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Comparative Seismic Analysis of Multi-Storeyed Building with Shear Wall, Bracing System and Combination of Both

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ABSTRACT: Seismic analysis is a subset of structural analysis and is the calculation of the response of a building (or non-building) structure to earthquakes. It is part of the process of structural design, earthquake engineering or structural assessment and retrofit in regions where earthquakes are prevalent. A building has the potential to 'wave' back and forth during an earthquake. This is called the 'fundamental mode', and is the lowest frequency of building response. To reduce the seismic forces, generally, Shear wall or Bracing system can be used. In this paper, a 20 storeyed building is analysed by using Response Spectrum method for seismic zone III for ten different cases using Shear wall, Bracing system and combination of both. After analysing all the ten case it was concluded that if adopting system with Bracing at corners or Bracing at edges, as compared to bare frame, the top storey displacement reduces upto 30% in X direction and 35% in Y direction for Bracing at corner and upto 45% in X direction and 47% in Y direction for bracing at edges, also the storey drift has a reduction of 60% in X direction and 65% in Y direction for Bracing at corners and 65% in X direction and 70% in Y direction for bracing at edges with increase in base shear of only 1% in both the cases. Thus adopting structure having bracing at edges will be more effective. If using frame with shear walls, the frame work with T shape shear wall at edges gives the best results with a reduction of top storey upto 62% in X direction and 65% in Y direction. The storey drift reduces upto 84% in X direction and 88% in Y direction. Though the base shear increases by 9%. In case of using structures with combination of both shear wall and bracing system, structure having T shape shear wall at edge with I shape shear wall at core and bracing systems at corner gives the best results with reduction in top storey displacement of about 76% in X direction and 81% in Y direction. The storey drift also reduces upto 90% in X direction and 95% in Y direction.

KEYWORDS: Shear wall, Bracing System, Response Spectrum Method, Base Shear, Lateral storey drift, Displacement.

I. INTRODUCTION

Earthquake engineering has developed a lot since the early days, and some of the more complex designs now use special earthquake protective elements either just in the foundation (base isolation) or distributed throughout the structure. A shear wall is a structural component provided to multi-storeyed or tall buildings or ordinary buildings in high wind velocity areas. These walls usually begin from the foundation level, along the length and width of buildings. Their thickness can be above 150 mm or below 400 mm in tall buildings; they are like vertical-oriented wide beams that carry the earthquake load towards the foundation. A braced frame is a structural system commonly used in structures subject to lateral loads such as wind and seismic pressure. The members in a braced frame are generally made of structural steel, which can work effectively both in tension and compression.



II. LITERATURE REVIEW

The present work is aimed at comparative study of analysis of Multi-Storeyed Buildings with Shear walls and Bracing Systems and combination of both. Various studies has been carried out till date for buildings with shear wall and bracing system but none of them compared them using both in the building.

Athira&Vineetha (2018) analysed a (20x20)m, G+19 building with shear wall at all four corners. The aim of this work was to find out the effect of lateral loads on building having shear wall with prismatic and non-prismatic coupled beam. Non prismatic beam used are stepped haunch cubical, haunch and parabolic haunch, then compare the behavior these beams on the buildings are studied They analysed two similar bldgs., With shear wall but in case 1 they used only shear wall, and in case 2 they used only coupling beam to connect shear wall.(stepped, linear, & parabolic coupling beam). They concluded linear and parabolic beam are more efficient in terms of stiffness, storey drift, displacement and time period.

Donthi Reddy &Sreenivasa (2019) carried out Structural Analysis of G+14 building with shear wall of W,U,H and T shape in all four zone using ETABS. In these work a high rise building with different shapes of shear walls is considered for analysis. The multi store building with G+14 storey's are analyzed for storey drift story displacement and base shear using ETABS software. For the analysis of these building for seismic loading with all Zones (Zone-II, III, and IV & V) is considered. The analysis of these building is done by using dynamic method (Response spectrum analysis). The result shows W and U shape shear wall shows better performance on storey drift. H was better on storey drift in Y direction & T shows better result in base shear value.

Abdul Karim&Srinivasa (2015) carried out analysis of G+20 structure in E-TABS. This work contains a comparative study on regular building with and without outrigger and irregular building with and without outrigger with centrally rigid shear wall and steel bracings as outrigger. The modeling of the structure is done using "ETABS" program. The analysis of the model is carried out by equivalent static method and response spectrum method. They used four structure, two structure with and without shear wall and two structure with and without outrigger bracing in vertically irregular building. They carried out following analysis, 1. Equivalent static analysis 2.Dynamic analysis method(Response spectrum) and found that there was reduction in time period, Overall stiffness, Minimized story drift due to outrigger system and also found that comparatively outrigger is more effective than steel x-bracing.

Diliprao&Kalurkar (2020) Used an existing structure and made it seismic resistant by application of methods like FRP, Jacketing etc. The computer software program E-TABS is utilized for dynamics analysis strategy is applied to look at the functionality of a reinforced concrete building. The various retrofitting techniques including steel and concrete application and jacketing of fiber reinforced polymer (FRP) composites that happened to be utilized to enhance the load bearing capacity of specific structure elements are highlighted and techniques including shear wall space plus shear cores that enables you to improve general balance of buildings. Most retrofitting techniques are going to result a rise in stiffness as well as somewhat enhance in mass that causes in return a shorter period. Shortening in period of vibration quite often results an increased ductility and strength of retrofitted structure. They analyzed a 12 story building in E-TABS and based on the analysis result they provided a suitable retro fitting method. After providing retrofitting with enhanced strength they analyzed the same building and compared the result in the terms of base shear story drift, (Intermediate and top), deflection.

III. METHODOLOGY

In this study, a comparative seismic analysis is done for multi-storeyed building of 20 storeys, for different cases of shear wall and Bracing System and combination of both. The result of this analysis will include base shear, lateral drift and displacement, the conclusion will be findings of most suitable case of shear wall, Bracing System and combination depending on their analytical results. 1. In present research we have used different model of Multi-Storeyed Building including shear wall and Bracing System 2. Model the structure in E-TABS 3. Seismic analysis is done as per IS1893-2016. 4. Running the model in E-TABS. 5. Obtaining seismic parameters like base shear, lateral drift and displacement. 5. Observation and comparison of result. 6. Conclusion

IV. STRUCTURAL MODELLING

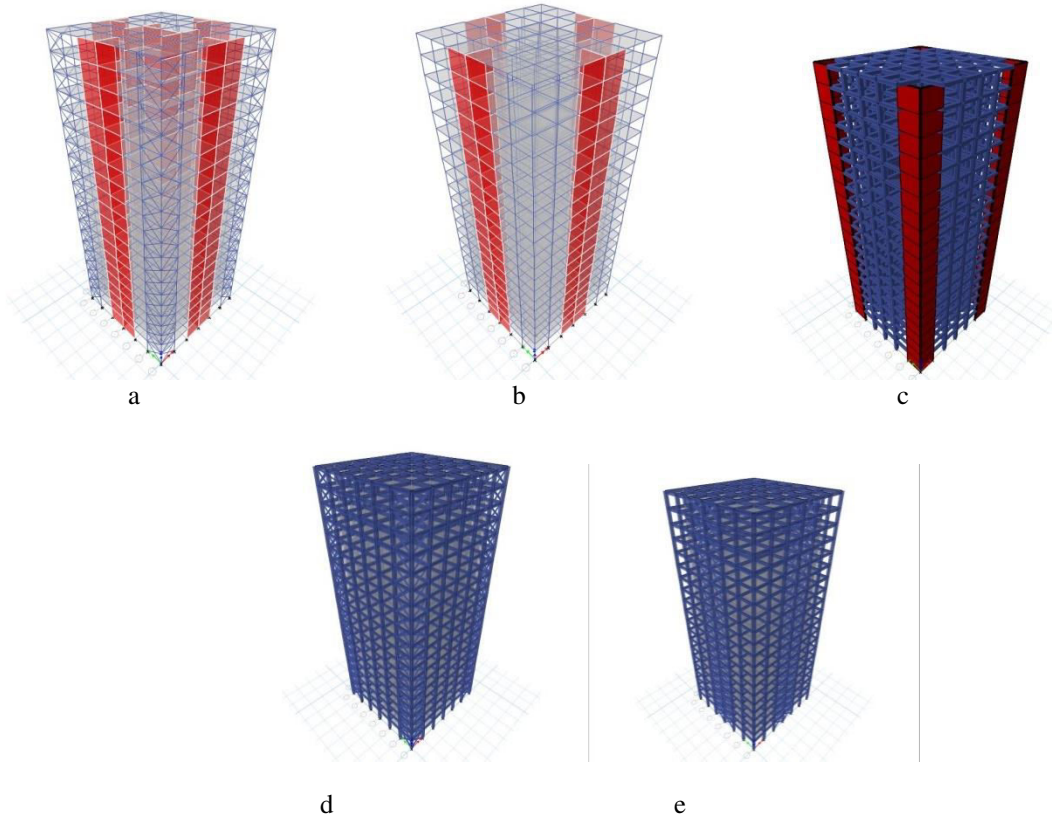
In this study, structure is modelled for the following cases: 1. 20 storeyed building without shear wall and bracing 2. Analysis and conclusion of same structure by using response spectrum method with X type bracing at corners 3. Analysis and conclusion by using response spectrum method with X type bracing at edges 4. Analysis and conclusion by using response spectrum method with L shape shear wall at corner. 5. Analysis and conclusion by using response spectrum method with T shape shear wall at edges. 6. Analysis and conclusion by using response spectrum method with I shape shear wall at core. 7. Analysis and conclusion by using response spectrum method with combination of shear wall and bracing; with shear wall at corner and bracing edges 8. Analysis and conclusion by using response spectrum method with combination of bracing at corner and T shape shear wall at edges. 9. Analysis and conclusion by using response spectrum method with combination of bracing at corner and I shape shear wall at core. 10. Analysis and conclusion response spectrum method with combination of bracing at corner and T shape shear wall at edge and I shape shear wall core.

V. PRELIMINARY DATA

Following are the data assumed for carrying out this study, 1. Length in X direction=20m. 2. Length in Y direction= 20m. 3. Typical storey height=3m. 4. Ground storey height=3.5m. 5. No. of storey =20. 6. Height of bldg. =60.5m. 7. Bay spacing in X direction= 4m

VI. MODELS

Fig a. shows the model with T shape shear wall at edge having a I shape shear wall at core and X type bracing at corners, Fig b shows T shape shear wall at edges and Fig c gives a glance of L shape shear wall at corner. Fig d represents model with bracing at corners whereas Fig e show Bracing at edges.



VI. RESULTS AND DISCUSSION

After running all the models in ETABS 2017 their analytical results were obtained and following observations were made: 1. After Comparison, it was observed that structure with Bracing at edges performs better than bare frame and Bracing at corners. 2. In case of shear wall, it was observed that T shape Shear wall at edges performs better as compared to L shape Shear wall at corners, and I shape shear wall at core 3. After analyzing models with different combinations, it was observed that model having combination of T shape shear wall at edge with I shape shear wall at Core and X type bracing at corners gives better results as compared to other three combinations viz., L shape shear wall at corner with bracing at edges, T shape shear wall at edges with bracing at corners and I shape shear wall at core with bracing at corner. 4. After comparing results of models of Point 1 and 2, it was found that in terms of bracing and shear walls, T shape shear wall gives better results. 5. After comparing results of points 1,2 & 3, it was found that model having T shape shear wall at edges with I shape shear wall at core and bracing at corners gives best results.

VII. CONCLUSIONS

Based on the analytical results of all the models, following conclusions are made; 1. Use of Lateral Load resisting systems like Shear wall and Bracing system increases stiffness and is more effective as compared to structures without any load resisting system i.e. Bare frame. 2. If adopting system with Bracing at corners or Bracing at edges, as compared to bare frame, the top storey displacement reduces upto 30% in X direction and 35% in Y direction for Bracing at corner and upto 45% in X direction and 47% in Y direction for bracing at edges, also the storey drift has a reduction of 60% in X direction and 65% in Y direction for Bracing at corners and 65% in X direction and 70% in Y direction for bracing at edges with increase in base shear of only 1% in both the cases. Thus adopting structure having bracing at edges will be more effective. 3. If using frame with shear walls, the frame work with T shape shear wall at edges gives the best results with a reduction of top storey upto 62% in X direction and 65% in Y direction. The storey drift reduces upto 84% in X direction and 88% in Y direction. Though the base shear increases by 9%. 4. Comparing the results of the structures with Bracing at edges and T shape shear wall at edges, T shape shear wall at edges, Shear wall performs better and will be more efficient if used. 5. In case of using structures with combination of both shear wall and bracing system, structure having T shape shear wall at edge with I shape shear wall at core and bracing systems at corner gives the best results with reduction in top storey displacement of about 76% in X direction and 81% in Y direction. The storey drift also reduces upto 90% in X direction and 95% in Y direction. 6. After comparing all the ten models, model with T shape Shear wall at edges having I shape shear wall at core and Bracing at corners gives the best result. 7. Also it was concluded that if a structure with combination system is not adopted, the adopting structure with shear will be more effective as compared to structure with bracing system.

VIII. FUTURE SCOPE

□ Various studies can be carried for design of this lateral load resisting system. □ The study can be carried for horizontally as well as vertically irregular building □ The study can be carried by increasing height of building as well as for different zones. □ Loading at different levels of the building could be changed □ Introduction of other lateral load resisting system like belt truss and outrigger system can be done and their results can be compared.

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