Designing shear walls based G+5 Commercial building

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Abstract - *Even though concrete structures make up a sizable component of civil infrastructure, due to the vast material discreteness their reliability is generally low. Inlight of this, civil engineering pays constant attention to the safety of concrete structures. It is crucial to assess the state of concrete structures as a result by following simple safety measures. Among all natural disasters, seismic activity are thought to be the most unpredictable. To reduce the seismic impact consider this when analysing and designing any structure. Today's designers and engineers are paying more attention to earthquake resilience. When analyzing and planning any construction, keeping this in mind to lessen the seismic impact. So as a result in high- rise building facing lateral wind as well as seismic forces, shear walls used. In this project, designed a shear wall based G+5 commercial building. Shear wall construction often have a regular layout and elevation. This project utilizes ETABS for building modeling and analysis.*

***Key Words*: Shear walls, Seismic design, ETABS, Commercial building, Storey drift.**

1.INTRODUCTION

Civil engineering construction activity have increased dramatically during the past few years. Inorder for our society to function properly, complex systems like dams, buildings and bridges must be built. They experience heavy loading and its possible that this will cause performance changes over time. For society to be prosperous economically and industrially civil buildings safety and durability are crucial. Unfortunately, a large number of our aging civic structures are degrading due to persistant extreme climatic conditions, loads and frequently poor maintenance.

A good designer must be able to cope with a variety of structures, from the straightforward rebar to more new multi frame buildings and bridges etc. These buildings endure a variety of loads including internal or external stressors that are evenly distributed, concentrated or change uniformily dynamic forces and seismic loads are taken into account during the design phase. The structure disperses its weight onto the supports then to the earth. During the transition internal forces such as axial forces are applied to the structures members as a result of loads. While examining we will find the shear force, bending and torsional moments in the structure.

High- rise building facing lateral wind as well as seismic forces, these walls used. Impact of wind forces on reinforced concrete framed constructions become more important as the height of the structure rises. Horizontal movement or sway is constrained by codes of practice. Shear wall construction often have a regular layout and elevation. But in certain structures, the lower floors serve commercial functions and those buildings are distinguished by having bigger plan proportions at those floors. There are setbacks in various situations at higher floor levels. Buildings with shear walls are frequently utilized for housing and have a capacity of 100-500 people.

1.1 Shear wall

Shear wall construction often have a regular layout and elevation. But in certain structures, the lower floors serve commercial functions and those buildings are distinguished by having bigger plan proportions at those floors. There are setbacks in various situations at higher floor levels.

1.2 Objectives

- To determine the G+5 commercial building's seismic analysis and design with shear wall.
- Determining the building's structural system's capacity to support both vertical and horizontal loads.

2. METHODOLOGY

This project deals with the seismic Analysis and Design of G +5 commercial building with Shear Walls. Height of each floor and each typical floor is 3m. M25 concrete and Fe500 is used. The design criteria are taken into account in accordance with the Indian Standard code of practice. IS456-2000 was followed when creating the design. For the design portions, SP16 design aid was taken in consideration. The structure must withstand and convey to the foundation all impacts of Gravity Load and Lateral Load operating in it as integrated system.

2.1 Salient features and dimensions of the building

GEOMETRIC DATA :

- Type of building : Commercial
- Location of building : Kerala
- Typical storey height : 3m

ELEMENT SIZES :

- Column : 230 x 500 mm
- Beam : 230 x 500 mm
- Shear wall : 200mm
- Slab depth : 125mm

SEISMIC DATA :

- Location : Kerala
- Importance factor : 0.16
- Response factor : 5
- Type of soil : Medium (Type 2)

VARIOUS LOADS :

- Ground Floor wall load = 15.058KN/m
- First floor wall load = 11.4 KN/m
- Parapet wall load = 4 KN/m
- Self weight = 1 KN/m
- Live load = 4 KN/m
- Staircase load = 9.435 KN/m
- Floor finish = 1 KN/m

PIER DETAILS :

- Centroid x = 1450mm
- Centroid y = 15500mm
- Length = 4000mm
- r_s = 1.15
- r_c = 1.5

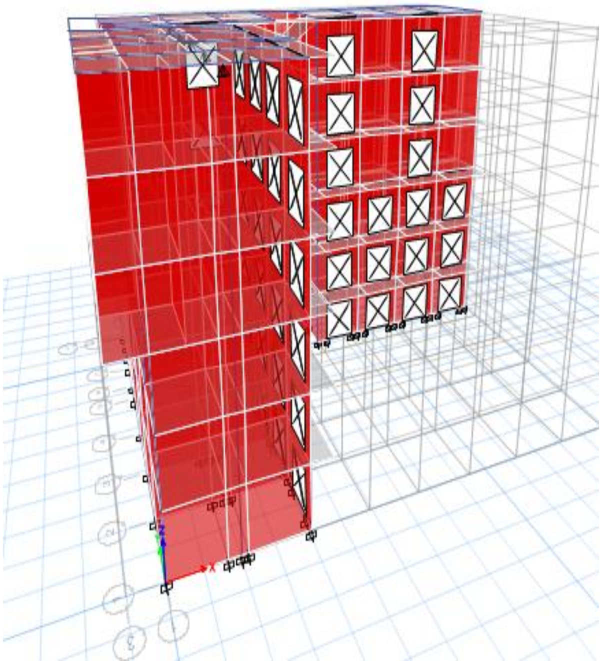

Fig -1: 3D view of structure

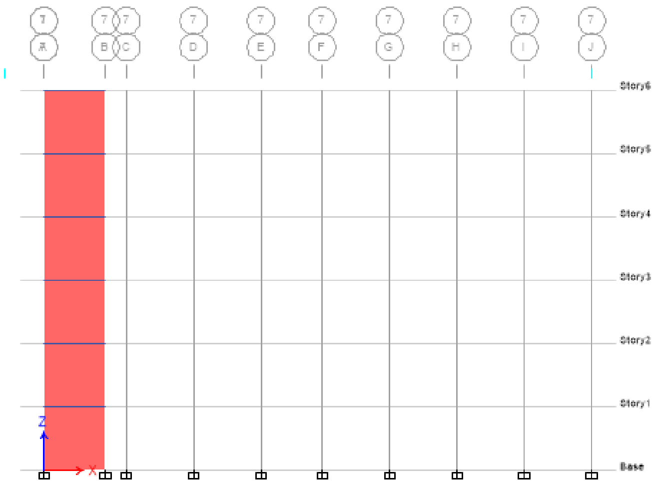

Fig -2: Shear wall Elevation

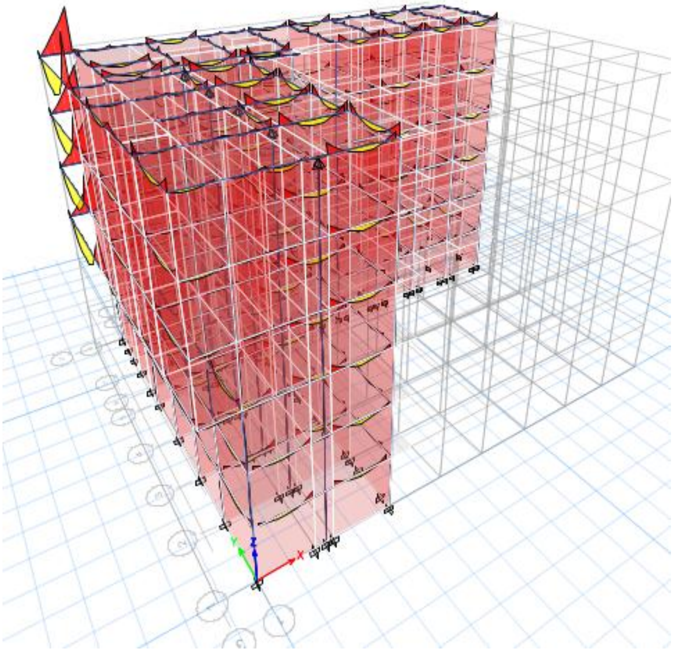

Fig -3: Bending moment

3. RESULT AND DISCUSSIONS

After analyzing the models, the results from ETABS are discussed in this chapter and shown in figures. After the study of commercial structure, simple parameters used to determine the stiffness of the structure like displacement, drift and overturning moment are evaluated.

3.1 Storey displacement along X and Y direction

It can be occurred due to movement in storey respect to foundation of structure.

- Load case : EQX

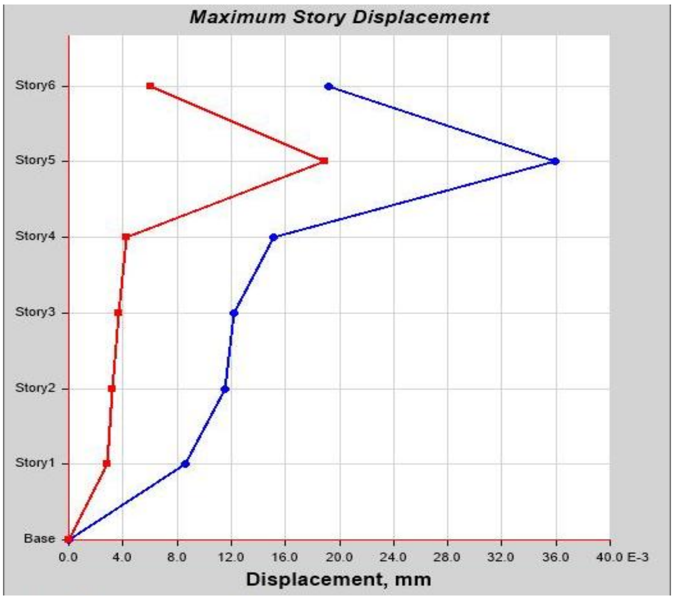

Fig -4: Maximum storey displacement acting due to EQX

Table -1: Storey response value

Storey	Elevation m	Location	x-direction mm	y-direction mm
Storey 6	18	Top	0.000001	2.652E-07
Storey 5	15	Top	0.000001	2.498E-07
Storey 4	12	Top	0.000001	3.864E-07
Storey 3	9	Top	0.000001	3.189E-07
Storey 2	6	Top	0.000001	2.177E-07
Storey 1	3	Top	0.000001	1.646E-07
Base	0	Top	0.000001	0

Discussion:

In the above graph of Maximum storey displacement acting due to EQX, the x direction displacement highlighted by blue colour whereas y direction displacement by red. The graph shows the displacement from base to top storey. From the graph we can obtain that Maximum displacement is on Storey 5 with a displacement value of 0.035936mm. Also, the Minimum displacement on base with a value of 0. When EQX is applied X direction displacement is larger than Y direction.

From the Storey response value table, the response value of building due to EQX seismic action from base to top storey is given. In X direction, response value of base to storey 6 is same with a value of 0.000001mm. In Y direction, response value of base is 0 and response value of storey 6 is 2.652E-07mm.

- Load case : EQY

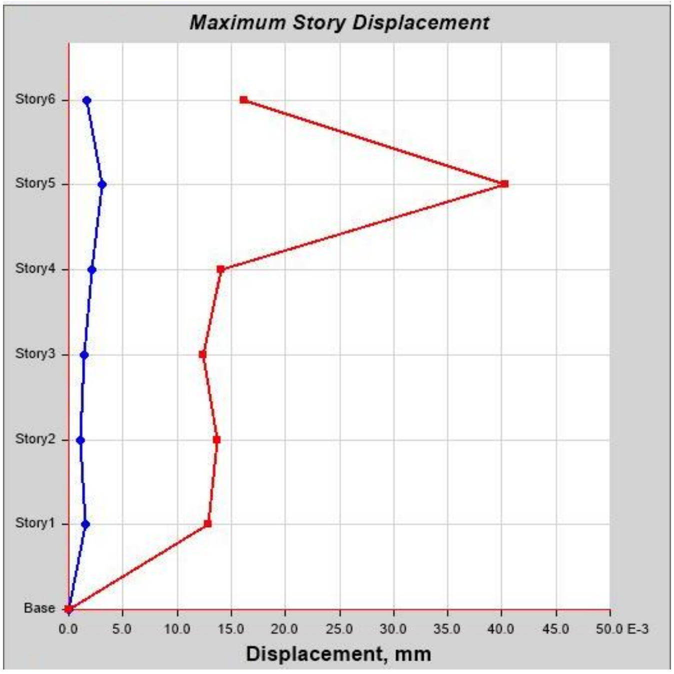

Fig -5: Maximum storey displacement acting due to EQY

Table -2: Storey response value

Storey	Elevation m	Location	x-direction mm	y-direction mm
Storey 6	18	Top	1.698E-03	1.62E-02
Storey 5	15	Top	3.13E-03	4.026E-02
Storey 4	12	Top	2.165E-03	1.401E-02
Storey 3	9	Top	1.396E-03	1.24E-02
Storey 2	6	Top	1.033E-03	1.374E-02
Storey 1	3	Top	1.5E-03	1.284E-02
Base	0	Top	0	0

Discussion:

In the above graph of Maximum storey displacement acting due to EQY, the x direction displacement highlighted in blue colour and y direction displacement by red. Graph shows the displacement from base to top storey. From the graph we can obtain that Maximum displacement is on Storey 5 with a displacement value of 0.040262mm. Also, the Minimum displacement on base with a value of 0. When EQY is applied Y direction displacement is larger than X direction.

From the Storey response value table, the response value of building due to EQY seismic action from base to top storey is given. In X direction, response value of base is 0 and response value of storey 6 is 1.698E-03mm. In Y direction, response value of base is 0 and response value of storey 6 is 1.62E-02mm.

3.2 Storey drift along x and y direction

It is lateral displacement of a multistory buildings uppermost level with respect to lower.

- Load case: EQX

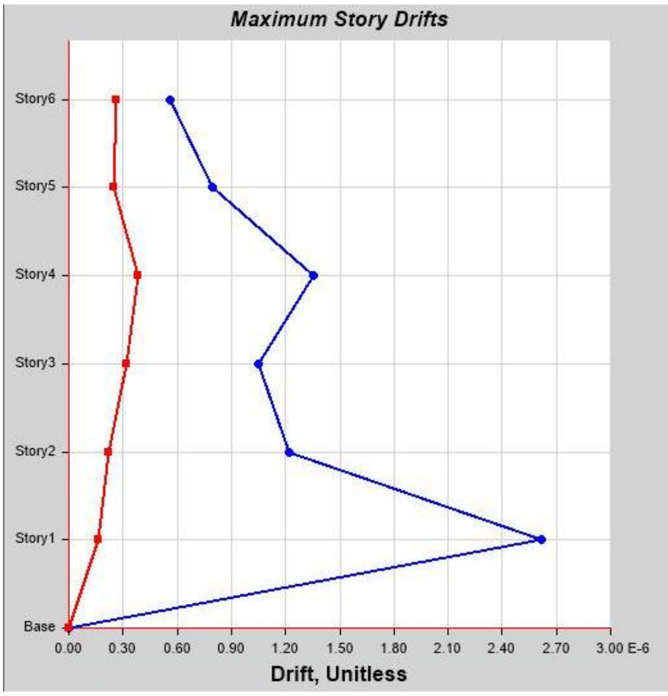

Fig -6: Maximum storey drift acting due to EQX

Table -3: Storey response value

Storey	Elevation m	Location	X-Direction	Y-Direction
Storey 6	18	Top	0.000001	2.652E-07
Storey 5	15	Top	0.000001	2.498E-07
Storey 4	12	Top	0.000001	3.864E-07
Storey 3	9	Top	0.000001	3.189E-07
Storey 2	6	Top	0.000001	2.177E-07
Storey 1	3	Top	0.000003	1.646E-07
Base	0	Top	0	0

Discussion:

In the above graph of Maximum storey drift acting due to EQX, the x direction drift highlighted by blue colour whereas y direction drift by red. Graph shows the drift from base to top storey. From the graph we can obtain that Maximum drift is on Storey 1 with a drift value of 0.000003. Also, the Minimum drift on base with a value of 0. When EQX is applied X direction drift is larger than Y direction.

From the Storey response value table, the response value of building due to EQX seismic action from base to top storey is given. In X direction, response value of base is 0 and response value of storey 6 is 0.000001. In Y direction, response value of base is 0 and response value of storey 6 is 2.652E-07.

- Load case: EQY

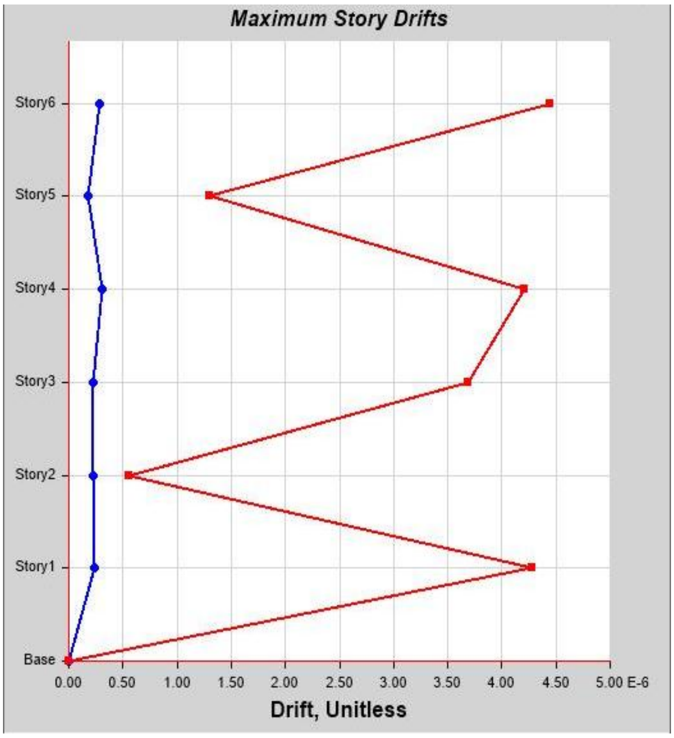

Fig -7: Maximum storey drift acting due to EQY

Table -3: Storey response value

Storey	Elevation m	Location	X-Direction	Y-Direction
Storey 6	18	Top	2.808E-07	0.000004
Storey 5	15	Top	1.738E-07	0.000001
Storey 4	12	Top	3.071E-07	0.000004
Storey 3	9	Top	2.271E-07	0.000004
Storey 2	6	Top	2.292E-07	0.000001
Storey 1	3	Top	2.398E-07	0.000004
Base	0	Top	0	0

Discussion:

In the above graph of Maximum storey drift acting due to EQY, the x direction drift highlighted by blue colour whereas y direction drift by red. Graph shows the drift from base to top storey. From the graph we can obtain that Maximum drift is on Storey 6 with a drift value of 0.000004. Also, the Minimum drift on base with a value of 0. When EQY is applied Y direction drift is larger than X direction.

3.3 Storey stiffness

- Load case : EQX

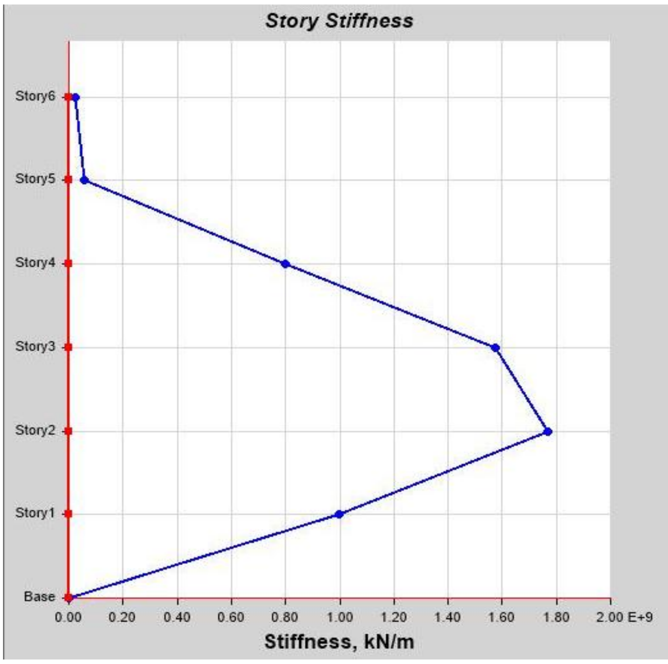

Fig -8: Storey stiffness acting due to EQX

Discussion:

In the above graph of Maximum storey stiffness acting due to EQX, the x direction stiffness highlighted by blue colour whereas y direction stiffness by red. Graph shows the stiffness from base to top storey. From the graph we can obtain that Maximum stiffness is on Storey 2 with a stiffness value of 1.76E+9 KN/m. Also, the Minimum stiffness on base with a value of 0.

- Load case: EQY

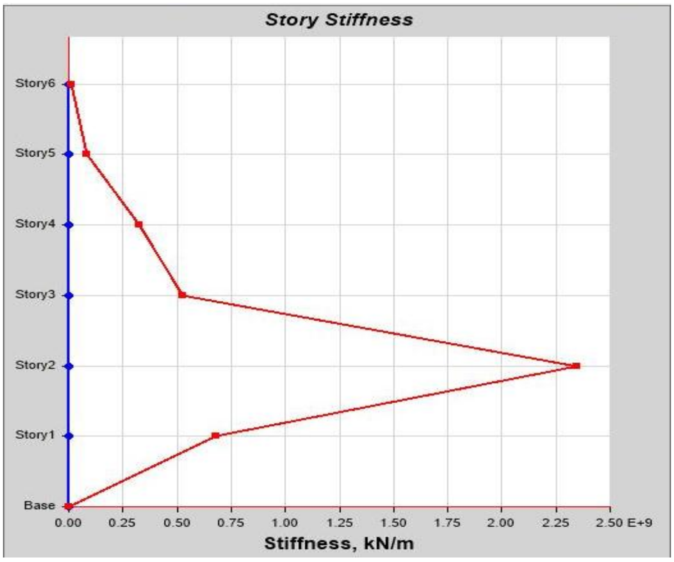

Fig -9: Storey stiffness acting due to EQY

Discussion:

In the above graph of Maximum storey stiffness acting due to EQY, the x direction stiffness highlighted by blue colour whereas y direction stiffness by red. Graph shows the stiffness from base to top storey. From the graph we can obtain that Maximum stiffness is on Storey 2 with a stiffness value of 2.34E+9 KN/m. Also, the Minimum stiffness on base with a value of 0. When EQY is applied Y direction stiffness is larger than X direction.

3.4 Storey overturning moment

- Load case: EQX

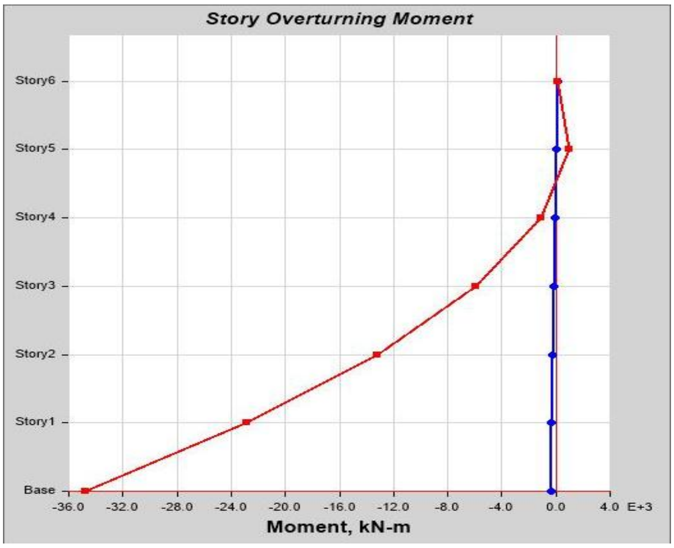

Fig -10: Storey overturning moment due to EQX

Discussion:

In the above graph of Overturning moment acting due to EQX, the x direction stiffness highlighted by blue colour whereas y direction stiffness by red. Graph shows the moment from base to top storey. From the graph we can obtain that moment is on Storey 5 with a moment value of 947.63 KN-m. Also, the Minimum moment on base with a value of -34.7E+3 KN-m. When EQX is applied X direction moment is larger than Y direction.

- Load case: EQY

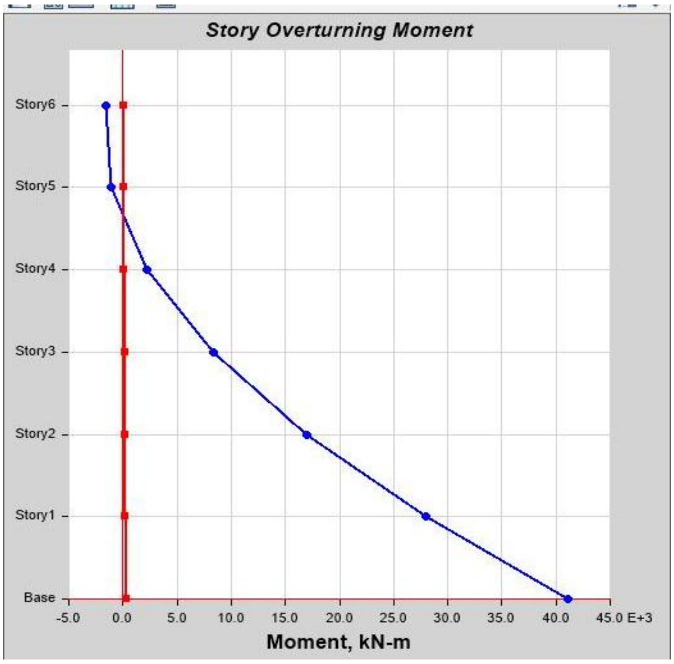

Fig -11: Storey overturning moment due to EQY

Discussion:

In the above graph of Overturning moment acting due to EQY, x direction moment highlighted by blue colour whereas y direction moment by red. Graph shows the moment from base to top storey. From the graph we can obtain that Maximum moment is on base with a moment value of 41.1E+3 KN-m. Also, the Minimum moment on storey 6 with a value of -1.5 KN-m. When EQY is applied Y direction moment is larger than X direction.

4. CONCLUSIONS

The following conclusions are made from the study :

- In this project, ETABS software is used for seismic analysis and design of G+5 commercial building with shear wall. The amount of time spent on analysis and design is reduced with the use of ETABS software.

- In this study, it is possible to limit the damage that can result from wind and earthquake forces because shear walls are constructed at potential deflection site.
- The study findings indicate that when compared to bare frames, shear wall arrangements provide the highest performance for building features such as storey displacement, inter story drift, storey shear etc.
- When compared to frame structures shear wall structures have less storey drift and displacement.
- A good technique to increase ductility and obtain more stable behavior is to confine concrete in shear walls. As a result, to have a suitable design, designer is free to increase the degree of axial stress.

4.1 Scope of future study

For further studies, we can identify the various places for placement of shear wall for better limiting potential harm from seismic and wind seismic factors at all possible deflection position. Also, the study can also be expanded to include analysis on steel frames.

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