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Seismic Analysis of Steel Frame Structure Using Magnetorheological Damper

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***Abstract*: The protection of civil structures under seismic force is an important thing. Structure should be able to withstand under seismic actions once designed and built. Effective use of dampers make a structure more resistant to seismic action by increasing the building's damping ability. So in this paper steel frame structure is analyzed by using damper. The control devices are used in the manner of passive, active and semi-active system of dampers. Here a semi- active device of magneto rheological damper is used for analysis and it is filled with magneto rheological fluid, which is controlled by a magnetic field this allows the damping characteristics of the shock absorber to be continuously controlled by varying power of electromagnet. A six storey building steel frame structure of 4 m storey height is modeled and magnetorherological damper is fixed. A structure is modelled and analyzed in ETABS software.**

***Keywords*: Magneto rheological damper (MR damper) buildings, MR fluid, Steel frame Building.**

1. Introduction

Civil infrastructure such as buildings, highways and bridges are susceptible to damage over their life time due to extreme loads. Among extreme loads, earthquake loading is one major concerns for structural engineers. Severe hazardous actions such as collapse or extreme damage to the infrastructure and loss of human lives are common consequences of a seismic activity. A magnitude from 7.0 to 7.9 of 18 major earthquakes and magnitude of 8.0 or more of one larger earthquake occurred annually since 1900. So Structural safety against natural hazards is great importance both for the structure itself and for the occupants. Nowadays structure constructed with a damper is emerging technique to reduce the seismic response of the structure effectively. In this paper the seismic analysis of six storey steel frame structure using the magneto rheological damper is studied. Dynamic behavior of structures with MR damper is studied in this paper for better seismic hazard mitigation. MR dampers are fitted in steel frame structure and it is analyzed by response spectrum analysis using ETABS software

2. Objectives

The main objectives of this paper are given below,

- To analyze the seismic response of steel frame structure using magneto rheological damper.
- To prevent a structure from seismic activity and to reduce the response of structure.
- Potential of magneto rheological damper as semi-active seismic control device is improving collapse resistance of steel frame buildings and eliminating the damage under various seismic hazard levels.

3. Plan and specification of steel frame building

In this paper a six storey steel frame building was modeled in ETABS. This model is designed with I shaped steel Beam and Column section and it is located in the area of zone III. The plan and elevation of structure is shown in Fig 1 and 2. The specification and properties of steel frame model are given below:

- Number of storey: 6
- Storey height: 3
- Column section: ISMB 350
- Beam section: ISHB 450
- Bracing section: ISA 150× 150×15

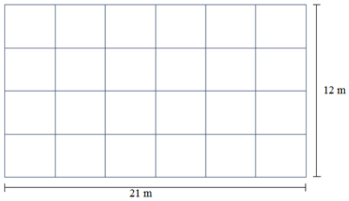

Fig. 1. Plan

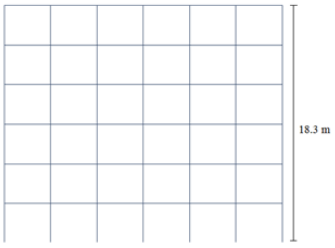

Fig. 2. Elevation

4. Magneto rheological damper

A Magneto rheological Damper is a damper filled with mageneto rheological fluid, which is controlled by a magnetic field, usually using an electromagnet. This allows the damping

characteristics of the shock absorber to be continuously controlled by varying the power of electromagnet. It is also called as magneto rheological shock absorber. The properties of MR fluid are given below

The change in viscosity is continuous.

- Viscosity can be increased in very short time under strong magnetic field.
- Yield strength is up to 50-100 kPa.
- Low voltage is required.

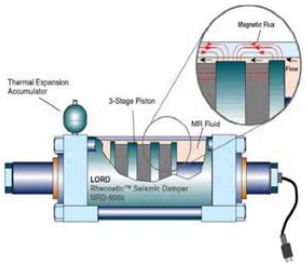

Fig. 3. Schematic model of the damper

5. Modeling of building and fixing of damper

A six storey steel frame structure was modeled in ETABS. It is analyzed by Response spectrum analysis method under seismic load consideration. Maximum displacement occurs in a structure and many columns gets failure. To reduce a structures response and to make a structure stronger under seismic loads a Magneto rheological Damper is provided at all corners by providing X bracings. The model of steel frame with and without damper is shown in Fig. 4 and 5.

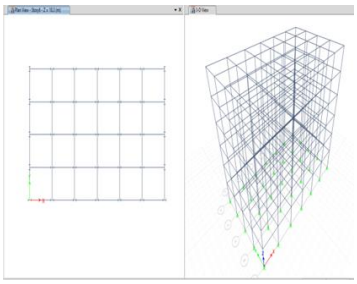

Fig. 4. Steel frame without damper

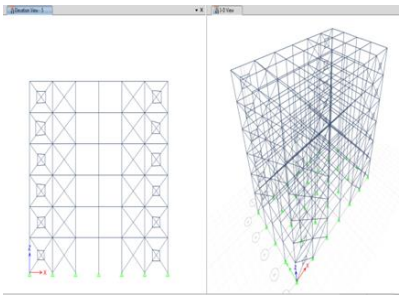

Fig. 5. Steel frame with damper

6. Results and discussion

The seismic performance of the moment resisting steel building is analyzed using ETABS. The displacement and store drifts at all storey levels under the action of seismic loads are observed and noted. Similarly for the steel frame with dampers placed at corners by using X bracings also analyzed. The displacement and storey drifts are observed. The results from both are compared. The response of steel frame for the above both cases are shown in Fig 6 and 7. Result shows that the steel frame model with damper effectively reduces the lateral displacement and storey drift.

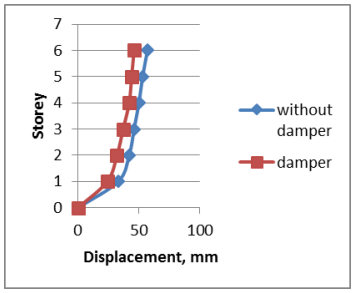

Fig. 6. Displacement with and without damper

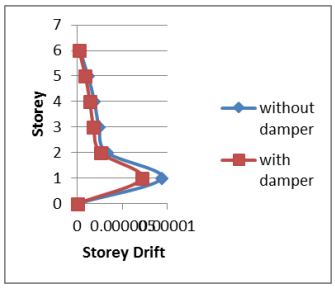

Fig. 7. Storey drift with and without damper

7. Conclusion

A six storey steel frame building with magenetorheological damper is analyzed by response spectrum analysis using ETABS. The displacement and storey drift are compared from this analysis. Its concluded that steel frame with MR damper reduces the displacement and storey drift considerably.

References

[1] Modeling and control of magnetorheological dampers for seismic response reduction, S.J. Dyke, B.F. Spencer Jr., M.K. Sain and J.D. Carlson (1996).
[2] Application of magneto-rheological dampers for multi-level seismic hazard mitigation of hysteretic structures, Luciana R. Barroso, Member Asce, Sephen Hunt, and J. Geoffrey Chase (2002).
[3] Semi-active control of structures incorporated with magnetorheological dampers using neural networks, Zhao-Dong Xu, Ya-Peng Shen and Ying-Qing Guo (2003)
[4] Magneto rheological dampers-a new paradigm in base isolation techniques in earthquake engineering, S. Suresh Babu (2004).
[5] Resetable devices with customized performance for semi-active seismic hazard mitigation of structures, J.G. Chase, K.J. Mulligan, A. Gue, J.B. Mander, T. Alnot and G. Rodgers (2005).
[6] Time delay study on the semi-active control with a magnetorheological damper, P. C. Chen and T. Y. Lee (2008)
[7] Seismic hazard mitigation of building structures using magneto-rheological dampers, yunbyeong chae (2011).
[8] Seismic control of building frames using magnetorheological dampers, Rithul Mohan.V. K, Sirajudheen. P. P, Riyas. P and S. Valli (2016).

[9] Development of a novel multi-layer mre isolator for suppression of building vibrations under seismic events, Jian Yang, Shuaishuai Sun, Tongfei Tian, Weihua Li, Haiping Du (2016).
[10] Seismic fragility estimates of a moment-resisting frame building controlled by mr dampers using performance-based design, Young-Jin Cha, Jong-Wha Bai (2016).
[11] Implementation of smart-passive dampers combined with double concave friction pendulum devices to retrofit anexisting highway viaduct exploiting the seismic early warning information, Gianluca Nestovito, Antonio Occhiuzzi (2016).
[12] Use of semi-active dampers in seismic mitigation of building structures, Nivithigala Polgaswaththe Kasun Viraj Karunaratne (2016).
[13] An experimental study of mr dampers for seismic protection, S.J. Dyke, B.F. Spencer Jr., M.K. Sain and J.D. Carlson.