Structural Design of Multistorey Building With Shear Walls At Different Locations

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Abstract- *In this project, a Research has been carried out to determine the structural configuration of a multistory building by changing the shear wall locations radically. Four different cases of shear wall position for G+10 storey building with keeping zero eccentricity between mass center and hardness center have been analyzed and designed as a frame system by computer application software ETABS. The comparison of these models for different parameters like Displacement, Storey Drift, Story Shear and Overturning turning has been presented .*

Keywords- ETABS, Story Drift, Story Shear and Overturning Moment

I. INTRODUCTION

A shear wall is a structural component often provided to multistoreyed or tall buildings or buildings in areas of high wind velocity or seismic activity. The purpose of a shear wall is to resist the lateral loads that are imposed on the structure due to wind, earthquake or sometimes due to hydrostatic or lateral earth pressure.

Such loads tend to act along the direction of movement of wind or vibrations of the earthquake and they act laterally to the building along one of the two directions.

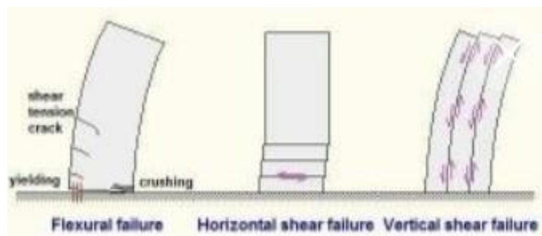
Forces on shear walls and corresponding failure modes:

Such loads induce the following to the shear wall in plane with their direction of action:

1. In plane shear.
2. Flexure.

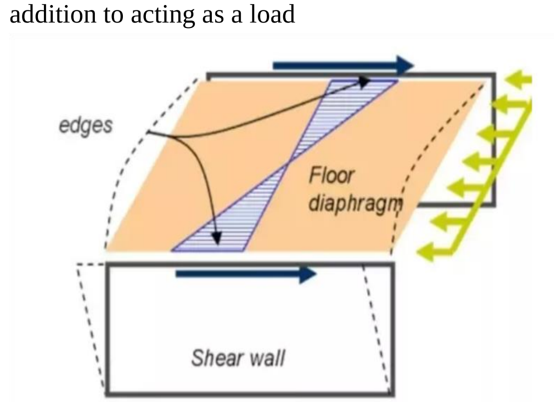
Hence, shear walls are structural elements meant to resist the effect of mainly two things, they are: in plane shear and in plane bending action due to moment from shear. Though in addition to these, the shear wall, as a structural element, tends also to resist in plane shear in vertical direction (as a direct consequence to shear in the horizontal direction) and the buckling effect of dead loads coming from top. Accordingly, a shear wall may fail either in 1 of these three modes or by buckling. The modes are:

- Flexural shear failure.
- Horizontal shear failure.
- Vertical shear failure.



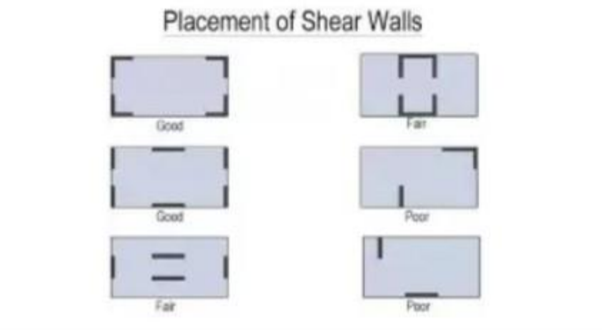
In order to resist these forces, a shear wall is designed and built so that it has:

- Large in plane shear resistance in the horizontal direction
- Large in plane shear resistance in the vertical direction
- Large flexural strength in the direction of flexure.
- Buckling strength to resist buckling due to dead loads from top.
- The loads from the building to the shear wall is usually transferred via a structural component known as diaphragm. These are stiff horizontal structures having connections throughout with the shear wall. In addition to acting as a load



transferring mechanism they also double up as floor/ roof of the building.

- Other than these, many alternative arrangements for the placement of shear walls are possible.



II. PROBLEM FORMULATION

Description of the structure

The typical framing plan of G+10 storey structure with rectangular in plan.
Length and width of the building structure is considered as 28m and 20m respectively. First story which is of 3.6m and Remaining Each storey height is considered as 3m.
Height of the building structure is 33.6m. (Approx. 35m)
Spacing of frame along length and width is 4m.
Material grades of M35& Fe500 were used for the design.

Building properties

Site Properties:

Details of building:: G+10
Outer wall thickness:: 230mm
Inner wall thickness:: 230mm
Soft storey height :: 3.6m
Floor height :: 3 m
Depth of foundation :: 3000mm
Seismic Properties
Seismic zone:: III
Zone factor:: 0.16
Importance factor:: 1.0
Response Reduction factor R:: 3
Soil Type:: medium

Preliminary Sizes of members

Column::300mm x 600mm
Beam :: 300mm x 500mm
Slab Thickness:: 125mm
Shear wall Thickness:: 300mm
Wind load not considered

Loading on structure

Dead load :: self-weight of structure
Weight of 230mm wall
Live load:: Floor 3 kN/m²
Roof 2 kN/m²
Wind load :: Not considered
Seismic load:: Seismic Zone II

III. MODELLING IN ETABS

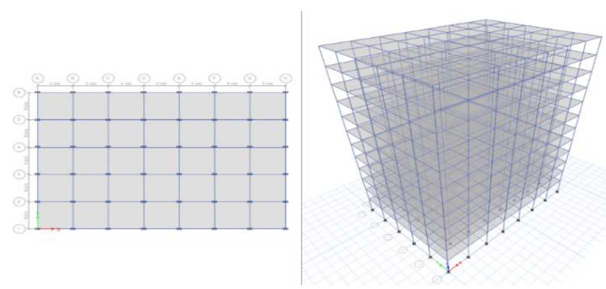
For this project, four models[M] were made. Their description is as follows:

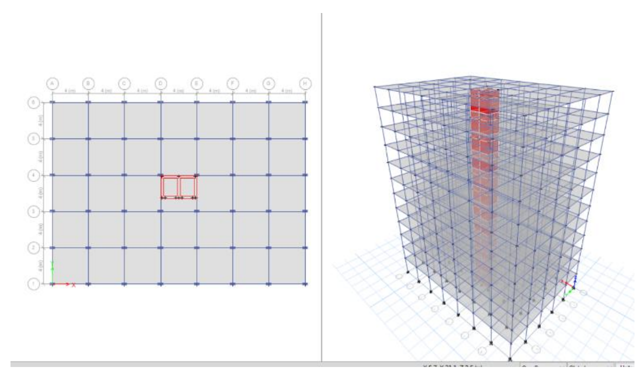
[M-1] Conventional Frame

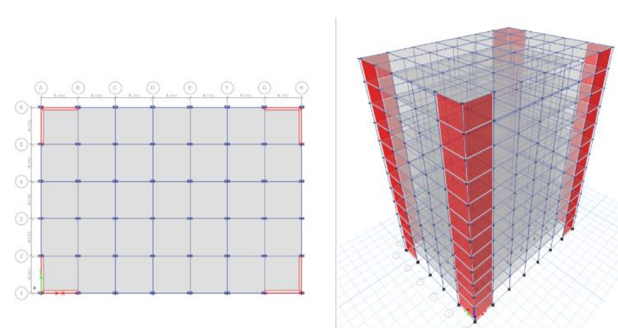
[M-2] Building with Box-type Shear Wall at the centerof the geometry

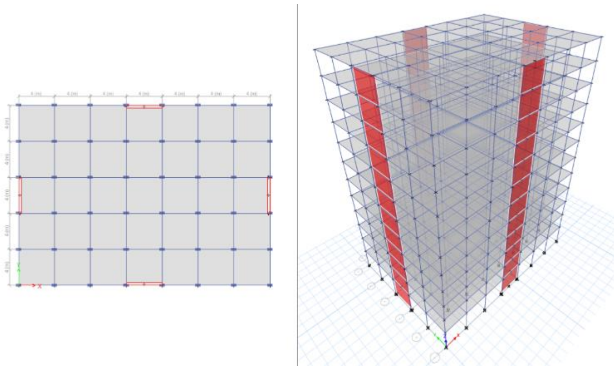
[M-3] Building with Shear Walls on Periphery atCorners

[M-4] Building with Shear Walls on Periphery at Centers









IV. ANAYLSIS

The behavior of all the framing systems is taken as a basic study on the modeled structure. The Story Drift is checked as per the IS-1893:2002 The following factors were considered to study a comparison between the different frames:

1. Maximum Storey Displacement
2. Storey Shear
3. Maximum Storey Drift
4. Storey Overturning Moment

The following load combinations are considered during the analysis of the model:

1. 1.5 DL + 1.5 LL
2. 1.2 DL + 1.2 LL
3. 1.2 DL + 1.2 LL + 1.2 EQX
4. 1.2 DL + 1.2 LL - 1.2 EQX
5. 1.2 DL + 1.2 EQX
6. 1.2 DL - 1.2 EQX

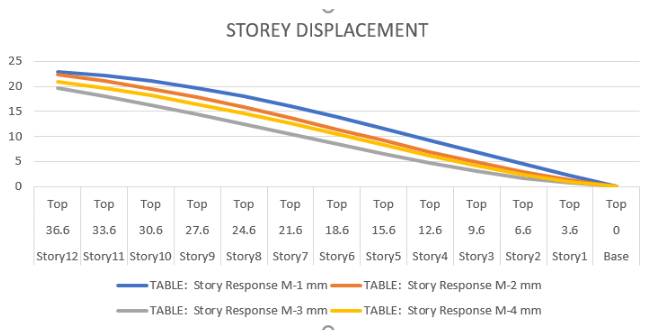
For asserting the simplest yet reliable method for analysis, the combined action of DL, LL & EQ forces are considered i.e. 1.2 DL + 1.2 LL + 1.2 EQX. The structure with different framing system has been modeled using ETABS software with the above mentioned load conditions and combinations.

V. INTERPREATATION OF RESULTS:

1. Max Storey Displacement

TABLE: Story Response

Story	Elevation	Location	M-1	M-2	M-3	M-4
	m		mm	mm	mm	mm
Story12	36.6	Top	22.936	22.326	19.64	20.996
Story11	33.6	Top	22.238	21.104	18.029	19.703
Story10	30.6	Top	21.148	19.545	16.276	18.193
Story9	27.6	Top	19.702	17.766	14.421	16.497
Story8	24.6	Top	17.964	15.799	12.488	14.626
Story7	21.6	Top	15.997	13.679	10.509	12.605
Story6	18.6	Top	13.856	11.458	8.528	10.477
Story5	15.6	Top	11.593	9.194	6.595	8.302
Story4	12.6	Top	9.252	6.952	4.77	6.156
Story3	9.6	Top	6.87	4.81	3.119	4.128
Story2	6.6	Top	4.484	2.865	1.719	2.338
Story1	3.6	Top	2.152	1.237	0.669	0.94
Base	0	Top	0	0	0	0



2. Storey Shear

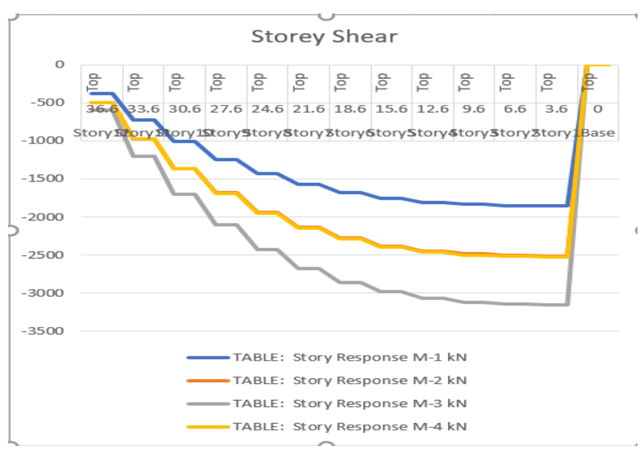
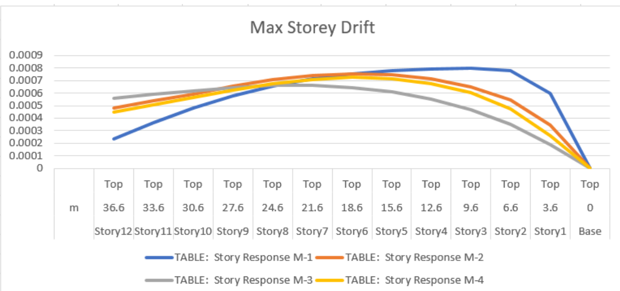


TABLE: Story Response

Story	Elevation	Location	M-1	M-2	M-3	M-4
	m		kN	kN	kN	kN
Story12	36.6	Top	-374.5518	-494.59	-598.8	-493.2
		Bottom	-374.5518	-494.59	-598.8	-493.2
Story11	33.6	Top	-722.5379	-969.37	-1200	-971.4
		Bottom	-722.5379	-969.37	-1200	-971.4
Story10	30.6	Top	-1011.158	-1363.2	-1698	-1368
		Bottom	-1011.158	-1363.2	-1698	-1368
Story9	27.6	Top	-1245.96	-1683.5	-2104	-1691
		Bottom	-1245.96	-1683.5	-2104	-1691
Story8	24.6	Top	-1432.492	-1938	-2426	-1947
		Bottom	-1432.492	-1938	-2426	-1947
Story7	21.6	Top	-1576.302	-2134.2	-2674	-2145
		Bottom	-1576.302	-2134.2	-2674	-2145
Story6	18.6	Top	-1682.94	-2279.7	-2858	-2291
		Bottom	-1682.94	-2279.7	-2858	-2291
Story5	15.6	Top	-1757.952	-2382.1	-2988	-2394
		Bottom	-1757.952	-2382.1	-2988	-2394
Story4	12.6	Top	-1806.887	-2448.8	-3072	-2462
		Bottom	-1806.887	-2448.8	-3072	-2462
Story3	9.6	Top	-1835.294	-2487.6	-3121	-2501
		Bottom	-1835.294	-2487.6	-3121	-2501
Story2	6.6	Top	-1848.721	-2505.9	-3145	-2519
		Bottom	-1848.721	-2505.9	-3145	-2519
Story1	3.6	Top	-1852.79	-2511.5	-3152	-2525
		Bottom	-1852.79	-2511.5	-3152	-2525
Base	0	Top	0	0	0	0
		Bottom	0	0	0	0

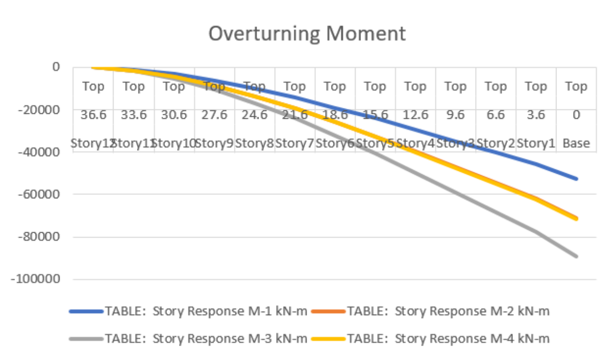
3.Max Storey Drift.

TABLE: Story Response						
Story	Elevation	Location	M-1	M-2	M-3	M-4
	m					
Story12	36.6	Top	0.000234	0.00048	0.000558	0.000447
Story11	33.6	Top	0.000363	0.00054	0.000588	0.000504
Story10	30.6	Top	0.000482	0.000593	0.000618	0.000565
Story9	27.6	Top	0.000579	0.000656	0.000644	0.000624
Story8	24.6	Top	0.000656	0.000706	0.00066	0.000674
Story7	21.6	Top	0.000714	0.00074	0.00066	0.000709
Story6	18.6	Top	0.000754	0.000755	0.000644	0.000725
Story5	15.6	Top	0.00078	0.000747	0.000609	0.000717
Story4	12.6	Top	0.000794	0.000714	0.000552	0.000678
Story3	9.6	Top	0.000796	0.000649	0.000467	0.000601
Story2	6.6	Top	0.000781	0.000543	0.000353	0.000474
Story1	3.6	Top	0.000598	0.000344	0.000186	0.000261
Base	0	Top	0	0	0	0



4.Overturning Moment

TABLE: Story Response						
Story	Elevation	Location	M-1	M-2	M-3	M-4
	m		kN-m	kN-m	kN-m	kN-m
Story12	36.6	Top	0	0	0	0
Story11	33.6	Top	-1123.66	-1483.76	-1796.46	-1479.54
Story10	30.6	Top	-3291.27	-4391.88	-5395.71	-4393.79
Story9	27.6	Top	-6324.74	-8481.37	-10490.2	-8497.99
Story8	24.6	Top	-10062.6	-13531.9	-16801.1	-13570.3
Story7	21.6	Top	-14360.1	-19346	-24078.4	-19411.6
Story6	18.6	Top	-19089	-25748.7	-32100.7	-25845.8
Story5	15.6	Top	-24137.8	-32587.9	-40675.4	-32719.7
Story4	12.6	Top	-29411.7	-39734.2	-49638.8	-39902.9
Story3	9.6	Top	-34832.3	-47080.7	-58855.7	-47287.8
Story2	6.6	Top	-40338.2	-54543.5	-68219.7	-54789.8
Story1	3.6	Top	-45884.4	-62061.3	-77653.3	-62347.2
Base	0	Top	-52554.4	-71102.8	-88999.3	-71436.4



VI. SUMMARY AND CONCLUSION

In above study it is clear that buildings with Shear walls behaves better than conventional bare frames model. The Following observations were seen-:

1. The Buildings with Shear walls are more Safer as compared to building without Shear walls, although they are costly but gives more Structural stability to building.
2. It is mandatory to provide Shear Walls in Earthquake Prone Zones.
3. Storey Drift is within Permissible limit as per IScode 1893.
4. Storey Displacement and Storey Drift givesModel 3 with better Results and Model 2 and Model 4 with Close results.
5. Storey Shear finalizes model 3 as case with lower values and works out best out of all and model 2 and model 4 as case with close Results
6. Overturning moment is less in model 1 but model 1 Outperform in others factors storeyshear,Storey Displacement and Storey Drift.

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