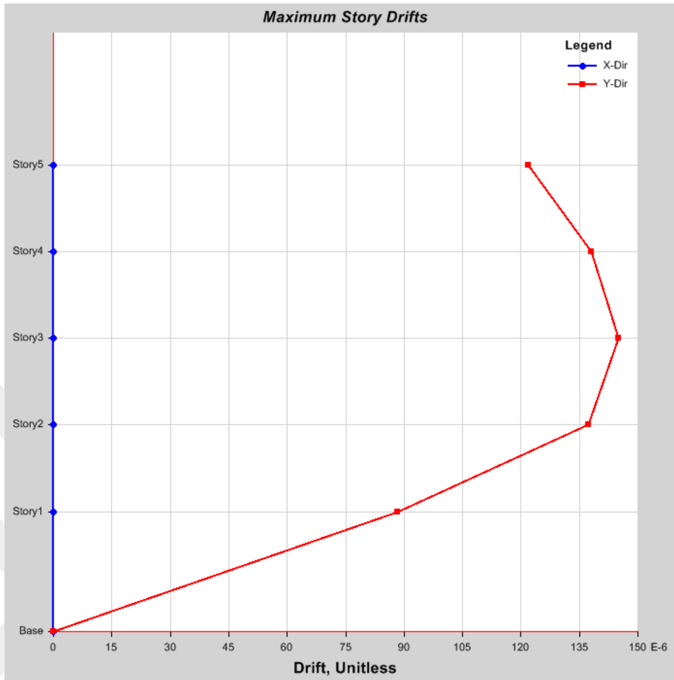

Figure 4: Diagram of Story Drift

Model2: Building with shear walls in the corners

Bending moment values:

Table 5: Bending Moment Values of Columns

stories	vertical frame values (KN.M)							
	top				bottom			
story 5	-0.28	-0.35	-0.36	-0.27	0.34	0.64	0.66	0.33
story 4	-0.54	-0.30	-0.31	-0.54	0.77	0.69	0.70	0.76
story 3	-0.73	-0.35	-0.36	-0.72	1.14	0.79	0.80	1.13
story 2	-0.90	-0.35	-0.36	-0.90	1.53	0.90	0.91	1.52
story 1	-0.1	-0.23	-0.24	-0.1	2.27	1.06	1.06	2.27

Table 6: Bending Moment Values of Beams

stories	horizontal frame values (KN.M)					
story 5	-0.22	0.14	-0.07	0.10	0.14	-0.21
story 4	-0.24	0.25	-0.11	0.13	0.24	-0.23
story 3	-0.32	0.36	-0.1	0.14	0.36	-0.31
story 2	-0.37	0.46	-0.08	0.15	0.45	-0.36
story 1	-0.29	0.5	-0.05	0.14	0.45	-0.28

Table 7: Bending Moment Values of Shear Walls

stories	Shear walls values (KN.M)			
	Top		Bottom	
Story 5	12.34	-11.65	-40.32	39.18
Story 4	2.32	-2.18	-54.18	51.78
Story 3	11.72	-12.58	-55.64	51.63
Story 2	29.82	-32.16	-33.12	27.18
Story 1	63	-67.44	90.59	-96.84

Shear force values:

Table 8: Shear Force Values of Columns

stories	Vertical frame values (columns) (KN.M)							
	Top				Bottom			
Story 5	0.67	0.02	0.01	0.65	0.63	0.67	0.68	0.62
Story 4	1.38	0.24	0.33	1.36	1.96	0.58	0.59	1.94
Story 3	1.97	0.23	0.24	1.94	2.5	0.59	0.6	2.47
Story 2	2.49	0.35	0.47	2.47	2.51	0.57	0.58	2.5
Story 1	2.63	0.25	0.30	2.62	3.26	0.4	0.4	3.26

Table 9: Shear Force Values of Beams

stories	Horizontal frame values (beam) (KN.M)			
Story 5	-0.26	-0.13	0.08	0.26
Story 4	-0.35	-0.20	0.15	0.34
Story 3	-0.53	-0.21	0.17	0.52
Story 2	-0.67	-0.22	0.18	0.66
Story 1	-0.69	-0.19	0.16	0.69

Table 10: Shear Force Values of Shear Walls

stories	shear walls values (KN.M)	
Story 5	-38.08	36.73
Story 4	-55.20	53.49
Story 3	-72.10	70.12
Story 2	-79.72	77.65
Story 1	-52.10	51.23

Displacement:

Load case: EX

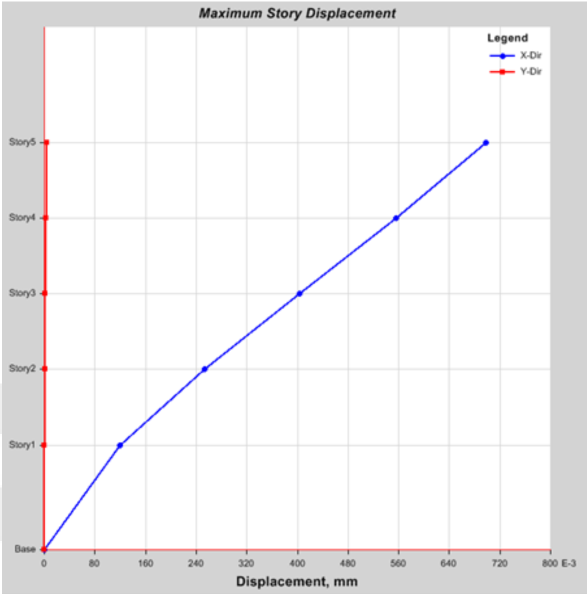

Figure 5: Diagram of displacement

Load case: EY

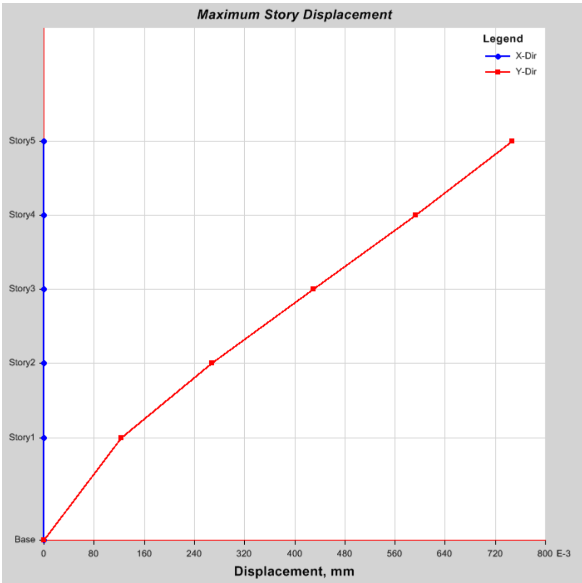

Figure 6: Diagram of Displacement

Story Drift:

Load case: EX

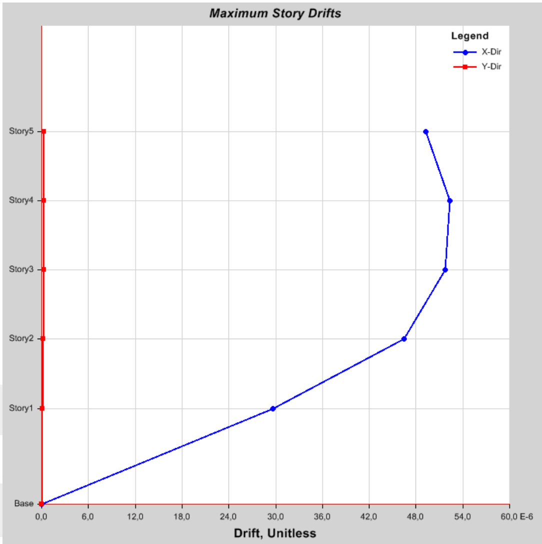

Figure 7: Diagram of Story Drift

Load case: EY

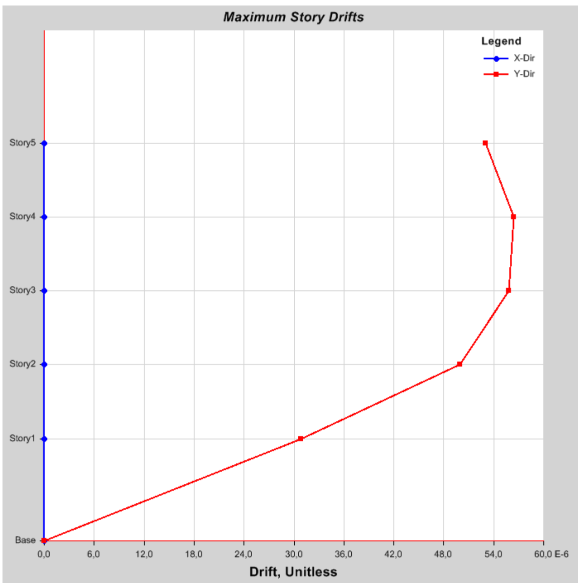

Figure 8: Diagram of Story Drift

Model3: Shear walls along the perimeter of building

Bending moment value:

Table 11: Bending Moment Value of Columns

STORIES	VERTICAL FRAME VALUES (KN.M)							
	Top				Bottom			
STOREY 5	-0.86	-0.61	-0.60	-0.68	1.16	0.87	0.86	1.15
STOREY 4	-0.80	-0.34	-0.33	-0.79	1.20	0.76	0.74	1.19
STOREY 3	-0.80	-0.40	-0.39	-0.79	1.23	0.78	0.77	1.21
STOREY 2	-0.73	-0.35	-0.35	-0.72	1.20	0.76	0.75	1.19
STOREY 1	-0.48	-0.25	-0.24	-0.48	0.98	0.92	0.92	0.98

Table 12: Bending Moment Values of Beams

Stories	Horizontal frame values (KN.M)					
Storey 5	-0.12	0.09	0.007	-0.01	-0.1	0.07
Storey 4	-0.19	0.15	-0.01	0.01	-0.15	0.1
Storey 3	-0.17	0.14	-0.01	0.01	-0.15	0.09
Storey 2	-0.16	0.13	-0.01	0.01	-0.14	0.09
Storey 1	-0.12	0.11	-0.01	0.01	-0.12	0.08

Table 13: Bending moment values of shear walls

stories	Shear walls values (KN.M)
Storey 5	-0.55
Storey 4	-1.67
Storey 3	-3.29
Storey 2	-5.29
Storey 1	-6.47

Shear force values:

Table 14: Shear Force Values of Columns

stories	Vertical frame values (columns) (KN.M)			
Story 5	0.85	0.89	0.88	0.84
Story 4	0.84	0.64	0.63	0.83
Story 3	0.84	0.62	0.61	0.83
Story 2	0.80	0.54	0.53	0.80
Story 1	0.42	0.37	0.37	0.42

Table 15: Shear Force Values of Beams

stories	Horizontal frame values (beam) (KN.M)					
Story 5	-0.16	0.15	-0.009	0.01	-0.17	0.12
Story 4	-0.22	0.25	-0.02	0.02	-0.29	0.16
Story 3	-0.21	0.24	-0.02	0.02	-0.28	0.16
Story 2	-0.19	0.24	-0.02	0.02	-0.27	0.15
Story 1	-0.15	0.21	-0.02	0.01	-0.23	0.12

Table 16: Shear Force Values of Shear Walls

stories	shear walls values (KN.M)
Story 5	-0.45
Story 4	-0.74
Story 3	-0.99
Story 2	-1.20
Story 1	-0.56

Displacement:

Load case: EX

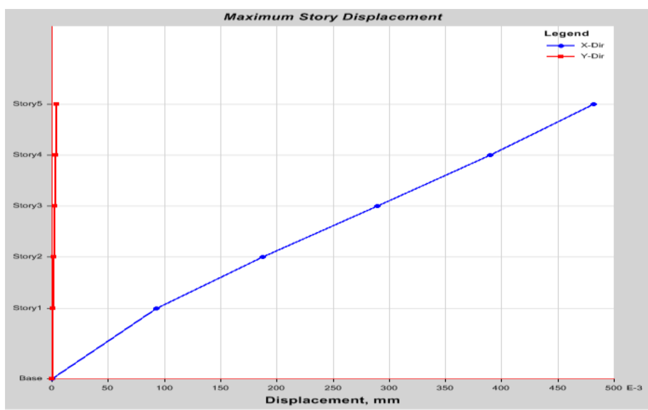

Figure9: Diagram of Displacement

Load case: EY

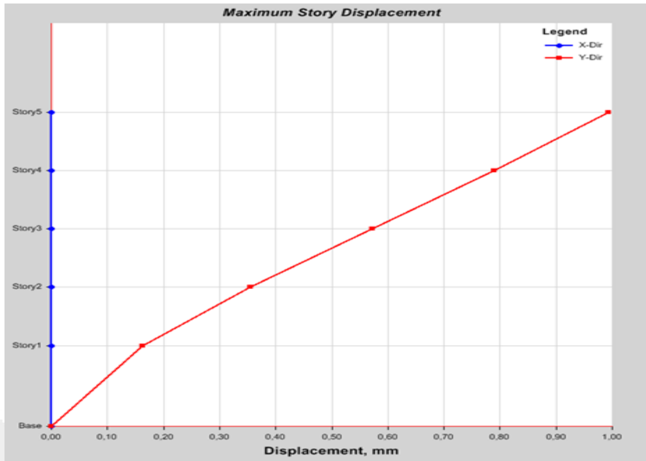

Figure 10: Diagram of Displacement

Story Drift:

Load case: EX

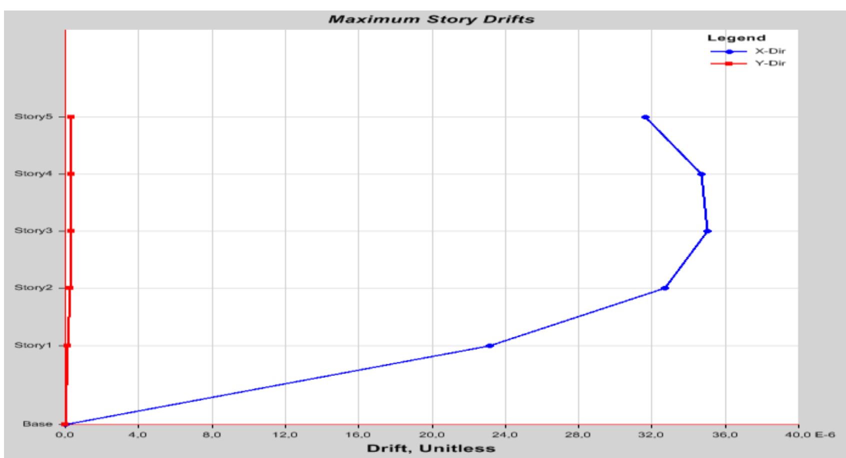

Figure 11: Diagram of Story Drift

Load case: EY

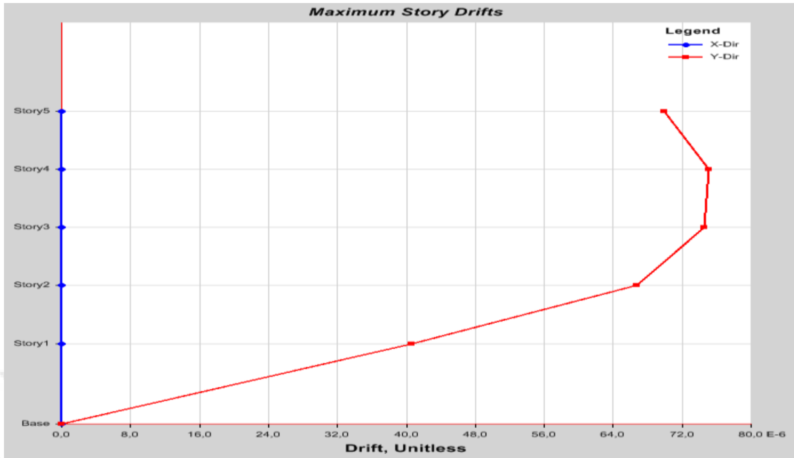

Figure 12: Diagram of Story Drift

Model4: Shear walls in some parts of building

Bending moment values:

Table 17: Bending Moment Values of Columns

STORIES	VERTICAL FRAME VALUES (KN.M)							
	Top				Bottom			
STORY 5	-3.13	-4.15	-4.10	-3.07	3.70	5.78	5.74	3.68
STORY 4	-2.72	-4.20	-4.15	-2.66	3.86	6.24	6.20	3.81
STORY 3	-3.07	-4.50	-4.45	-2.98	4.36	6.68	6.64	4.25
STORY 2	-2.96	-4.31	-4.38	-2.90	4.82	6.65	6.58	4.66
STORY 1	-1.56	-2.29	-2.28	-1.58	3.52	3.45	3.40	3.37

Table 18: Bending Moment Values of Beams

Stories	Horizontal frame values (KN.M)					
Story 5	0.57	-0.07	-0.61	0.35	-0.15	1.09
Story 4	0.50	-0.12	-0.70	0.70	-0.35	1.25
Story 3	-0.02	0.33	-0.78	0.83	-0.28	1.31
Story 2	-0.02	0.31	-0.81	0.91	-0.19	1.25
Story 1	-0.06	0.35	-0.70	0.76	0.12	0.90

Table 19: Bending Moment Values of Shear Walls

stories	Shear walls values (KN.M)			
	Top		bottom	
Story 5	-2.01	4.32	2.96	-1.12
Story 4	1.29	4.85	1.79	-1.72
Story 3	1.41	4.91	-0.49	-3.48
Story 2	0.34	3.27	-3.67	-6.02
Story 1	-2.89	-1.49	-7.19	-7.56

Shear force values:

Table 20: Shear Force Value of Columns

stories	Vertical frame values (columns) (KN.M)			
Story 5	2.74	4.14	4.10	2.73
Story 4	2.65	4.35	4.31	2.64
Story 3	3.00	4.66	4.62	2.96
Story 2	3.15	4.56	4.53	3.10
Story 1	1.46	1.64	1.62	1.44

Table 21: Bending Moment Values of Beams

stories	Horizontal frame values (beam) (KN.M)					
Story 5	-0.02	0.33	0.70	-0.84	-0.62	0.04
Story 4	-0.03	0.42	1.07	-1.30	-0.74	0.03
Story 3	-0.04	0.24	1.24	-1.51	-0.79	0.03
Story 2	-0.03	0.07	1.32	-1.62	-0.76	0.02
Story 1	-0.02	-0.11	1.16	-1.33	-0.54	0.01

Table 22: Shear Force Values of Shear Wall

stories	shear walls values (KN.M)	
Story 5	2.11	-2.07
Story 4	0.3	-2.57
Story 3	-0.83	-3.39
Story 2	-1.81	-3.86
Story 1	-1.50	-2.21

Displacement:

Load case: EX

Figure 13: Diagram of Displacement

Load case: EY

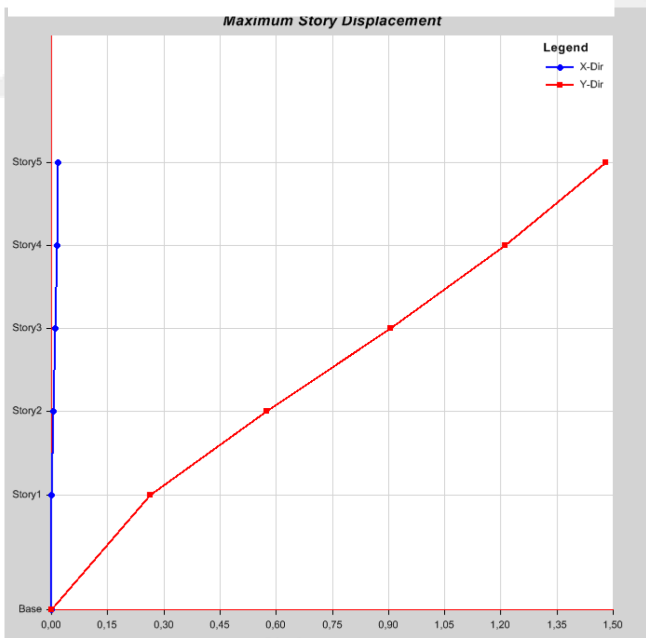

Figure 14: Diagram of Displacement

Story Drift:

Load case: EX

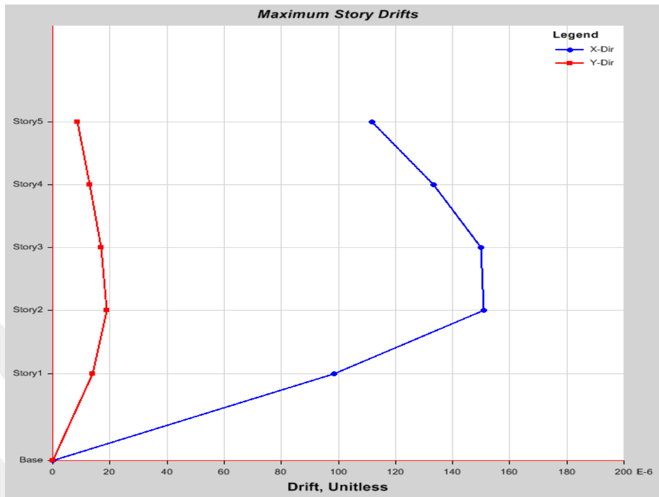

Figure 15: Diagram of Story Drift

Load case: EY

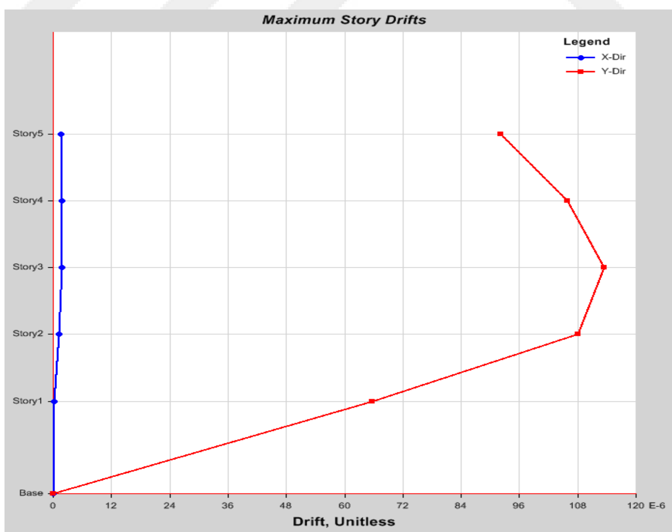

Figure 16: Diagram of Story Drift

Model5: Shear walls as (u) form

Bending moment values:

Table 23: Bending Moment Values of Columns

STORIES	VERTICAL FRAME VALUES (KN.M)							
	Top				Bottom			
STORY 5	-0.94	-0.29	-0.79	-2.07	1.33	0.48	1.27	2.90
STORY 4	-1.13	-0.67	-0.88	-2.20	1.68	1.07	1.46	3.32
STORY 3	-1.26	-0.96	-1	-2.35	1.92	1.54	1.63	3.59
STORY 2	-1.34	-1.28	-1.04	-2.34	2.12	2.11	1.78	3.72
STORY 1	-1.03	-1.68	-0.78	-1.58	1.64	3.28	1.60	2.49

Table 24: Bending Moment Values of Beams

Stories	Horizontal frame values (KN.M)					
Story 5	1.79	-3.18	-0.42	0.19	1.07	-0.75
Story 4	2.90	-3.77	-0.43	0.25	1.30	-1.30
Story 3	2.94	-4.02	-0.48	0.37	1.48	-1.41
Story 2	2.90	-3.98	-0.49	0.47	1.56	-1.48
Story 1	2.20	-3.31	-0.40	0.48	1.37	-1.21

Table 25: Bending Moment Values of Shear Walls

stories	Shear walls values (KN.M)
Story 5	-75.96
Story 4	-40.28
Story 3	66.54
Story 2	271.24
Story 1	797.02

Shear force values:

Table 26: Shear Force Values of Columns

stories	Vertical frame values (columns) (KN.M)			
Story 5	0.95	0.93	1.06	2.07
Story 4	1.17	1.79	1.09	2.30
Story 3	1.32	2.59	1.15	2.48
Story 2	1.44	3.50	1.17	2.53
Story 1	0.76	4.95	0.68	1.17

Table 27: Shear Force Values of Beams

stories	Horizontal frame values (beam) (KN.M)		
Story 5	1.67	-0.42	0.73
Story 4	2.26	-0.51	1.12
Story 3	2.31	-0.63	1.21
Story 2	2.28	-0.71	1.25
Story 1	1.83	-0.71	1.02

Table 28: Shear Force Values of Shear WALLS

stories	shear walls values (KN.M)
Story 5	-46.09
Story 4	-37.46
Story 3	-37.66
Story 2	-26
Story 1	36.84

Displacement:

Load case: EX

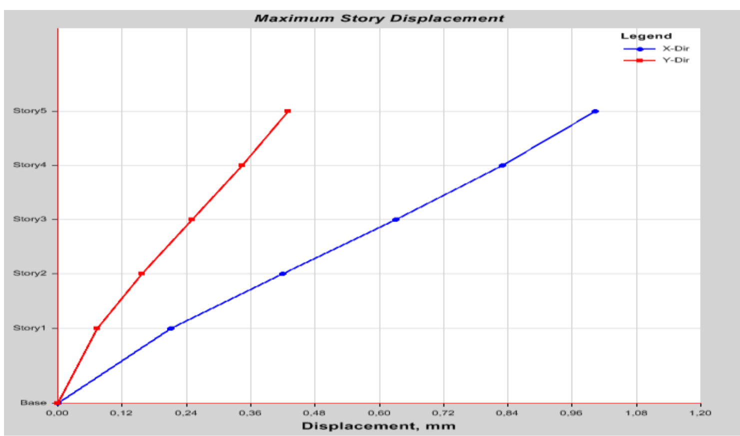

Figure 17: Diagram of Displacement

Load case: EY

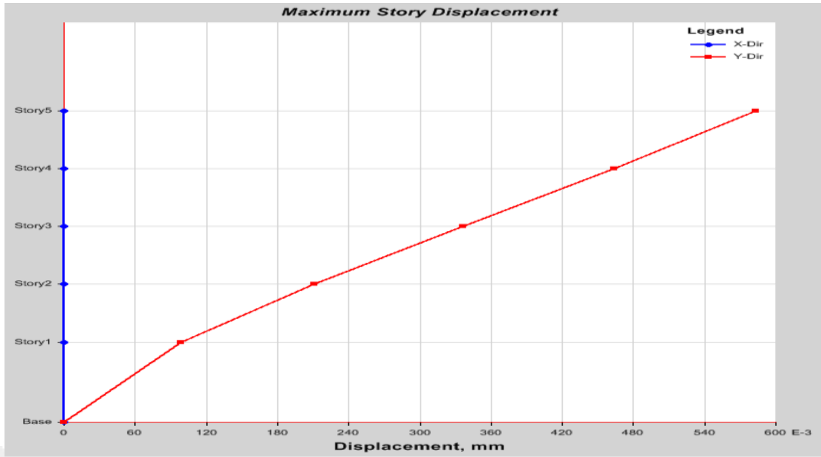

Figure 18: Diagram of Displacement

Story Drift:

Load case: EX

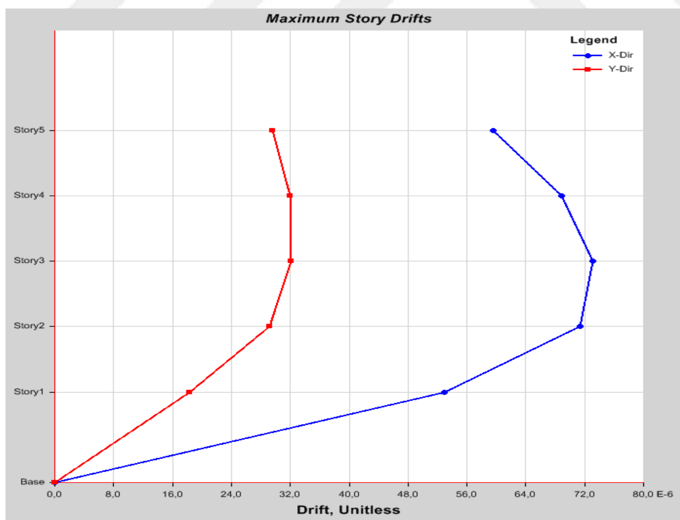

Figure 19: Diagram of Story Drift

Load case: EY

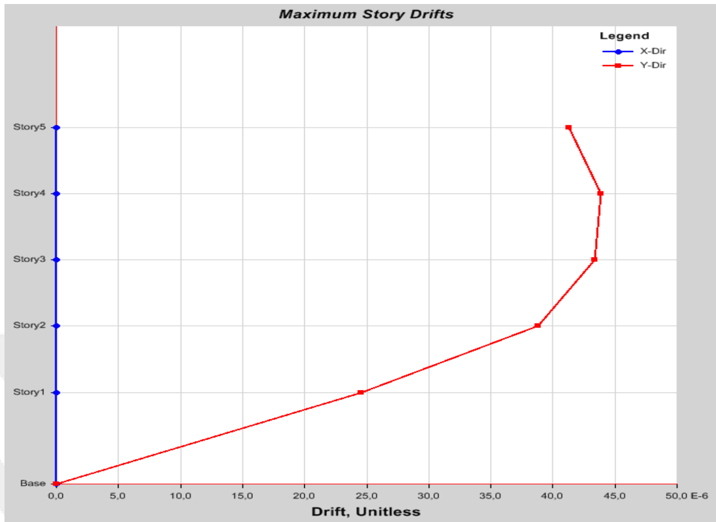

Figure 20: Diagram of Story Drift

CASE2: (G+15)

Model1:

Table 29: Bending Moment Values of Columns

stories	Column force (KN.M)							
	TOP				BOTOM			
Storey15	-15,4167	-18,6739	-18,1943	-14,9074	19,7408	24,9483	24,2938	19,1842
Storey14	-15,0595	-18,7701	-18,5243	-15,1809	21,6787	27,484	27,0655	21,7371
Storey13	-17,8951	-22,0353	-21,9596	-18,433	25,6703	32,1863	32,0159	25,6703
Storey12	-20,3727	-24,9964	-25,0753	-21,2521	29,5354	36,7702	36,8389	30,7089
Storey11	-22,7457	-27,8097	-28,0293	-23,949	33,287	41,1781	41,4655	34,9703
Storey10	-24,907	-30,3693	-30,7184	-26,4104	36,7846	45,2569	45,7467	38,9386
Storey9	-26,7992	-32,6066	-33,0804	-28,5881	39,9311	48,8948	49,5796	42,527
Storey8	-28,3621	-34,4537	-35,054	-30,4296	42,6344	51,9873	52,8695	45,6544
Storey7	-29,5313	-35,8385	-36,5738	-31,8787	44,799	54,4274	55,5197	48,2374
Storey6	-30,2303	-36,6769	-37,5632	-32,8679	46,3163	56,0941	57,4204	50,1804
Storey5	-30,3616	-36,8631	-37,9235	-33,3076	47,0467	56,8356	58,431	51,3569
Storey4	-29,8069	-36,2643	-37,5249	-33,079	46,8489	56,4836	58,3921	51,6426
Storey3	-28,3564	-34,6428	-36,1066	-31,9118	45,1701	54,5019	56,7456	50,4299
Storey2	-26,5255	-32,4849	-34,0301	-30,0895	44,3328	53,382	55,9618	50,3971
Storey1	-20,0555	-23,3337	-24,0297	-21,6077	38,0422	40,6598	41,8482	41,0036

Table 30: Bending Moment Value of Beams

Stories	Beam force (KN.M)					
Storey15	0,6944	-1,6924	0,5416	-2,0002	-2,6394	0,7984
Storey14	1.0038	-2.8556	0.94	-2.9127	-3.432	1.0467
Storey13	1.232	-3.721	1.215	-3.8462	-2.9479	0.931
Storey12	1.6366	-4.7633	1.6458	-4.9351	-2.4773	1.0367
Storey11	2.0052	-5.7192	2.0588	-5.9763	1.3089	-3.3157
Storey10	2.3447	-6.5793	2.4446	-6.9416	1.6425	-4.3096
Storey9	2.6603	-7.3517	2.8012	-7.8253	1.9709	-5.2331
Storey8	2.9518	-8.0534	3.1301	-8.6299	2.3004	-6.11
Storey7	3.2312	-8.704	3.4584	-9.36	2.6231	-6.967
Storey6	3.5118	-9.325	3.7179	-10.0205	2.9255	-7.8338
Storey5	3.9828	-9.9391	4.0033	-10.6155	3.2931	-8.7422
Storey4	4.7941	-10.5638	4.202	-11.1405	3.6608	-9.721
Storey3	5.7513	-11.1497	4.5084	-11.5304	4.0384	-10.7241
Storey2	6.6265	-11.4973	4.6018	-11.5952	4.3483	-11.5313
Storey1	5.0936	-9.0082	3.5177	-8.8939	3.4697	-9.4809

Displacement:

Load case: EX

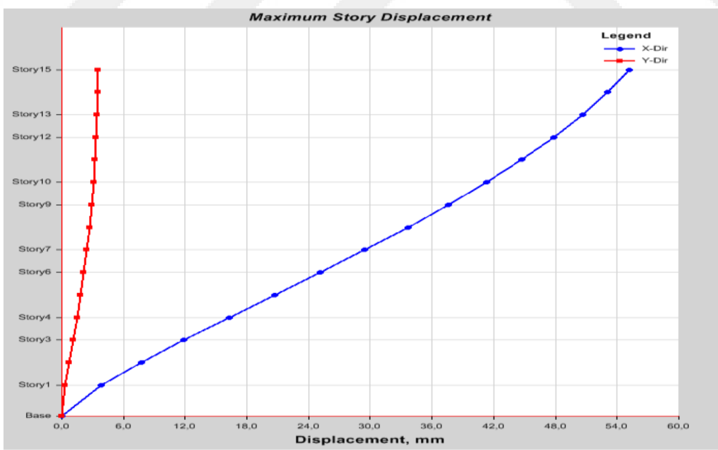

Figure 21: Diagram of Displacement

Load case: EY

Figure 22: Diagram of Displacement

Story Drift:

Load case: EX

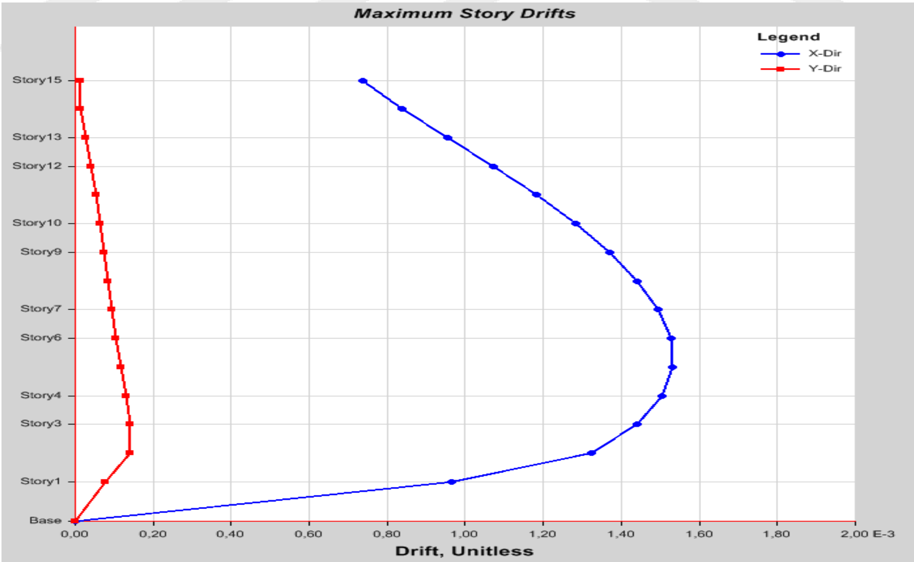

Figure 23: Diagram of Story Drift

Load case: EY

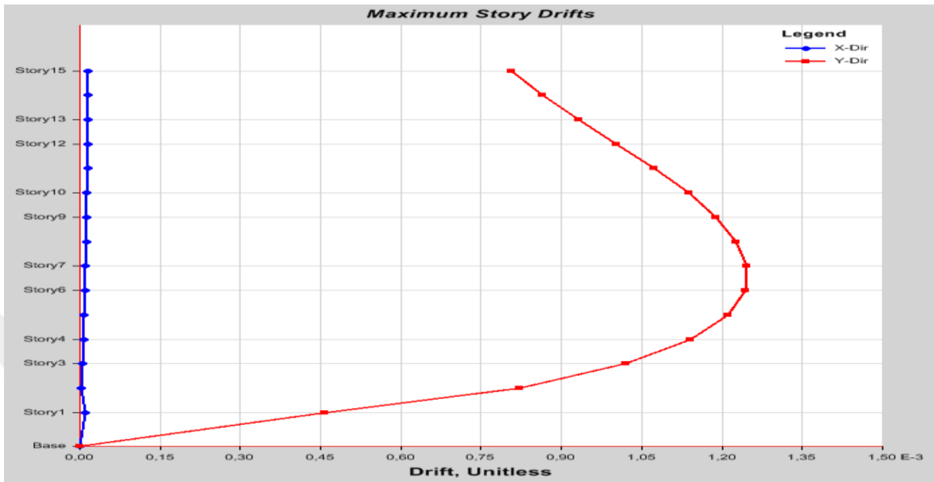

Figure 24: Diagram of Story Drift

Model2:

Table 31: Bending Moment Values of Columns

STORIES	COLUMN FORCES (KN.M)							
	Top				Bottom			
Storey15	0,2813	-1,298	-1,1424	0,2697	-0,4022	1,8055	1,5893	-0,3891
Storey14	-0,2827	-1.2313	-1.102	-0.19	0,1902	1,8429	1,6404	0,2076
Storey13	-0.4805	-1.3962	-1.2647	-0.5	0.608	2.058	1.8765	0.6305
Storey12	-0.7418	-1.5015	-1.3727	-0.7646	1.017	2.2637	2. 0672	1.044
Storey11	-0.9666	-1.5867	-1.4612	-0.9921	1.418	2.2714	2.2811	1.4489
Storey10	-1.1594	-1.6437	-1.5228	-1.1872	1.8137	2.6712	2.489	1.8481
Storey9	-1.3233	-1.6696	-1.5545	-1.3531	2.058	2.8561	2.6843	2.2433
Storey8	-1.4613	-1.661	-1.5532	-1.4927	2.5959	3.0196	2.8605	2.6364
Storey7	-1.5757	-1.6142	-1.5153	-1.6083	2.986	3.1549	3.011	3.029
Storey6	-1.6685	-1.5249	-1.4366	-1.702	3.3777	3.2548	3.1287	3.4228
Storey5	-1.7407	-1.3879	-1.3118	-1.7748	3.7721	3.3109	3.2052	3.8191
Storey4	-1.7917	-1.1957	-1.1336	-1.826	4.1697	3.3125	3.2299	4.2182
Storey3	-1.8144	-0.9355	-0.8891	-1.8487	4.5617	3.2383	3.1812	4.6111
Storey2	-1.7793	-0.5924	-0.5625	-1.8103	4.919	3.0992	3.0671	4.9588
Storey1	-1.7875	-0.1321	-0.1188	-1.7698	6.2983	2.9038	2.8979	6.2763

Table 32: Bending Moment Values of Beams

Stories	Beam forces (KN.M)					
Storey15	-0.5533	0.0272	0.7556	-1.6684	0.0038	-0.5374
Storey14	-0.2181	0.0173	0.834	-1.7244	0.0063	-0.1918
Storey13	-0.2874	0.1365	0.8647	-1.7191	0.1523	-0.2674
Storey12	-0.3496	0.2844	0.8982	-1.7084	0.3029	-0.3331
Storey11	-0.418	0.4231	0.9261	-1.6862	0.4442	-0.4392
Storey10	-0.5334	0.5525	0.9465	-1.6504	0.5761	-0.5571
Storey9	-0.6416	0.6741	0.9573	-1.5982	0.7	-0.6676
Storey8	-0.7432	0.789	0.9568	-1.5269	0.817	-0.7713
Storey7	-0.839	0.8984	0.9434	-1.4339	0.9282	-0.869
Storey6	-0.9292	1.0031	0.9151	-1.3168	1.0344	-0.9608
Storey5	-1.0124	1.1029	0.87	-1.1739	1.1355	-1.0452
Storey4	-1.0835	1.1954	0.8053	-1.0042	1.2286	-1.1167
Storey3	-1.1273	1.2712	0.7166	-0.8086	1.3038	-1.1591
Storey2	-1.0985	1.2968	0.5967	-0.5927	1.3252	-1.1236
Storey1	-0.8069	1.1141	0.4606	-0.3037	1.1183	-0.7976

Displacement:

Load case: EX

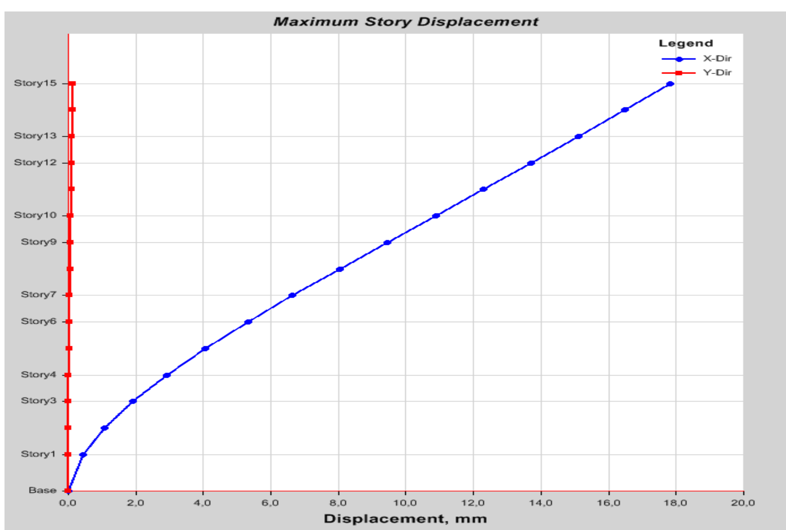

Figure 25: Diagram of Displacement

Load case: EY

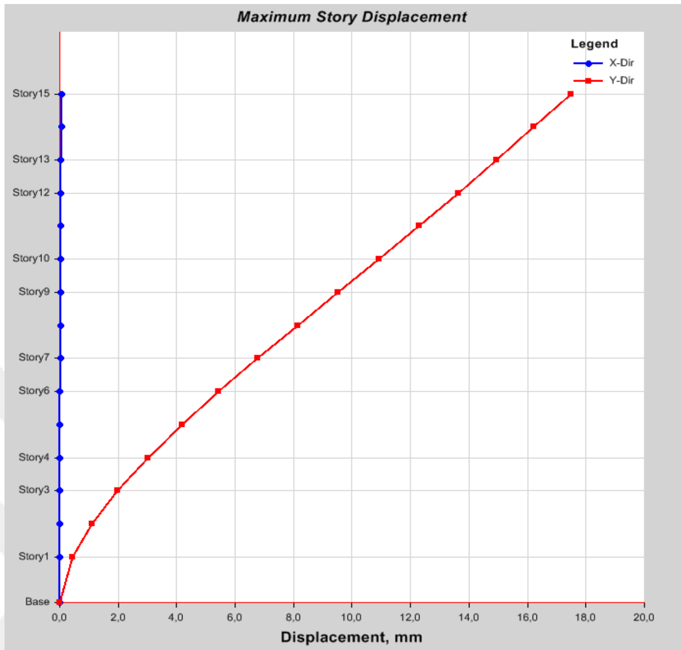

Figure 26: Diagram of Displacement

Story Drift:

Load case: EX

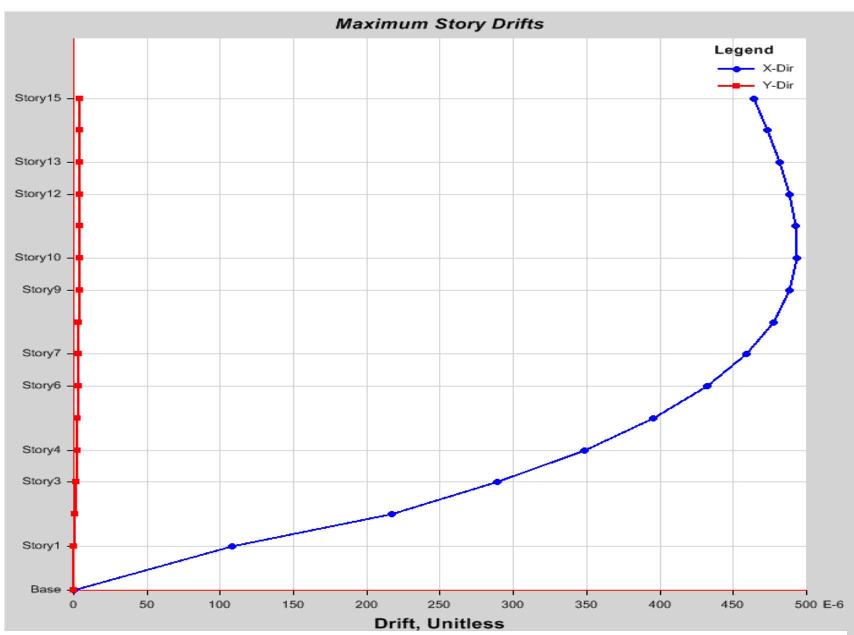

Figure 27: Diagram of Story Drift

Load case: EY

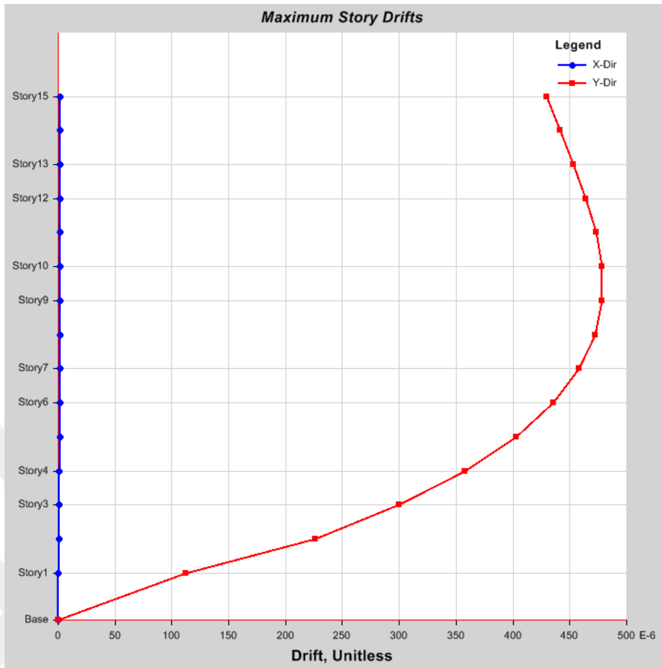

Figure 28: Diagram of Story Drift

Model3:

Table 33: Bending Moment Values of columns

Stories	Column forces (KN.M)							
	Top				Bottom			
Storey15	-11.1632	-6.7171	-6.7369	-11.029	14.8662	7.932	7.971	14.9267
Storey14	-9.0017	-4.3702	-4.3981	-9.0684	13.8071	6.8452	6.8921	13.94
Storey13	-9.2629	-4.8336	-4.8701	-9.3649	13.9964	7.1036	7.1531	14.1451
Storey12	-9.2448	-4.7695	-4.8018	-9.3415	14.0129	7.1018	7.1529	14.161
Storey11	-9.1887	-4.7485	-4.7822	-9.2885	13.9582	7.1003	7.1531	14.1092
Storey10	-9.0488	-4.6653	-4.6999	-9.1496	13.7919	7.039	7.0932	13.944
Storey9	-8.8127	-4.5299	-4.5652	-8.9135	13.4909	6.914	6.969	13.6422
Storey8	-8.4651	-4.3324	-4.3679	-8.5641	13.0317	6.7131	6.7679	13.1794
Storey7	-7.992	-4.0668	-4.1017	-8.087	12.3927	6.4261	6.4798	12.5334
Storey6	-7.3702	-3.7267	-3.7602	-7.4686	11.5541	6.0435	6.0946	11.6835
Storey5	-6.6174	-3.3058	-3.3369	-6.696	10.4976	5.5556	5.6025	10.6107
Storey4	-5.6927	-2.7983	-2.8258	-5.7575	9.2082	4.9555	4.9962	9.2984
Storey3	-4.593	-2.1959	-2.2183	-4.6393	7.6578	4.2233	4.2558	7.719
Storey2	-3.3387	-1.4998	-1.5159	-3.3611	6.0029	3.4096	3.432	6.0223
Storey1	-1.5003	-0.6682	-0.6736	-1.4955	3.2567	2.5237	2.5282	3.2581

Table 34: Bending Moment Values of beams

Stories	Beam forces (KN.M)					
Storey15	-2.7617	2.3756	-0.0206	0.1326	2.6026	-3.0725
Storey14	-4.1122	2.8105	-0.063	0.1442	3.0648	-4.5485
Storey13	-3.8974	2.7396	-0.0566	0.1343	2.9987	-4.3181
Storey12	-3.8781	2.7227	-0.059	0.1359	2.9866	-4.311
Storey11	-3.7899	2.6698	-0.0617	0.1362	2.9376	-4.2291
Storey10	-3.6699	2.5939	-0.0645	0.1357	2.864	-4.1135
Storey9	-3.5106	2.4911	-0.0667	0.1339	2.7609	-3.9544
Storey8	-3.3114	2.3602	-0.0683	0.1306	2.6265	-3.75
Storey7	-3.0713	2.2001	-0.0688	0.1258	2.4586	-3.4978
Storey6	-2.7898	2.0099	-0.068	0.119	2.2557	-3.196
Storey5	-2.4668	1.7893	-0.0656	0.1103	2.0156	-2.8432
Storey4	-2.1031	1.5381	0.0993	-0.063	1.7404	-2.4391
Storey3	-1.6987	1.2566	0.0858	-0.0588	1.4265	-1.9818
Storey2	-¨1.2657	0.9474	0.0677	-0.0498	1.0772	-1.4847
Storey1	-0.7524	0.6102	0.0415	-0.0437	0.6884	-0.8799

Displacement:

Load case: EX

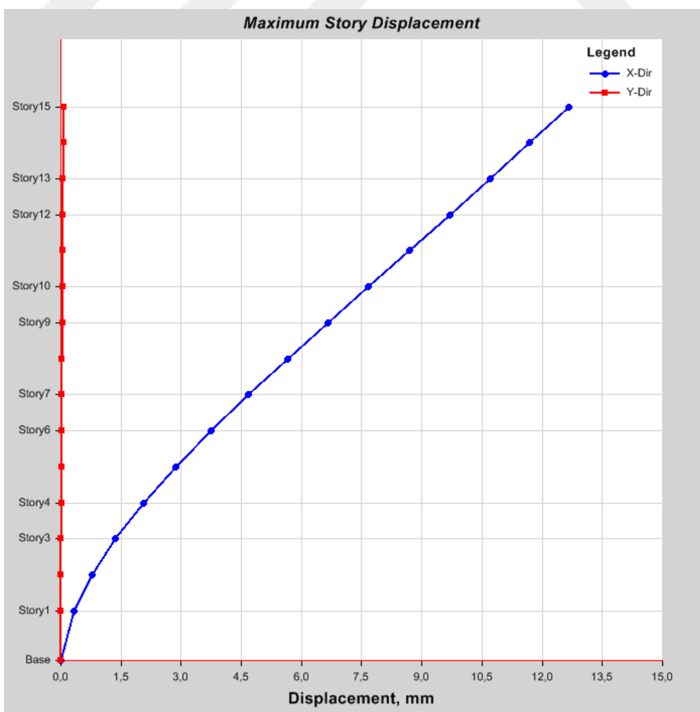

Figure 29: Diagram of Displacement

Load case: EY

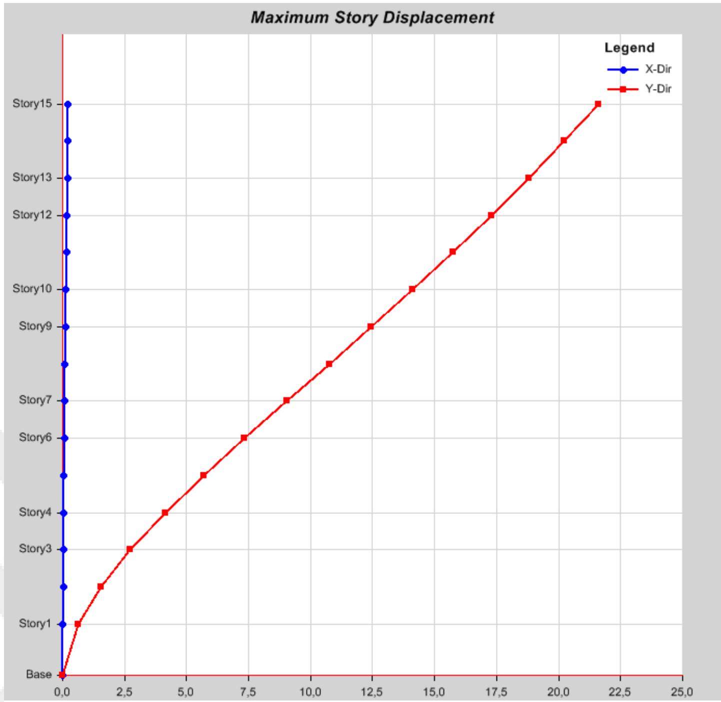

Figure 30: Diagram of Displacement

Story Drift:

Load case: EX

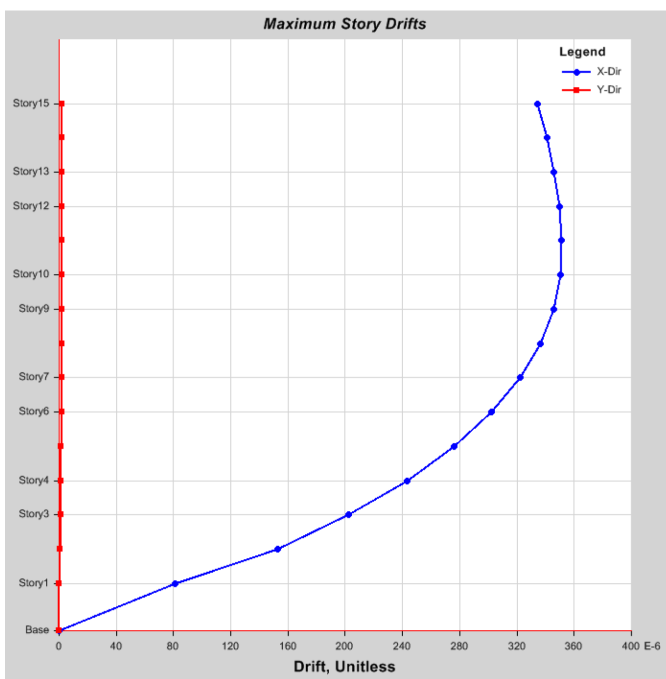

Figure 31: Diagram of Story Drift

Load case: EY

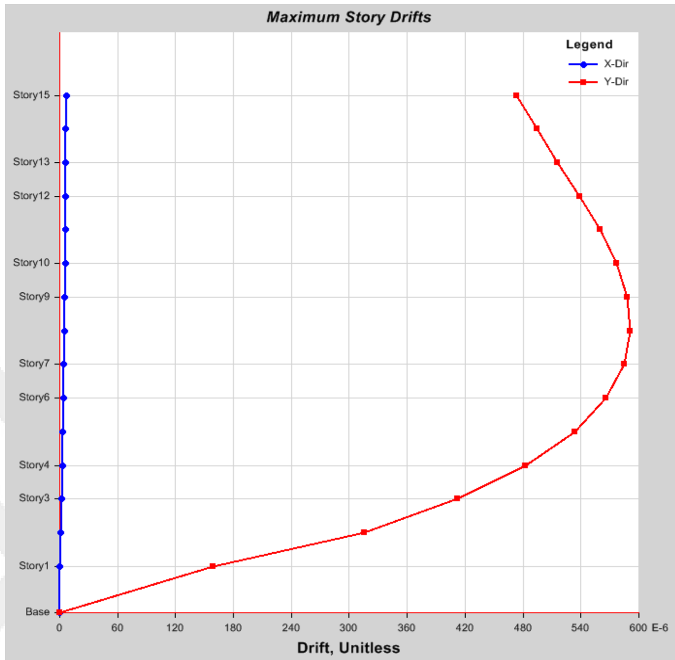

Figure 32: Diagram of Story Drift

Model4:

Table 35: Bending Moment Values of Columns

Stories	Column forces (KN.M)							
	Top				Bottom			
Storey15	-13.6152	-19.0921	-18.9	-13.8958	15.9136	27.0056	26.7427	16.5091
Storey14	-10.8598	-18.4406	-18.2704	-11.3581	15.3504	28.0854	27.8366	16.089
Storey13	-12.6568	-20.484	-20.3135	-13.1764	17.3374	31.0737	30.8269	18.1467
Storey12	-13.8795	-22.5083	-22.3412	-14.4734	19.1662	34.2011	33.9594	20.0729
Storey11	-15.1273	-24.5271	-24.365	-15.7906	21.0144	37.3016	37.0672	22.0115
Storey10	-16.2455	-26.3952	-26.24	-16.978	22.7311	40.1648	39.9434	23.8227
Storey9	-17.1889	-28.0038	-27.8572	-17.9843	24.2332	42.6299	42.4183	25.4035
Storey8	-17.899	-29.2466	-29.1105	-18.7475	25.4382	44.5262	44.3299	26.6696
Storey7	-18.3176	-30.0129	-29.8889	-19.2024	26.263	45.5875	45.5092	27.5311
Storey6	-18.3698	-30.1756	-30.0564	-19.272	26.6143	45.9211	45.7631	27.8972
Storey5	-17.9628	-29.5773	-29.4823	-18.8575	26.3749	44.9902	44.8537	27.612
Storey4	-16.9699	-28.0093	-27.931	-17.8276	25.41.79	42.5898	42.475	26.5653
Storey3	-15.1641	-15.1634	-25.1044	-15.9544	23.3574	38.2421	38.1472	24.3599
Storey2	-12.4184	-20.705	-20.67	-13.1284	21.2752	32.0956	32.0081	22.0719
Storey1	-5.9242	-9.8535	-9.8553	-6.3474	13.3053	14.1752	14.1275	13.3896

Table 36: Bending Moment Values of Beams

Stories	**Beam forces (KN.M)**					
Storey15	7.1521	-1.6813	-3.8797	0.9466	-1.9011	8.1045
Storey14	8.1319	-2.8717	-4.3148	2.7442	-3.1542	9.493
Storey13	8.4864	-2.6746	-4.8929	3.2469	-3.0155	10.0306
Storey12	9.0533	-2.6092	-5.5619	3.8814	-3.0068	10.8241
Storey11	9.716	-2.5928	-6.2495	4.5055	-3.045	11.7066
Storey10	10.3937	-2.6027	-6.9125	5.0977	-3.1045	12.5904
Storey9	11.0108	-2.6074	-7.5193	5.6415	-3.1531	13.3921
Storey8	11.4941	-2.5742	-8.4033	6.1272	-3.1577	14.0335
Storey7	11.769	-2.4693	-8.458	6.5454	-3.0845	14.4358
Storey6	11.755	-2.2583	-8.7324	6.8827	-2.899	14.5129
Storey5	11.3621	-1.9078	-8.8249	7.1154	-2.5661	14.1657
Storey4	10.4928	-1.392	-8.6744	7.1999	-2.0543	13.2766
Storey3	9.0527	-0.7074	-8.1865	7.0524	-1.3431	11.703
Storey2	-0.0088	6.9881	-7.2117	6.5395	-0.4593	9.2849
Storey1	-0.0139	4.2307	-5.4204	4.8604	0.8141	5.6813

Displacement:

Load case: EX

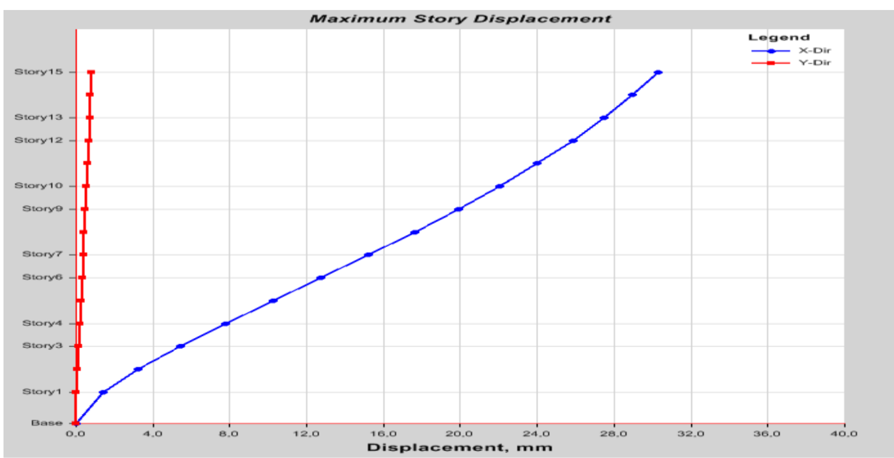

Figure 33: Diagram of Displacement

Load case: EY

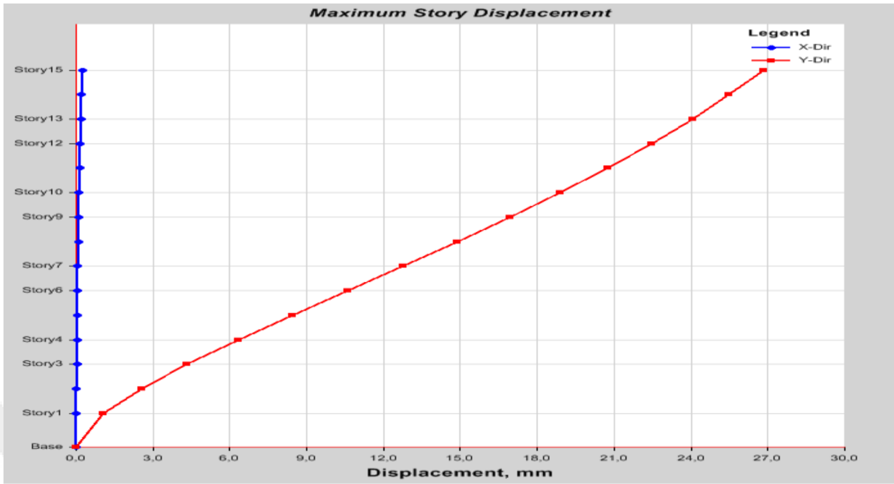

Figure 34: Diagram of Displacement

Story Drift:

Load case: EX

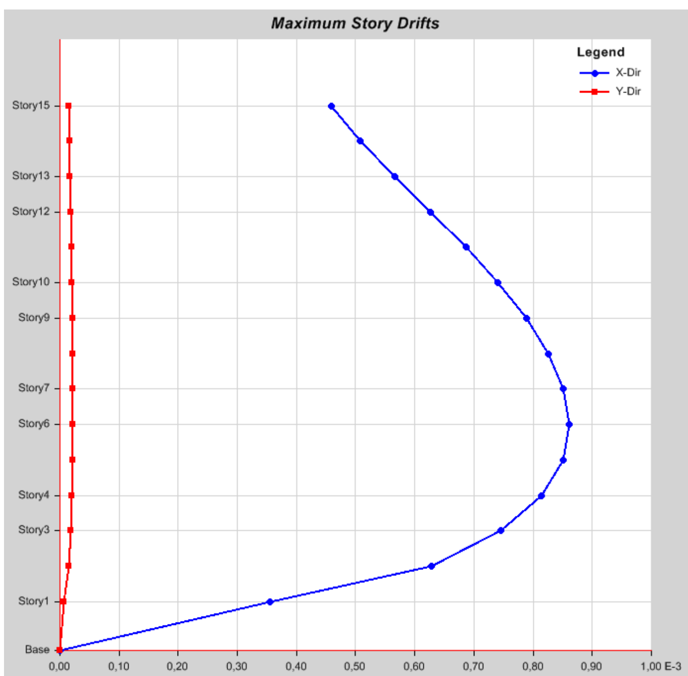

Figure 35: Diagram of Story Drift

Load case:EY

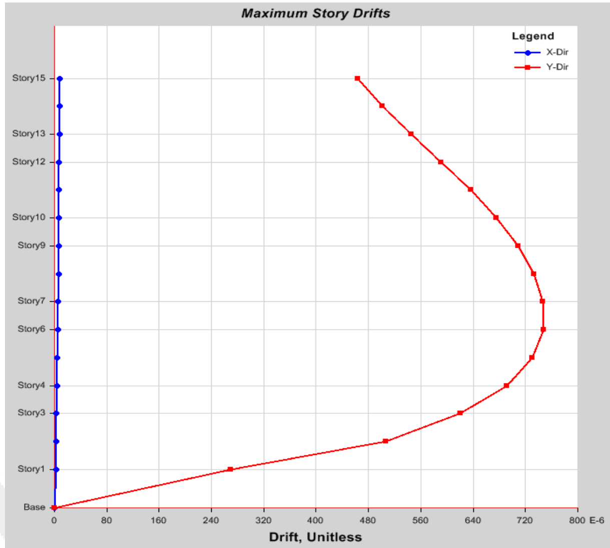

Figure 36: Diagram of Story Drift

Model5:

Table 37: Bending Moment Values of Columns

Stories	Column forces (KN.M)							
	Top				Bottom			
Storey15	-5.2708	-7.4781	-7.0016	-6.542	6.7999	10.1953	9.5326	8.5001
Storey14	-4.4065	-6.8016	-6.4596	-5.6977	6.735	10.528	9.8054	8.5602
Storey13	-4.8804	-7.6237	-7.1268	-6.3363	7.3666	11.7323	10.7558	9.3817
Storey12	-5.2384	-8.3923	-7.7309	-6.8282	7.9522	12.9504	11.7078	10.1669
Storey11	-5.5924	-9.1614	-8.3176	-7.3079	8.5219	14.1536	12.6381	10.9402
Storey10	-5.9038	-9.8715	-8.842	-7.726	9.0303	15.2626	13.4839	11.643
Storey9	-6.1514	-10.4794	-9.2702	-8.0568	9.4432	16.211	14.1915	12.2324
Storey8	-6.3128	-10.9429	-9.568	-8.2732	9.7263	16.9339	14.7087	12.6666
Storey7	-6.3659	-11.2189	-9.7007	-8.3464	9.8458	17.3646	14.9824	12.9032
Storey6	-6.2877	-11.2608	-9.6308	-8.2469	9.7669	17.43	14.9561	12.8968
Storey5	-6.0535	-11.0145	-9.3158	-7.9374	9.4527	17.045	14.567	12.5954
Storey4	-5.6359	-10.4146	-8.7059	-7.3743	8.8658	16.1088	13.7439	11.9403
Storey3	-4.9954	-9.3672	-7.4334	-6.4944	7.9281	14.4439	12.3738	10.8213
Storey2	-4.1243	-7.83	-6.3689	-5.2624	6.8544	12.3424	10.683	9.4624
Storey1	-2.5716	-4.4676	-3.6701	-3.0729	4.3913	6.0481	6.1813	6.3239

Table 38: Bending Moment Values of Beams

Stories	Beam forces (KN.M)					
Storey15	6.7664	-5.3275	2.6338	-2.4804	-0.4586	-0.3855
Storey14	10.3405	-8.7919	4.7203	-3.7807	0.1447	-0.9555
Storey13	10.4813	-8.9229	5.0182	-4.0959	0.6273	-1.6211

Storey12	11.2195	-9.4956	5.584	-4.5585	1.2098	-2.393
Storey11	11.9212	-10.0525	6.1685	-5.0408	1.858	-3.2451
Storey10	12.5935	-10.5779	6.74	-5.5117	2.5232	-4.1154
Storey9	13.164	-11.0178	7.2594	-5.94	3.1799	-4.9637
Storey8	13.5769	-11.3257	7.6909	-6.2972	3.7968	-5.751
Storey7	13.775	-11.4554	7.9989	-6.5551	4.3437	-6.438
Storey6	13.699	-11.3586	8.1447	-6.6825	4.7864	-6.9803
Storey5	13.2833	-10.983	8.0835	-6.6435	5.0833	-7.3235
Storey4	12.4536	-10.2696	7.7611	-6.3937	5.1817	-7.3987
Storey3	11.1135	-9.1437	7.1051	-5.8741	5.0107	-7.1127
Storey2	9.1983	-7.5721	6.052	-5.0347	4.4943	-6.3581
Storey1	6.1851	-4.9255	4.1706	-3.4524	3.3261	-4.774

Displacement:

Load case: EX

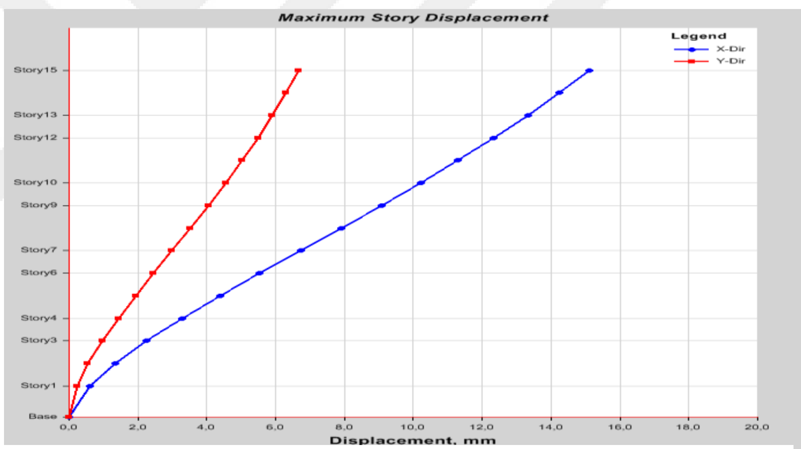

Figure 37: Diagram of Displacement

Load case: EY

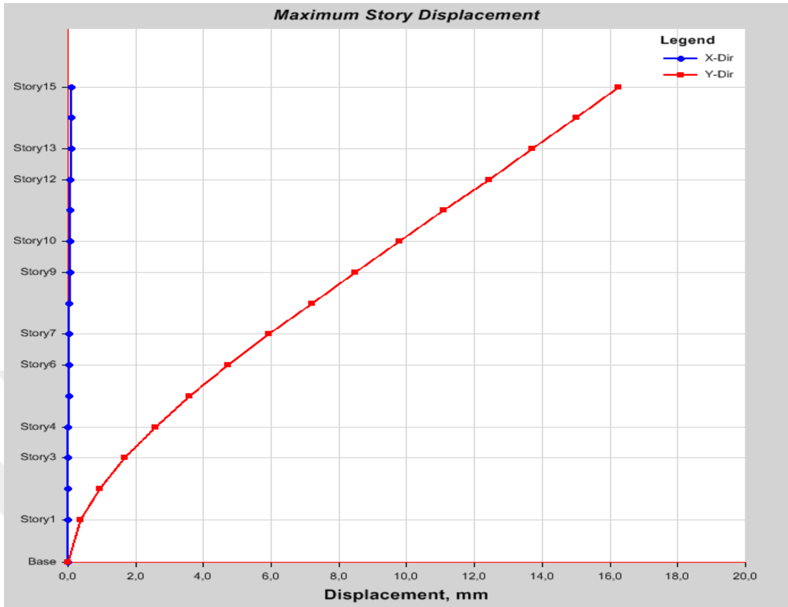

Figure 38: Diagram of Displacement

Story Drift:

Load case: EX

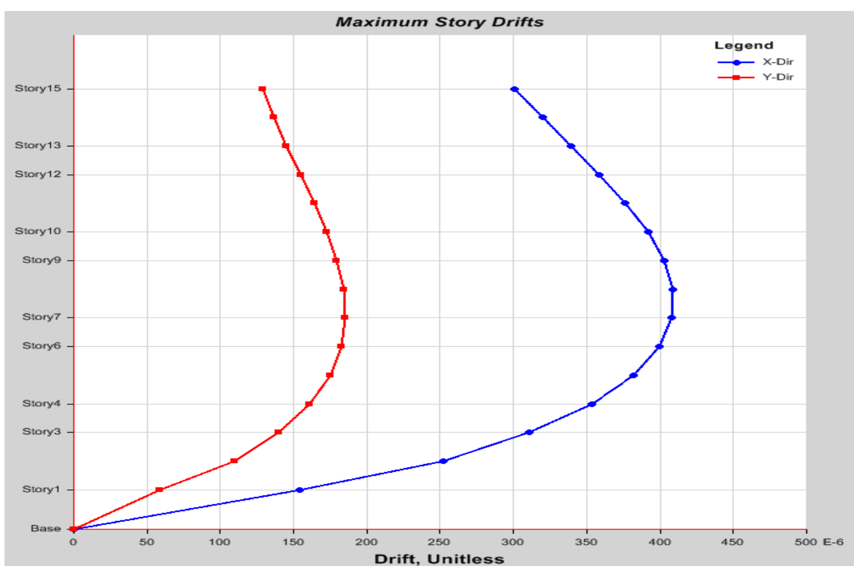

Figure 39: Diagram of Story Drift

Load case: EY

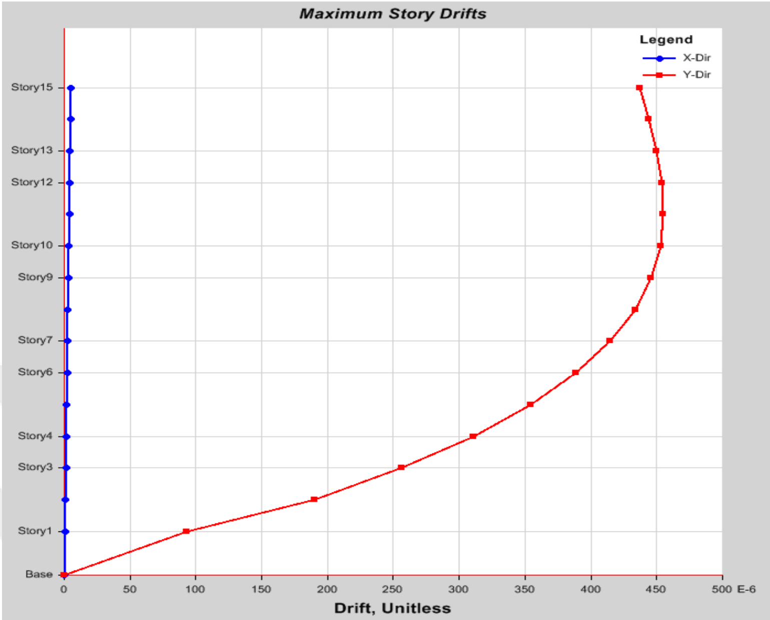

Figure 40: Diagram of Story Drift