



e-ISSN: 2319-8753 | p-ISSN: 2347-6710

IJIRSET

International Journal of Innovative Research in
SCIENCE | ENGINEERING | TECHNOLOGY



INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 13, Issue 9, September 2024

ISSN INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA

Impact Factor: 8.524

9940 572 462

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Performance of Viscous Dampers on Seismic Response of RC Frame Structure

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ABSTRACT: Seismic analysis is a branch of structural analysis that predicts a building's response to earthquakes. It is an integral component of structural engineering practices, particularly in regions with a high risk of seismic activity. It plays a vital role in ensuring the safety and resilience of buildings and other structures. A Buildings has the potential to oscillate during earthquakes or strong winds. This is called the 'fundamental mode' which is the primary oscillation pattern of a structure, occurs at the lowest frequency of building response. In this paper, 30 storeyed rectangular building is analysed by using Response Spectrum method for seismic zone IV for six different cases of viscous damper at different location.

KEYWORDS: Viscous Damper, Response Spectrum, Storey Displacement, Storey Drift.

I. INTRODUCTION

Earthquake engineering has evolved significantly, with modern designs often incorporating specialized earthquake protection systems, either at the foundation level or distributed throughout the structure. Viscous dampers are passive energy vanishing device which is added to the structure to increase the effective stiffness of the building. Viscous dampers are also referred as seismic dampers are hydraulic component that diffuse kinetic energy induced during earthquakes and soften structural collisions. It improves the seismic performance and structural damping of the building. They can be used in a wide range of applications including buildings and bridges.

II. LITERATURE REVIEW

The present work aims to investigate the performance of viscous damper on seismic response of reinforced concrete frame structure. Numerous studies have been conducted on buildings with viscous dampers but none have explored the application of viscous dampers at alternate stories in a building.

Ubair Gul Khan & Mirza Aamir Baig (2020) Tuned Mass Damper is used to analysed a G+15 storey building for different mass ratios. The analyses of this building was done using ETABS software. In this study four building models were created that is undamped building and three building equipped with dampers having mass ratios of 0.01, 0.02 and 0.04. The analyses of all the four building is done by using time history method. In time history method bhuj earthquake data is considered for the analysis. After the analysis they concluded that acceleration of the building in the fundamental mode is reduced by 17.67%, 23.72%, and 28.83% for the mass ratios of 0.01, 0.02 and 0.04. The effective damping of the building in the fundamental mode is increased to 8.01%, 9.27% and 11.09% for the mass ratio of 0.01, 0.02, and 0.04. The effective damping of the building increases and the dynamic response of the building reduces as the mass ratio of the tuned mass damper is increased. The TMD becomes robust with increasing mass ratio.

Kiran Kumar Poloju & Sachin Kuckian (2018) A G+9 storey building with a combination of shear wall and fluid viscous damper is considered for the analysis. The analysis of this building is done using SAP2000 software. In this study four different damping placements have been considered to study the influence of location on the seismic response of these models. The position of damper differ in each of the four models which are as follows in Type A dampers was placed in the lower three floors in Type B second and third floor in Type C second, third and fourth floor and in Type D dampers were placed at the top two floors. All the four building models were analyzed using time

history analysis. The building is analyzed for the seismic parameters like peak deflection, peak acceleration and inter-story drift. After the analysis they concluded that Damper devices located within the cut-out sections of the shear wall, showed that substantial reduction could be achieved in the seismic response of the building. By placing dampers in the lower levels, maximum reduction in peak deflection and peak acceleration is achieved. Dampers placed in the upper levels had little to no effect on the structural response.

S.Lakshmishireenbanu & Pathaushasri (2019) analysed a G+10 storey RCC building with and without dampers in zone II for soil type II using ETABS. In this study four models are created namely rectangular building with rectangular column (SBSC), rectangular building with rectangular column (SBRC), rectangular building with rectangular column (RBSC), rectangular building with rectangular column (RBRC) with dampers provided at extreme corner of the building. The analysis of this building for seismic loading zone II is considered. This building are analyzed for story displacement, story drift and base shear. The analysis of this building is done by using both time history and response spectrum method. The result shows reduction in storey displacement, storey drift and base shear values compare to a regular building without dampers. In time history analysis there is a 75% reduction in base shear.

Anita Tippnagoudar & Dr J G Kori & Dr D K Kulkarni (2015) analysed a G+15 story building in ETABS by using following combinations, combination of damper and bracing system in symmetrical building, combination of damper and bracing system in unsymmetrical building and building without damper and bracing system. The analysis of this building for seismic loading zone III and soil type II is considered. This building are analyzed for story displacement, story drift and base shear using Etabs software. The analysis of this building was done using response spectrum method. The result shows that the building with a symmetrical plan performs better than the building with unsymmetrical plan. The building with combination of dampers and bracing have lower values of displacement, base shear, storey drift as compare to the building without dampers and bracing system.

III. METHODOLOGY

This study conducts a seismic analysis of 30 storey rectangular buildings equipped with dampers on alternate floors. The result of this analysis will include storey drift and storey displacement, the conclusion will be findings of most suitable position of damper in rectangular building depending on their analytical results. 1) In present research we have used rectangular shape model of multi-storeyed building with dampers at different locations. 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 storey displacement and lateral drift. 6) Observation and comparison of result. 7) Conclusion.

IV. STRUCTURAL MODELLING

In this study, structure will be model for the following cases: 1) 30 storeyed rectangular building without viscous damper.

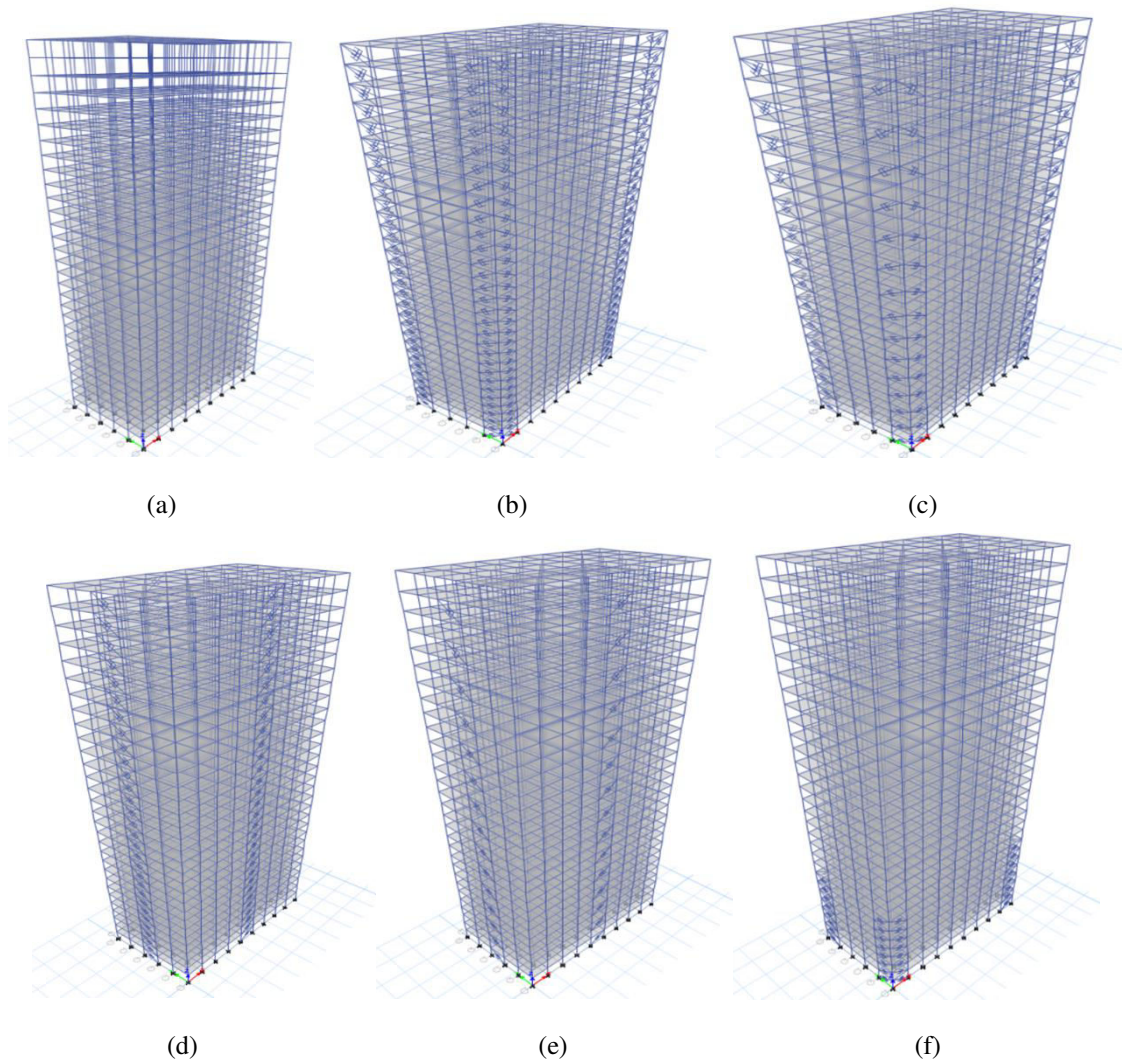
2) Analysis and conclusion of same structure by using response spectrum method with viscous damper at corners in rectangular building. 3) Analysis and conclusion by using response spectrum method with viscous damper at corners at alternate storey in rectangular building. 4) Analysis and conclusion by using response spectrum method with viscous damper at the center in rectangular building. 5) Analysis and conclusion by using response spectrum method with viscous damper at the center at alternate storey in rectangular building. 6) Analysis and conclusion by using response spectrum method with viscous damper at the corner of bottom eight story in rectangular building.

V. PRELIMINARY DATA FOR RECTANGULAR BUILDING

1) Length in X direction = 36m. 2) Length in Y direction = 20m. 3) Typical storey height = 3m. 4) Ground storey height = 3m. 5) No of storey = 30. 6) Height of building = 90m. 7) Bay spacing in X direction = 4m. 8) Bay spacing in Y direction = 4m. 9) Size of Beams = 300 x 450mm. 10) Size of Columns = 450 x 1050mm. 11) Grade of Concrete = M30 12) Grade of Steel = Fe500. 13) Type Of Damper = Viscous Damper. 14) Weight Of Damper = 44kg. 15) Mass Of Damper = 250kn.

VI. MODELS

Fig (a) shows model without damper, fig (b) shows model with viscous damper at corner, fig (c) shows model with viscous damper at corner of alternate storey, fig (d) shows model with viscous damper at center, fig (e) shows model with viscous damper at center of alternate storey and fig (f) shows model with viscous damper at corner of bottom 8 storey.



VII. RESULTS AND DISCUSSION

After running all the models of rectangular building in ETABS 2018 their analytical results were obtained and following observations were made (1) After Comparison, it was observed that structure with viscous damper performs better than structure without damper. (2) It is observed that Center dampers on every floor were found to be more effective than corner dampers on the bottom eight floors. (3) Corner dampers were found to be more effective than center dampers when installed on every floor. (4) Corner dampers, when placed on all floors were more efficient than when placed only on the corners of the bottom eight stories. (5) It is observed that Center dampers installed on alternate floors were more effective than those placed on every floor. (6) It is observed that Corner dampers installed on alternate floors were more effective than those placed on every floor. (7) After analyzing all the models with damper at different locations it was observed that corner dampers placed on alternate floors were found to be most effective compared to other locations.

VIII. CONCLUSIONS

Based on the analytical result of all the models, following conclusions are made; (1) Use of energy dissipating devices like viscous damper increases structural stiffness and is more effective as compared to structures without any dissipating device system i.e. bare frame. (2) If adopting structure with damper at corners or damper at center when installed on every floor, as compared to bare frame, the top storey displacement reduces up to 63% in X direction and 67% in Y direction for Damper at corner and up to 61% in X direction and 64% in Y direction for damper at center. Storey drift reduces up to 60% in X direction and 50% in Y direction for corner dampers and 53% in X direction and 51% in Y direction for center dampers. Thus adopting structure with dampers at corner will be more effective as compare to damper at the center. (3) When damper at corner installed on alternate floor storey displacement reduces up to 69% in X direction and 69% in Y direction. Storey drift reduces by 63% in X direction and 56% in Y direction. Therefore damper installed at corner of alternate storey is more effective as compare to damper installed at corner of every floor. (4) When damper at center installed on alternate floor storey displacement reduces up to 65% in X direction and 66% in Y direction. Storey drift reduces by 53% in X direction and 54% in Y direction. Therefore damper installed at center of alternate storey is more effective as compare to damper installed at corner of every floor. (5) In case of using damper at corner of bottom eight floors storey displacement reduces up to 13.33% in X direction and 16.69% in Y direction. Storey drift reduces by 1% in X direction and 3% in Y direction. Therefore damper installed at corner of bottom five floors is less effective as compare to dampers at other location. (6) After comparing all the six models of rectangular building it was concluded that Corner dampers installed on alternate floors gives the best result.

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