

Seismic Performance of Asymmetric Buildings with Friction Damper

Ashik L Keremane¹, C S Vijaya Kumar², Dr.M N Shiva Kumar³

P.G. Student, Department of Civil Engineering, B.I.E.T, Davanagere, India¹

Assistant Professor, Department of Civil Engineering, B.I.E.T, Davanagere, India²

Associate Professor, Department of Civil Engineering, B.I.E.T, Davanagere, India³

ABSTRACT:The present work aimed at the study of seismic behaviour or performance of a multi-storeyed with friction damper. In order to study the seismic performance, a G+9 story structure with and without Friction Damper have been considered. Response Spectrum Analysis has been carried out on both the models. All the modelling and analysis has been done using ETABS 2018 Software package by following all the standard procedure. After analysing both the models, the results of parameters like Lateral Displacement, Storey drift and Storey shear are compared. From the outcome of the analysis, it can be said that, by using friction damper the building performs well under seismic activities.

KEYWORDS:Friction Damper, Response Spectrum Analysis, Lateral Displacement, Storey Drift, Storey Shear

I. INTRODUCTION

With the rapid growth of world population, high rise buildings have become a trend in the major cities. These High-rise buildings represent the power and technology possessed by the population of the country. However, these High-rise buildings are subjected to wind loads, Earthquake loads and other machinery loads. These loads are the source for Vibrations in the building and these vibrations can cause damage to the structure and even it can collapse the structure. To counteract earthquake effects in the building, the concept of Earthquake resistant design of structure has been introduced. The primary objective of the earthquake resistant design of structure is to prevent structure from complete collapse. The main objective of structural control devices is to reduce structural vibrations that occurs due to earthquakes and strong winds.

Configuration, Regularity and Irregularity of the building has a great impact on the behaviour of buildings against earthquakes and thus, these factors or parameters should be carefully considered while designing the earthquake resistant structures. Friction Damper is one such damper which is capable of dissipating and absorbing the vibration caused by the earthquake. These are made up of steel plates that are fixed to high strength bolts. Friction dampers are reliable, repeatable and have expansive property. These Friction dampers are passive energy dissipation devices, fundamentally comprising of steel plates, that are made to produce friction during earthquake.

The objectives of the study are:

- To model the L-shaped building, with and without friction damper.
- To apply of all the important data and important factors derived from IS 1893:2002 codebook with respect to Response Spectrum Analysis.
- To compare various seismic parameters like Displacement, drift and storey shear of Simple RCC structure with the structure with Friction damper

II. LITERATURE REVIEW

In 2019, S Lakshmin Shireen Banu et al [1] studied the seismic response of RCC structure using Friction damper, Time History method of analysis was carried by the researcher and it was concluded that reduction in PSA, PSV and SD over time period was possible with the usage of friction dampers. Also, in 2019, Akshay et al. [2] studied the effect of friction dampers on RC structures subjected to earthquake. Both equivalent static method and time history method of analysis were carried on a G+15 storey building, after analysis it was concluded that placing the friction dampers at the periphery reduces lateral displacement, storey shear and storey drift. S SShangai et al [3] in 2017 studied the seismic response of unsymmetrical building with optimally placed friction dampers. An L shaped building model was modelled in SAP2000 and five different damper location formats were made. After the time history analysis, friction dampers when placed in zigzag manner showed to be most optimal as it reduced the displacement, drift and shear. Shameena Khannavar et al [4] in 2017 researched about the use of damping device to control the response of the structural system. A 10 storeyed structure was modelled and analysed in ETABS. Both static and dynamic analysis was adopted. After the analysis it was observed that friction dampers positioned at the periphery caused the reduction in storey displacement.

On studying the research works carried by others, it was observed that Friction dampers has effectively increased the seismic performance of buildings and by the thorough review of all the literatures the various stages of work was divided. The work in this paper is mainly divided in Three stages. 1) Building modelling in ETABS 2) Performing of Response Spectrum Analysis on the model (3) Interpretation and comparison of Results.

III. METHODOLOGY

The study deals with Modelling and Analysis of structure with and without Friction Damper. To accomplish the modelling and analysis, a Finite Element Method (FEM) based program called ETABS (Extended Three-dimensional Analysis of Building System) is used. Response Spectrum Method of Analysis is used to study various seismic parameters like Lateral displacement, Storey Drift and Storey Shear. All the necessary data required for Response Spectrum analysis have been derived from IS 1893:2002 Code Book. The Live loads and Dead loads have been opted as per the codebook IS 875: 1987 (Part I) and IS 875:1987 (Part II).

• ETABS

ETABS is a software product that focuses on the analysis and designing of multistorey structures. Modelling tools and prototypes, code-based commands, analysis methods and solution procedures, all co-ordinate with a grid like geometry distinctive to a category of structure. Simple or enhanced systems under static or dynamic settings may be assessed utilizing ETABS. For a superior assessment of seismic performance, modal and direct integration time history analysis may combine with P Delta and Large Displacement impacts. Basic to the modelling of ETABS is the generalization that multi - storied structures usually consist of the same or similar floor plans that reproduce in the vertical direction. Once the modelling is complete, ETABS generates and assigns automatically code based design loads for gravity, seismic, wind and thermal forces. Users may specify an unrestricted number of cases and combinations for load.

• Response spectrum Analysis

Response spectrum Analysis, which is the better and also vast majority of the technology which has been used from few years ago that supports the results helps to obtain from the monotonically increasing lateral forces that vary along with the height of the building and also to study the displacement that reaches the maximum values. This form of analysis helps to get the elastic analyses and even the extra ordinary values like superimposed to approximate a force and its displacement values. Response spectrum analysis is carried out in ETABS by following the below procedure

- (1) Function Definition- Response spectrum function is defined using function options available under Define menu
- (2) Function Modification – Various codal provisions like Damping ratio, Seismic zones and soil type are modified as per the requirement.
- (3) Load case Definition – The modified function defined as a load case in ‘Load cases’ option present in ‘Define’ menu. Various parameters like Load case type, Loads applied, Modal combination method are available for modification. For the current study, Load-case type is set to Response Spectrum, Loads applied are of type ‘Acceleration’ and it is added twice to have it in both X and Y Direction. Modal Combination method it set to CQC (Complete Quadratic Combination).

• **Building Description**

The present work is to study how a G+9 storeys building with and without friction damper performs under seismic activity. A plan of school building is considered for the project. As per IS: 875 (Part 2), the loads on Classrooms, Corridors and Staircase are considered.

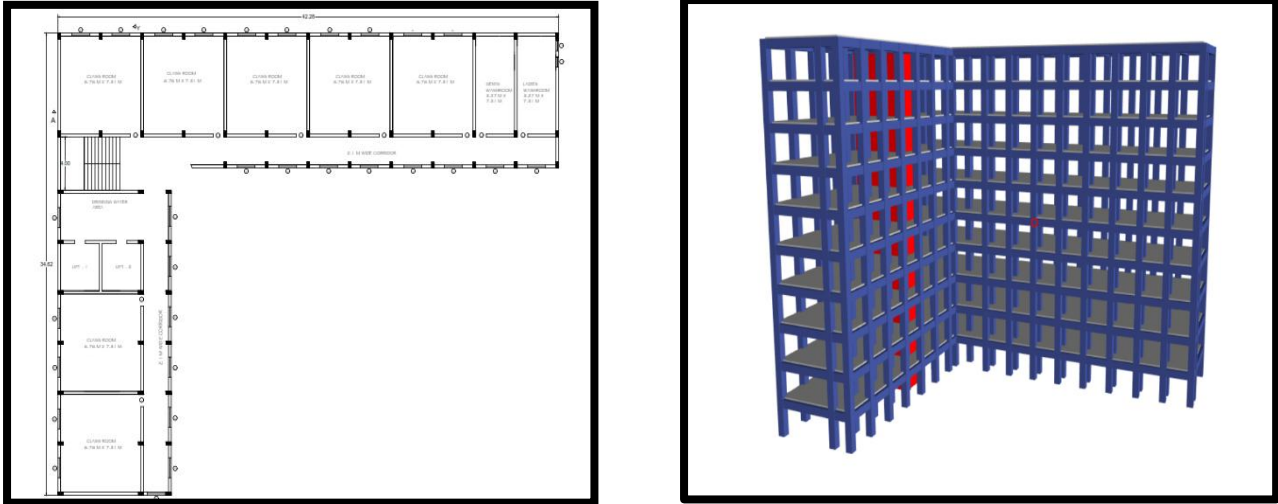


Fig.1.Plan and rendered 3D view of the building

The data taken for the analysis is as follows:

Grade of concrete	:	M30
Grade of steel	:	Fe 550
Floor Height	:	3m
Beam	:	600×600 mm
Column	:	700×600 mm.
Slab thickness	:	200mm
Wall	:	250mm
Friction Damper	:	Force 261KN & Weight 41 KG
Live Load on classrooms	:	3 KN/m ²
Live Load on corridor	:	4 KN/m ²
Floor Finish	:	1.5 KN/m ²
Load on Staircase	:	5 KN/m ²

Seismic Loads

Seismic design shall be done in accordance with IS: 1893:2002. The building is situated in earthquake zone IV. The parameters to be used for analysis and design are given below (As per IS: 1893:2002 (Part I)).

Zone factor	:	0.24
Importance factor	:	1.0
Response reduction Factor	:	5.0
Soil Type	:	Medium
Structure Type	:	RC Structure, Damper Structure.

IV. EXPERIMENTAL RESULTS

After the Response Spectrum Analysis of the buildings with and without friction damper, a few parameters are considered for the comparison. The parameters considered are Lateral Storey Displacement, Storey Drift and Storey Shear.

• **Storey Displacement**

The below graph will show the displacement of the model along X and Y direction where we can clearly identify the better model performance of Structure with and without Friction Damper

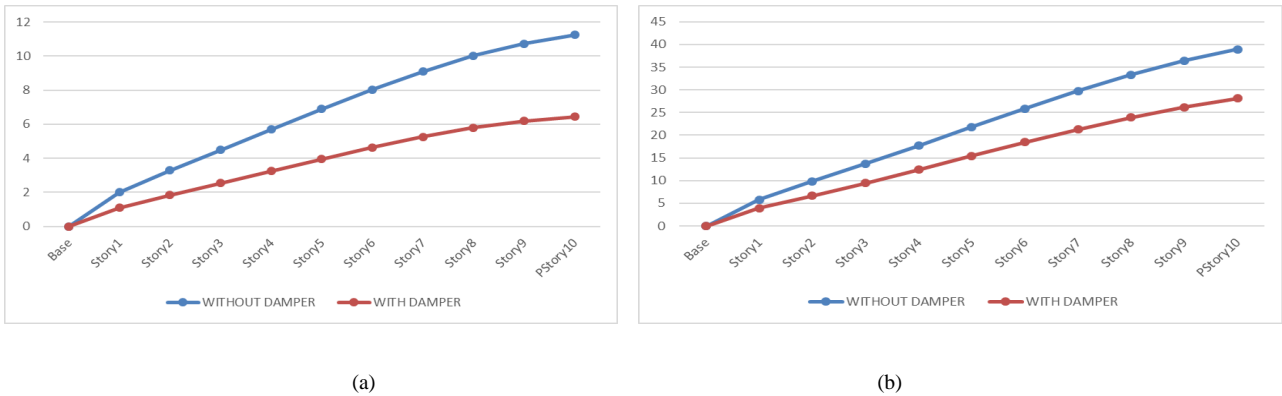


Fig.2.Comparison of Displacement(a) In X Direction (b) Y Direction

The maximum displacement of the model without Damper is found to be 11.245mm in X direction and 38.911mm in Y direction when comparing with that of Model with damper ,it is 6.445mm in X direction and 28.083 mm in Y direction.

• **Storey Drift**

The below graph will show the drift of the model along X and Y direction after analysing both the structures, with and without friction damper.

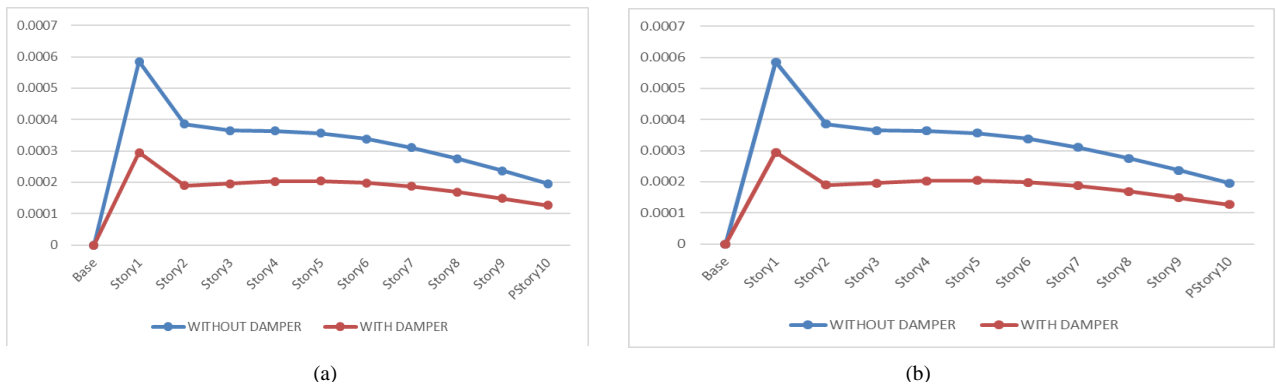


Fig.3.Comparison of Drift(a) In X Direction (b) Y Direction

Considering the values of drift, the model without damper is found to be having a drift value of 0.000585 in X direction & 0.001952 in Y direction while comparing with that of model with damper the drift value is found to be 0.000294 in X direction and 0.001298 in Y direction.

• **Storey Shear**

The below graph will show the shear values of the model along X and Y direction after analysing both the structures, with and without friction damper

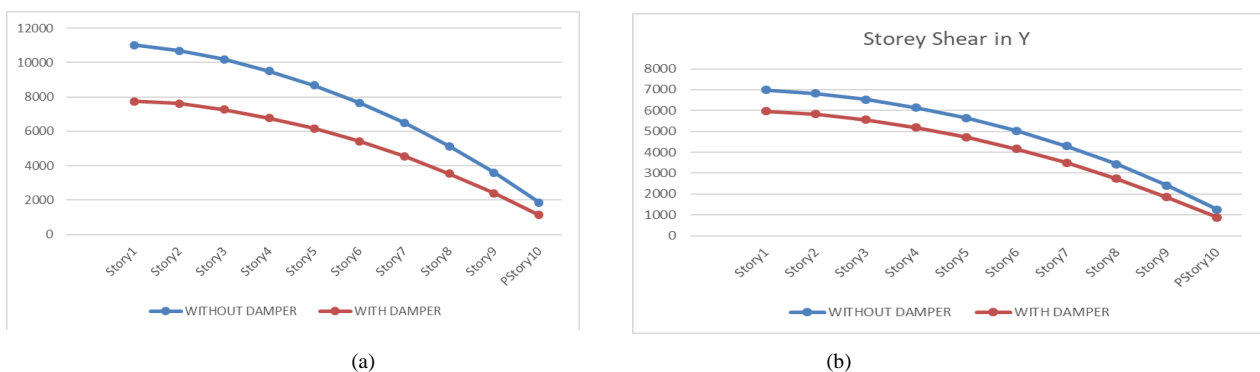


Fig.4.Comparison of Shear(a) In X Direction (b) Y Direction

V. CONCLUSION

The displacement of the Building Model without Friction Damper is found to be 11.245mm in X direction and 38.911mm in Y direction when comparing with that of Model with Friction damper , it is 6.445mm in X direction and 28.083 mm in Y direction. Considering the drift values after analysis, the Building Model without Friction Damper is found to be having a drift value of 0.000585 in X direction & 0.001952 in Y direction while comparing with that of Building model with Friction damper model ,the drift Value is found to be 0.000294 in X direction and 0.001298 in Y direction. While comparing the shear values ,the Building Model without Friction Damper is found to be having 11022.52 kN in X direction and 6986.26kN in Y direction, when comparing with that of the Building Model with Friction damper ,the value is found to be 7755.14 kN in X direction and 5982.10kN in Y direction.

So by seeing the comparison ,we can finally conclude that model with Friction damper is better when compared with that of the model without friction damper..

REFERENCES

- [1] S. Lakshmi Shireen Banu and Kothakonda Ramesh, Seismic Response Study and Evaluation of Vibration Control of Elevated RCC Structure using Friction Damper,International Journal of Innovative Technology and Exploring Engg.(IJITEE),ISSN:2278-3075, Volume-8, Issue-7, May 2019
- [2] Akshay R and B S Suresh Chandra, Effect of Friction Dampers on RC Structures Subjected to Earthquake, International Journal of Trend in Scientific Research andDevelopment(IJTSRD), e-ISSN:2456-6470, Volume-3, Issue-5 , August 2019
- [3] S.S Sanghai and S.N Khante, Seismic Response of Unsymmetric Building with Optimally placed Friction Dampers, International Journal of Civil Engineering andTechnology (IJCIET), ISSN : 0976-6316, Volume-8, Issue-2, February 2017
- [4] ShameenaKhannavar and et.al. , Seismic Analysis of RC Structures Using Friction Dampers, International Journal for Research in Applied Science & EngineeringTechnology (IJRASET), ISSN:2321-9653, Volume -5, Issue-12, December 2017
- [5] IS 1893:2002 – Criteria for Earthquake Resistant Design of structures, Part 1 GeneralProvisions and Buildings.
- [6] IS 456: 2000 – Plain and Reinforced Concrete- Code of Practice
- [7] IS 875(Part 1):1987 – Code of Practice for Dead Loads(other than Earthquake) forbuidings and Structures
- [8] IS 875(Part 2):1987 – Code of Practice for Design loads(Other Than Earthquake) forbuidings and structures