ANALYTICAL STUDY ON SEISMIC BEHAVIOUR OF HIGH RISE BUILDING USING DIFFERENT LOAD RESISTING METHOD

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ABSTRACT: Height of the building has now become the primary point of focus of today's world. Since buildings are getting taller and slender the primary concern of design engineers is shifting from gravity loads to lateral loads. The effect of lateral forces becomes more and more dominant as the building becomes taller and taller. These lateral forces can produce critical stresses in the structure, induce undesirable stresses and vibrations or cause excessive lateral sway of the structure.

In this project a, G+16 storey building, along with shear wall and two different types of bracing is considered for analysis. The performance of building will be evaluated on the basis of following parameters –Storey displacement, Storey drift, Base shear. In this work, the shear walls and bracings are provided at corner with the overall analysis to be carried out using ETABS software.

Keywords: ETABS, Seismic analysis, Bracing, Shear wall.

1.INTRODUCTION

Earlier buildings were designed gravity loads but now because of tall height and seismic zone the engineers have taken care of lateral loads due to earthquake and wind forces. So, to cater all the lateral forces, we have to design the structure very uniquely so that the structure can withstand for the maximum time period without causing any harm to the society. The Engineers and professional in the structural designing fields have found out many ways to tackle this problem. Traditional simple framed structures have now been replaced by complex yet more effective structural systems that perform better in case of lateral load. When reinforced concrete was first introduced as a building material, there were limitations on the heights that those buildings could reach. Structural engineers have gradually learned more about the properties of concrete and the structural systems.

These elements are a variety of shapes such as Circular, curvilinear, oval, box-like, triangular or rectilinear. Many times, a shear wall exists as a core-wall holding internal services like elevators, janitor's closets, stair wells and storage areas. Sometimes they serve external functions as a diagonal bracing system. When carefully planned, these walls may be used as partitions in a structure serving as both gravity- and a lateral-load bearing system

Few of the lateral load resisting system

1. Frame Action of Column and Slab Systems

2.Braced Frame

3. Shear Wall

4. Framed shear Wall

5. Framed Tube System

6. Tube in Tube System

2. OBJECTIVE

The main objective of this project is to check and compare the seismic response of multi-storied building by using shear wall, X bracing and inverted V bracing.

1) Behaviour study of G+16 storey tall building with four different models one is bare frame, one with shear wall and other with X and inverted V bracing at corner of building for seismic loads.

2) The variation of displacement, storey drift, storey shear of the models to be studied.

3)The model is analysed in zone V.

4) Response spectrum analysis is to be carried out.

3. METHODOLOGY

1. Modelling of G+16 storey building using ETABS software

2. Shear wall and Bracing system (X bracing and inverted V bracing) are applied at corner periphery of the building.

3. Parameters considered in this project are storey displacement, storey shear and storey drift.

4.Seismic zone considered in this project is zone V

5.Evaluate the analysis result and verify the requirement of geometrical limitations.

3.1 PROBLEM STATEMENT

The study is focused on seismic behaviour of Regular Multi-Storey RCC (G+16) building located in Zone V with using ETABS-2018 Software. The Lateral load resisting system used in the building are Bracings and Shear wall.

Model-1 Bare frame building.

Model-2 Frame with Shear wall at the corner of building.

Model-3Frame with X Bracing at the corner of building.

Model-4 Frame with inverted V bracing at the corner of building.

3.2 GEOMETRICAL PROPERTOES

Description of Building

The size of the building in plan – (35 m x 35 m) (COMMERCIAL)

Bay width of plane frame (In both X and Z): 3.5 m

Number of stories: 17 (G+16)

Ground storey height: 3.5 m

Intermediate floor height: 3 m

Type of soil: Medium soil

Zones: V

Materials

Grade of concrete: M25

Grade of steel: Fe-550

Density of concrete: 25 KN/m3

Density of masonry infill: 20 KN/m3

Member Dimensions

Column size: (900 mm * 600 mm)

Beam size: (500mm * 300mm)

Slab thickness: 125 mm

Thickness of external Wall: 230 mm

Thickness of internal Wall: 115 mm

Thickness of Shear Wall: 200mm

Clear cover of Column: 40 mm

Clear cover of beam: 25 mm

Clear cover of slab: 20 mm

Clear cover of shear wall: 25

Loads Considered:

Dead Load: Self weight

Floor Live Load: 4KN/m²
Roof live load: 1.5KN/m²

Wall Load: 13 KN/m² (9" Thick)

Other Loads: Seismic Load

Seismic Load:

Seismic design shall be done in accordance with IS: 1893:2016. The parameters to be used for analysis and design are given below (As per IS: 1893:2016 (Part I)).

Zone: V

Zone factor: 0.36 (IS 1893 (Part 1)

Importance factor: 1.2

Response Reduction: 5.0

Soil type: Type 2

4. MODELLING OF STRUCTURE

The modeling of the members like Beam, Column and Slab will be done as per the standard procedure by adopting following properties –

1. Beams, Column will be designed by M30 grade of concrete and Fe415 and Fe250 grade of steel.

2. The slab will be defined as thin shell in ETABS.

3. The building to be modeled is having G+16 storeys.

4. Shear wall and Bracing system are applied in the building to resist Lateral Loads.

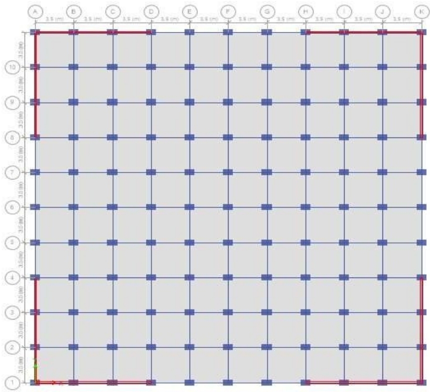


Figure.1: Plan view of building

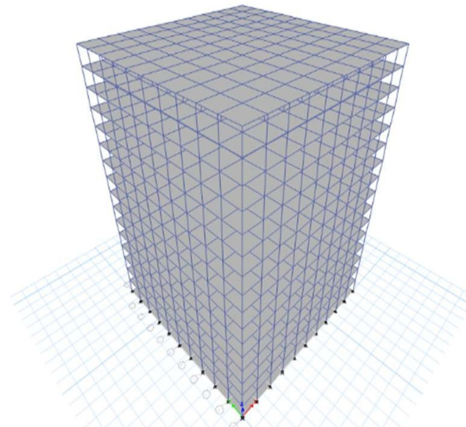


Figure 2: Bare Frame Building

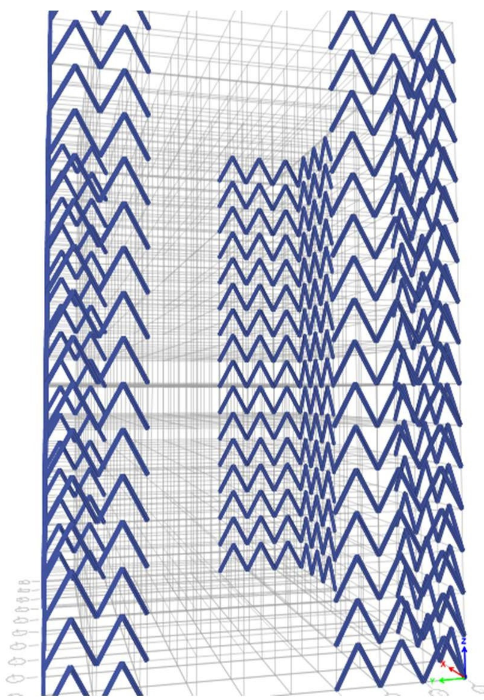


Figure 3: Building with X Bracing

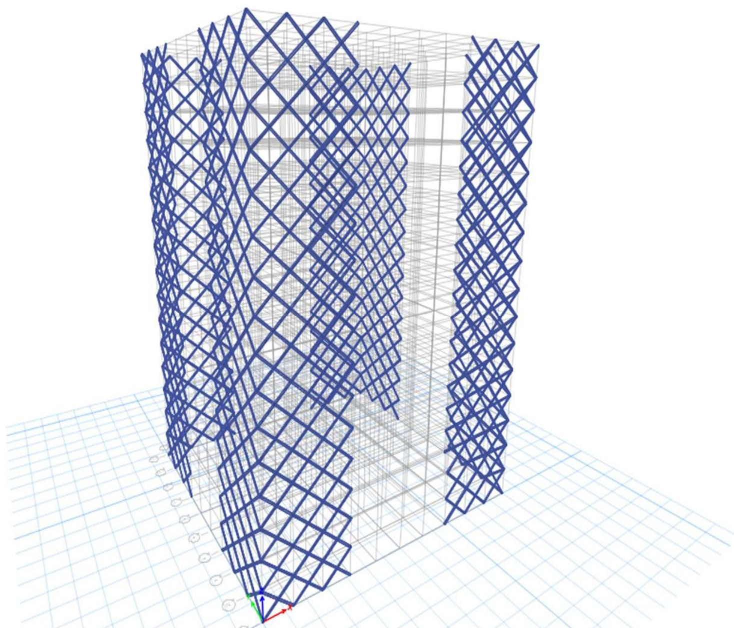


Figure 4: Building with Inverted V Bracing

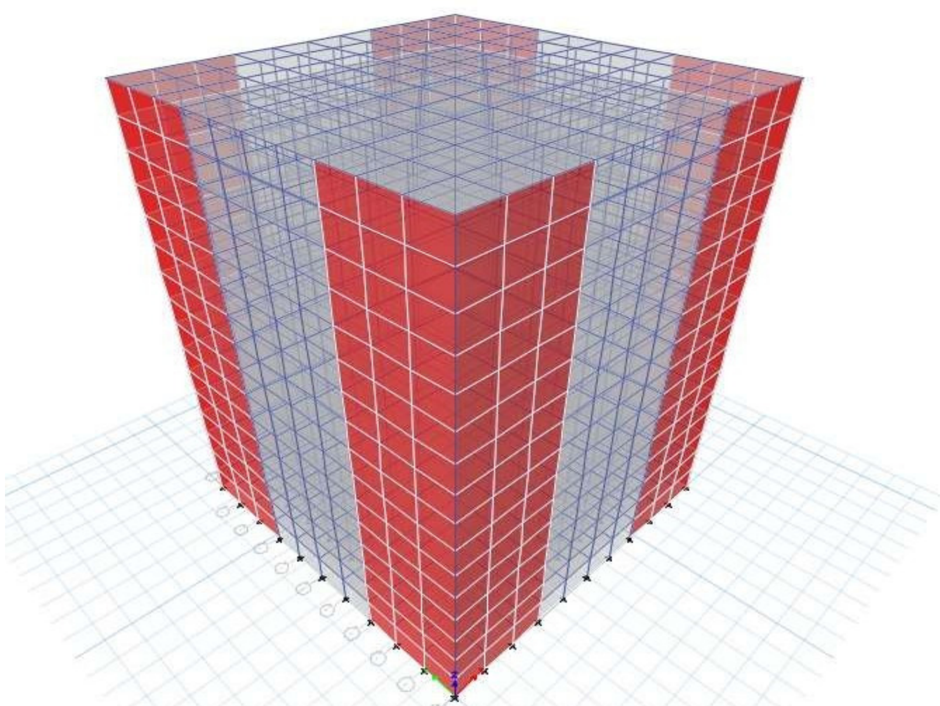
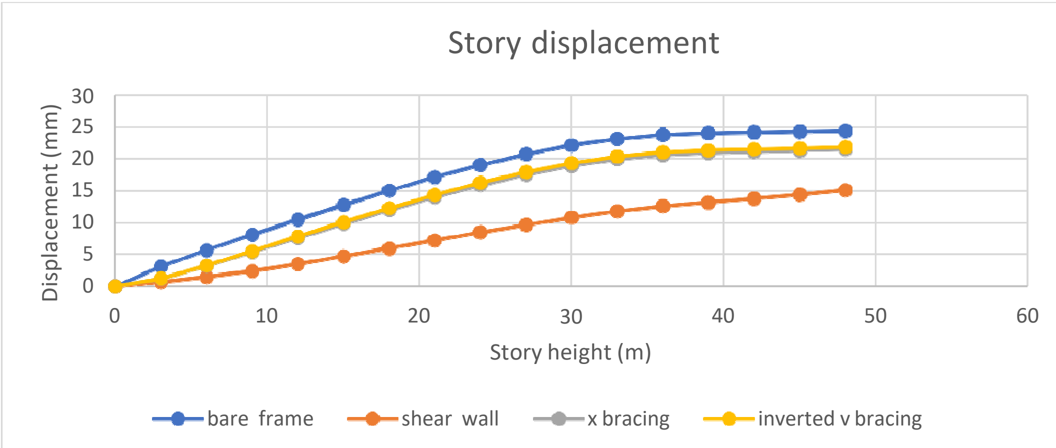


Figure 5: Building with Shear Wall

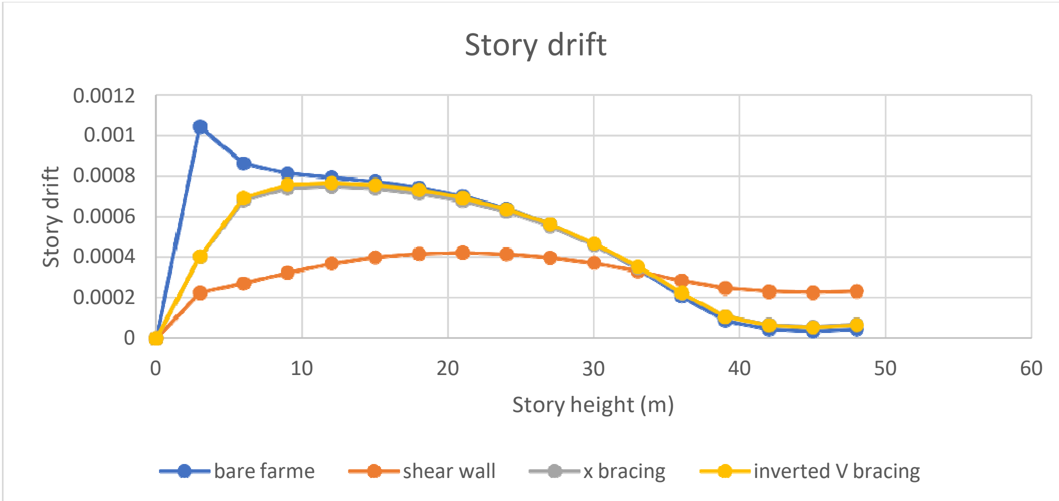
RESULTS AND DISCUSSIONS



Comparative Graph Showing Displacement in Y Direction

Elevation m	bare frame	shear wall	x bracing	inverted v bracing
48	24.462	15.145	21.545	21.889
45	24.337	14.447	21.344	21.703
42	24.232	13.811	21.172	21.547
39	24.098	13.208	20.982	21.371
36	23.836	12.612	20.682	21.08
33	23.21	11.804	20.025	20.424
30	22.176	10.812	18.977	19.367
27	20.784	9.697	17.591	17.963
24	19.095	8.5	15.931	16.275
21	17.171	7.251	14.057	14.366
18	15.069	5.983	12.022	12.29
15	12.838	4.732	9.876	10.099
12	10.517	3.532	7.661	7.836
9	8.137	2.436	5.425	5.543
6	5.704	1.476	3.225	3.28
3	3.133	0.679	1.208	1.216
0	0	0	0	0

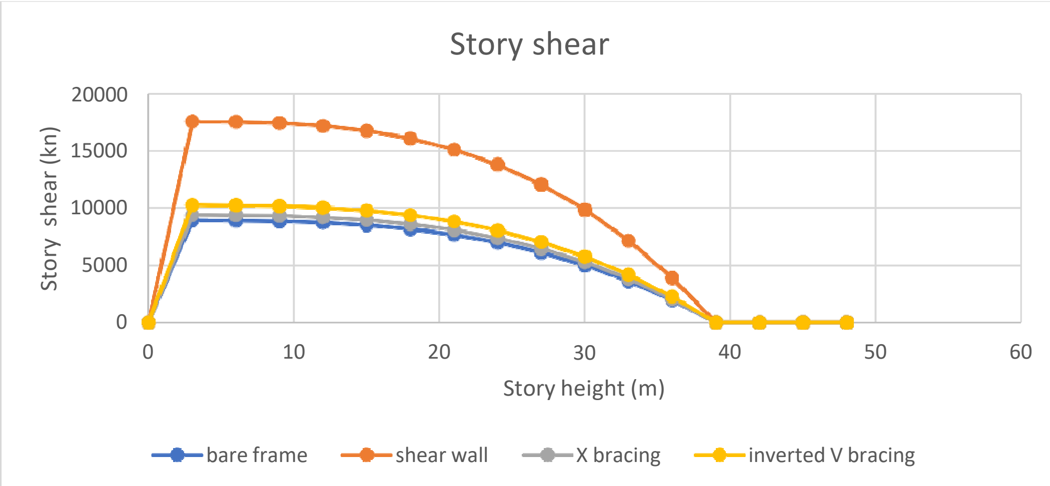
Total displacement of any story with respect to ground is defined as story displacement. Maximum permissible story displacement is limited to H/500, where H is the total height of building. The maximum displacement in bare frame, shear wall, X bracing and inverted V bracing are 24.46mm, 15.45mm, 21.5mm, and 21.88 mm respectively.



Comparative Graph Showing Drift in Y Direction

Elevation m	Bare Frame	Shear Wall	x bracing	inverted V bracing
48	4.5E-05	0.000233	0.00007	0.000066
45	3.5E-05	0.000227	0.000058	0.000053
42	4.5E-05	0.000232	0.000068	0.000064
39	8.9E-05	0.000248	0.000109	0.000107
36	0.00021	0.000286	0.000222	0.000225
33	0.00035	0.000331	0.000349	0.000355
30	0.00046	0.000372	0.000462	0.000469
27	0.00056	0.000399	0.000553	0.000563
24	0.00064	0.000416	0.000625	0.000637
21	0.0007	0.000423	0.000678	0.000693
18	0.00074	0.000417	0.000715	0.000732
15	0.00077	0.0004	0.000739	0.000756
12	0.00079	0.000369	0.000749	0.000766
9	0.00081	0.000324	0.000741	0.000758
6	0.00086	0.000272	0.000681	0.000695
3	0.00104	0.000226	0.000403	0.000405
0	0	0	0	0

The word “Drift” can be defined as the lateral displacement of the structure, Storey drift is the slower and small movement of one level of a multilevel building relative to the level below. Inner storey drift is the difference between the floor and roof displacements of any given story as the building sways during the earthquake, marked by the story height, more is the storey drift will cause more damages to the structures, its value should not be beyond the limit 0.004h, where (h) is height of the building. The value of story drift increases up to the mid height of building and then decreases to the top of building.



Comparative Graph Showing Shear in Y Direction

Elevation m	bare frame	shear wall	X bracing	inverted V bracing
48	0	0	0	0
45	0	0	0	0
42	0	0	0	0
39	0	0	0	0
36	1982	3900	2068.7	2278.2
33	3648	7178	3840.1	4192.5
30	5024	9886	5289.2	5774.6
27	6139	12080	6463	7056.1
24	7020	13814	7390.4	8068.6
21	7694	15141	8100.5	8843.8
18	8190	16116	8622.2	9413.4
15	8534	16793	8984.4	9809.9
12	8754	17226	9216.3	10062
9	8878	17470	9364.7	10204
6	8933	17579	9404.7	10268
3	8947	17606	9419.2	10284
0	0	0	0	0

The amount of maximum lateral force because of seismic ground motion at the soffit or base of the structure is base shear, its horizontal movement of base of the structures, it depends on following factors: Condition of soil on the site, Closeness to potential sources of seismic activity like geological faults, Probability of significant seismic ground motion due to earthquakes, Total weight of Building, Period of the vibration. Base shear is inversely proportional to story displacement. Maximum shear occurs on bottom of the building.

CONCLUSION

1. The maximum story displacement occurs in building with bare frame i.e., 24.462mm in Y direction followed by 21.889 mm in inverted V bracing, 21.454 in X bracing and minimum in shear wall i.e., 15.145mm.

2. The values of story drift for all buildings are found to be increasing from base to mid height of building and again decreases from mid to top height of building. Story shear found to be maximum in case of building with shear wall i.e., 17942 KN followed by 11024.27 KN in inverted v bracing, 10023.49 KN in X bracing and minimum in bare frame i.e., 9402 KN.

3. On comparison of various parameters like story drift, story displacement and story shear, building with shear wall has better performance than both bracing.

4. Model with least story displacement and maximum base shear value resist maximum lateral force therefore building with shear wall resist maximum lateral loads.

5. As the height of building increases displacement increases. Shear wall is more effective than both inverted v and x bracing.

6. In x and inverted v bracing maximum story displacement is near about same so we can use any of the system. the value of story drift is found are found within permissible limits i.e., not more than 0.004 times height of building.

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