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Design And Analysis Of G+20 Storey Building With And Without Shear Wall

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ABSTRACT

The structural safety and soundness of the built environment relies heavily on the design and study of multistory buildings with shear walls. The purpose of this research is to determine whether or not shear walls improve the seismic resistance of a multistory structure.

The task at hand is settling on the right layout for the building and including shear walls at strategic points. By using dynamic analysis, we can test how a building will react to different earthquake loads and get a better sense of how safe it is. This work sheds light on the importance of shear wall location and size for structural performance, which is crucial in the design and study of multistory buildings with shear walls. This research helps fill in some of the gaps in our knowledge of shear wall behavior in high-rise buildings. The structure is modeled in ETABS, loads are applied, and the structural behavior is analyzed.

Keywords: Storey Drift, Storey Displacement, Shear Walls.

I. INTRODUCTION

1.1 GENERAL

A shear wall is a kind of vertical support structure designed to resist horizontal loads that operate perpendicular to the plane of a wall, such as wind, earthquake, and other lateral pressures. These walls are crucial to a structure's strength and stability. Redistributing these lateral loads and limiting excessive lateral movement is especially important in multi-story buildings. Even with earthquake protection in place, the structure is still vulnerable to a wide range of aftershock impacts. The distribution of loads and the building's strength are crucial to the structure's behavior. During extreme wing load or seismic stress, the structure might swing dangerously without a shear wall.

These walls are responsible for transmitting the horizontal pressures that push a structure down onto its base. They provide the building the rigidity and strength it needs to resist the pressures that may otherwise cause it to bend or even collapse. Locating shear walls at strategic areas, such as around the building's periphery, central core, or at the building's corners, helps to evenly distribute forces.

II. LITERATURE REVIEW

Greeshma and Jaya (2006) exploring the right way to link the shear wall to the diaphragm. When compared to the other two arrangements, the differences between the shear wall and diaphragm connection with a hook stand out more clearly. Consequently, under dynamic lateral stress, the effectiveness of the hook connection between the shear wall and diaphragm was enhanced..

Agrawal and Charkha (2012): According to the findings, the orthogonal deflection is significantly affected by the placement of the shear wall. Most of the members saw an increase in force as the shear wall was moved farther from the center of gravity.

Chandurkar and Pajgade (2013) examine how moving the shear wall about changes the distribution of forces, and how important it is to get that part just right. When the shear wall's dimensions are large, it must bear a great deal of the horizontal forces. An effective placement of the shear wall may drastically reduce earthquake-induced displacements.

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Kevadkar and Kodag (2013) determined that steel bracing is an effective method of increasing the structure's resistance to stress. By bringing the demand curve closer to the elastic range, both the shear wall and the steel bracing contribute to greater safety. Steel bracing structures provide more capacity than shear wall systems. In addition, steel bracing offers a higher margin of safety against collapse than shear walls provide.

III. OBJECTIVES

- A multi-story building's seismic response to different shear wall configurations is one of this project's key foci.
- Then, using the ETABS program, we will model the effects of several shear wall locations inside the building and compare the results with respect to storey displacements and storey drift.

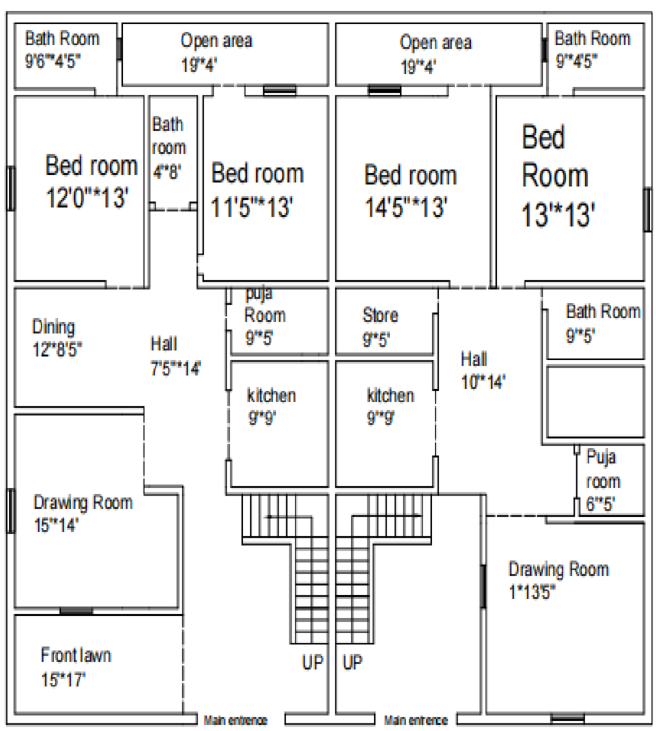
IV. METHODOLOGY

4.1 Modelling of the building

It is common practice to use ETABS for both structural analysis and building design. It uses the finite elements approach to evaluate complicated structural systems including skyscrapers, bridges, and other structures. Generally speaking, ETABS employs the following methods:

1. Model creation: Develop a three-dimensional representation of the building by outlining its many components. Materials like concrete strength and steel characteristics might also be entered.
2. Load and boundary conditions: use a mix of dead load, live load, and seismic load to stress the structure. If you want an exact simulation of the structure's behavior, you'll need to provide support conditions like fixed connections.
3. analysis :Run the evaluation using suitable techniques for the goal of determining structural response to the applied loads. Etabs use matrices and equations to compute motion, pressure, and torque.
4. Shear wall design: Design shear wall at necessary shear wall position based on analysis findings..

4.2 Autocad 2d view



4.3 Analysis methodology

Seismic analysis:

1. static method
   A. Equivalent static method
2. Dynamic method
   A. Time history method
   B. Response spectrum method

In this project as per IS 1893:2016 seismic analysis can be performed by response spectrum method.

Response spectrum method: It is possible to evaluate how a building reacts to seismic or other dynamic stresses by using the response spectrum method of structural analysis. A response spectrum is a graphical depiction of ground motion that shows the frequency-dependent acceleration, velocity, or displacement of a structure. Using this strategy, we can predict how a building would react during an earthquake or other dynamic event.

4.4 Data of Building

Table 1: Data of building

Height of the building	3m
Area of the building	3000 sq feet
Number of stories	20 floors
Grade of concrete	M25
Grade of steel	Fe415
Thickness of slab	150mm
Thickness of wall	230mm
Beam size	450X600mm
Column size	450X600mm
Seismic zone	V
Type of soil	II
Importance factor (I)	1.5
Response reduction factor (R)	5
Live load	2KN/m2
Floor finish	1.5KN/m2

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4.5 MODELS OF BUILDING

Model 1: Building without any shear wall

Model 2: structure featuring shear wall positioned at each of its four corners.

Model 3: structure featuring shear wall positioned at each of its four edge.

Model 4: structure featuring shear wall positioned at both front and back

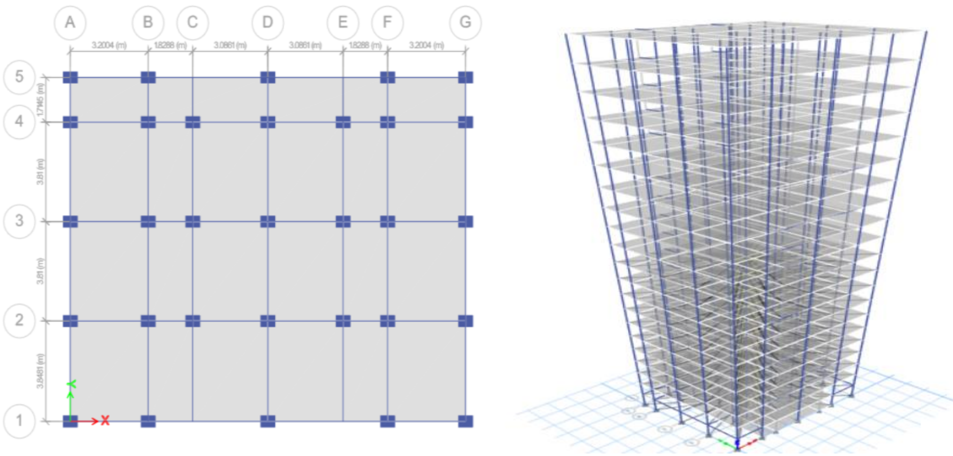


Fig.1. Model 1-buildig without any shear wall

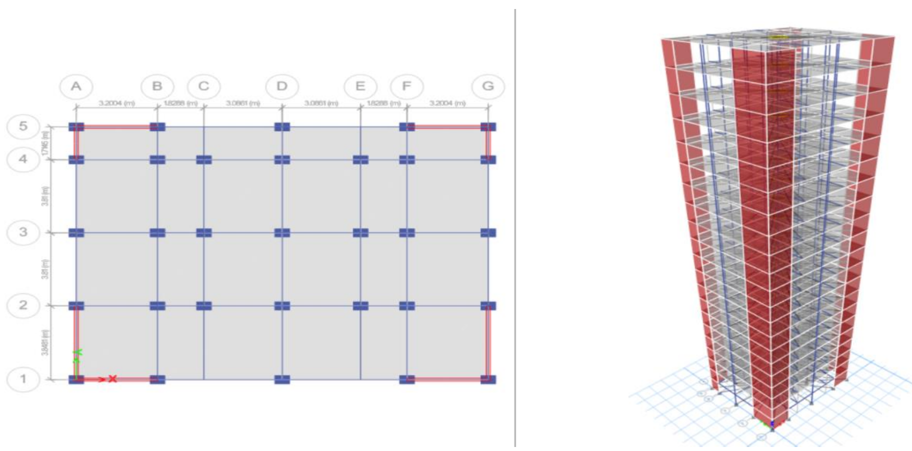


Fig.2. Model 2- Structure featuring shear wall positioned at each of its four corner.

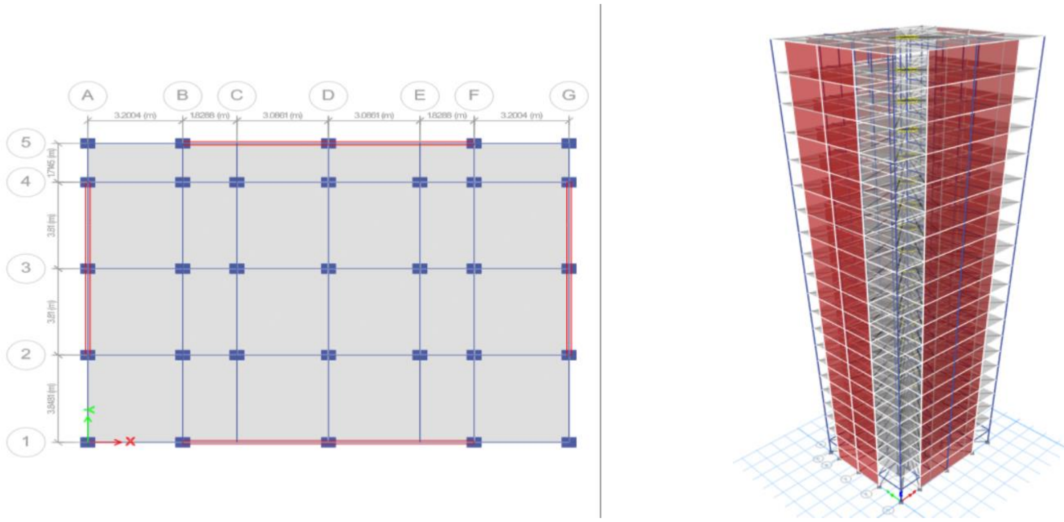


Fig.3. Model 3 structure featuring shear wall positioned at each of its four edge.

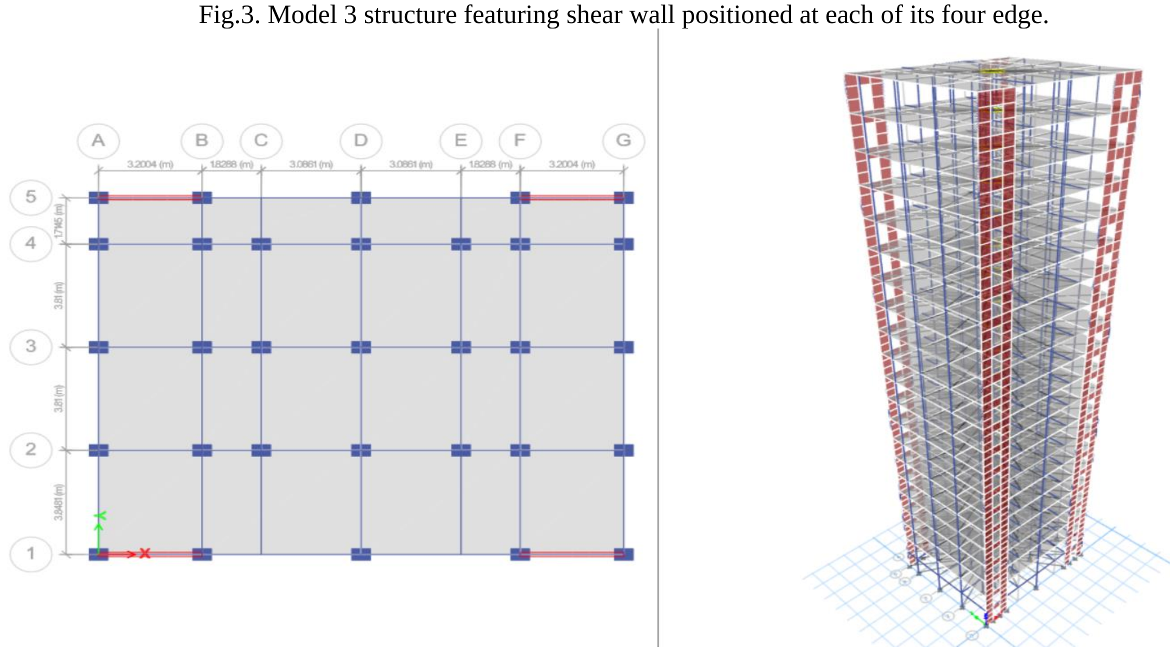


Fig.4. Model 4- Structure featuring shear wall positioned at both front and back

V. RESULTS

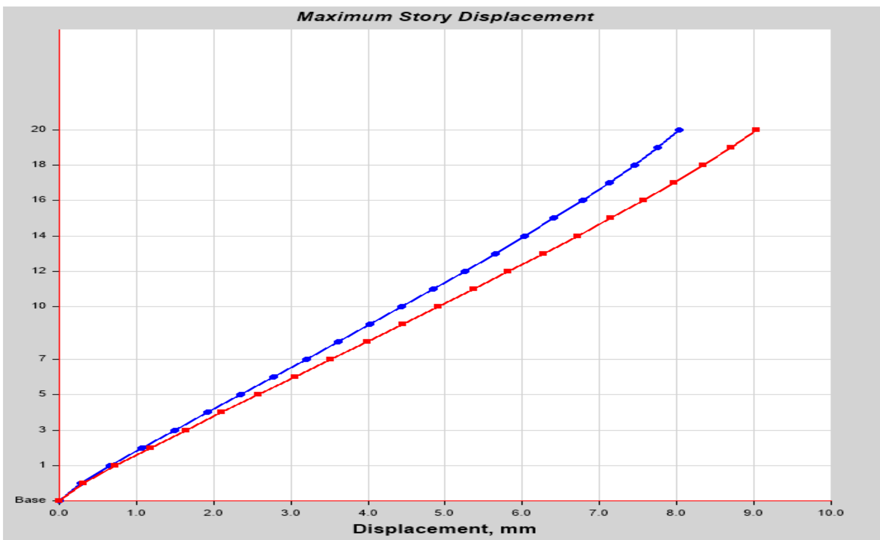
5.1 BUILDING WITHOUT ANY SHEAR WALL

5.1.1 STOREY DISPLACEMENT

Table 2: max storey displacement of building without any shear wall

Storey	Max. storey displacement in mm	
	X direction	Y direction
20	8.027	9.034
19	7.75	8.704
18	7.448	8.347
17	7.122	7.966
16	6.775	7.564
15	6.411	7.144
14	6.034	6.712
13	5.646	6.27

12	5.25	5.821
11	4.849	5.366
10	4.442	4.908
9	4.031	4.447
8	3.616	3.983
7	3.196	3.517
6	2.773	3.048
5	2.347	2.577
4	1.919	2.106
3	1.493	1.638
2	1.073	1.176
1	0.665	0.729
P	0.28	0.309
Base	0	0



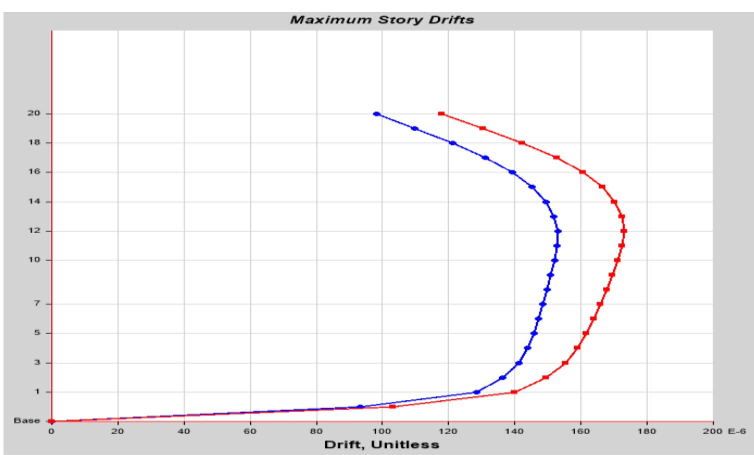
Graph 1: Storey v/s displacement of building

5.1.2 STOREY DRIFT

Table 3: max storey drift of building without any shear wall

Storey	Max. storey drift in mm	
	X direction	Y direction
20	0.000098	0.000118
19	0.00011	0.00013
18	0.000121	0.000142
17	0.000131	0.000153
16	0.000139	0.000161
15	0.000145	0.000166

14	0.000149	0.00017
13	0.000152	0.000172
12	0.000153	0.000173
11	0.000153	0.000173
10	0.000152	0.000171
9	0.000151	0.00017
8	0.00015	0.000168
7	0.000148	0.000166
6	0.000147	0.000164
5	0.000146	0.000162
4	0.000144	0.000159
3	0.000141	0.000155
2	0.000136	0.000149
1	0.000128	0.00014
P	0.000093	0.000103
Base	0	0



Graph 2: Storey v/s storey drift of building

5.2 RESULT OF STRUCTURE FEATURING SHEAR WALL POSITIONED AT EACH OF ITS FOUR CORNER

5.2.1 STOREY DISPLACEMENT

Table 4: Max storey displacement of structure featuring shear wall positioned at each of its four corner

Storey	Max. storey displacement in (mm)	
	X direction	Y direction
20	8.666	9.445
19	8.331	9.068
18	7.98	8.674
17	7.609	8.26
16	7.219	7.827
15	6.811	7.375
14	6.384	6.908
13	5.942	6.427
12	5.486	5.934
11	5.018	5.431
10	4.54	4.92
9	4.055	4.402
8	3.565	3.88
7	3.074	3.355
6	2.586	2.832
5	2.105	2.314
4	1.639	1.809
3	1.196	1.326
2	0.79	0.879
1	0.437	0.487
P	0.159	0.177
Base	0	0

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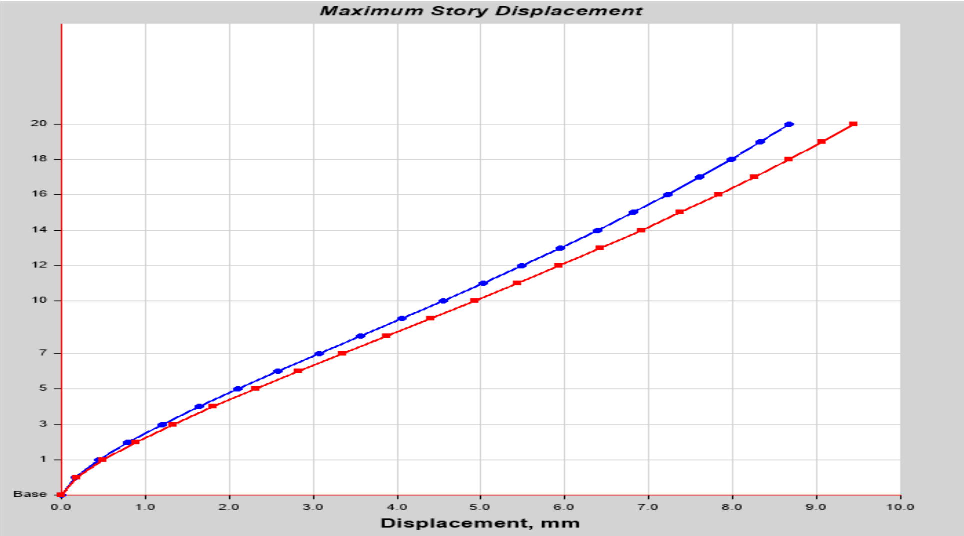


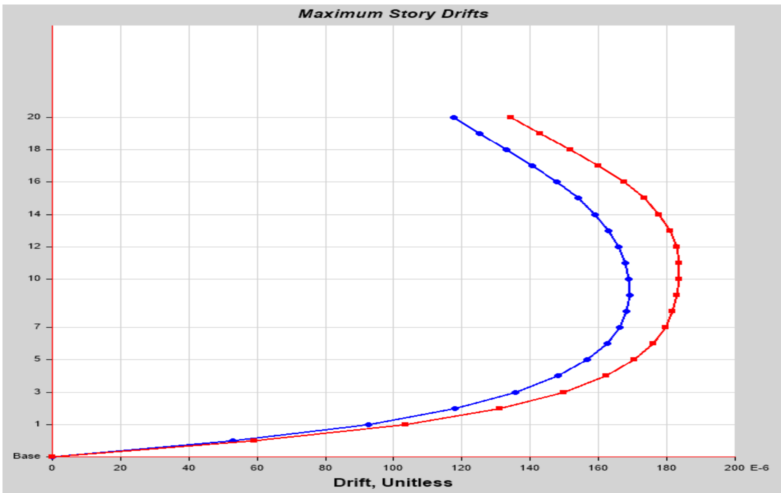
Graph 3: Storey v/s displcement of building

5.2.2 STOREY DRIFT

Table 5: Max storey drift of structure featuring shear wall positioned at each of its four corner

Storey	Max. storey drift in (mm)	
	X direction	Y direction
20	0.000118	0.000134
19	0.000125	0.000143
18	0.000133	0.000152
17	0.000141	0.00016
16	0.000148	0.000167
15	0.000154	0.000173
14	0.000159	0.000178
13	0.000163	0.000181
12	0.000166	0.000183
11	0.000168	0.000184
10	0.000169	0.000184
9	0.000169	0.000183
8	0.000168	0.000182
7	0.000166	0.000179

6	0.000163	0.000176
5	0.000157	0.000171
4	0.000148	0.000162
3	0.000136	0.00015
2	0.000118	0.000131
1	0.000093	0.000103
P	0.000053	0.000059
Base	0	0



Graph 4: Storey v/s storey drift of building

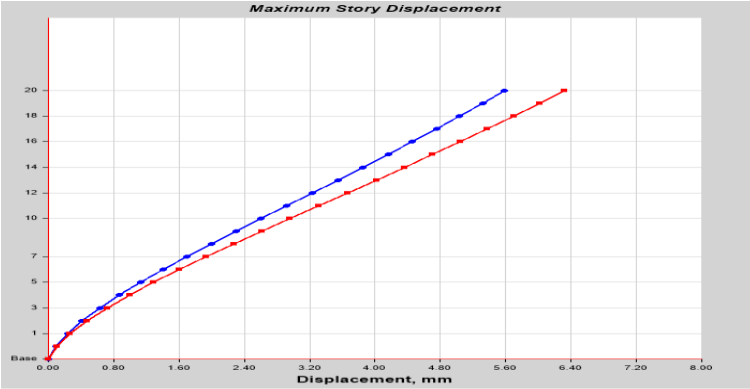
5.3 RESULT OF STRUCTURE FEATURING SHEAR WALL POSITIONED AT EACH OF ITS FOUR EDGE.

5.3.1 STOREY DISPLACEMENT

Table 6: Max storey displacement of structure featuring shear wall positioned at each of its four edge.

Storey	Max. storey displacement in (mm)	
	X direction	Y direction
20	5.584	6.325
19	5.315	6.018
18	5.037	5.702
17	4.751	5.378
16	4.459	5.046
15	4.159	4.708
14	3.854	4.363
13	3.544	4.015
12	3.232	3.664
11	2.919	3.312
10	2.606	2.961

9	2.296	2.613
8	1.991	2.27
7	1.692	1.933
6	1.403	1.607
5	1.127	1.293
4	0.867	0.996
3	0.627	0.721
2	0.413	0.474
1	0.231	0.264
P	0.089	0.1
Base	0	0

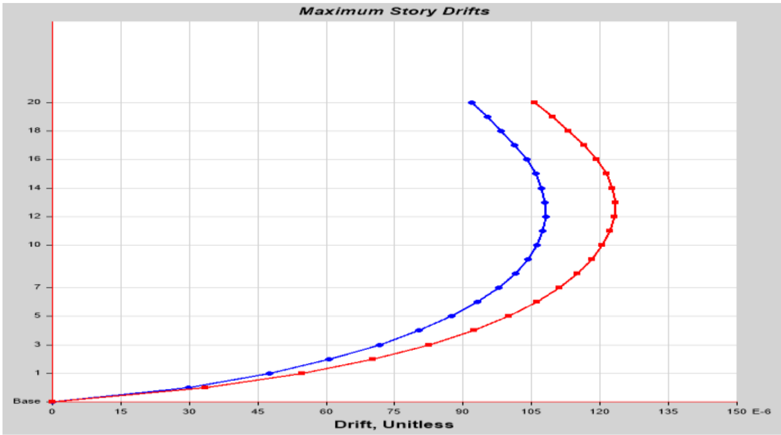


Graph 5: Storey v/s storey displacement of building

5.3.2 STOREY DRIFT

Table 7: Max storey drift of structure featuring shear wall positioned at each of its four edge..

Storey	Max. storey drift in (mm)	
	X direction	Y direction
20	0.000092	0.000106
19	0.000095	0.00011
18	0.000098	0.000113
17	0.000101	0.000117
16	0.000104	0.000119
15	0.000106	0.000121
14	0.000107	0.000123
13	0.000108	0.000123
12	0.000108	0.000123
11	0.000107	0.000122
10	0.000106	0.00012
9	0.000104	0.000118
8	0.000101	0.000115
7	0.000098	0.000111
6	0.000093	0.000106
5	0.000087	0.0001
4	0.00008	0.000092
3	0.000072	0.000083
2	0.000061	0.00007
1	0.000047	0.000055
P	0.00003	0.000033
Base	0	0

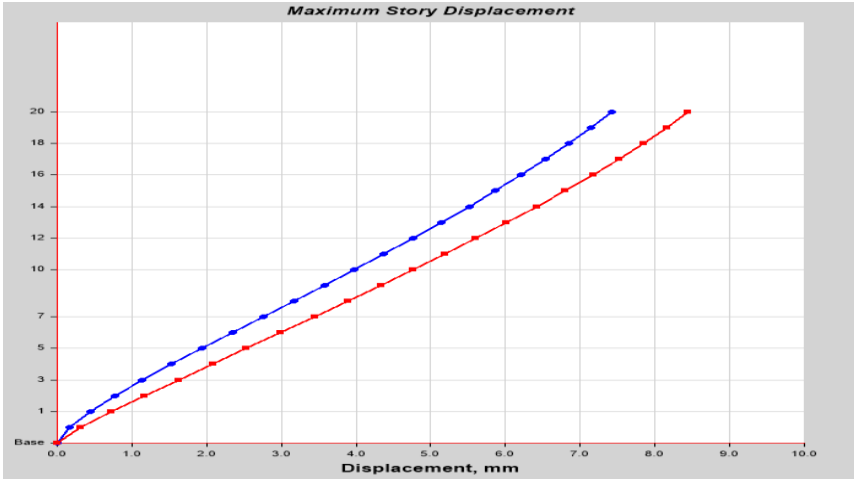


Graph 6: Storey v/s storey drift of the building

5.4 RESULT STRUCTURE FEATURING SHEAR WALL POSITIONED AT BOTH FRONT AND BACK
5.4.1 STOREY DISPLACEMENT

Table 8: Max storey displacement structure featuring shear wall positioned at both front and back

Storey	Max. displacement in (mm)	
	X direction	Y direction
20	7.42	8.433
19	7.144	8.158
18	6.852	7.856
17	6.542	7.527
16	6.214	7.175
15	5.87	6.804
14	5.512	6.417
13	5.141	6.017
12	4.761	5.607
11	4.371	5.188
10	3.975	4.761
9	3.572	4.328
8	3.165	3.889
7	2.754	3.443
6	2.342	2.992
5	1.932	2.536
4	1.528	2.078
3	1.138	1.619
2	0.771	1.166
1	0.441	0.725
P	0.168	0.309
Base	0	0



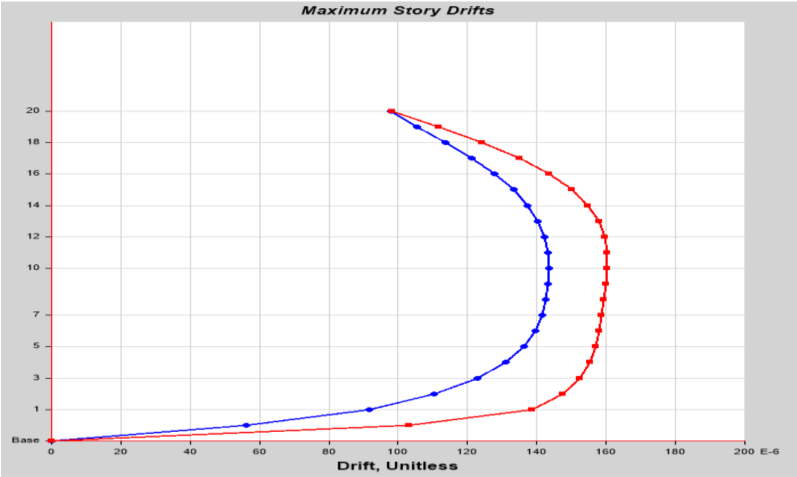
Graph 7: Storey v/s storey displacement of building

5.4.2 STOREY DRIFT

Table 9: Max storey drift of structure featuring shear wall positioned at both front and back

Storey	Max. storey drift in (mm)	
	X direction	Y direction
20	0.000098	0.000098
19	0.000106	0.000112
18	0.000114	0.000124
17	0.000121	0.000135
16	0.000128	0.000143
15	0.000133	0.00015
14	0.000137	0.000155
13	0.00014	0.000158
12	0.000142	0.00016
11	0.000143	0.00016
10	0.000143	0.00016
9	0.000143	0.00016
8	0.000143	0.000159
7	0.000142	0.000159
6	0.00014	0.000158
5	0.000136	0.000157
4	0.000131	0.000155
3	0.000123	0.000152
2	0.00011	0.000147

1	0.000091	0.000139
P	0.000056	0.000103
Base	0	0



Graph 8: Storey v/s storey drift of building

VI. CONCLUSION

- The Y-value for storey displacement in the study of a building without a shear wall is greater than it is for buildings with shear walls at corners, on edges, or at the front and rear elevations.
- Compared to placement along the margins and front/back elevations, shear walls cause higher displacement when located at the corners of a building's story.
- Response spectrum analysis reduces the resulting storey drift.
- Using shear walls in the corners of a building results in more storey drift than using shear walls at the borders, front, and rear of the building.

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