RESPONSE OF MULTISTORIED BUILDINGWITH DIFFERENT BRACING SYSTEMS UNDER SEISMIC CONDITIONS USING ETABS

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***Abstract*— Earthquakes are one of the natural calamities that cause many damages to multi-storeyed structures. Many RC buildings need to retrofit to overcome the damages under earthquake loads. There are many ways to protect the buildings under these circumstances. Bracings systems are one of the horizontal load resisting systems which got structural importance. So bracing is the most effective method which can be incorporated to the RC buildings to reduce the seismic effects. In tall building structures, bracing has been used to stabilize the structure laterally. Different bracing systems are there to retrofit the building under seismic conditions. Among all, Steel bracing is the most efficient and economical method to resist lateral forces in a RC frame structure. Because, Steel bracing can improve the stiffness and strength of the RC building and can also reduce the deformation. In this study we have mainly focused on comparative study of a regular building and building with different bracing systems. Shape study and location study has also been done on building with bracing for comparison with regular RC building. X, V and inverted V bracing system is used for shape study. The comparative study is done under Response Spectrum method using ETABS Software. This study is mainly focused to determine which shape of bracing system is effective and also the best suited location for bracing to reduce the effect of seismic loading.**

Keywords— regular buildings; bracing systems; response spectrum analysis; ETABS

I. INTRODUCTION

Why seismic analysis is important? The seismic analysis allows us to monitor the response of a building during an earthquake, which enables us to obtain the additional forces or deformations that would generate because of lateral forces. Seismic design is an important process of structural analysis while designing a building, which is subjected to earthquake ground motions, such that the facility continues to function and serve its purpose even after an Earthquake. Seismic analysis is a subset of structural analysis and is the calculation of the response of a building (or nonbuilding) structure to earthquakes. To prevent structural damage and also minimize non- structural damage underground shaking events are the objective of the seismic design of the structure. When the seismic wave's frequency approximates or is similar to the building's natural frequency, resonance takes place, and the buildingsget affected. Therefore, the energygets transmitted to the building at tremendous efficiency. - Small buildings are affected more by high-frequency waves. To create an adequate and proper seismic design, it is important to analyze the building's period, ductility, strength, stiffness, damping, etc. This analysis also helps determine which devices and strategies to employ for seismic design. These factors of seismic analysis include among others: soil condition, building heights, the relative difference between building's heights, the separation between adjacent buildings, lateral load resisting structural system, the peak ground acceleration of the earthquake at the location of the building etc .

Bracing system is capable of resisting lateral forces through the compression or tension of its brace members, which makes the system highly effective in resisting the lateral forces. In addition, the braced frame system's efficiency enhanced its ability to provide lateral stiffness and strengthen the structure. This research is mainly concerned with the following system: Bracings shape and its appropriate locations. There are various methods available for the evaluation of seismic performance of any structures.

In this study, the performance of RC building under lateral load resisting bracing systems is compared, including outer corners, the centre of outer sides and the inner core to determine the most favourable location for installing bracing systems in RC buildings.

Bracing is a construction method used to stabilize or stiffen the building structure against lateral loads. It enhances the ability of building structures to withstand lateral load due to wind and earthquakes. Bracing is essential in earthquake-resistant buildings to keep them in place .

II. Objectives

The main objectives of the study is to model and analyse the performance of multi-storied braced framed building with different bracing systems and to compare with an RC building under Response spectrum analysis using ETABS software.

III. Parametric Study

A G+9 story building with 3 meters height for each story, regular in plan is modelled for this study. The building consists of 5 spans of 5 m in X direction and 4 spans of 4 m in the Y direction as shown in figure. The plan of all buildings is 25 m x 16 m. Building with various bracing are modelled with three different positions named as Model- I, Model- II and Model- III and a regular RC building is also modelled for comparison. X bracing, K bracing, V & Inverted V bracing system are selected for this parametric study which are the types of vertical bracing systems .

IV. Modelling

“Members of the structure such as Beams, columns and braces were modelled as frame element with specific defined material properties of concrete (M30), steel (rebars (HSD500)) and structural steel (Fe250). The support condition was assumed as fixed. Slab were modeled as shell element with slab having rigid diaphragm in each story level. Each model was designed as per NBC 105:2020 load combinations for linear static and response spectrum method. In this study, G+9 Storey building with each floor height of 3m is considered. Because, in our country, here has been a considerable increase in the construction of tall buildings both in case of residential and commercial too. The modern trend is towards more tall and slender structures. If a result satisfies for the tall structure, then it obviously satisfies for low rise structure. Here we used two methods for analysing the models: Equivalent Static Method (ESM) and Response Spectrum Method (RSM) .

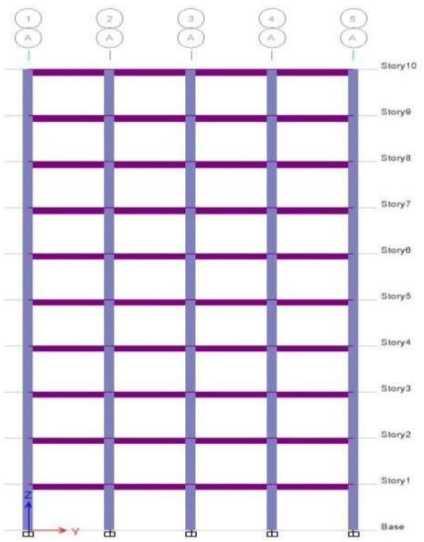

Fig. 1. G+9 Storey Building

The procedure was adopted for this study are as follows:

1. G+9 storey regular bare framed model and 6 models with bracing system are modelled for the study. Each of 6 cases with different position and types of Bracing System developed. Total 7 models are modelled which are shown in Fig.
2. Modelling and Analysis is done using ETABS 2017. Linear static analysis i.e., Equivalent Static Method (ESM) and linear dynamic analysis i.e., Response Spectrum Method (RSM) is considered for the analysis. Design as per NBC 105:2020 for earthquake, IS 456:2002 for RCC and IS 800:2007 for steel.
3. Seismic zone considered is Zone V with type II soil (medium soil).
4. Parameters considered in this project are Storey displacement, Storey drift, Base shear, Stiffness and these are compared with regular RC frame structure.
5. After the analysis parameters were valuated individually. Comparison between the different systems with different position with respect to different parameters are valuated and compared with the regular structure.
6. Based on the result obtained from the analysis, the conclusion and recommendation are made.

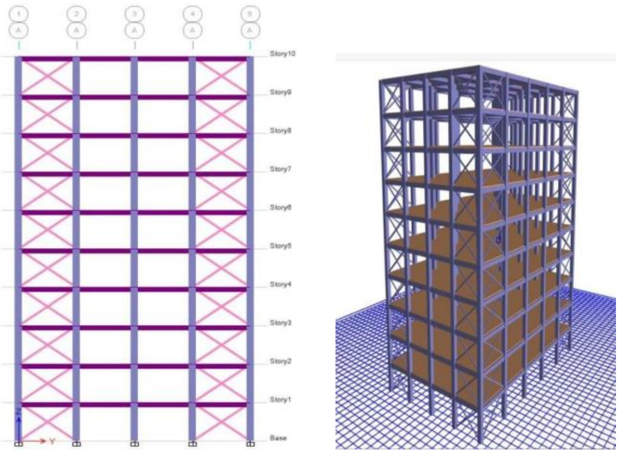

Fig. 2. X_BS@C (a) Elevation (b) 3D Model

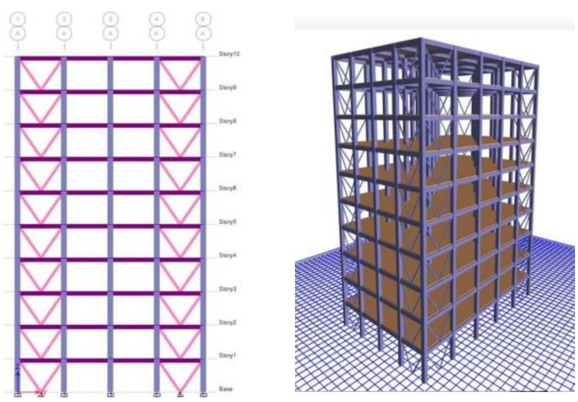

Fig. 3. V_BS@C (a) Elevation (b) 3D Model

V. RESULTS AND DISCUSSION

The results obtained from this study which consists of analysing seven models. The behaviour and response of the structure under different bracing systems and its different locations is studied with respect to story displacement, story shear, story drift and story stiffness.

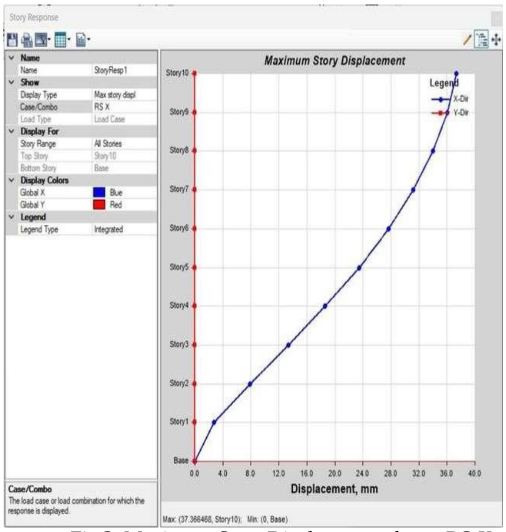

Fig.3. Maximum Story Displacement due to RS X

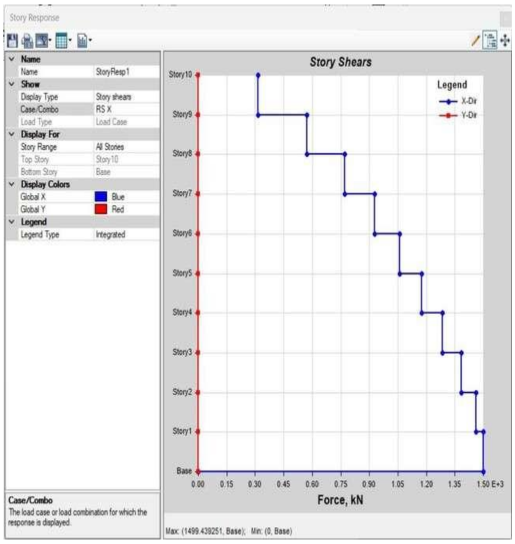

Fig.4. Story Shear due to RS X

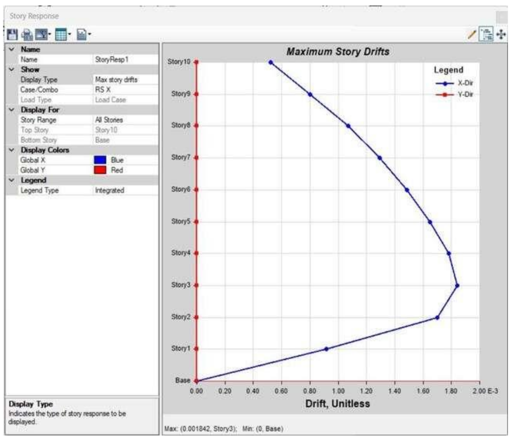

Fig. 5. Max Story Drift due to RS X

TABLE I. COMPARISON OF RESULTS OF REGULAR MODEL

	Max story displacement	Storey shear	Story drift
RS X	37.366	1499	0.001842
RS Y	35.734	1594.5	0.001744

When comparing the results of building with different bracing systems (X, V & Inv V) @ corners with respect to regular RC building, it is found that the story displacement can be decreased up to 25% in case of X bracing, 21% in case of V bracing and 21% in case of inverted V bracing.

When comparing the results of building with different bracing systems (X, V & Inv V) @ corners with respect to regular RC building, it is found that the story displacement can be decreased up to 25% in case of X bracing, 21% in case of V bracing and 21% in case of inverted V bracing.

When comparing the results of building with different bracing system (X, V & Inv V) @ outer middle span with respect to regular RC building, it is found that the story displacement is decreased up to 25% in case of X bracing, 23% in case of V bracing and 25% in case of inverted V bracing.

Similarly, the story shear is increased up to 41% in case of X bracing, 35% in case of V bracing and 16% in case of inverted V bracing. And in the case of story drift, it is decreased up to 33% in case of X bracing, 27% in case of V bracing and 28% in case of inverted V bracing.

VI. CONCLUSION

The response or behaviour of the building with and without bracing system is studied under seismic condition and the story displacement, story shear and story drift is compared.

When comparing the results of building with different bracing system (X, V & Inv V) @ corners with respect to regular RC building, it is found that the story displacement is can be decreased up to 25% in case of X bracing, 21% in case of V bracing and 21% in case of invertedV bracing. And also, when comparing the results of building with different bracing system (X,V & Inv V) @ outer middle span, it is found that the story displacement is decreased up to 25%in case of X bracing, 23% in case of V bracing and 25% in case of inverted V bracing.

Similarly, the story shear is increased up to 41% in case of X bracing, 35% in case of V bracingand 16% in case of inverted V bracing. And in the case of story drift, it is decreased up to 33%in case of X bracing, 27% in case of V bracing and 28% in case of inverted V bracing. From the above findings we can say that, the stiffness of the building can be increased or improved by providing bracing system and thereby increase the strength of the structure because, we found that the story displacement is decreased. Similarly, story shear of the structure is increased by proving bracing. Story shear means nothing, it is the lateral force acting on the structure due to seismic and wind load. i.e.; building with higher stiffness attract higher story shear.

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