COMPARATIVE STUDY OF FLAT SLAB BUILDING WITH SHEAR WALL AND BRACING

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ABSTRACT

Earthquake is the natural calamity, it produce strong ground motions which affect the structure. Small or weak motions that can or cannot be felt by the humans. Provision of shear walls and bracings are installed to enhance the lateral stiffness, ductility, minimum lateral displacements and safety of the structure. Story drift and lateral displacements are the critical issues in seismic design of buildings. Three types of frame models are developed and evaluated by static analysis by ETABS. In the present work G+24 multistory building is analyzed by using shear wall and bracing .Main purpose of this study is to compare the seismic response of the structure.

1. INTRODUCTION

1.1 General

Lateral forces on buildings such as wind, earthquake and blast forces can be produced critical stresses in the buildings that it causes excessive lateral sway of the buildings and undesirable stresses and vibrations in the buildings. Design and structural evaluation of the building systems subjected to lateral loads form the important task of the present generation and the designers are faced with problems of providing adequate strength and stability of buildings against lateral loads. Different lateral loads resisting systems are used in high-rise building as the lateral loads due to earthquakes are a matter of concern. The major criteria now-a-days in designing RCC structures in seismic zones is control of lateral displacement resulting from lateral forces. In this thesis effort has been made to investigate the effect of Shear Wall position on lateral displacement in RCC frames. Two models of flat slab with shear wall and flat slab with bracing of 24 storied buildings are designed and performed linear static analysis. In this project shear wall systems are taken consideration and executed for lateral forces.

1.2 Flat Slab

Flat slabs system of construction is one in which the beams used in the conventional methods of constructions are done away with. The slab directly rests on the column and load from the slab is directly transferred to the columns and then to the foundation. To support heavy loads the thickness of slab near the support with the column is increased and these are called drops, or columns are generally provided with enlarged heads called column heads or capitals. Absence of beam gives a plain ceiling, thus giving better architectural appearance and also less vulnerability in case of fire than in usual cases where beams are used. In general normal frame construction utilizes columns, slabs & Beams.

1.3 Shear wall

Shear walls are vertical elements of the horizontal force resisting system. Shear walls are constructed to counter the effects of lateral load acting on a structure. In residential construction, shear walls are straight external walls that typically form a box which provides all of the lateral support for the building. When shear walls are designed and Constructed properly, and they will have the strength and stiffness to resist the horizontal forces. In building construction, a rigid vertical diaphragm capable of transferring lateral forces from exterior walls, floors, and roofs to the ground foundation in a direction parallel to their planes. Examples are the reinforced-concrete wall or vertical truss. Lateral forces caused by wind, earthquake, and uneven settlement loads, in addition to the weight of structure and occupants; create powerful twisting (torsion) forces. These forces can literally tear (shear) a building apart.

1.4 Bracing

Bracing is a highly efficient and economical method to laterally stiffen the frame structures against wind loads. A braced bent consists of usual columns and girders whose

Primary purpose is to support the gravity loading, and diagonal bracing members that are connected so that total set of members forms a vertical cantilever truss to resist the horizontal forces. Bracing is efficient because the diagonals work in axial stress.

2. Objective

1. To study the behavior of G+ 24 storey's building with three different models.
2. To carry out response spectrum analysis.
3. To compare the results of the models and put comments forward.

3. Methodology

In designing and analyzing the performance of flat slab buildings and conventional building, it is especially important that an effective modeling technique be involved because of the complexity of the real structural behavior and the difficulties of full scale measurement. In both the cases, foundations slightly vary. During the whole process of analysis and design structural member dimensions will seems to vary being of difference in load transfer mechanism. The analysis has been done both for gravity load and lateral load.

3.1 Applied Loads

The loads that are applied on the model so as for the model verification are determined according to the IS875-2016 code.

3.2 Dead Load

The dead load applied on the modal is determined by the ETABS program itself based on the material properties the model also includes floor loads. The floor loads are taken as 1 KN/$m^{2.}$Those loads are considered as 'super dead' loads in the ETABSsoftware since the program separates them with structural dead loads (column, beam, slab etc.)

3.3 Live Load

Live load is the load that accounts for the intended use or occupancy. The value of live load shall be taken as 3kn/m^2in conventional slab and 5kn/m2 in flat slab including wall load in flat slab will be the same for floor from top to bottom.

3.4 Earthquake Load

As earthquake load case is also considered in the ETABS analysis. The earthquake load case is defined using ETABS program's joint weight and response spectrum in accordance to IS 1893:2005codes.

4. Geometrical Properties

Description of Building-

The size of the Building in plan – (35 m x 35 m) (Commercial)

Number of stories: G+24

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: $4KN/m^2$

Roof live load: $1.5KN/m^2$

Wall Load: 13 KN/m² (9” Thick)

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

5. Structure Modeling

The modeling of the members like column and slab will be done as per the standard procedure by adopting following properties-

1. Columns and slabs will be designed by M25 grade of concrete and Fe550 and Fe250 grade of steel.
2. The optimum position of shear wall is at core and corner of the building because the displacement of the structure is minimum so we provide shear wall at core and corner in our model.
3. Three models were designed one is bare frame structure, second is flat slab building with shear wall, and third is flat slab building with bracing.
4. Shear wall and bracing system are applied in the building to resist the lateral loads.
5. The building to be modeled is having G+24 stories.

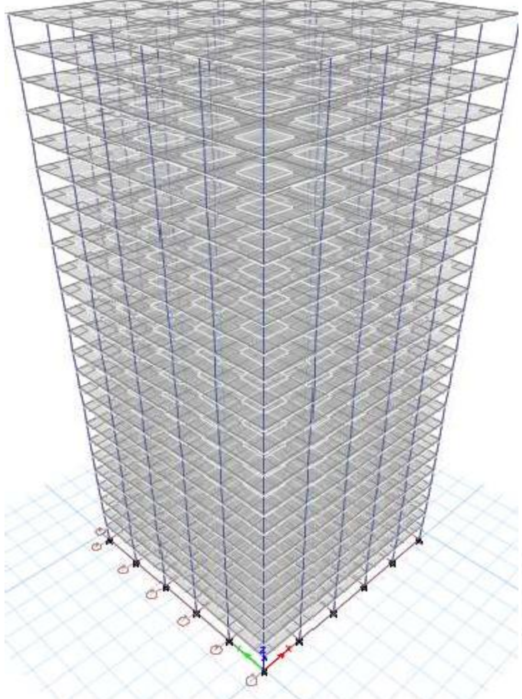

Fig.5.1- 3D view of Bare Frame structure.

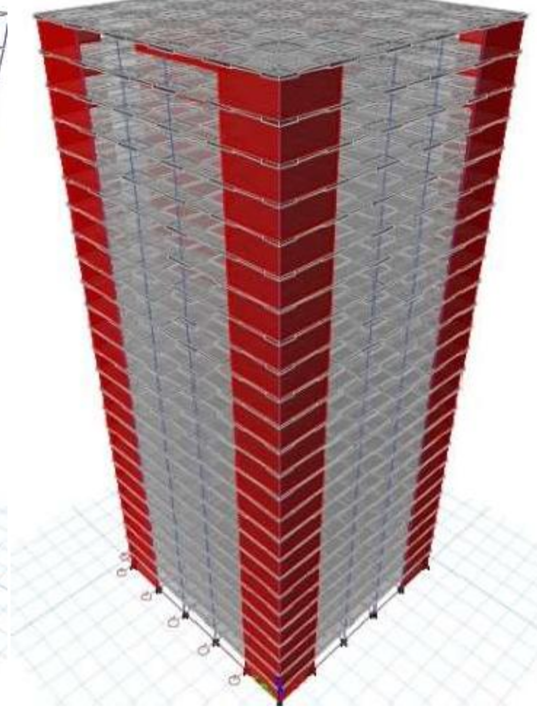

Fig.5.2- 3D view of flat slab building with shear wall.

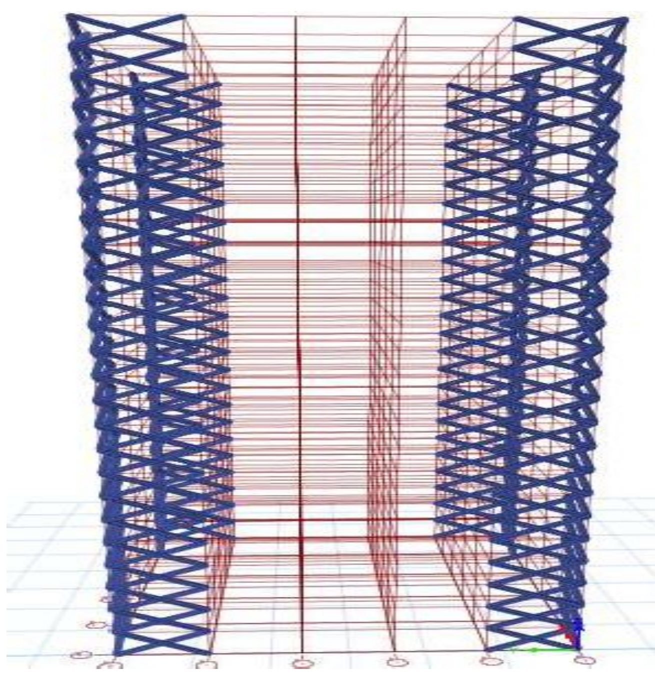

Fig.5.3 - 3D view of flat slab building with bracing.

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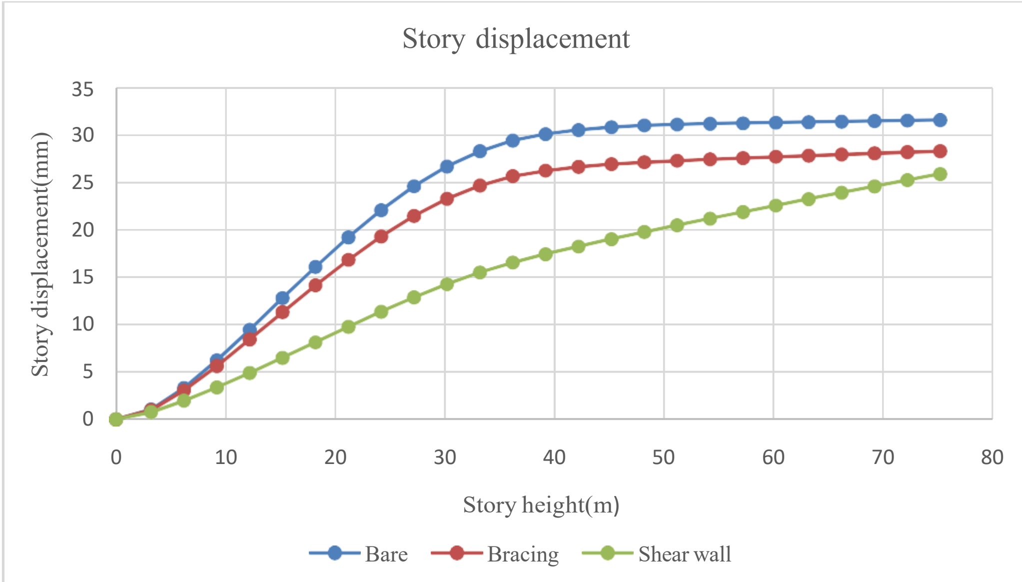

Fig. 5.4- GRAPH SHOWING STORY DISPLACEMENT IN Y DIRECTION

Elevation	Bare	Bracing	Shear wall
m	mm	mm	mm
75.2	31.596	28.304	25.907
72.2	31.541	28.193	25.27
69.2	31.486	28.075	24.6
66.2	31.431	27.955	23.93
63.2	31.375	27.832	23.254
60.2	31.319	27.706	22.574
57.2	31.262	27.577	21.889
54.2	31.201	27.443	21.197
51.2	31.131	27.3	20.496
48.2	31.033	27.14	19.784
45.2	30.847	26.926	19.037
42.2	30.55	26.64	18.25
39.2	30.116	26.252	17.439
36.2	29.423	25.652	16.569
33.2	28.305	24.681	15.518
30.2	26.695	23.283	14.279
27.2	24.606	21.472	12.881
24.2	22.09	19.301	11.366
21.2	19.225	16.835	9.771
18.2	16.097	14.148	8.136
15.2	12.806	11.319	6.502
12.2	9.468	8.439	4.905
9.2	6.236	5.623	3.383

6.2	3.322	3.044	1.981
3.2	1.062	0.995	0.767
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, bracing and shear wall are 31.59 mm, 28.30 mm, and 25.90 mm respectively.

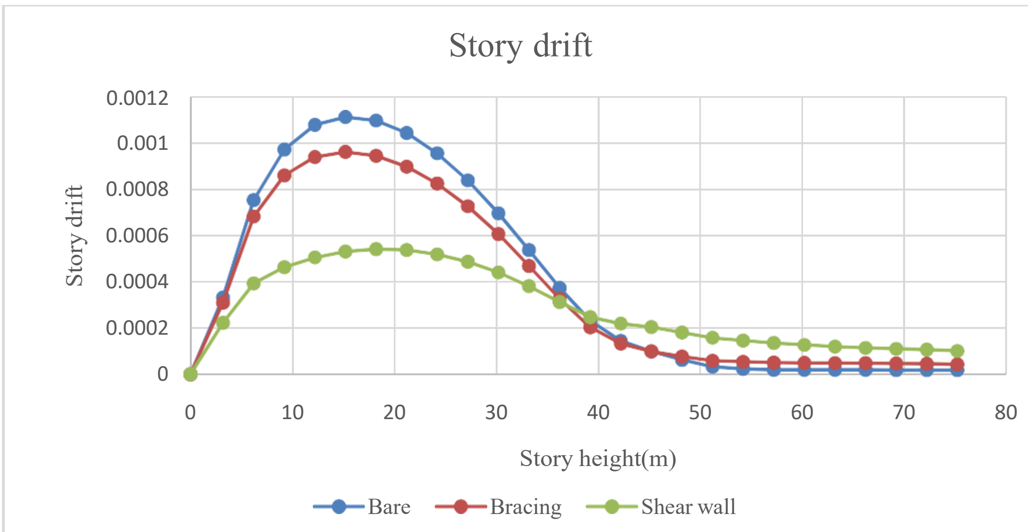

Fig. 5.5- GRAPH SHOWING STORY DRIFT IN Y DIRECTION

Elevation	Bare	Bracing	Shear wall
m	frame		
75.2	0.000018	0.000043	0.000101
72.2	0.000018	0.000046	0.000107
69.2	0.000018	0.000047	0.00011
66.2	0.000019	0.000048	0.000114
63.2	0.000019	0.000049	0.00012
60.2	0.000019	0.00005	0.000127
57.2	0.00002	0.000051	0.000135
54.2	0.000023	0.000054	0.000146
51.2	0.000033	0.000059	0.000158
48.2	0.000062	0.000077	0.000181
45.2	0.000099	0.000099	0.000204
42.2	0.000145	0.000133	0.000219

39.2	0.000231	0.000203	0.000247
36.2	0.000373	0.000326	0.000312
33.2	0.000537	0.000468	0.000381
30.2	0.000696	0.000606	0.00044
27.2	0.000838	0.000726	0.000486
24.2	0.000955	0.000824	0.000518
21.2	0.001043	0.000897	0.000537
18.2	0.001097	0.000944	0.000541
15.2	0.001112	0.000961	0.00053
12.2	0.001078	0.000939	0.000505
9.2	0.000971	0.000859	0.000463
6.2	0.000753	0.000682	0.000393
3.2	0.000332	0.00031	0.000222
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.

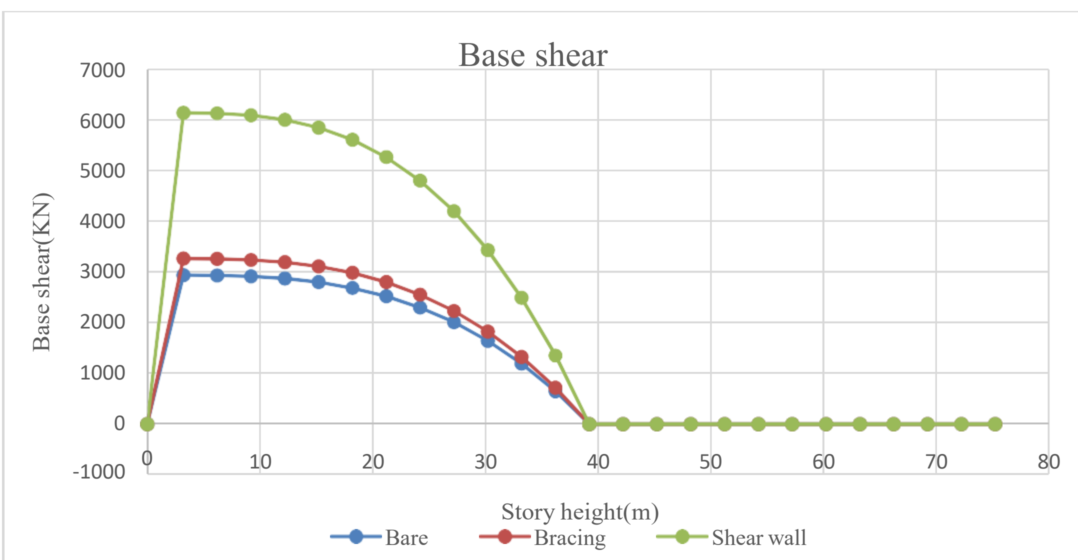

Fig 5.6- GRAPH SHOWING BASE SHEAR IN Y DIRECTION

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Elevation	Bare	Bracing	Shear wall
m	kN	kN	kN
75.2	-0.000007619	-7.1E-06	-2.8E-06
72.2	-0.00001487	-1.4E-05	-5.2E-06
69.2	-0.00002197	-2.1E-05	-7.6E-06
66.2	-0.00002926	-2.8E-05	-1E-05
63.2	-0.00003651	-3.4E-05	-1.3E-05
60.2	-0.00004389	-4.1E-05	-1.5E-05
57.2	-0.0001	-4.8E-05	-1.8E-05
54.2	-0.0001	-0.0001	-2E-05
51.2	-0.0001	-0.0001	-2.3E-05
48.2	-0.0001	-0.0001	-2.6E-05
45.2	-0.0001	-0.0001	-2.8E-05
42.2	-0.0001	-0.0001	-3.1E-05
39.2	-0.0001	-0.0001	-3.4E-05
36.2	647.808	720.1827	1353.397
33.2	1192.6937	1325.944	2491.769
30.2	1643.5552	1827.177	3433.706
27.2	2009.2907	2233.773	4197.799
24.2	2298.7983	2555.626	4802.636
21.2	2520.9762	2802.626	5266.809
18.2	2684.7227	2984.666	5608.907
15.2	2798.936	3111.64	5847.521
12.2	2872.5141	3193.438	6001.24
9.2	2914.3554	3239.954	6088.655
6.2	2933.358	3261.08	6128.355
3.2	2938.4712	3266.764	6139.106
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.

6. RESULTS AND CONCLUSION

The maximum story displacement of flat slab with shear wall, flat slab with bracing and bare frame is 25.90 mm, 28.30mm and 31.59 mm respectively. The values of story drift for all the stories are found to be within the permissible limit i.e. not more than 0.004 times to story height. The story shear values of flat slab with shear wall structure shows maximum value as compared to flat slab with bracing and bare frame. Shear wall positioned at building core has good seismic response compared to other options due to higher tendency of attraction of lateral loads. As shear wall gets apart from center of the building, its seismic response getting reduced. Base shear is inversely proportional to the story displacement. Hence the model with least story displacement has the maximum base shear value. It means it resists the maximum lateral force. On comparison of different parameters like story displacement, story drift and base shear of flat slab with shear wall structure, flat slab with bracing and bare frame we found that flat slab with shear wall structure show better performance against lateral loads. From the results and discussions, it can be concluded that, Flat slab with shear wall structure are preferable than Flat slab with bracing and bare frame structure because story displacements and story drifts are found to be less.

7. FUTURE SCOPE

1. In this paper i have considered building of 25 storey's only, we can also consider buildings with more number of storeys.

2. I have studied only three major parameters i.e. storey displacement, storey drift and storey (or) base shear. The volume of work undertaken in this study is limited to comparison of seismic response parameters in a building with different shear wall locations using linear analysis. The study could be extended by including various other parameters such as torsion effects and soft storey effects in a building. Non-linear dynamic analysis may be carried out for further study for better and realistic evaluation of structural response under seismic forces.

3. In this paper I considered the building with regular plan and assumes seismic load be acts in a unidirectional. It also to carry out for irregular plan and load acts in a multi directional.

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