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"Seismic Performance of High Rise Building with Different Structural System

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ABSTRACT
In this study a G+15 storey building is considered for modelling and analysis is done with different structural systems like shear wall, bracing system and friction damper. ETABS 2017 is used for analysis high rise building. Result has been obtained parameters like story displacement, story drift and base shear. From the result can concluded that Zone V has a lateral displacement that is 2% more than zone II. Lateral displacement is reduced when shear walls are present at different points in the structure; at the shear core and corner, it is reduced by 50% and 25%, respectively. The lateral displacement using X-bracing in this construction is 30% at zone II and 50% at zone V. When compared to similar buildings, friction dampers are effective at reducing the response of distant adjacent structures. As the number of stories increased after the earthquake, the friction damper dropped.

Keywords: ETABS, lateral load, Structural System, Shear Wall, Bracing System, Storey Displacement, Story Drift, Base Shear.

I. INTRODUCTION

High-rise structures are chosen as a solution to the land shortage brought on by the growing population. These kinds of high-rise structures are vulnerable to natural disasters. Because they can't be controlled and inflict damage and mayhem to the structural components, natural disasters like earthquakes are the most harmful. Engineers face a challenging problem when building these high-rise structures because of the numerous requirements, including lateral pressures, soil conditions, structural strength, stiffness, and economics. The damage and vibration in high rise building can be reduced by adopting various structural system like shear wall, bracing and friction damper these are on the whole having their fundamental capacity is to resist lateral forces.

BRACINGS

Bracing is the most effective method which can be incorpated to the reinforced concrete building to resist damages to structure. Large amount of lateral forces can be resisted using braced frames, which in turn reduces the lateral deflection. Bracing system is highly efficient and economical to lateral stiffening of the frames structure against lateral load.

FRICTION DAMPER

A device that dissipates power is a friction damper. The purpose of passive control devices is to reduce the power of earthquakes. The design of friction dampers allows them to slide over one another during an earthquake research since they feature a transferring element. Friction is created as parts move over one another, using some of the energy from the earthquake that is entering the building.

SHEAR WALL

Shear walls are vertical components that protect building structures from lateral stresses like wind and seismic impacts. Shear walls can resist heavy horizontal loads and support gravity loads at the same time because of their high in plane stiffness and strength.These vertically positioned partitions also include slabs, beams, and columns that can withstand lateral loads. Depending on the system's vertical elevation, the shear wall's thickness ranges from (150mm) to (400mm).

OBJECTIVE

- To model the high rise building using ETABS Version17.0.1.

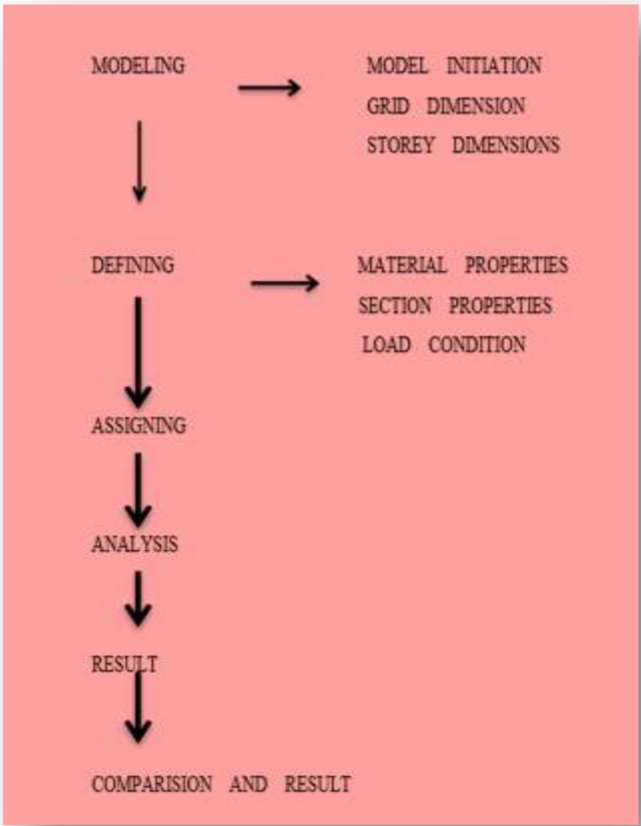
- To study the seismic responses like story drift, story shear and displacement of buildings in zone II and zone V.
- To ascertain the performance of shear wall on different locations of the building.
- To select braced system, shear wall and friction damper from the results of story drift, story shear and displacement of buildings.

METHODOLOGY

The current study analyses high rise building in seismic zones for the effects of wind and earthquake forces. ETABS is used to produce a 3D model for a high rise building.For structures that are not resistant to earthquake forces, a seismic study should be performed. Regular and low rise buildings will be the subject of this kind of examination, and this approach will produce effective results in these types of buildings dynamic analysis will be performed in accordance with IS 1893-2002 code (part1).The analysis procedure is carried out using the following techniques.

- Equivalent Static Analysis.
- Analysis of the Response Spectrum.

The current study analyses high rise structures in seismic zones for the effects of wind and earthquake forces. ETABS is used to create a 3D model for a high rise building. The steps involved in the study are as follows:



II. ANALYSIS AND RESULTS:

Structure Model Data

1. Building Type: Residential Building
2. No. Of Story: G+15
3. Building Shape: Rectangular
4. Geometrical Details:
a. Ground Floor: 3m
b. Floor –Floor Height: 3m
c. Height Of Building: 45m
5. Material Details:
a. Concrete Grade: M30
b. Steel Grade: Fe500
6. Section Details:
a. Beam Size: 350*350mm
b. Column Size:450*450mm
c. Slab Thickness : 150mm

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d. Shear WallThickness : 200mm
e. Bracing Property: ISMB350mm
f. Fiction Damper: ISA100*75*10mm

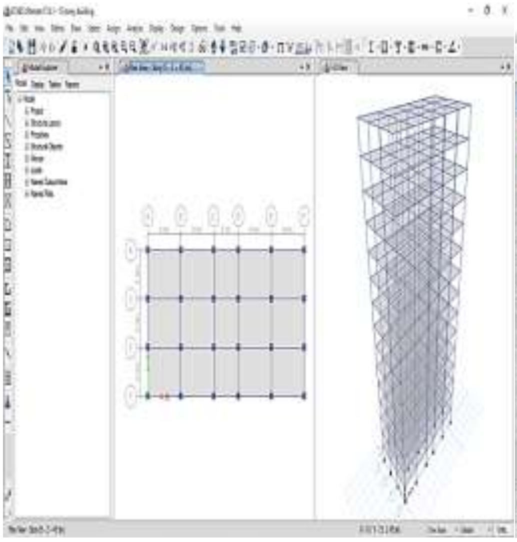
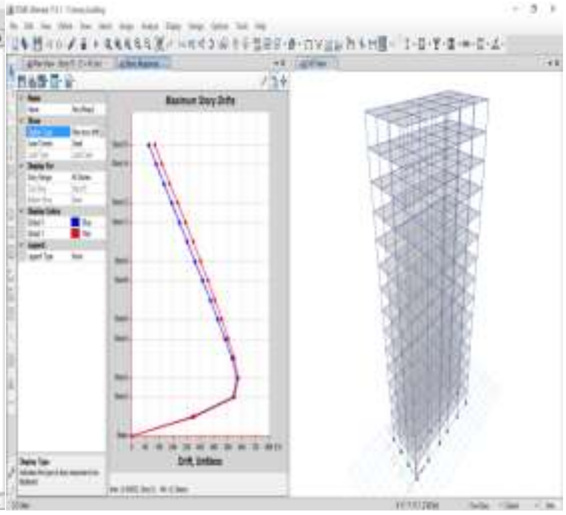

Figure 1: Plan of high rise building Figure 2: Maximum story drift for zone 2

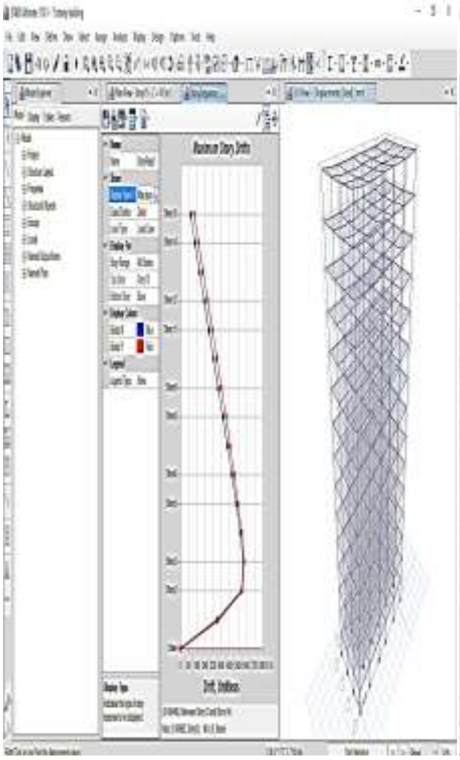
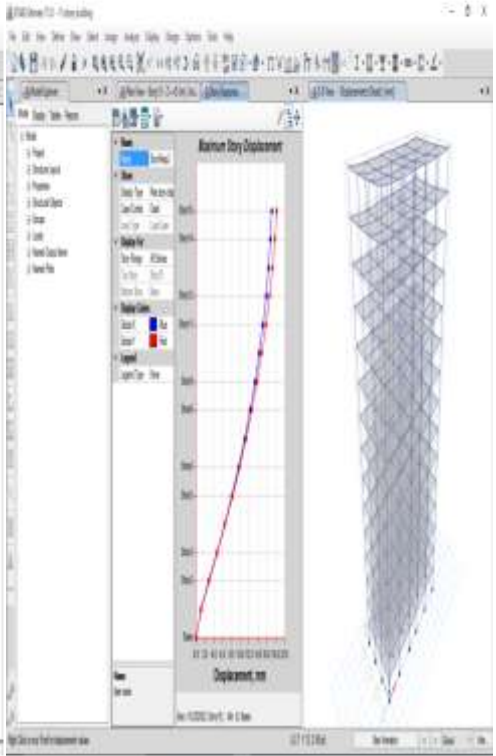

Figure 3: Maximum story drift for zone 3. Figure4: maximum story displacement

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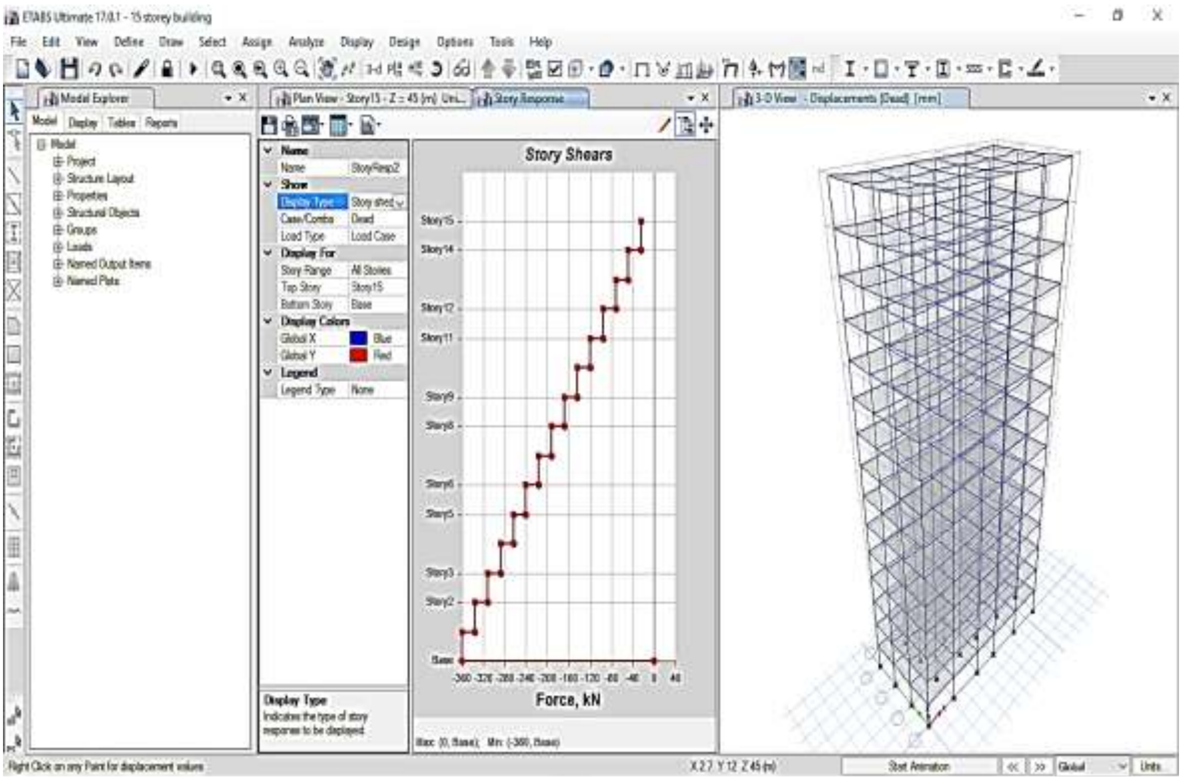

Figure 5: story shear

ZONE 5 RESULTS:

Table 1 :STORY DRIFT IN X DIRECTION

STORY	LOAD CASE	DIRECTION	DRIFT
Story 15	Seismic	X	0.001147
Story 14	Seismic	X	0.001699
Story 13	Seismic	X	0.002291
Story 12	Seismic	X	0.002873
Story 11	Seismic	X	0.003434
Story 10	Seismic	X	0.003975
Story 9	Seismic	X	0.004494
Story 8	Seismic	X	0.004993
Story 7	Seismic	X	0.005472
Story 6	Seismic	X	0.005932
Story 5	Seismic	X	0.006369
Story 4	Seismic	X	0.006764
Story 3	Seismic	X	0.007028
Story 2	Seismic	X	0.006746
Story 1	Seismic	X	0.004005

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Table 2: STORY DRIFT IN Y DIRECTION

STORY	LOAD CASE	DIRECTION	DRIFT
Story 15	Seismic	Y	0.001912
Story 14	Seismic	Y	0.002421
Story 13	Seismic	Y	0.002962
Story 12	Seismic	Y	0.003487
Story 11	Seismic	Y	0.003988
Story 10	Seismic	Y	0.004463
Story 9	Seismic	Y	0.004909
Story 8	Seismic	Y	0.005328
Story 7	Seismic	Y	0.005718
Story 6	Seismic	Y	0.006078
Story 5	Seismic	Y	0.006404
Story 4	Seismic	Y	0.006682
Story 3	Seismic	Y	0.006836
Story 2	Seismic	Y	0.006502
Story 1	Seismic	Y	0.00388

Table 3: BASE RECTION

Load Case/Combo	Force in x direction FxkN	Force in y direction FykN	Force in z direction FzkN	Moment in x direction MxkN m	Moment in y direction My kN m	Moment in z direction MzkN m
Dead	0	0	40940.7321	192489.2957	-397960.9576	0
Live	0	0	7695	34627.5	-73102.5	0
Seismic 1	-4444.0862	0	0	0	-112972.2402	19998.3877
Seismic 2	0	-4433.3341	0	112600.392	0	-42116.6737
Seismic 3	-802.589	0	0	0	-19997.6004	3611.6504
Seismic 4	0	-1694.3545	0	42217.1563	0	-16096.3678
Comb1 Max	6090.1292	-576	61411.096	288733.94	-427483.07	-33453.5815
Comb1 Min	-345.6	-2887.14	36846.7	236566.11	-358164.862	-26218.158

ZONE 2 RESULTS

Table 4:STORY DRIFT IN X DIRECTION

STORY	LOAD CASE	DIRECTION	DRIFT
Story 15	Seismic	X	0.000941
Story 14	Seismic	X	0.001388
Story 13	Seismic	X	0.001876
Story 12	Seismic	X	0.002367
Story 11	Seismic	X	0.002852
Story 10	Seismic	X	0.003329
Story 9	Seismic	X	0.003799
Story 8	Seismic	X	0.00426

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Story 7	Seismic	X	0.004711
Story 6	Seismic	X	0.005153
Story 5	Seismic	X	0.00558
Story 4	Seismic	X	0.005975
Story 3	Seismic	X	0.006254
Story 2	Seismic	X	0.006043
Story 1	Seismic	X	0.003605

Table 5: STORY DRIFT IN Y DIRECTION

STORY	LOAD CASE	DIRECTION	DRIFT
Story 15	Seismic	Y	0.001912
Story 14	Seismic	Y	0.002421
Story 13	Seismic	Y	0.002962
Story 12	Seismic	Y	0.003487
Story 11	Seismic	Y	0.003988
Story 10	Seismic	Y	0.004463
Story 9	Seismic	Y	0.004909
Story 8	Seismic	Y	0.005328
Story 7	Seismic	Y	0.005718
Story 6	Seismic	Y	0.006078
Story 5	Seismic	Y	0.006404
Story 4	Seismic	Y	0.006682
Story 3	Seismic	Y	0.006836
Story 2	Seismic	Y	0.006502
Story 1	Seismic	Y	0.00388

Table 6: BASE RECTION

Load Case/Combo	Force in x direction FxkN	Force in y direction FykN	Force in z direction FzkN	Moment in x direction MxkN m	Moment in y direction My kN m	Moment in z direction MzkN m
Dead	0	0	40940.7321	192489.2957	-397960.9576	0
Live	0	0	7695	34627.5	-73102.5	0
Seismic 1	-4013.2184	0	0	0	-98071.1778	18059.4827
Seismic 2	0	-4010.2317	0	97967.8867	0	-38097.201
Seismic 3	-606.8726	0	0	0	-15121.0589	2730.9266
Seismic 4	0	-1281.1754	0	31922.2654	0	-12171.166
Comb1 Max	5674.2276	-345.6	36846.6591	173240.3662	-211058.0951	-29162.824
Comb1 Min	-345.6	-2267.3631	36846.7	221123.72	-358164.862	-20330.349

Shear wall at corner

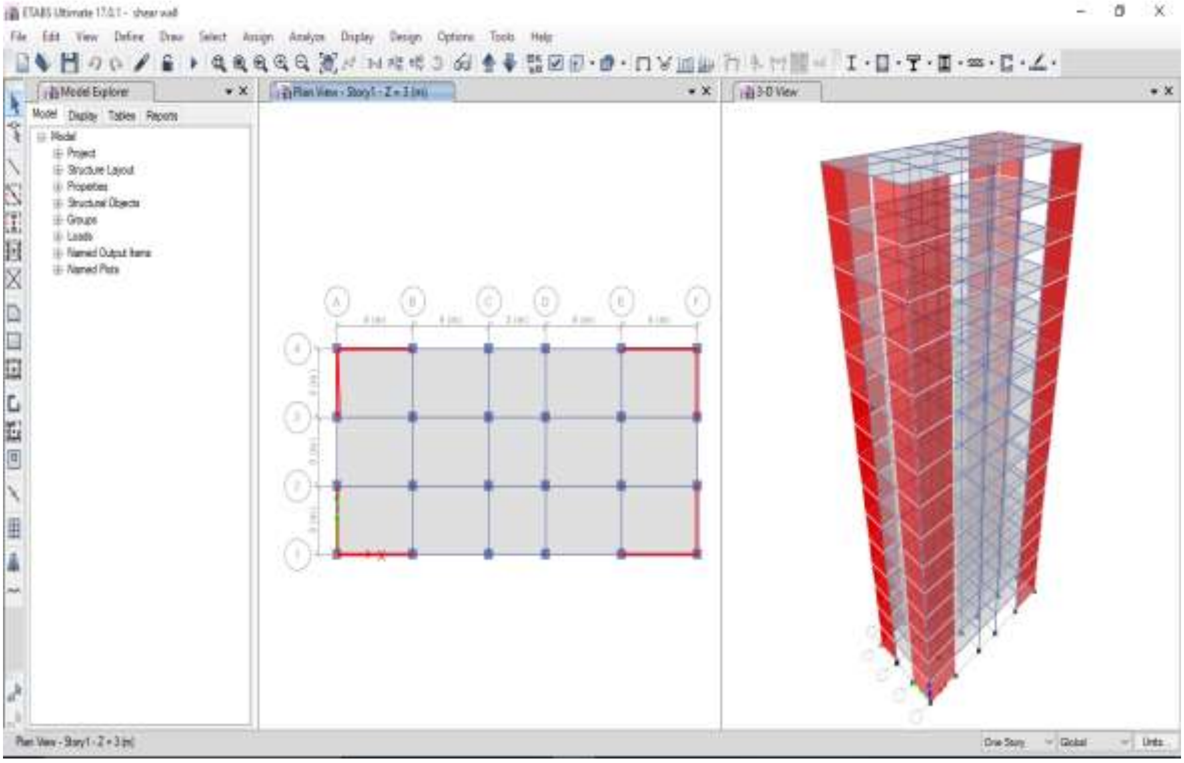

Figure 6: plan of shear wall at corner

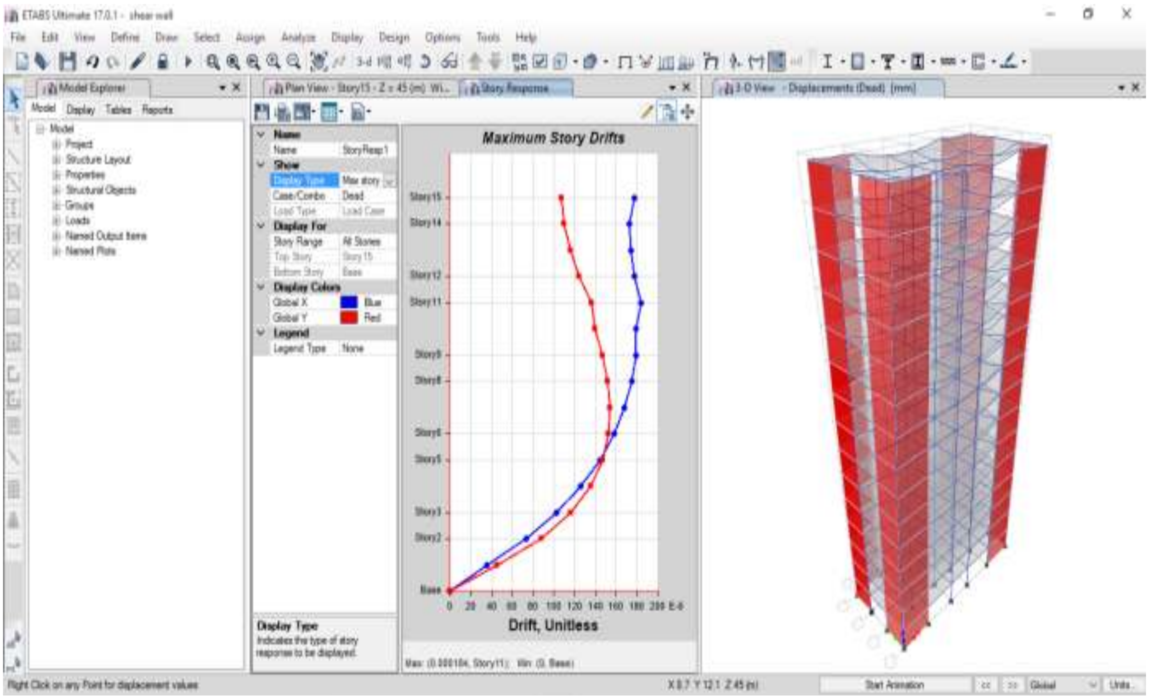

Figure 7: Maximum Story Drift

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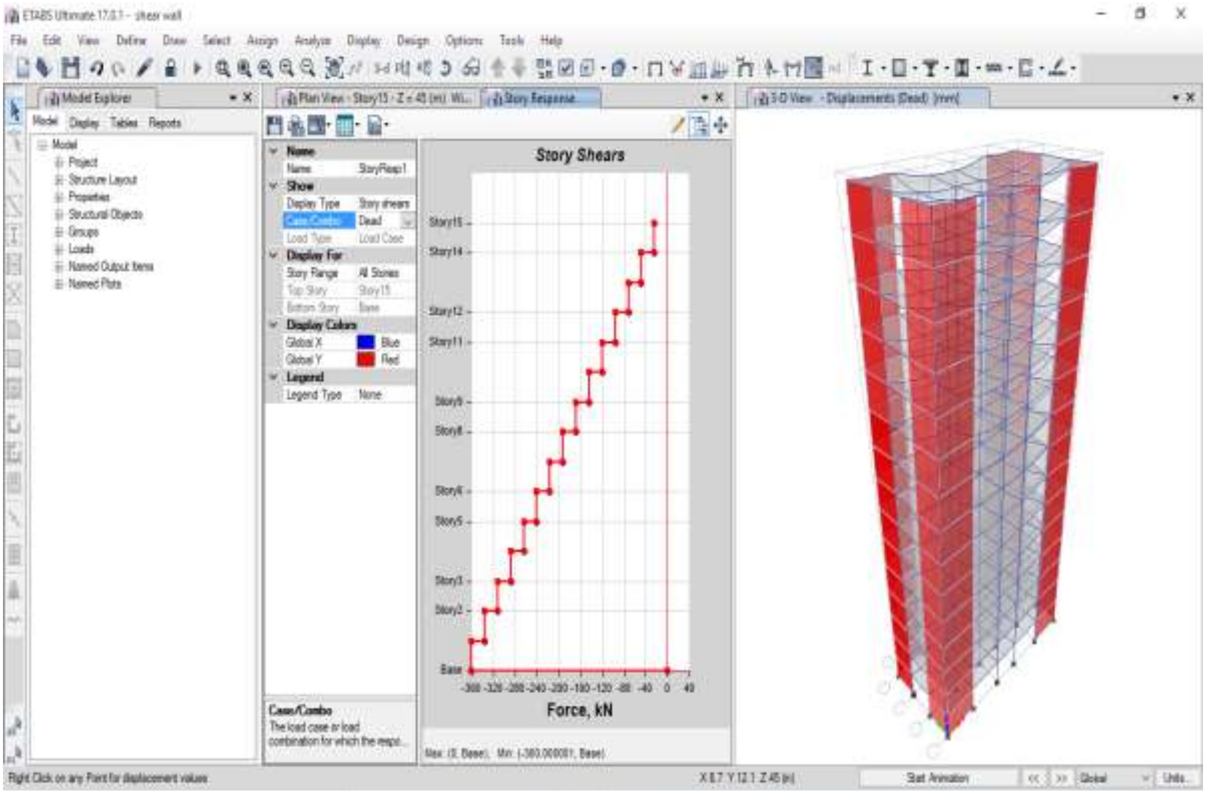

Figure 8: Story shear

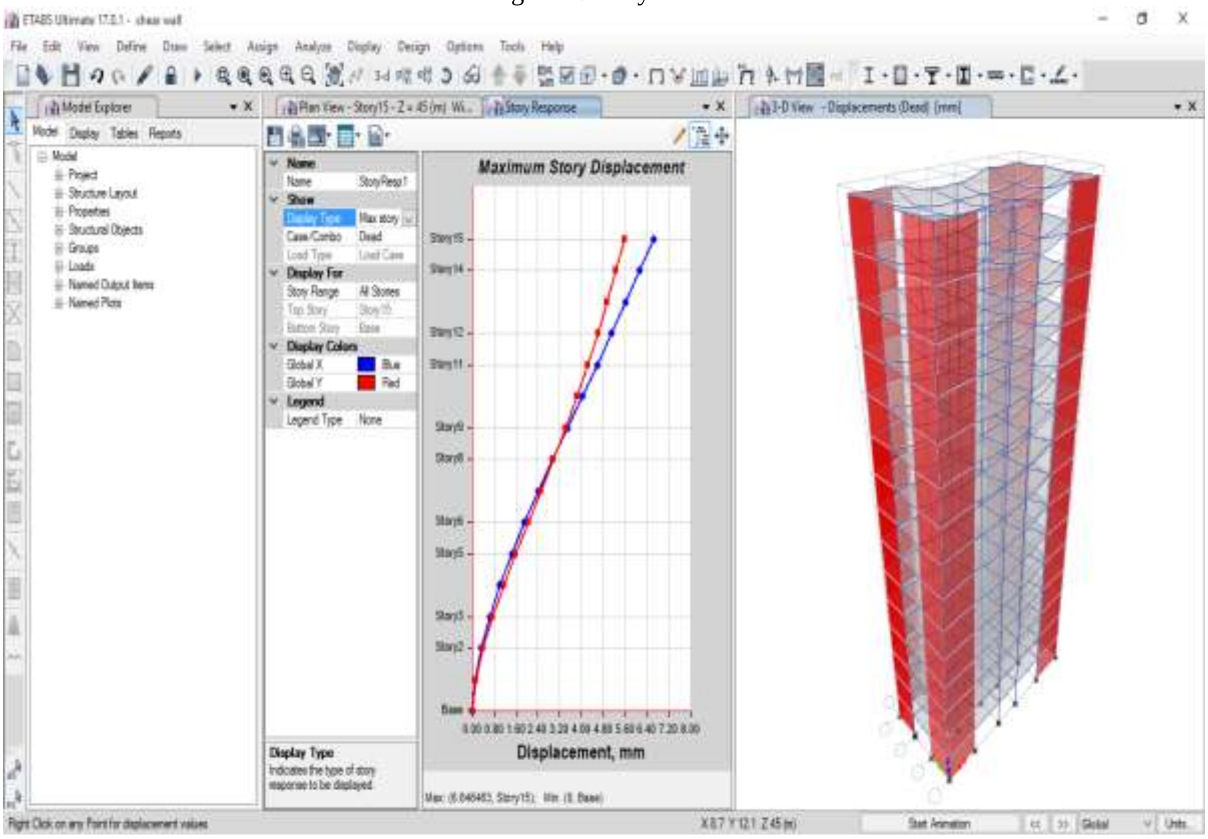

Figure 9: Maximum Story Displacement

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Shear wall in middle

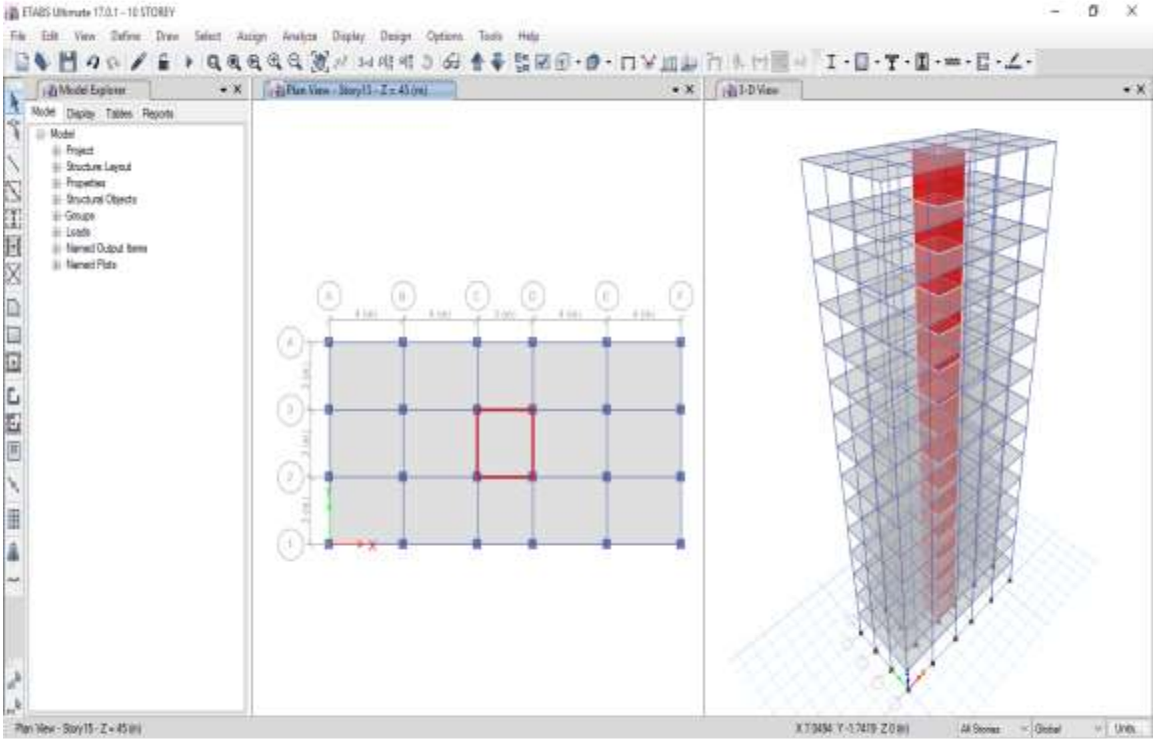

Figure 10: plan of shear wall in middle

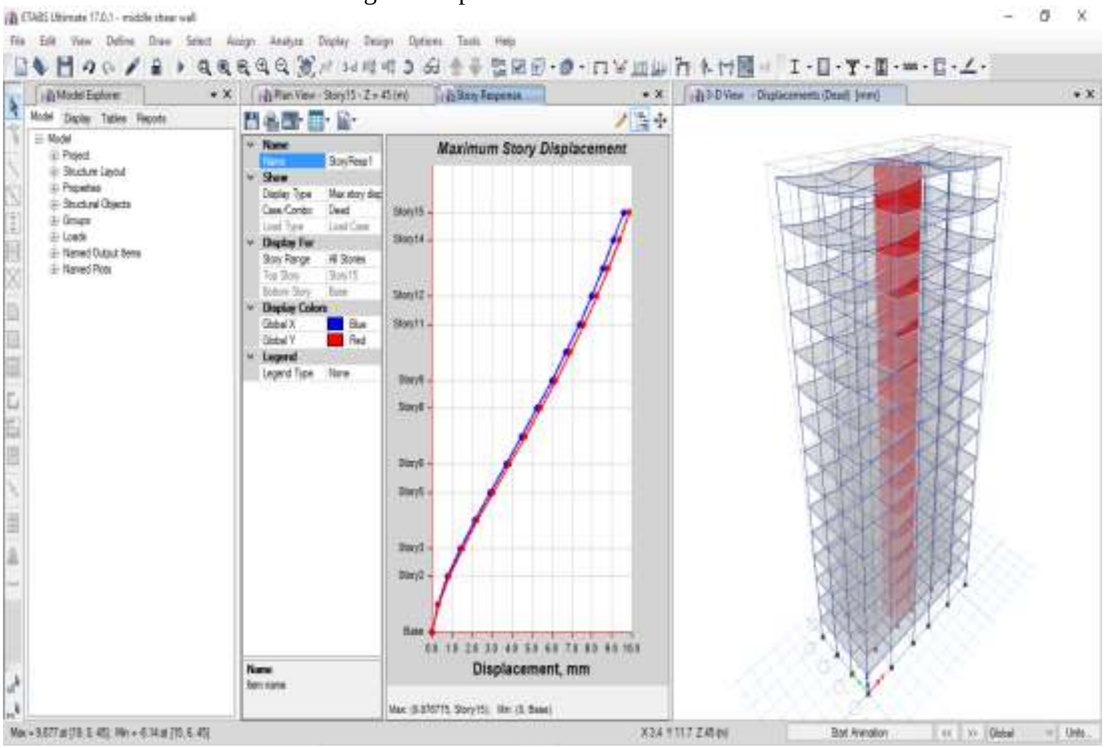

Figure 11:maximum story displacement

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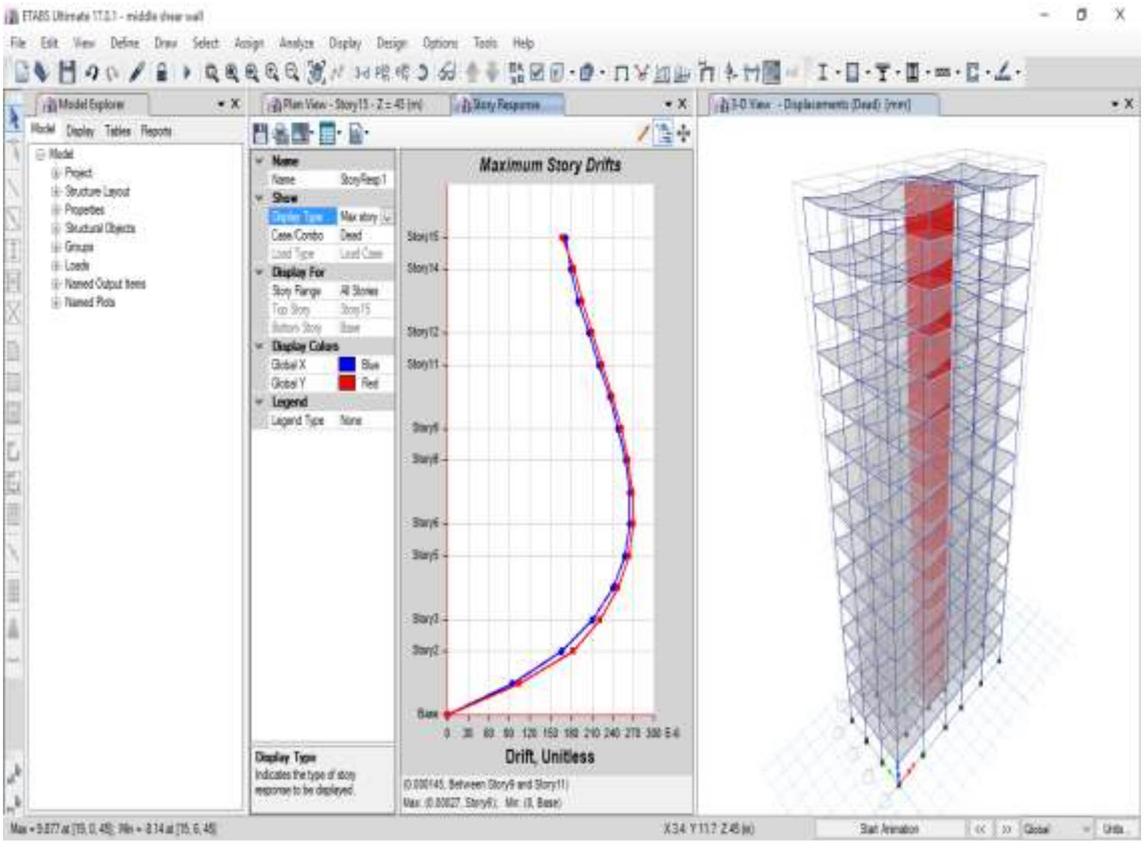

Figure 12:maximum story drift

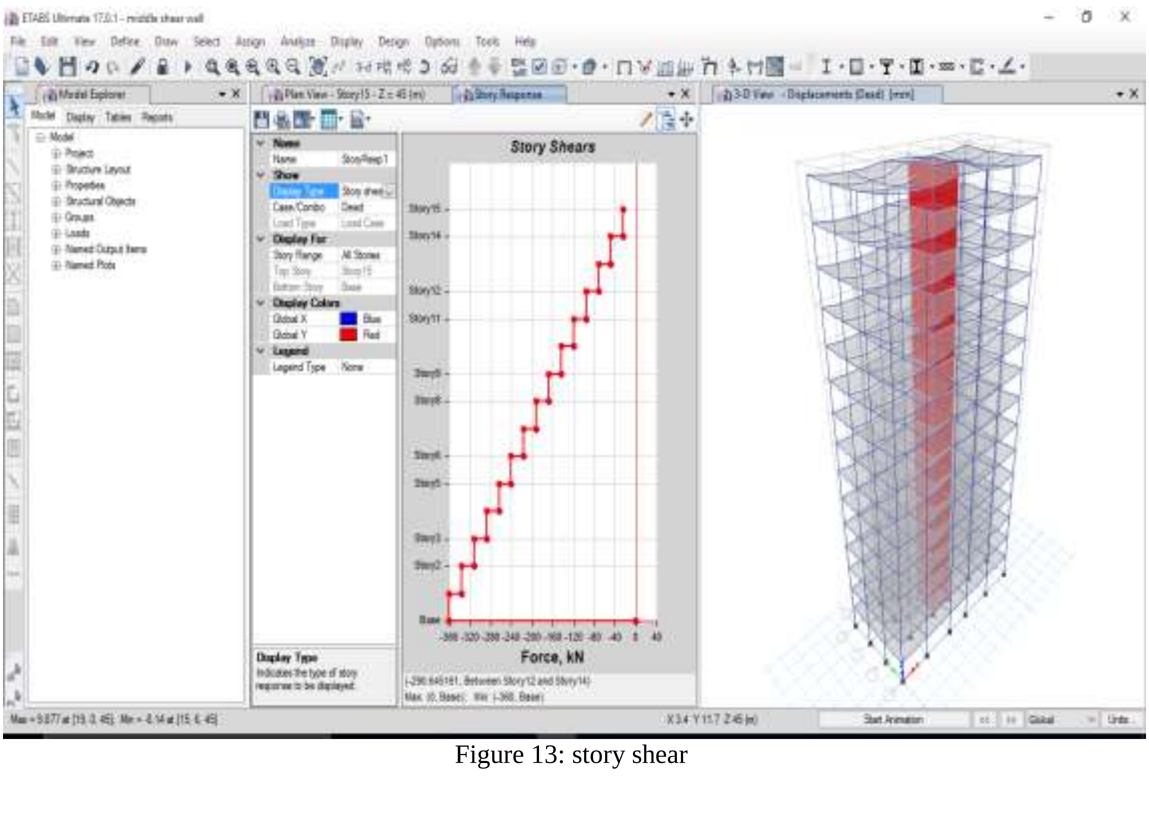

Figure 13: story shear

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BRACING

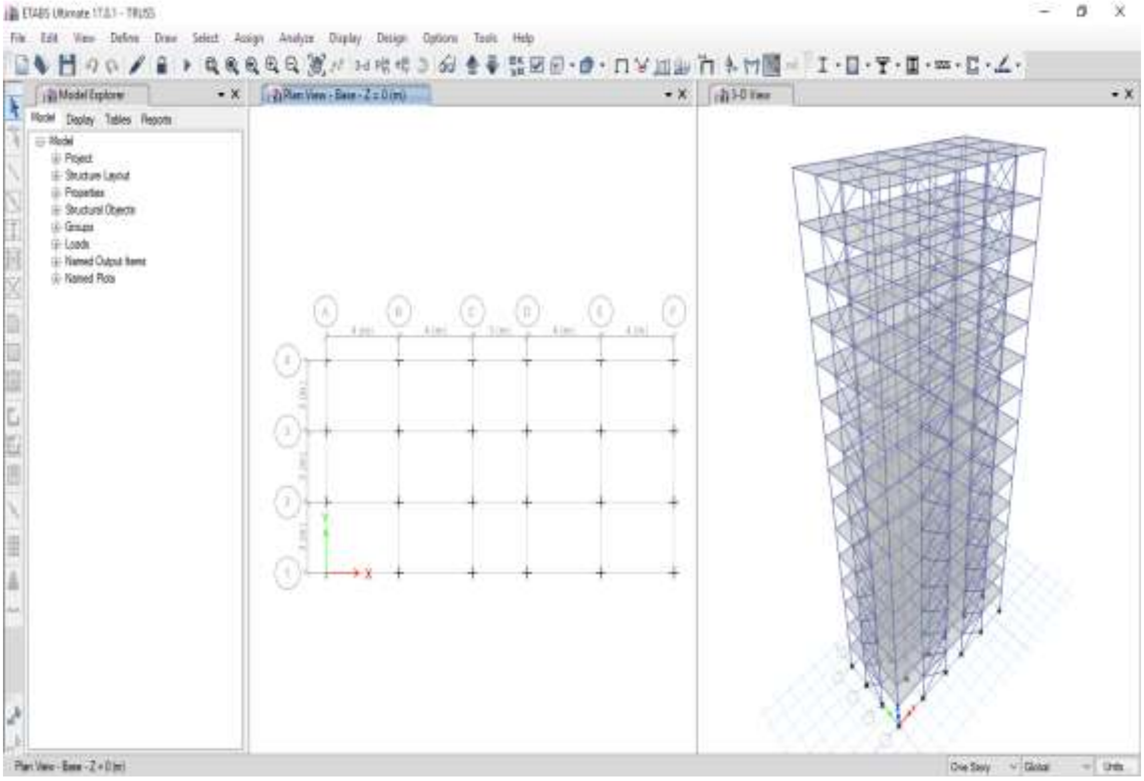

Figure 14: plan of cross bracing

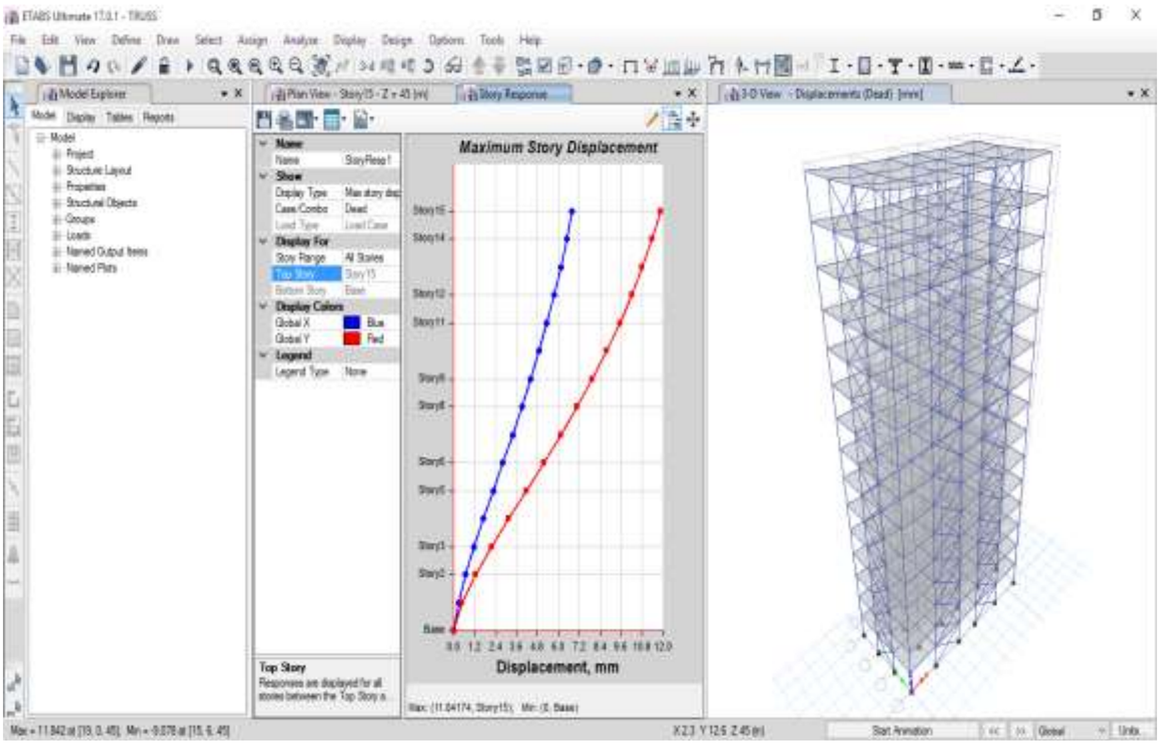

Figure 15: maximum story displacement

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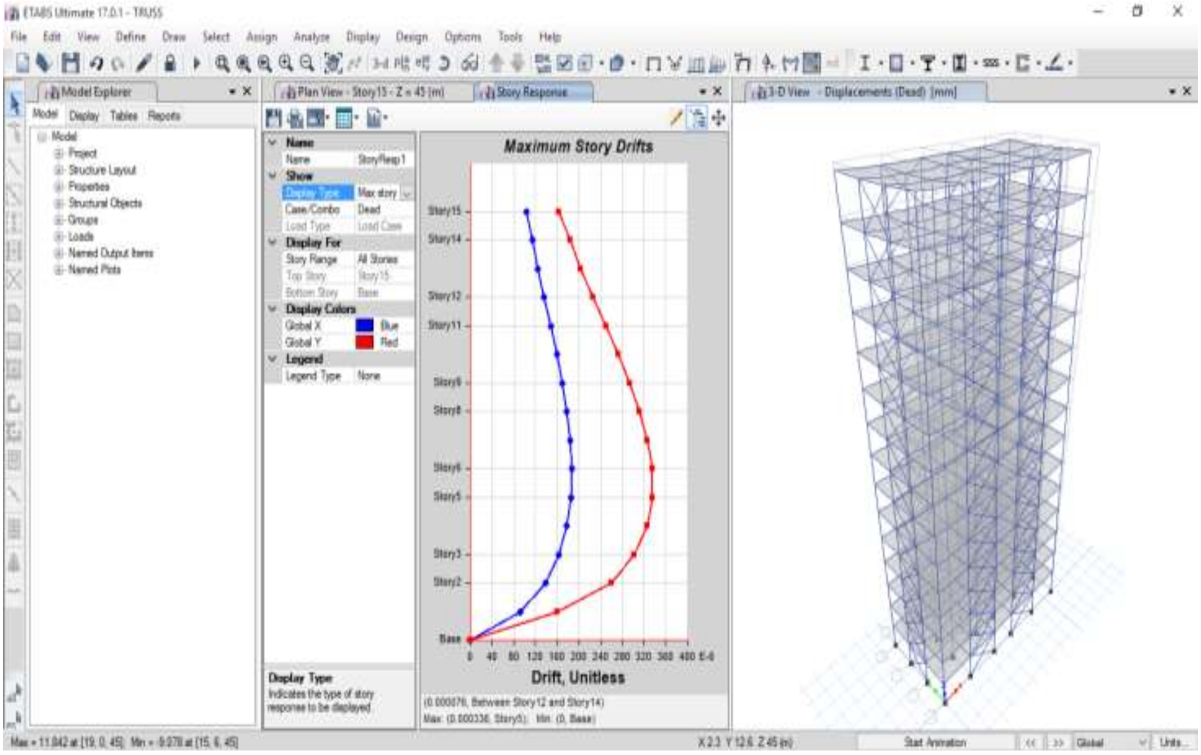

Figure 16 :maximum story drift

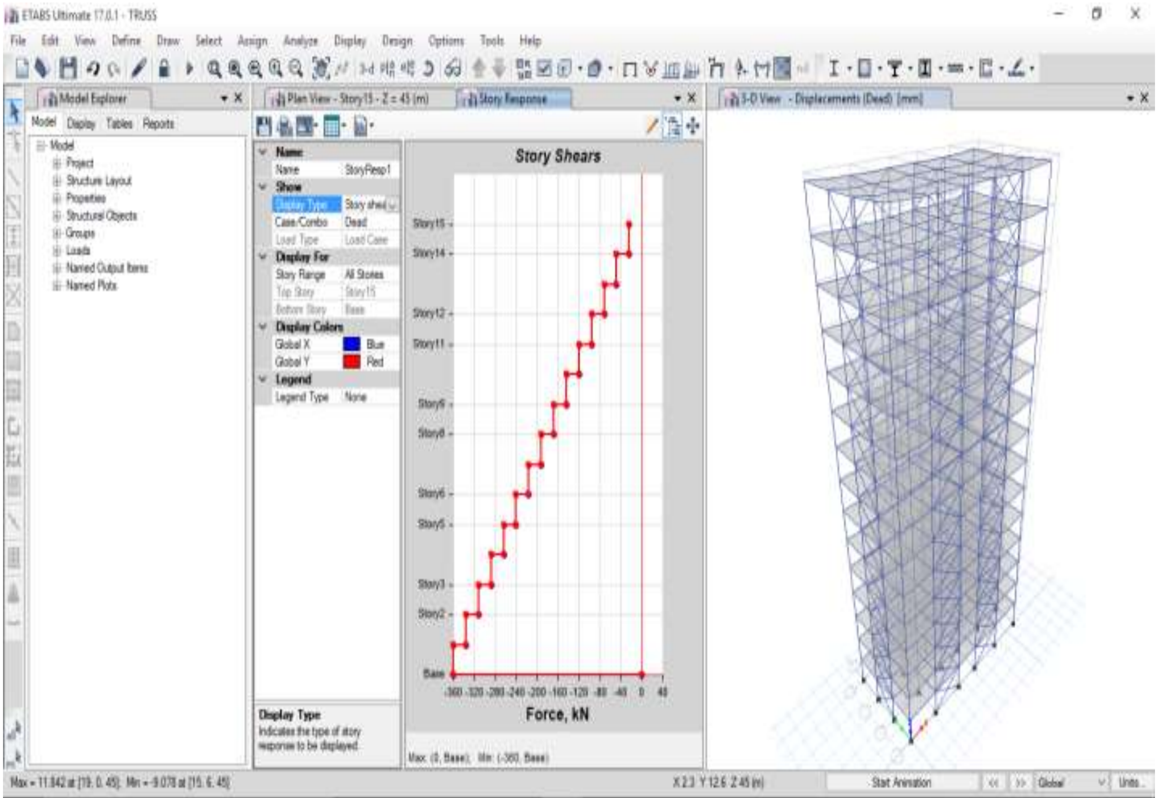

Figure 17 :story shear

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FRICTION DAMPER

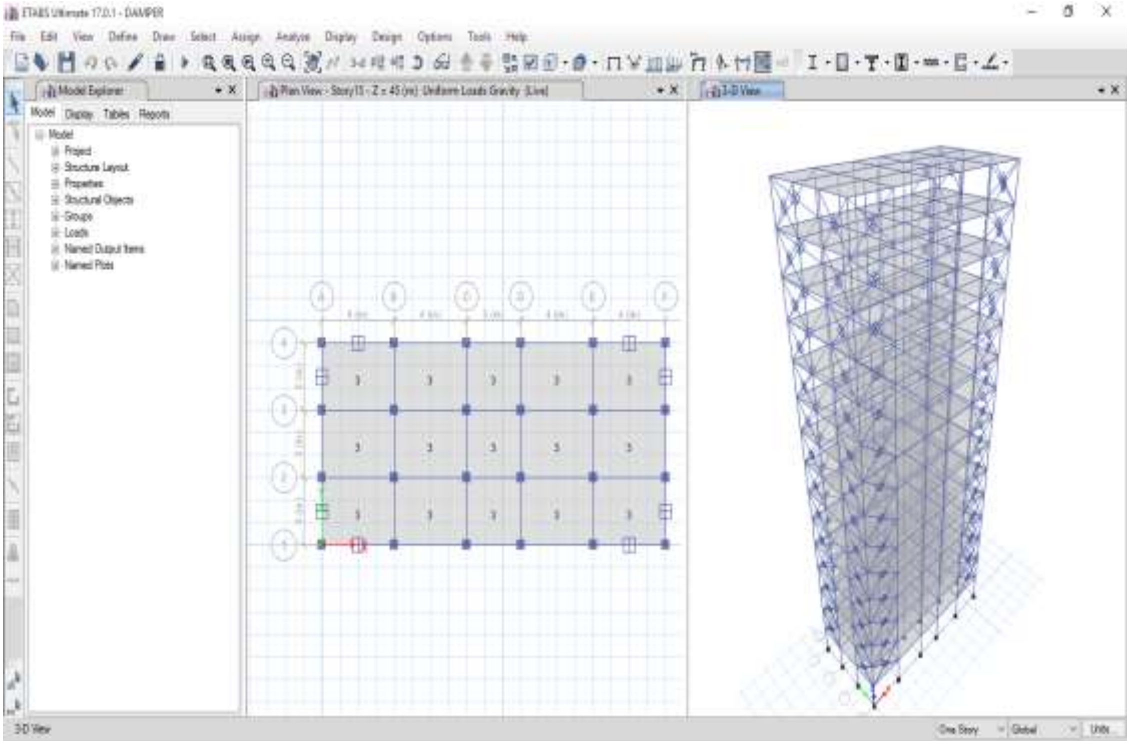

Figure 18: plan of Friction damper

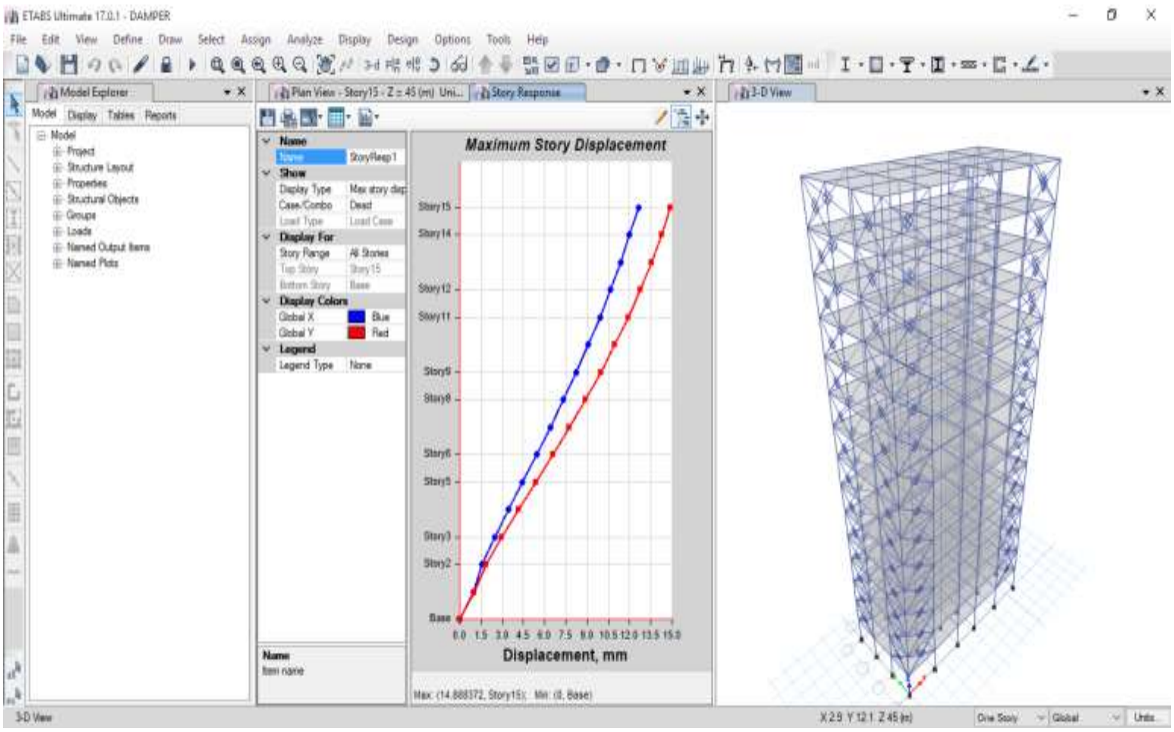

Figure 19 :maximum story displacement

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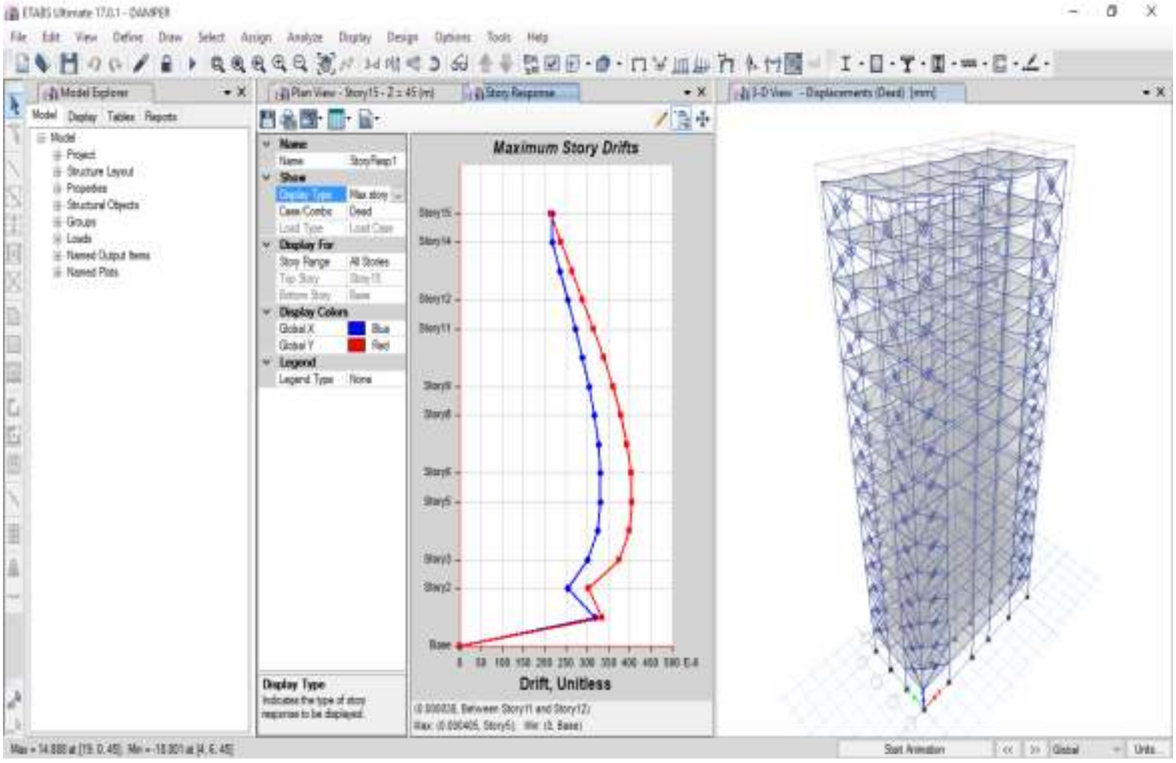

Figure 20: maximum story drift

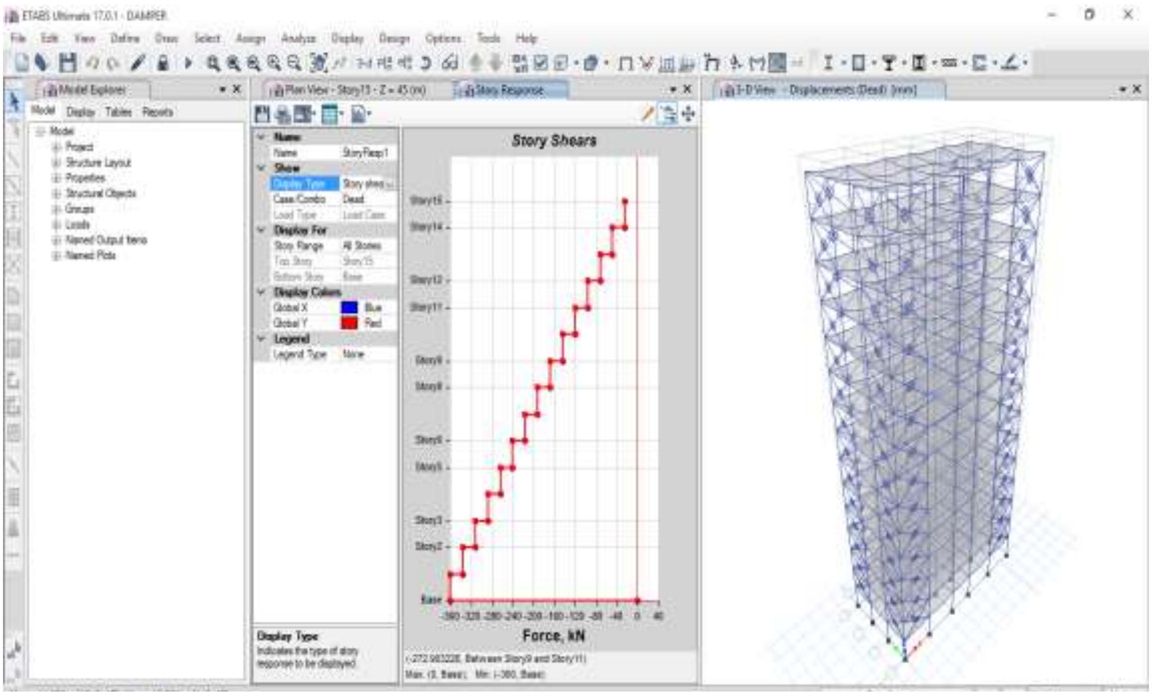

Figure 21: storyshear

III. CONCLUSIONS

- Using ETABS Software, the analysis of 15 story high-rise building subjected to Seismic, wind and live load carried out.
- Graphs of lateral displacements were used to show the behavior of high rise building.
- Zone V has a lateral displacement that is 2% more than zone II.

- If Shear walls are provided at corner and core of the building, then the Displacement is reduced by 50% and 25%.
- In this project when using the X-bracing, the lateral displacement is 30% at zone II and 50% at zoneV.
- The fluid viscous dampers are provided in corner of building, the Maximum displacement is 30%, maximum story drift is 55%(15.00mm) , base shear is increased by 20% for zone V.

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4. IS 875- 1987 (Part-3) – Wind loads.
5. IS 1893-2016 (Part-1) - Seismic design.
IS 16700 – 2017 - Criteria for structural safety for high rise building.