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Optimizing shear wall design for earthquake-resistant buildings: a study using etabs

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Abstract

This article describes how to use the capacity spectrum approach to estimate the seismic performance of tall structures. The 3D analytical model of a 22-story structure was created using the structural analysis program ETABS and compared to standard building models. The structure's insightful model integrates all significant variables that influence the construction's mass, strength, solidness, and deformability. To investigate the impact of the considerable center wall and shear wall at various locations during an earthquake, seismic analysis was conducted using direct static, non-straight static, and straight unique techniques. The reaction range approach was utilized to analyze the diversions at every story level to evaluate the presentation level, request, and limit of the structure models that were considered. Previous research has shown that non-linear response spectrum methods are useful for estimating both global and local inelastic deformation demands, as well as for uncovering design weaknesses that could otherwise go unnoticed in elastic analyses and for gauging a structure's performance. Using the response spectrum approach, this study investigated how shear walls affected bending, torsion, building shear, and deflection in a G+21 storey structure.

Keywords: High rise buildings, regular building, irregular building, ETABS, G+21, Deflection, building shear, Bending, Building Torsion.

1.Introduction

In India, shear walls are commonly integrated into reinforced concrete frames to enhance earthquake resilience, particularly in medium-rise residential buildings. Openings such as windows, doors, and ducts may be strategically incorporated for functional purposes, influencing both the behaviour of the structure and the stress distribution in the shear walls. These walls, often used in high-rise buildings alongside framed structures, include multiple apertures for elevators, stairways, and other essential accesses. Generally, in structural analysis, shear walls are represented using plane stress elements, while frames are represented by beam elements. It is crucial to include degrees of freedom in plane stress elements to accurately reflect the interaction between shear walls and frames; otherwise, bending moments at beam ends might not transfer correctly to the walls. Additionally, structures with large entrances, such as theatres and banquet halls, are more affected by the quantity, placement, and shape of openings, leading to variations in deflection and stress levels that impact analysis accuracy and structural efficiency.

A rigid reinforced concrete (R.C.) frame typically combines beams and columns in a rectangular layout with rigid joints, where diagonal stiffness within the beams, columns, and joints dictates the lateral stiffness of the frame. R.C. frames, advantageous for design flexibility, are effective in concrete buildings up to approximately 15 stories and in steel structures up to 25 stories. For taller frames, more lateral stiffness is essential to control drift. In rigid frames, horizontal stiffness is determined by the bending resistance of girders, columns, and joints, while axial rigidity in columns becomes significant for taller frames. Horizontal shear is resisted by the cumulative shear forces in columns, which exhibit a dual bending curvature with points of contra-flexure at mid-story heights. Frames deflect primarily in shear mode, leading to a concave upward configuration due to column and girder distortion.

1.1. Masonry Infilled Frames

In multi-story construction, lateral stiffness is critical for resisting wind and seismic forces, with composite stiffness provided by the structural framework and infill walls enhancing overall stability. Brick masonry is the typical material for infilled frames, where the interaction between frame and infill walls governs the system's behavior. Lateral forces can lead to slippage and separation at frame-infill interfaces, causing cracks that reduce the overall stiffness and moment of inertia of the infill over time, leading to a gradual failure.

1.2. Shear Wall

Vertical structural components known as shear walls offer lateral resistance to seismic and wind loads. A shear wall functions as a deep beam under shear and flexure because of its stiffness, which enables it to support lateral loads and prevent overturning. Shear wall behavior under lateral forces is influenced by shape and positioning, with horizontal diaphragms transferring lateral forces to shear walls aligned with the applied load. In eccentrically placed cores, torsional stresses can develop due to the offset between the center of mass and the center of stiffness. Shear walls, more rigid than frames, are efficient up to 35-story heights and effectively carry lateral loads in low- to medium-rise buildings when paired with frames. A shear wall's resistance increases linearly with thickness, but width has a more substantial impact on overall strength.

1.3. Shear Wall Components

Shear walls, particularly those made of reinforced concrete or masonry, often include openings like doors and windows, necessitating a structural analysis that treats walls as assemblies of rigid and flexible components, including wall segments, column segments, and piers.

1.3.1. Column Segments

Vertical members with a height-to-thickness ratio exceeding three and a width less than 2.5 times their thickness, primarily carrying axial loads. Although their contribution to lateral resistance is minimal, their stiffness is still accounted for in design.

1.3.2. Wall Piers

Wall sections with height-to-length ratios exceeding two are termed wall piers, serving as key lateral resistance elements.

1.3.3. Wall Segments

Portions that extend beyond the wall piers, integral to the shear wall's primary load resistance.

1.4. Necessity and Importance in Shear Wall Design

In high-rise structures, adequate lateral stiffness and minimized displacements are crucial for stability, with shear wall systems providing two main advantages over frames:

Sufficient strength to bear heavy lateral loads cost-effectively.

Sufficient stiffness to control lateral displacement within acceptable limits, minimizing non-structural damage.

Shear walls should ideally serve dual functions, such as housing utility cores, to avoid design interference, with placement along both axes for balanced lateral rigidity. Symmetrical arrangements around the building's centre prevent torsion effects.

1.5. Shear Walls with Openings

Framed structures in high-rise buildings often include shear walls with openings for functional needs. However, these openings reduce the in-plane stiffness of the walls, altering deflection, bending, shear force, and stress distributions. Openings are essential in buildings like theatres or banquet halls, requiring large entryways, while standard windows, doors, and corridors are typical in residential structures. The opening size is determined by the ratio of the opening area to the area of the wall section; big apertures are indicated by ratios larger than 1.

1.6. Frame-Shear Wall Interaction

Shear walls and frames exhibit distinct deformation modes when subjected to lateral forces. Stiff frames undergo shear deformation, while shear walls deflect mainly due to bending. Their interaction forms a combined structural system, with the shear wall carrying most lateral loads at lower levels and the frame contributing more at upper levels, where lateral stresses are lower. Consequently, floor deformations are predominantly translational with limited rigid body rotation.

1.7. Earthquake

Structural design must account for forces resulting from earthquakes. Unlike wind loads, which exert force directly on exposed surfaces, seismic loads arise from ground movement, creating inertial forces that induce stress within the structure. Earthquake-induced stress reversals can occur frequently within the tremor's short duration, unlike wind forces that vary more gradually over time.

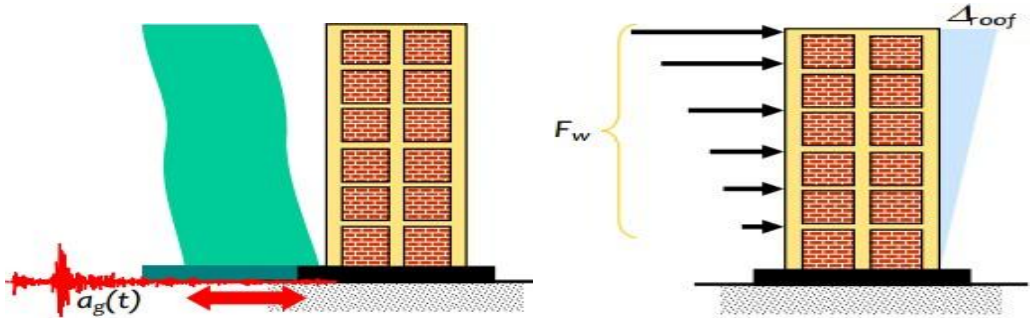


Fig 1 Difference in the design effect on a building

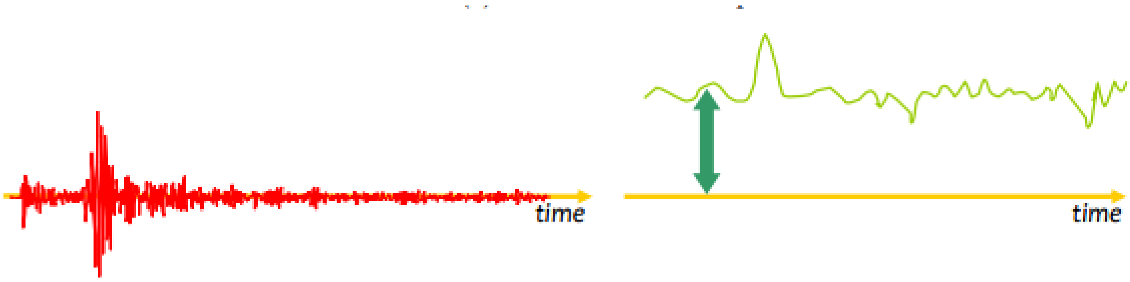


Fig 2 Nature of temporal variations of design actions: earthquake ground motion

1.8.Basic aspects of seismic design

Seismic plan and building solidness are both impacted by the structure's mass, as the latency powers initiated by a tremor are straightforwardly relative to the mass of the construction.

Making structures that can endure tremors without supporting harm could make the undertaking monetarily unworkable. This implies the structure might need to get hammered during the quake to deliver all that energy. Structures ought to be intended to endure various sorts of shaking, as per conventional tremor safe standards. Typical structures ought to have the option to endure moderate shaking without primary or non-underlying harm, moderate shaking with a harm to non-underlying components yet no breakdown, and extreme shaking with harm to underlying components however no breakdown to save lives and property inside or contiguous the structure.

Subsequently, structures are simply expected to endure a little part (around 8 to 14%) of the power that they would truly experience assuming that they were made to be already super versatile to endure the expected serious ground shaking without supporting harm. Nonetheless, to forestall primary harm even with little shaking, giving a satisfactory starting stiffness is vital. Subsequently, seismic plan guarantees the undertaking's reasonability by offsetting diminished cost with average harm. This sensitive harmony is arrived at after a lot of study and examination concerning the impacts of the seismic tremor. Broad utilization of this information takes into account exceptionally precise seismic plan contemplations. The plan wind powers, then again, don't allow underlying harm. In this manner, tremor safe plan is utilized rather than quake resistant plan to depict plans that relieve the results of tremors.

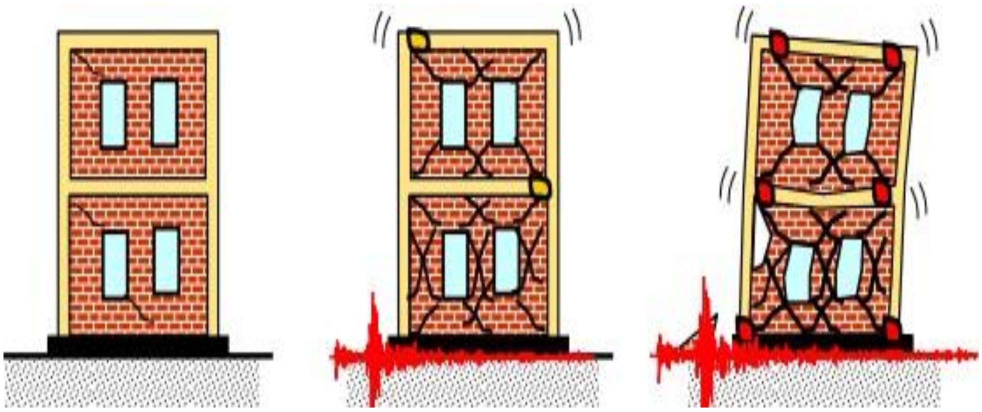


Fig 3 Earthquake-Resistant Design Philosophy for buildings

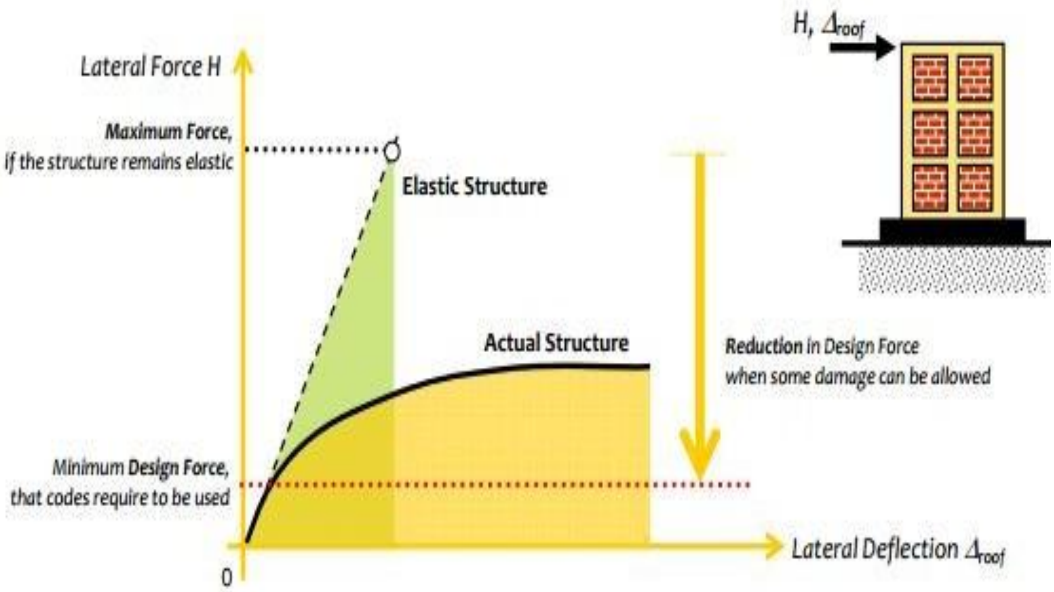


Fig 4 Basic strategy of earthquake design: Calculate maximum elastic forces

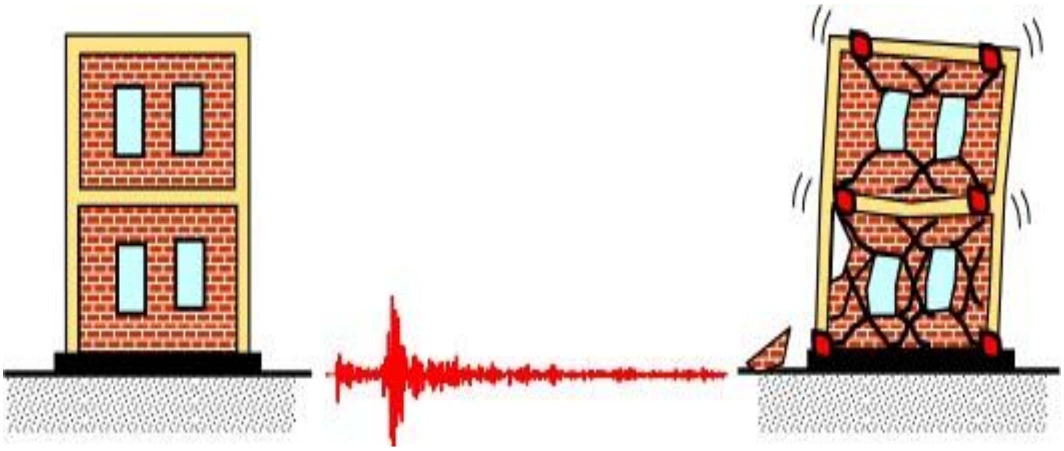


Fig 5 Earthquake-Resistant and NOT earthquake proof

Only when a building can stably withstand significant displacement demands via structural damage without collapsing or losing too much strength can it be constructed to withstand a portion of the elastic level of seismic forces. This characteristic is called ductility. It is simple to design structures with certain lateral strength and initial stiffness by varying the component sizes and material proportions. However, achieving sufficient ductility is more difficult and requires extensive laboratory testing on full-scale specimens to identify the most effective precise processes. In summary, an earthquake causes displacement-type loading on a structure's underbelly, whereas wind and all other hazards cause force-type loading on the building. In order to defend themselves against wind and other hazards, buildings must be able to endure specific amounts of force. Additionally, earthquake shaking requires that buildings be able to withstand relative displacement inside of them due to the displacement imposed at their bases. Although the ultimate allowable force on a structure may be calculated with reasonable accuracy, the maximum allowable displacement underneath it is not as well understood. Buildings designed for wind design must exhibit only elastic behaviour across the full displacement range in order to endure the same maximum displacement, whereas buildings designed for earthquakes must exhibit either inelastic or continuous elastic behaviour. While most structures go with the second choice, some exceptions, such as the crucial buildings of nuclear power plants, need the first.

2.Objective of the study

Coming up next are the primary goals of the venture

1.To plan the earthquake safe structure and focus on the seismic behavior of multi-story buildings using IS 1893:2002.

2.To compare the different sections of multi-story buildings with and without shear walls.

3. To examine the consequences of story float, shear force, bowing second, and building twist in multistory buildings without shear walls at different locations

4.To concentrate on the structures in ETABS V9.7.4 Accordingly range examination.

3.Methodology And Modelling of Building

3.1Problem statement

The current study uses ETABS to analyze G+21-story buildings located in Zone V seismic zones.

The fundamental parameters taken into account for the analysis are

1. Grade of concrete : M30
2. Grade of Reinforcing steel : HYSD Fe500
3. Dimensions of beam : 230mmX300mm
4. Dimensions of column : 230mmX480mm
5. Thickness of slab : 120mm
6. Height of bottom story : 3m
7. Height of Remaining story : 3m
8. Live load : 3.5 KN/m2
9. Floor load : 1.5 KN/m2
10. Density of concrete : 25 KN/m3
11. Seismic Zone : Zone 5
12. Site type : II
13. Importance factor : 1.5
14. Response reduction factor : 5
15. Damping Ratio : 5%
16. Structure class : B
17. Basic wind speed : 39m/s
18. Risk coefficient (K1) : 1.08
19. Terrain size coefficient (K2) : 1.14
20. Topography factor (K3) : 1.36
21. Wind design code : IS 875: 1987 (Part 3)
22. RCC design code : IS 456:2000
23. Steel design code : IS 800: 2007
24. Earthquake design code : IS 1893 : 2002 (Part 1)

3.2. Plan of Regular building

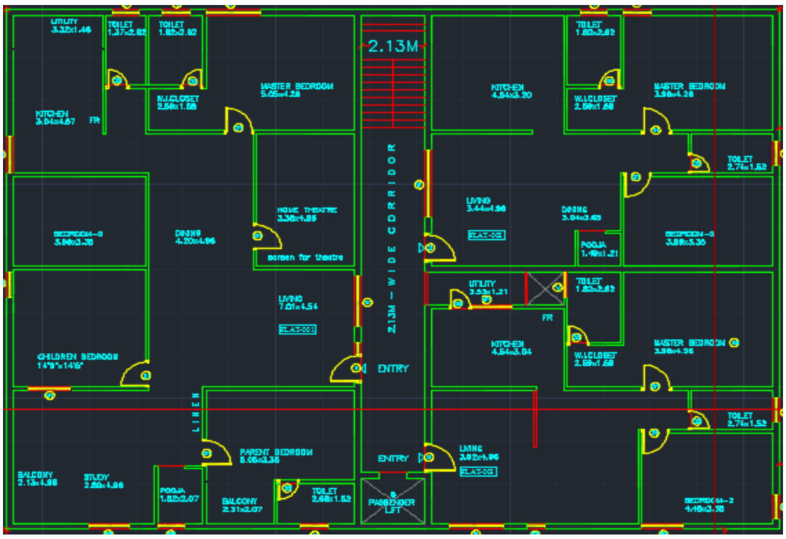


Fig 6 Typical floor plan for Regular building

3.3. Models in ETABS

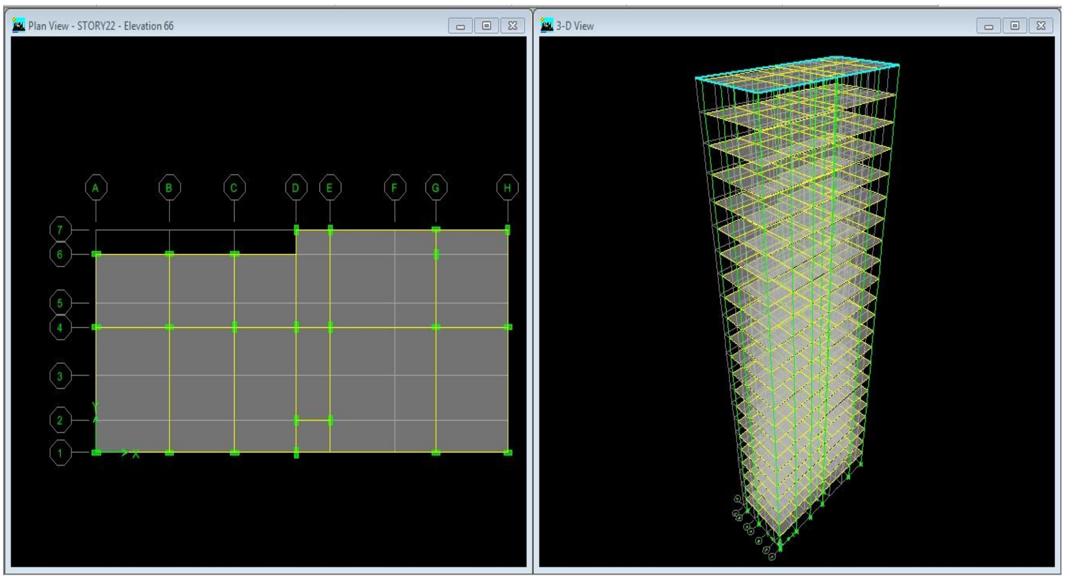


Fig 7 Building without Shear wall

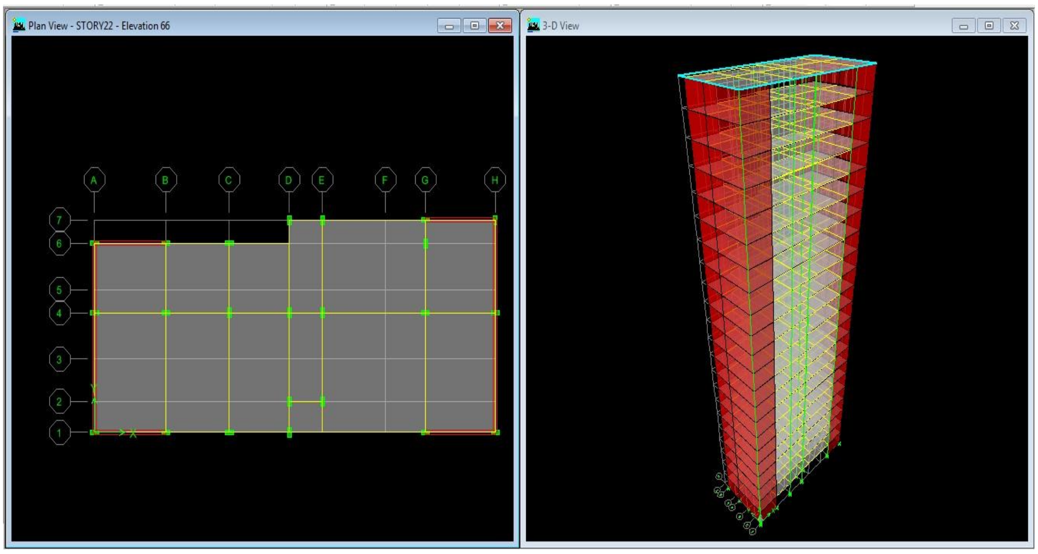


Fig 8 Building with Shear wall at corner

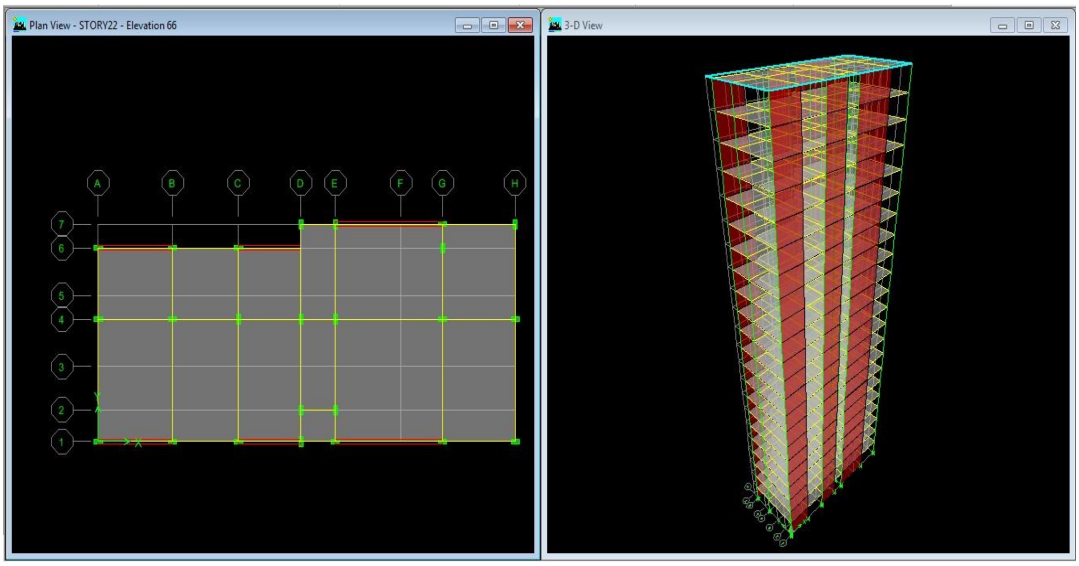


Fig 9 Building with Shear wall at alternative position

4. Results And Analysis

4.1.Storey Drift

The lateral displacement is called drift. A multi-story building's story drift is its movement with respect to the level below. As a structure sways during an earthquake, the interstory drift is the sum of the floor and roof displacements for each story, normalized by the story height. If the interstory drift is 0.10 for a 10-foot-tall building, for instance, it means that the roof is one foot lower than the floor below it.

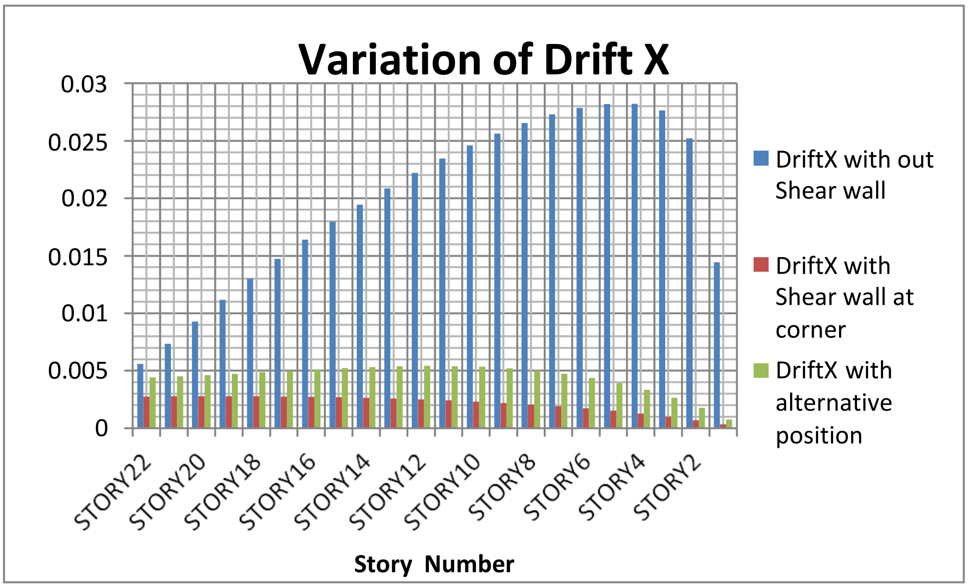
The risk of harm increases as drift increases. Values above 0.025 suggest that the damage could be severe enough to endanger human safety, while values over 0.06 indicate severe damage. A valuegreater than 0.10 suggests that the structure is likely to collapse

X-Direction

Table 1 Storey drift X Values

Story	Drift X without Shear wall	DriftX with Shear wall at corner	DriftX with alternative position
STOREY22	0.005584	0.002766	0.004437
STOREY21	0.007351	0.002782	0.004515
STOREY20	0.00927	0.002791	0.004614
STOREY19	0.011168	0.002791	0.004733
STOREY18	0.012998	0.002782	0.004863
STOREY17	0.014744	0.002761	0.004996
STOREY16	0.016398	0.00273	0.005123
STOREY15	0.017959	0.002689	0.005237
STOREY14	0.019461	0.002637	0.005329
STOREY13	0.02088	0.002575	0.005392
STOREY12	0.022214	0.002501	0.00542

STOREY11	0.023459	0.002415	0.005405
STOREY10	0.024606	0.002314	0.005338
STOREY9	0.025641	0.002198	0.005212
STOREY8	0.026546	0.002063	0.005016
STOREY7	0.027295	0.001907	0.004743
STOREY6	0.027859	0.001728	0.004383
STOREY5	0.028197	0.001521	0.003923
STOREY4	0.028226	0.001283	0.00335
STOREY3	0.027654	0.00101	0.002644
STOREY2	0.025206	0.000699	0.001787
STOREY1	0.01442	0.000334	0.000742



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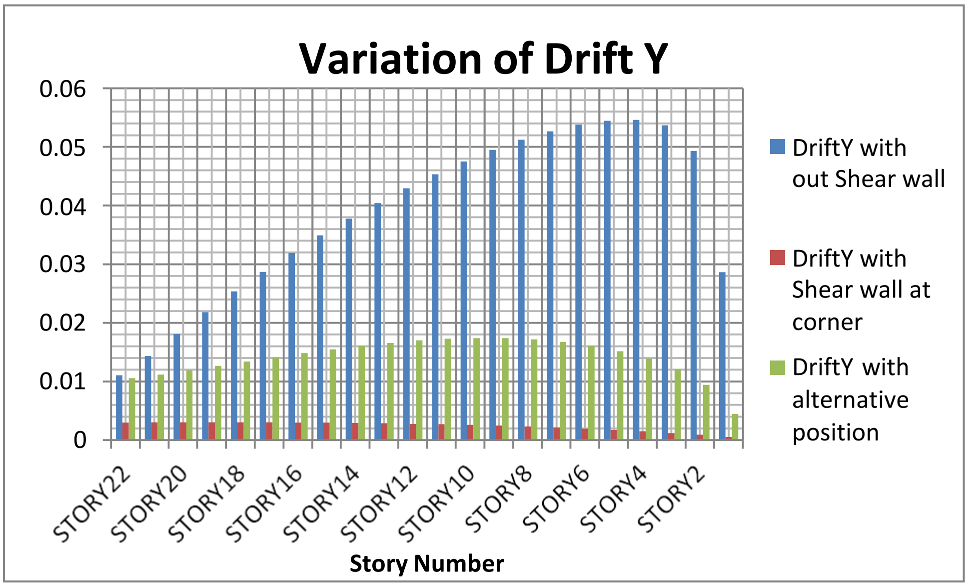
Graph 1 Comparison of Storey drift X Values

Y-Direction

Table 2 Storey drift Y Values

Storey	DriftY with out Shear wall	DriftY with Shear wall at corner	DriftY with alternative position
STOREY22	0.011064	0.002985	0.010547
STOREY21	0.014338	0.003008	0.011148
STOREY20	0.018095	0.003022	0.011868
STOREY19	0.021781	0.003027	0.012618
STOREY18	0.025319	0.00302	0.013367
STOREY17	0.028685	0.003003	0.014103
STOREY16	0.031872	0.002976	0.014812
STOREY15	0.034883	0.002938	0.015474

STOREY14	0.037728	0.00289	0.016067
STOREY13	0.040413	0.002831	0.01657
STOREY12	0.042941	0.002758	0.016967
STOREY11	0.045307	0.00267	0.017245
STOREY10	0.047493	0.002566	0.017382
STOREY9	0.049472	0.002442	0.017357
STOREY8	0.051207	0.002297	0.017142
STOREY7	0.052653	0.002128	0.016715
STOREY6	0.053758	0.001934	0.016052
STOREY5	0.054452	0.001711	0.01512
STOREY4	0.054596	0.001458	0.013852
STOREY3	0.053675	0.001174	0.012088
STOREY2	0.049284	0.000859	0.009401
STOREY1	0.028635	0.000494	0.004426



Graph 2 Comparison of Storey drift Y Values

The lateral displacement is called drift. A multi-story building's story drift is its movement with respect to the level below. As a structure sways during an earthquake, the interstory drift is the sum of the floor and roof displacements for each story, normalized by the story height. If the interstory drift is 0.10 for a 10-foot-tall building, for instance, it means that the roof is one foot lower than the floor below it.

The risk of harm increases as drift increases. Values above 0.025 suggest that the damage could be severe enough to endanger human safety, while values over 0.06 indicate severe damage. A value greater than 0.10 suggests that the structure is likely to collapse.

According to the data shown above, the shear wall at the corner exhibits lower values for story drift (lateral displacement) compared to the other two scenarios (alternative location and general building). structures situated inside terrain shear walls at corners are therefore subject to smaller load effects than other types of regular high-rise structures.

4.2. Storey shears and overturning moments

The global coordinate system reports for story shears and overturning moments are P, VX, VY, T, MX, and MY. The forces are described at the very top of the story, just below the story level, and at the very bottom, just above the story level below.

Narrative level forces are represented from bottom to top using the same sign convention as frame elements, with the tale represented by the j-end and the frame element by the i-end of the story. As previously stated, the usual locations for reporting narrative shears and overturning moments are Global X=0, Global Y=0, and Global Z.

P, the axial force

V2, and the shear force in the 1-2 plane are the internal forces of the frame element.

V3, the 1-3 plane's shear force

The axial torque, or T, is approximately one axis.

M2, the bending moment about the 2-axis in the 1-3 plane

M3, the bending moment about the 3-axis in the 1-2 plane

All the frame element's cross sections exhibit these internal forces and moments.

An unbalanced vertical force to the section's right or left is one definition of shear force at the beam's cross section.

4.3. Shear force

Whether it's a fixed point or the center of mass, shear forces are the algebraic total of all the forces that act to shear along an axis.

X-Direction:

Table 3 Storey shear force X Values

Story	Shear force (VX) without Shear wall	Shear force (VX) with Shear wall at corner	Shear force (VX) with Shear wall at alternative position
STOREY22	110.12	406.17	149.25
STOREY21	219.08	724.16	298.06
STOREY20	324.4	933.94	438.87
STOREY19	425.25	1047.82	571.55
STOREY18	520.98	1087.06	695.94

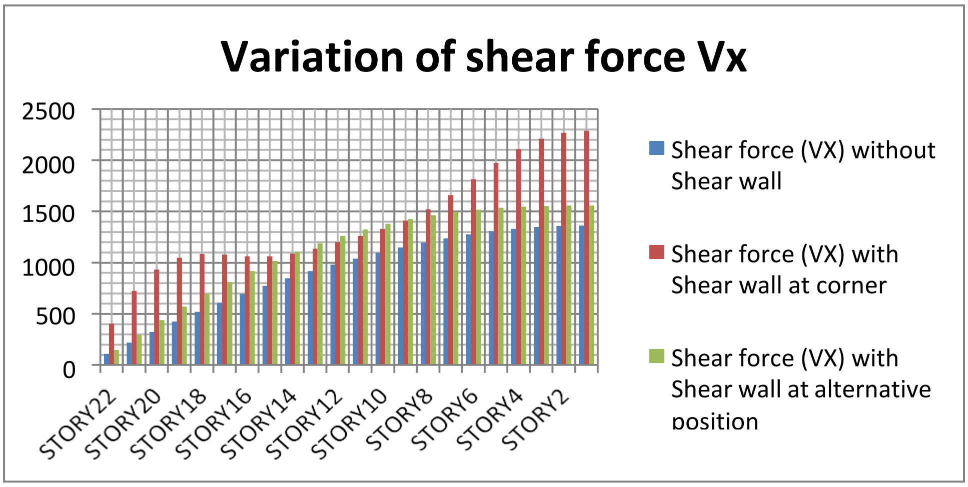
STOREY17	611.2	1081.07	811.87
STOREY16	695.76	1063.16	919.22
STOREY15	774.73	1061.48	1017.85
STOREY14	848.38	1088.5	1107.67
STOREY13	917.06	1138.92	1188.65
STOREY12	981.15	1199.63	1260.8
STOREY11	1040.96	1262.32	1324.19
STOREY10	1096.67	1329.45	1378.98
STOREY9	1148.27	1411.99	1425.4
STOREY8	1195.53	1521.18	1463.79
STOREY7	1238.05	1659.29	1494.57
STOREY6	1275.27	1816.1	1518.28
STOREY5	1306.55	1972.77	1535.57
STOREY4	1331.3	2109.01	1547.23
STOREY3	1348.99	2209.48	1554.19
STOREY2	1359.43	2267.85	1557.52
STOREY1	1363.15	2288.76	1558.46

Y-Direction:

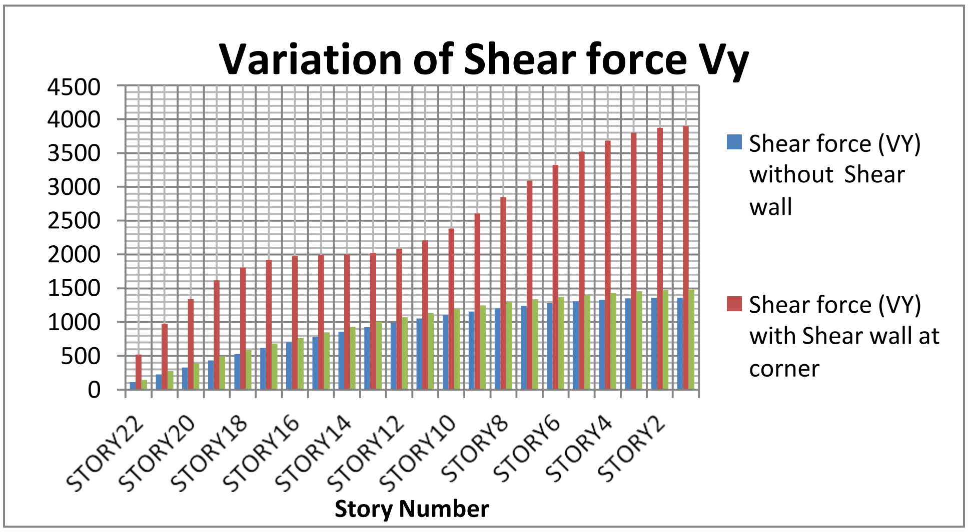
Table 4 Storey shear force Y Values

Story	Shear force (VY) without Shear wall	Shear force (VY) with Shear wall at corner	Shear force (VY) with Shear wall at alternative position
STOREY22	112.72	516.35	143.3
STOREY21	223.64	973.51	277.9
STOREY20	330.4	1338.91	395.06
STOREY19	432.29	1614.22	497.12
STOREY18	528.82	1804.84	589.81
STOREY17	619.68	1920.73	678.76
STOREY16	704.79	1977.07	766.37
STOREY15	784.23	1994.81	851.38
STOREY14	858.25	2000.12	931.2
STOREY13	927.18	2021.8	1004.45
STOREY12	991.32	2085.39	1071.84
STOREY11	1050.92	2205.66	1134.96
STOREY10	1106.11	2382.31	1194.4
STOREY9	1156.86	2602.17	1249.07
STOREY8	1202.95	2845.41	1297.21
STOREY7	1244.01	3091.33	1338.21
STOREY6	1279.6	3321.69	1373.32
STOREY5	1309.2	3522.26	1404.63

STOREY4	1332.37	3683.33	1432.96
STOREY3	1348.79	3799.82	1456.57
STOREY2	1358.41	3871.35	1472.14
STOREY1	1361.84	3901.99	1477.88



Graph 3 Comparison of Storey shear force X Values



. **Graph 4 Comparison of Storey shear force Y Values**

Based on the data shown above, it is clear that the instance without a shear wall produced the highest shear force value, as compared to the other two scenarios (alternative location and corner position). As a result, regular high-rise structures without shear walls are less affected by shear forces.

4.4. Bending Moment

A bending moment applies bending stress to a material along the bending moment's axis, which is perpendicular to the relevant cross section. The material experiences bending stress as a result of the tensional moment. Both tensions grow in direct proportion to the magnitude of the moment. The second moment of area around the neutral axis and the cross section center, respectively, are inversely proportional to the bending moment and torsion stress.

X-Direction:

Table 5 Storey Bending X Values

STOREY	Bending moment (MX) without Shear wall	Bending moment (MX) with shear walls at corner	Bending moment (MX) with shear walls at alternative position
STOREY22	338.148	1549.047	429.905
STOREY21	1009.045	4468.975	1262.944
STOREY20	2000.106	8482.62	2444.15
STOREY19	3296.563	13315.21	3922.251
STOREY18	4881.926	18703.47	5660.422
STOREY17	6738.557	24405.75	7640.038
STOREY16	8848.264	30212.7	9855.978
STOREY15	11192.86	35957.83	12307.18
STOREY14	13754.6	41527.24	14988.64
STOREY13	16516.57	46867.37	17888.82
STOREY12	19462.77	51989.28	20992.11
STOREY11	22578.2	56967.62	24282.57
STOREY10	25848.65	61932.2	27745.68
STOREY9	29260.44	67051.09	31367.28
STOREY8	32800.06	72505.84	35131.46
STOREY7	36453.82	78462.86	39019.86

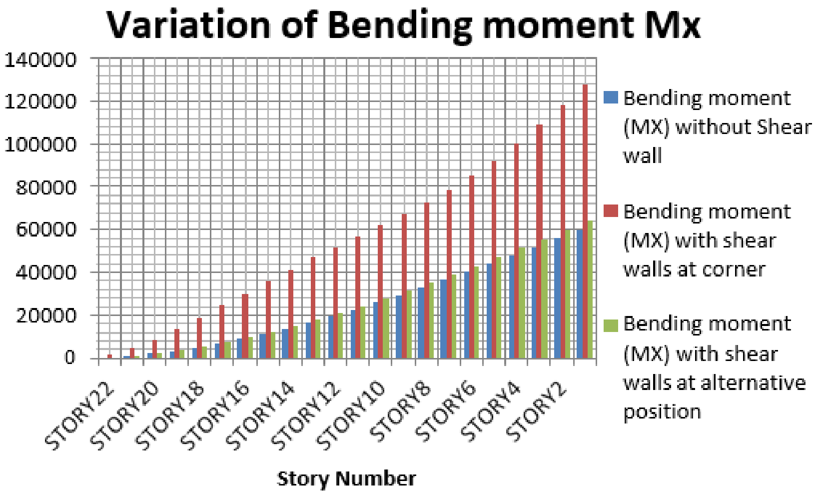
STOREY6	40207.44	85047.15	43013.17
STOREY5	44045.89	92324.99	47093.64
STOREY4	47953.21	100299.2	51246.33
STOREY3	51912.66	108916.5	55458.03
STOREY2	55907.17	118084	59714.86
STOREY1	59920.69	127688.2	64001.5

Y-Direction:

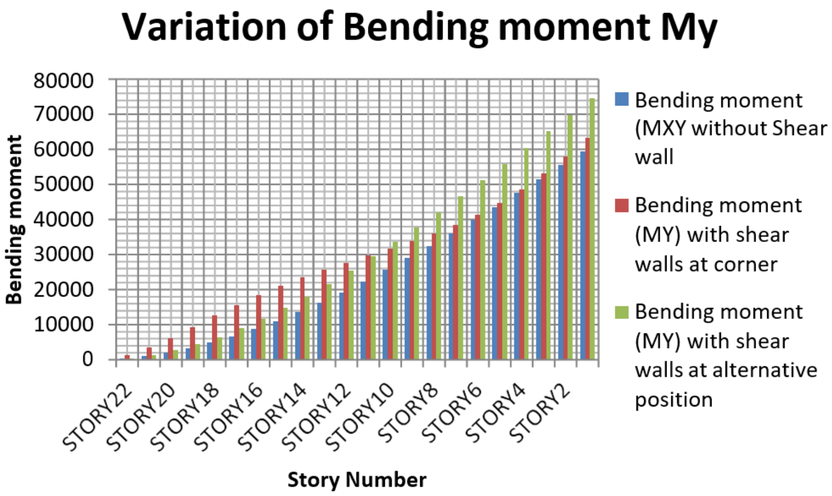
Table 6 Storey Bending Y Values

STOREY	Bending moment(MXY without Shear wall	Bending moment (MY)with shear walls at corner	Bending moment (MY)with shear walls at alternative position
STOREY22	330.366	1218.498	447.744
STOREY21	987.591	3389.612	1341.932
STOREY20	1960.694	6183.738	2658.557
STOREY19	3236.068	9300.398	4373.208
STOREY18	4797.993	12488.48	6461.015
STOREY17	6629.29	15563.1	8896.636
STOREY16	8712.011	18414.58	11654.29
STOREY15	11028.1	21006.23	14707.84
STOREY14	13559.95	23360.26	18030.85
STOREY13	16290.82	25534.58	21596.8
STOREY12	19205.06	27598.21	25379.19
STOREY11	22288.17	29614.67	29351.75
STOREY10	25526.63	31639.93	33488.68
STOREY9	28907.56	33733.77	37764.88
STOREY8	32418.38	35975.25	42156.25
STOREY7	36046.24	38469.51	46639.95
STOREY6	39777.63	41336.76	51194.77
STOREY5	43598	44684.25	55801.47

STOREY4	47491.55	48573.98	60443.16
STOREY3	51441.2	53003.06	65105.73
STOREY2	55429.04	57907.72	69778.28
STOREY1	59437.86	63188.95	74453.66



Graph 5 Comparison of storey bending X Values



Graph 6 Comparison of storey bending Y Values

The bending moment at the cross section of the beam can be expressed as the algebraic sum of the moments of the forces operating to the right and left of that cross section.

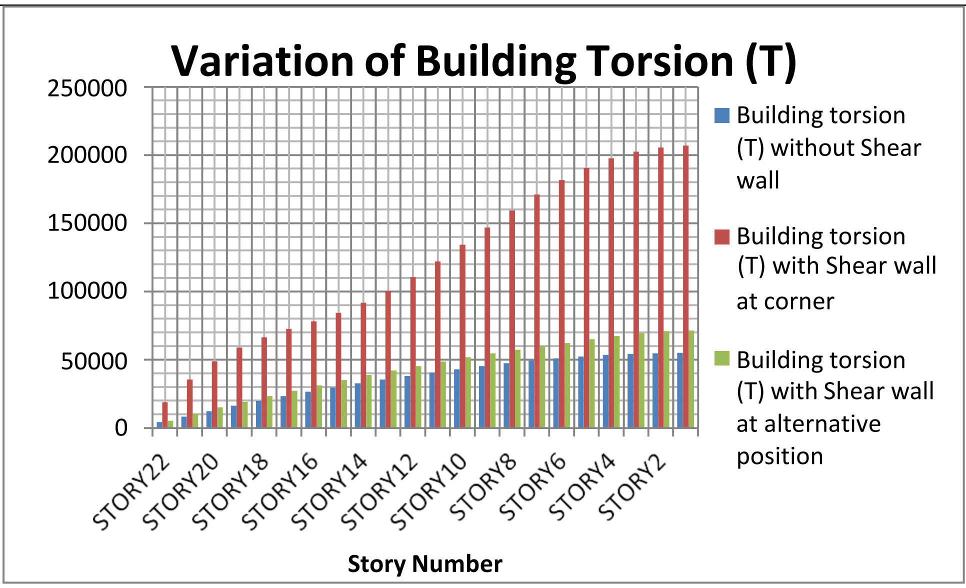
According to the data in the tables and graphs above, the scenario without a shear wall had the maximum bending moment when compared to the other two scenarios (alternate position and corner position). Therefore, conventional high-rise constructions without shear walls are less affected by the bending moment.

4.5. Building Torsion:

Torque is a twisting or rotating force that can be applied to rotate an axis, such as the center of mass or a fixed point. The force that a rotating item, like a gear or shaft, may exert to overcome rotational resistance is one definition of torque.

Table 7 Storey Torsion Values

Story	Building torsion (T) without Shearwall	Building torsion (T) with Shear wallat corner	Building torsion (T)with Shear wall at alternative position
STOREY22	4234.634	18879.2	5404.464
STOREY21	8402.912	35534.31	10503.22
STOREY20	12417.5	48849.09	15037.58
STOREY19	16255.78	59023.56	19195.1
STOREY18	19903.79	66579.57	23238.52
STOREY17	23357.78	72525.75	27297.2
STOREY16	26623.86	78155.45	31313.62
STOREY15	29715.94	84423.63	35148.24
STOREY14	32652.09	91823.95	38725.15
STOREY13	35449.95	100575.4	42108.41
STOREY12	38122.12	110708.2	45424.28
STOREY11	40672.7	122064.1	48709.88
STOREY10	43095.48	134296	51870.72
STOREY9	45374.05	146912.6	54770.97
STOREY8	47483.28	159355.6	57379.76
STOREY7	49391.96	171074.8	59853.33
STOREY6	51066.03	181581.6	62392.15
STOREY5	52472.07	190485.1	65016.05
STOREY4	53580.89	197518.3	67527.95
STOREY3	54371.53	202556.6	69608.08
STOREY2	54837.47	205635	70951.93
STOREY1	55004.57	206950.8	71444.53



Graph 7 Comparison of Storey Torsion Values

Torque is a twisting or rotating force that can be applied to rotate an axis, such as the center of mass or a fixed point.

The force that a rotating item, like a gear or shaft, may exert to overcome rotational resistance is one definition of torque.

Building Torsion was found to be highest in the corner shear wall scenario compared to the other two instances (alternative position and corner position), as seen in the graphs and tables above. Therefore, regular high-rise structures without shear walls are less affected by building torsion.

5. Conclusions

The study mentioned above led to the following results.

1.Compared to non-shear wall construction, conventional building with shear walls has lower drift values in the X and Y directions. Moreover, shear walls placed at corners provide superior results than those placed at alternative positions in both directions.

2.Buildings without shear walls, either at an alternate location or at a corner, have lower values of shear force in the X and Y axes compared to buildings with shear walls. In addition, the shear wall's values are greater when it's located at an alternate location rather than a corner.

3.structures without shear walls, shear walls at alternative positions, and shear walls at corners had lower values of Building Torsion (T) than structures. In addition, the shear wall's values are greater when it's located at an alternate location rather than a corner.

4.Under the bending moment (M) perspective, buildings with shear walls in alternate positions have lower bending moment values compared to those with shear walls at corners.

5.The bending moment and shear force in the columns linked to a shear wall are significantly increased when the shear wall has an opening in it. The increase is smaller for the opening percent, but it is still considerable.

6.When the location of the opening in the wall was changed, it was noticed for a specific opening.

7.This investigation found that as the proportion of shear wall rises, the drift decreases and the shear force, bending moment, and building torsional moments all rise.

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