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COMPARATIVE STUDY ON THE EFFECTS OF SHEAR WALL AND BRACING ON MULTI-STORIED BUILDING

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***Abstract*: High rise structures are susceptible to failure and collapse in case of earthquakes. Now a days, shear wall and steel bracings are most popular systems to resist lateral loads due to earthquakes. Both the systems have significant roles in reducing the damage caused due to lateral loads in case of an earthquake. In this study, an attempt has been made to study the performance of a G+9 story building with shear wall and bracing in seismic zone V and comparison has been made between the two systems to find the most suitable earthquake resistant structure. Response Spectrum Analysis has been performed in the software ETABS. The performance is evaluated on the basis of story displacement and story drift.**

***Keywords:* Shear Wall, Bracing, Response Spectrum, ETABS, Displacement, Base Shear.**

I. INTRODUCTION

Earthquake is unpredictable and cause great damage to structures as well as human beings. Hence the structural engineers need to design buildings in order to make it resistible to damages caused due to the effects of seismic actions. The lateral loads due to earthquakes produce sway moments and hence reduces the stability of the structure. Lateral load resisting systems such as rigid frame, shear wall, diagrid structural system, and braced system are used in construction of high-rise buildings.

1. **Shear Wall**: Shear Walls are vertical members that resist seismic forces. Shear walls have high strength and stiffness to resist the lateral forces. The lateral sway of the RC frame combined with the shear wall deflected in the parabolic sway results in improved stiffness of the system significantly because the shear wall is effectively restrained by the moment frame at the top level whereas at the bottom levels, the moment frame is restrained by the shear wall. As a result, the failure and the lateral displacement of the structure are reduced by shear walls.

Fig 1: Shear Wall

2. **Bracing**: Steel bracing is highly efficient and economical method of resisting horizontal forces in a structure. It is efficient because the diagonals work in axial stress and therefore require minimum member sizes in providing stiffness and strength. The lateral stiffness under seismic performance is increased by the provision of bracings. Therefore the use of steel bracings is widely used in buildings especially in earthquake prone areas.


Fig 2: Steel Bracing

II. LITERATURE REVIEW

1. Azad et al (2016) studied the behavior of building against seismic forces with shear wall and steel bracing. The

analysis of both systems was carried out in ETABS software to determine the behavior and performance of each model. They compared the maximum displacement and storey drift of the models. They concluded that the model with shear wall at mid portion was the safest among all the models assessed in the research.

2. A Dharanya et al (2017) analyzed a G+4 storey residential RC building with soft storey retrofitted with cross bracings and shear wall. The analysis was performed in the ETABS software by equivalent stiffness method. The building was considered to be located at Bhuj (seismic zone V). The cross bracings such as X bracing were provided at the outer periphery of the column and the shear walls were provided at the corners of the building. From the results, it was found that the natural time period of the structure was reduced after placing shear wall than the bracings that improved the stability against earthquake. The structure with shear wall was found to be having the least lateral displacement. In case of two-dimensional image, after a DWT transform, the image is divided into four corners, upper left corner of the original image, lower left corner of the vertical details, upper right corner of the horizontal details, lower right corner of the component of the original image detail (high frequency). You can then continue to the low frequency components of the same upper left corner of the 2nd, 3rd inferior wavelet transform.
3. Pallavi et al (2017) carried out a comparative study of seismic analysis of multistoried building with shear wall and bracings. A G+9 storey building, along with shear wall and bracings was considered for the analysis of parameters like storey displacement, storey drift and base shear. From the analysis, it was found that the storey drift decreased in model with shear walls and increased in the case of model with bracings. The storey displacement decreased in model with shear walls and bracings. The storey shear increased in model with shear walls and bracings. It was suggested that providing a shear wall element is more efficient in reducing lateral displacement of building as drift and horizontal deflection are much less when compared with bare frame and bracings.
4. Shastri et al (2017) carried out a dynamic analysis of multistoried building with and without shear wall and bracing. In this study, a spatial configuration structure of 20 stories up to 70 m height of each storey height of 3.5m with shear wall, and bracing at a different location is considered. The dynamic behavior of the building in all seismic zones II, III, IV and V and on different soil conditions like hard, medium and soft were studied. Response spectrum analysis was performed in the ETABS software. For all types of building configurations , the base shear in zone II was very less as compared to different types of zones for same soil because base shear depends on type of zone areas. Story shear depends upon the building rigidity contributed by the different types of building configurations, The value of story shear in shear wall at external frame corner in building was more as compared to other configuration due to high stiffness in shear wall at external frame corner. However, it has the least story drift value in all zones and different soils due to shear wall at external frame corner introduced in the building which develops high amount of stiffness in the building. The displacement value increased from zone II to zone V as earthquake effect on structure in higher zone is large.
5. N. A. Ghate et al (2018) studied various building models like soft storey structure with shear wall and a structure with steel bracings at the first storey. Pushover analyses of the structures were performed in ETABS software and various parameters like maximum base shear, maximum displacement, and maximum inter storey drift, maximum storey force were analyzed. Three models were studied- 1. Infill frame with soft storey (IFSS), 2. Infill frame with shear wall in soft storey (IFSW) and 3. Infill frame with cross bracing (IFCB). The results showed that IFSW exhibit higher base shear than any other systems. Building with shear wall at the bottom storey had higher moment when compared to other systems.

6. Neela (2019) performed an earthquake resistant building design by considering bracings and shear wall system of a G+10 story building. Pushover analysis of the building was performed in the ETABS software and the comparison was made between the general building, steel building and shear wall buildings. The results like storey drift, storey shear, storey moment, building torsion, time period and model stiffness were compared. From the analysis, it was found that the story drift in X and Y direction decreased from top to bottom story; the higher value of story drift in X direction was observed for building with shear wall than building with bracings and general building. The higher value of story drift in Y direction was observed for general building than remaining cases due to effect of extra load from the shear wall. The maximum value of building torsion was observed for building with shear wall. The maximum value of time period was observed for the general building than the other cases. The maximum value of stiffness was observed for the building with shear wall. It was concluded that the building with shear wall has more advantages than the other cases.

III. METHODOLOGY

For this study, a G+9 story building is considered. The modeling and analysis of the building is carried out using the software ETABS. Response Spectrum Method is used for analysis of the structure. Three models are studied in zone V and parameters like storey displacement and storey drift are studied.

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Model 1: Bare frame building
Model 2: Building with shear wall
Model 3: Building with steel bracings

- Building details:
  - Number of stories = G+9
  - Floor to floor height = 3m
  - Grade of concrete = M25 and M30
  - Grade of steel =Fe 500
  - Size of beam= 300 mm * 600 mm
  - Size of column= 300 mm * 600 mm
  - Size of shear wall= 200 mm
  - Size of bracing= ISHB 150mm * 150 mm* 9mm
  - Depth of slab= 150 mm
  - Zone= V

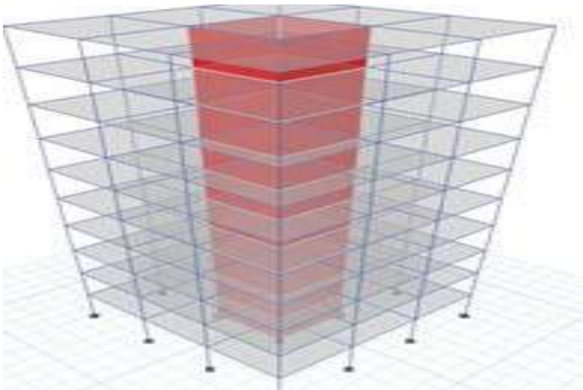

Fig. 3: Building model with shear wall

IV. RESULTS AND DISCUSSIONS

The results have been compared among the bare frame model, building with shear wall and building with bracing based on the following parameters:

- Story Displacement
- Story Drift

Story	Bare Frame(mm)	Shear Wall(mm)	Bracing(mm)
1	6.208	3.174	4.031
2	12.103	4.955	6.656
3	18.758	8.401	10.983
4	25.775	12.271	15.716
5	31.817	16.363	20.607
6	40.604	20.508	25.453
7	44.892	24.564	30.085
8	51.485	28.427	34.377
9	58.246	33.039	39.26
10	64.024	38.354	45.688

Table 1: Table showing the displacement in x-direction

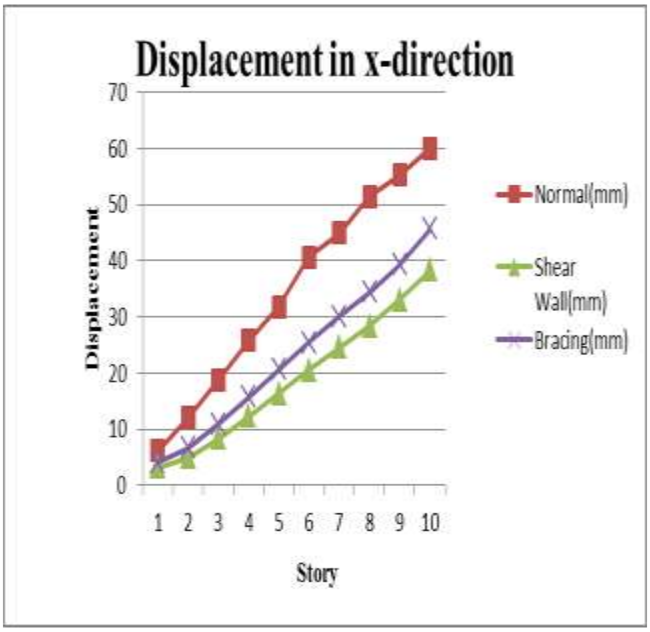

Fig 4: Displacement in x-direction

Story	Bare Frame(mm)	Shear Wall(mm)	Bracing(mm)
1	7.298	3.918	5.089
2	17.433	8.836	10.327
3	27.769	14.643	18.508
4	38.57	21.122	26.341
5	49.335	27.976	34.457
6	59.602	34.914	42.504
7	68.996	41.696	50.199
8	77.224	48.111	57.305
9	84.021	53.86	63.522
10	88.057	55.689	66.608

Table 2: Table showing the displacement in y-direction

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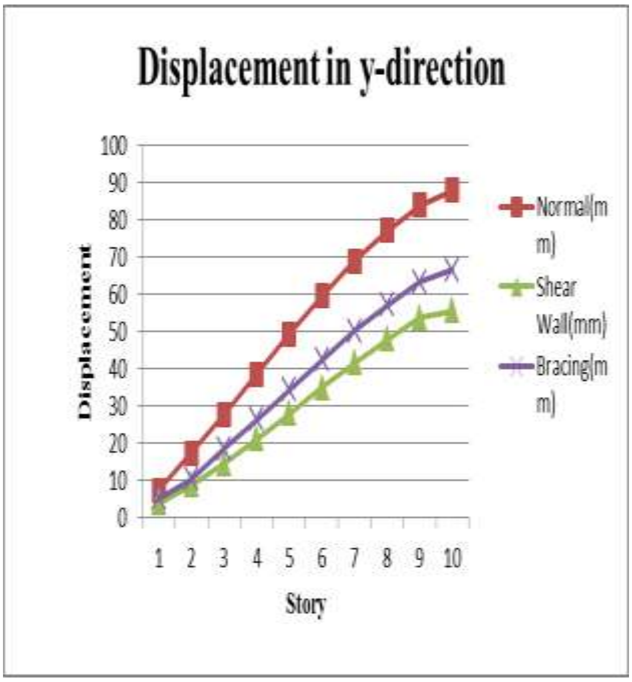

Fig 5: Displacement in y-direction

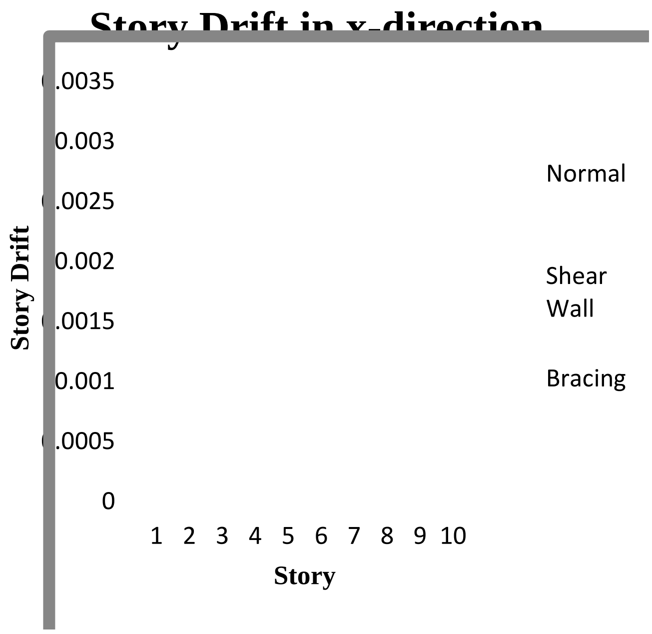

Fig 6: Story Drift in x-direction

Story	Bare Frame	Shear Wall	Bracing
1	0.00177	0.000907	0.00115
2	0.00197	0.000594	0.00088
3	0.00222	0.001148	0.00144
4	0.00234	0.00129	0.00157
5	0.00214	0.001364	0.00163
6	0.00293	0.001381	0.00162
7	0.00143	0.001352	0.00154
8	0.0022	0.001287	0.00143
9	0.00225	0.001537	0.001627
10	0.00193	0.00177	0.00214

Table 3: Table showing story drift in x-direction

Story	Bare Frame	Shear Wall	Bracing
1	0.002265	0.001119	0.00145
2	0.003378	0.001405	0.001746
3	0.00344	0.001935	0.00273
4	0.0036	0.002159	0.002611
5	0.003588	0.002284	0.00271
6	0.00342	0.002312	0.00268
7	0.00313	0.002606	0.00257
8	0.002742	0.002138	0.002368
9	0.002265	0.001916	0.00207
10	0.001345	0.0006096	0.001028

Table 4: Table showing story drift in y-direction

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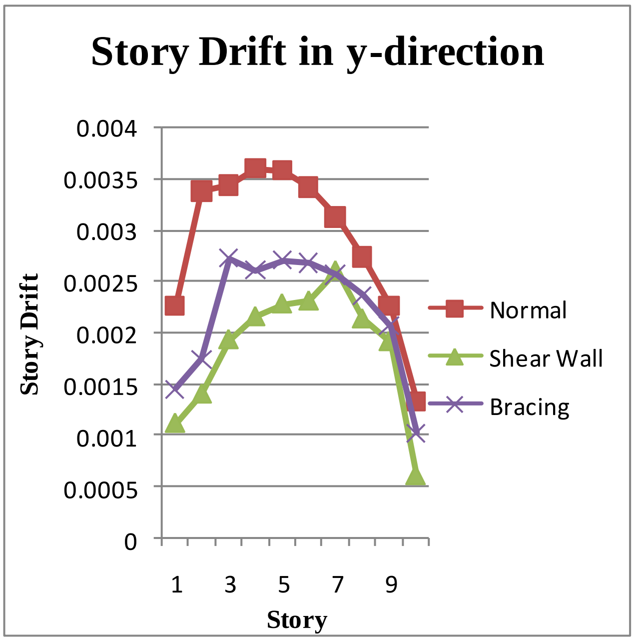

Fig 7: Story Drift in y-direction

V. CONCLUSION

- The shear wall model and braced model gives better resistance to earthquake forces than the bare frame model.
- Shear wall and steel bracings can be used in high rise buildings to resist the impact of earthquake forces.
- Among all the three models, shear wall model is the best as it gives least displacement values.
- The displacement in case of shear wall model is reduced by 40.094% than that in bare frame and by 16.5%in braced model in x-direction. Similarly, in case of y-direction, displacement in shear wall model is reduced by 36.75% for bare model and 16.4% in braced system.
- The story drift is found to be minimum in case of shear wall model than that of bare frame model and braced model in both x and y directions.

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