Effect of Shear Wall Location on Performance of High-Rise Building

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Abstract - In many respects concrete is an ideal building material, combining economy, versatility of form and function, and noteworthy resistance to fire and the ravages of time. The raw materials are available in practically every country, and the manufacturing of cement is relatively simple. It is little wonder that in this century it has become a universal building material. Tall buildings are the most complex built structures since there are many conflicting requirements and complex building systems to integrate. Today's tall buildings are becoming more and more slender, leading to the possibility of more sway in comparison with earlier high-rise buildings. Thus, the impact of wind and seismic forces acting on them becomes an important aspect of the design (Mirghaderi et al. 2008). Seismic design of structures is essential to improve the performance of buildings subjected to dynamic earthquake loads. In the last decades, seismic design has become more rational due to new knowledge provided by comprehensive research and the development of more efficient analysis techniques (Ugalde et al. 2017). In the design of tall buildings, the lateral system that resists wind and seismic loading usually dominates the structural engineering effort; therefore, optimal lateral system design is important for material efficiency

Key Words: building without shear wall, with shear wall and shear wall at center, Story displacement, Story drift, Story shear

1. INTRODUCTION

Shear wall is a structural member positioned at different pleases in a building from foundation level to top parapet level, used to resist lateral forces i.e., parallel to the plane of the wall. There are different materials by which shear wall can be constructed but reinforced concrete (RC) buildings often have vertical plate-like Reinforced concrete walls in addition to slabs, beams and columns. Their thickness can be as low a 150 mm, or as high as 400 mm in high rise buildings. Shear walls are usually provided along both length and width of buildings.

These walls are more important in seismically active zones because during earthquakes shear forces on the structure increases. Shear walls should have more strength and stiffness. Shear walls provide adequate strength and stiffness to control lateral displacements. Shear walls perform dual action that is they as lateral as well as gravity load-bearing elements. Concrete Shear wall buildings are usually regular in plan and in elevationanalysis is mainly used to estimate strength and drift capacity of structure.

2. ADVANTAGES OF SHEAR WALLS IN RC BUILDINGS

1. Shear wall resist horizontal lateral force and provide earthquake resistance.

2. It possesses very large in-plane stiffness which resist lateral load.

3. Shear walls are helpful in controlling deflection.

4. It minimizes earthquake damage to structural damage and non-structural damages.

5. Well-designed shear walls not only provide adequate safety but also provide great measure of protection against costly non- structural damage during moderate seismic damages.

3. NEED OF STUDY

The seismic behavior of buildings is significantly affected by the arrangement of shear walls, the rigidity of floors and the connections of floors to the walls. Shear walls are normally arranged in such a way that they resist lateral load on either axis of the building effectively. As the efficiency of the system is affected by the location of shear walls, the present study has, therefore been planned on "Seismic Behavior of Shear Wall Framed Buildings" with an aim to identify the most suitable shear wall type with or without shear wall. The study will help in deciding which thickness and length of dumbbell shape shear wall is give maximum advantages.

4. DESCRIPTION OF PROBLEM

RC framed regular buildings with shear walls situated in seismic zone V have been taken for the purpose of the study. The framed regular buildings are G+10 storied. The size of the building in plan is 15 m x 15 m. The other features of the buildings are as follow.

Height of each story-3000 mm

Size of beam -230 x 450 mm

Size of column – 450 x 450 mm

Size of Slab – 175 mm

Size of shear wall- 300 x 5000 mm

No of bays in X and Y direction- 3

Spacing between support – 5000 mm

Live load- 3 KN/m2

All supports assumed to be fixed

Concrete mix used – M30

Models:

Model 1- G+10 storied building without shear wall

Model 2- G+10 storied building with shear wall

Model 3- G+10 storied building with shear wall at center

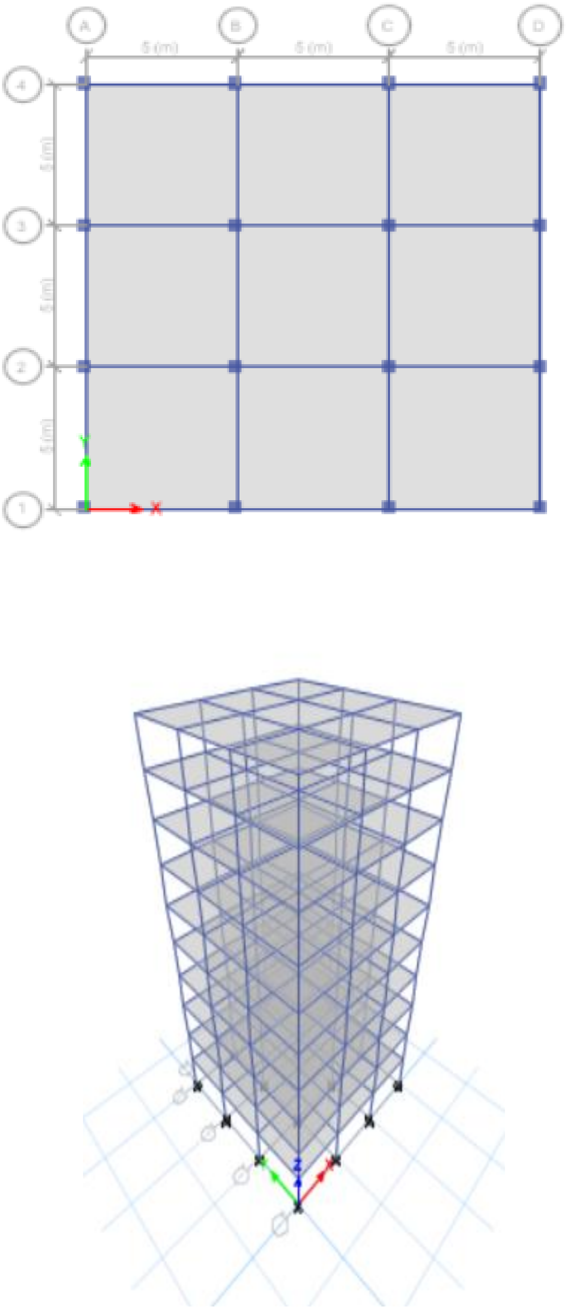

Fig.1 Plan and 3D view of model 1

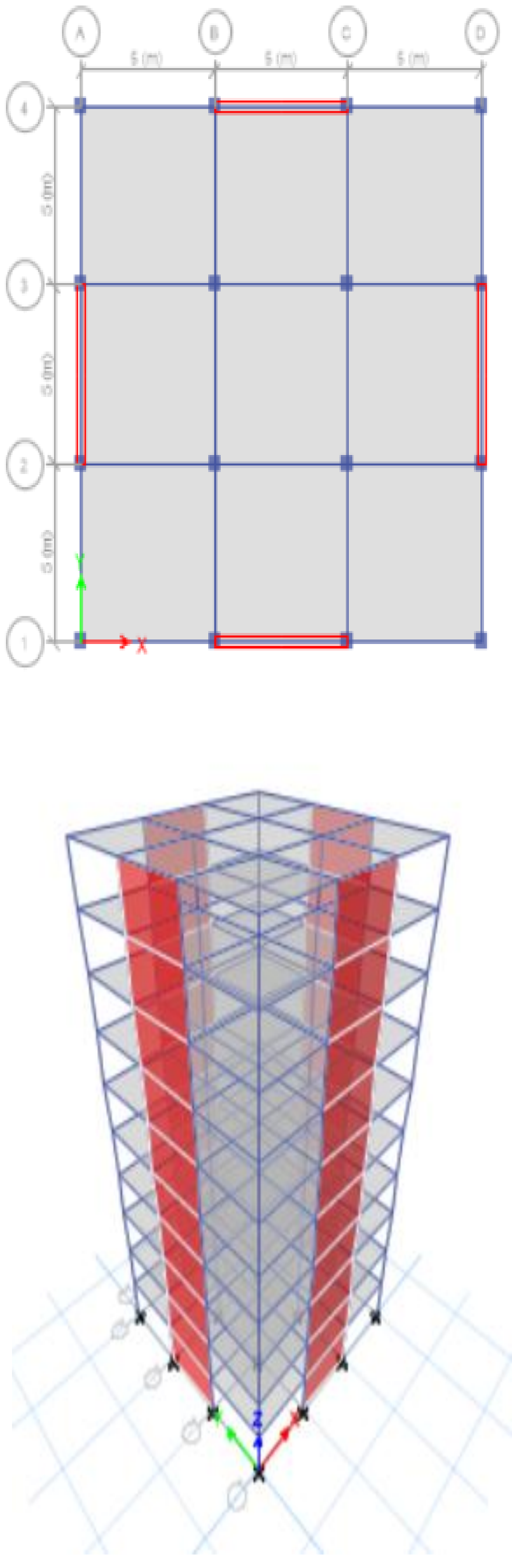

Fig.2 Plan and 3D view of model 2

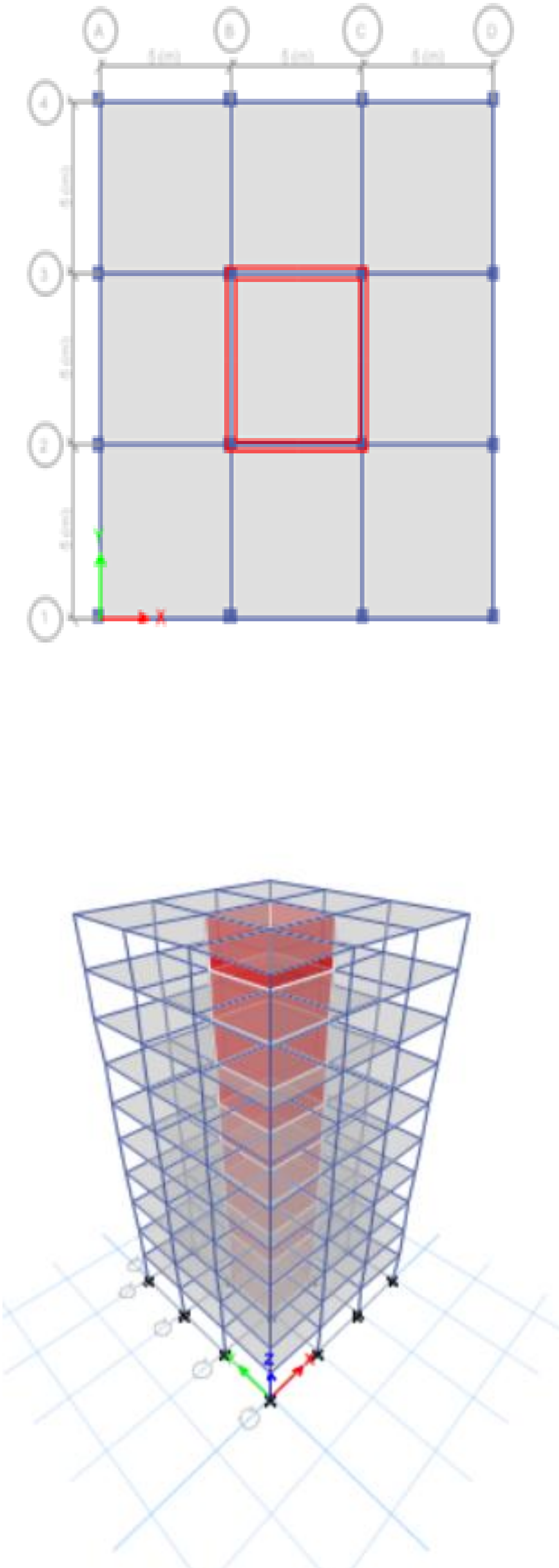

Fig.3 Plan and 3D view of model 3

5. RESULT AND DISCUSSION FOR COMPARISON OF RESULTS WITHOUT, WITH AND CENTRAL POSITION OF SHEAR WALL FOR G+10 STORY BUILDING.

Above problem is analyzed in e-tab with and without incorporation of shear wall. following results are obtained.

5.1 STORY DISPLACEMENT

Table 1. Story displacement values

Story	Elevation	Model 1	Model 2	Model 3
Story10	30	33.884	19.233	12.382
Story9	27	32.463	16.833	10.833
Story8	24	30.222	14.347	9.229
Story7	21	27.235	11.86	7.627
Story6	18	23.659	9.41	6.057
Story5	15	19.65	7.064	4.562
Story4	12	15.349	4.901	3.189
Story3	9	10.885	3.011	1.991
Story2	6	6.418	1.493	1.023
Story1	3	2.321	0.448	0.337
Base	0	0	0	0

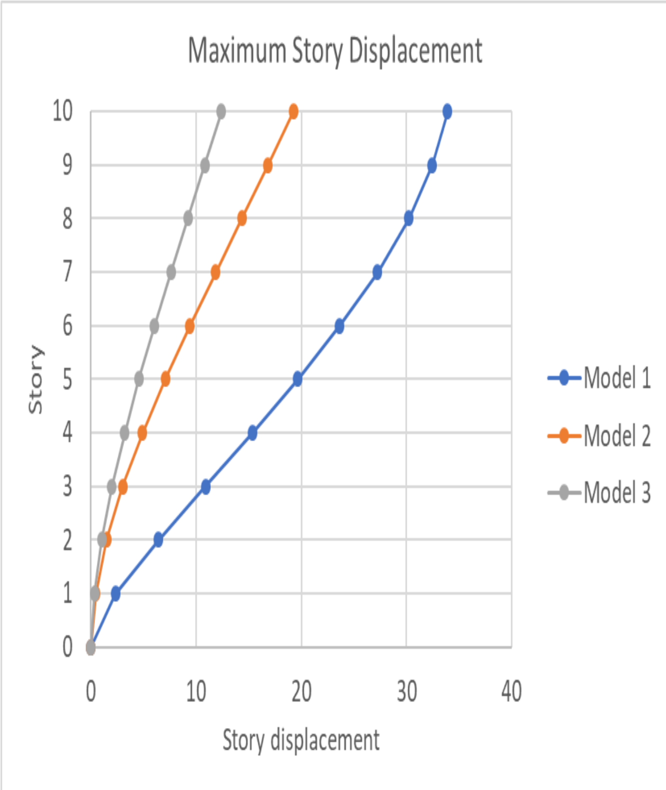

Fig.4. Maximum story displacement

The story displacement for three various models are observed and listed in the table. It is seen that, displacement of model 2 and model 3 is less than model 1. So, model 2 and model 3 are more stable structures than model 1.

Also, by comparing model 2 and model 3, it is observed that model 3 get 36% less displacement than model 2. Hence building with central shear wall location performed best in high-rise building.

5.3 STORY DRIFT

Table 2. Story drift values

story	Elevation	Model 1	Model 2	Model 3
Story10	30	0.000474	0.000809	0.000521
Story 9	27	0.000747	0.000829	0.000535
Story8	24	0.000996	0.000829	0.000534
Story7	21	0.001192	0.000817	0.000524
Story6	18	0.001336	0.000782	0.000499
Story5	15	0.001434	0.000721	0.000458
Story4	12	0.001488	0.00063	0.0004
Story3	9	0.001489	0.000506	0.000323
Story2	6	0.001366	0.000348	0.000229
Story1	3	0.000774	0.000149	0.000112
Base	0	0	0	0

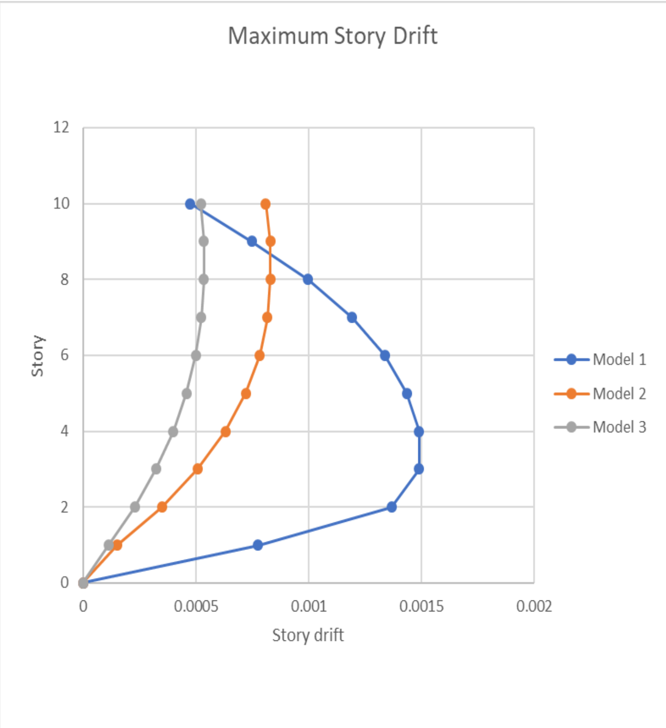

Fig.5 Maximum story drift

The story drift for three various models are observed and listed in the table. It is seen that, story drift of model 2 and model 3 is less than model1. So, model 2 and model 3 are more stable structures than model 1.

Also, by comparing model 2 and model 3, it is observed that model 3 get 36% less story drift than model 2. Hence building with central shear wall location performed well in the view point of story drift for high-rise building

5.4 STORY SHEAR

Table 3. Story shear values

story	Model 1	Model 2	Model 3
10	133.1855	342.3147	427.8099
9	249.4828	674.0705	841.7072
8	341.3721	936.1986	1168.7372
7	411.7248	1136.89	1419.1195
6	463.4126	1284.3374	1603.0739
5	499.3068	1386.7312	1730.82
4	522.2791	1452.2632	1812.5775
3	535.2011	1489.125	1858.5661
2	540.9442	1505.508	1879.0055
1	542.3799	1509.603	1884.1153
0	0	0	0

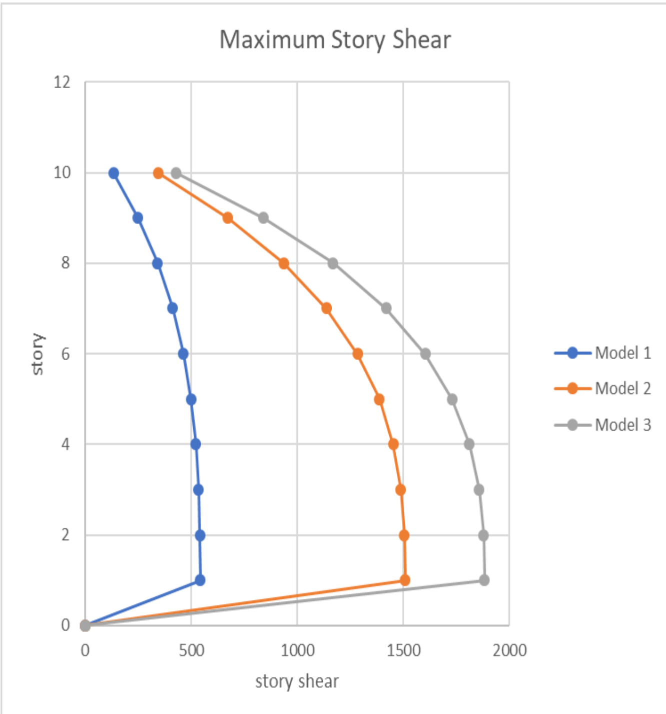

Fig.6 Maximum story shear

The story shear for three various models are observed and listed in the table. It is seen that, story shear of model 2 and model 3 is more than model 1 . So, model 2 and model 3 are more stable structures than model 1 to the earthquake.

Also, by comparing model 2 and model 3, it is observed that model 3 get 20 % more story shear than model 2. Hence building with central shear wall location performed well in the view point of story shear for high-rise building.

6. CONCLUSIONS

1) From the seismic analysis of G+10 story RCC building, it is observed that G+10 story RCC building provided with central shear wall get 36% less story displacement and story drift than building with randomly placed shear wall. Hence building with central shear wall location performed well in the view point of story displacement and story drift for high-rise building.

2) From the seismic analysis of G+10 story RCC building, it is observed that G+10 story RCC building provided with central shear wall get 20% more story shear than building with randomly placed shear wall. Hence building with central shear wall location performed well in the view point of story shear and for high-rise building.

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