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Seismic Performance Assessment of Asymmetric Buildings with Friction Damper using Time History Method of analysis

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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. Time History method of 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.*

Key Words: (Friction Damper, Time History Analysis, Lateral Displacement, Storey Drift, Storey Shear

1. 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.

1.1 Objectives

- 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 Time History Analysis.
- To compare various seismic parameters like Displacement, drift and storey shear of Simple RCC structure with the structure with Friction damper

2. 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 S Shangai 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.

3. METHODOLOGY

The study deals with Modelling and Analysis of structure with and without Friction Damper. To accomplish the modelling and analysis, an Finite Element Method (FEM) based program called ETABS (Extended Three-dimensional Analysis of Building System) is used. Time History Method of Analysis is used to study various seismic parameters like Lateral displacement, Storey Drift and Storey Shear. All the necessary data required for Time History 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.

- Time History Method of Analysis

Time history analysis is a practice where loading and response of the structure are calculated at subsequent time intervals. After each step the response is calculated from initial conditions present at the starting point i.e displacement , velocities and the loading history in the interval.

(1) Function Definition- Time history 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 Time History

- 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.

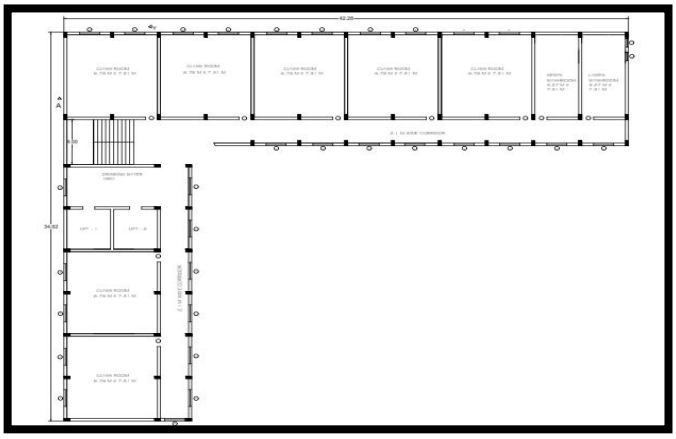


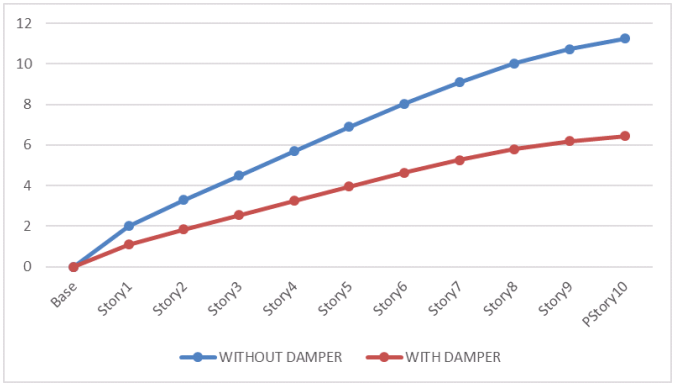
Fig -1: Plan

4. RESULTS AND CONCLUSIONS

After the Time History 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



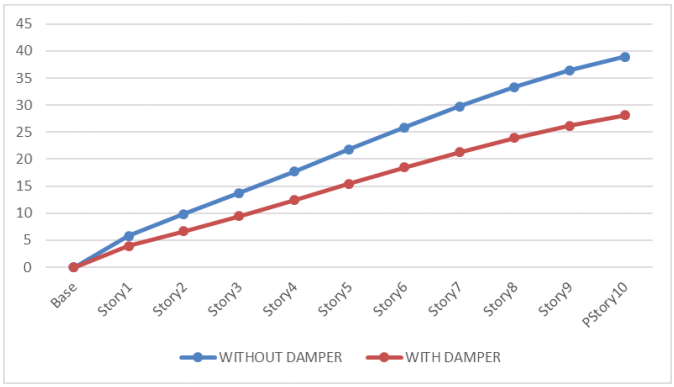


Fig -2: Comparison of Displacement in X and Y Direction

The maximum displacement of the model without Damper is found to be 11.325mm in X direction and 39.161mm in Y direction when comparing with that of Model with damper, it is 6.565mm in X direction and 28.283 mm in Y direction.

• Storey Drift

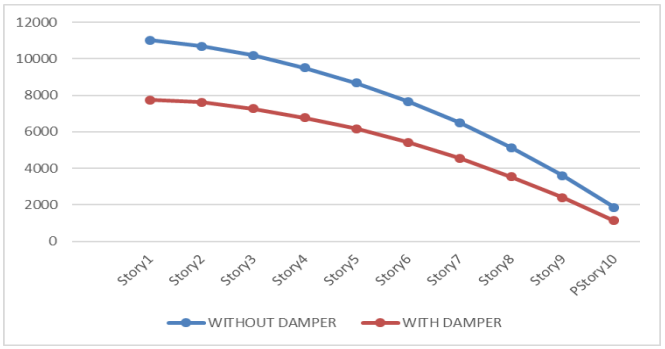
The below graph will show the drift of the model along X and Y direction after analysing both the structures, with and without friction damper.

Fig -3: Comparison of Drift in X and Y Direction

Considering the values of drift, the model without damper is found to be having a drift value of 0.000596 in X direction & 0.001952 in Y direction while comparing with that of model with damper the drift value is found to be 0.000304 in X direction and 0.001288 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



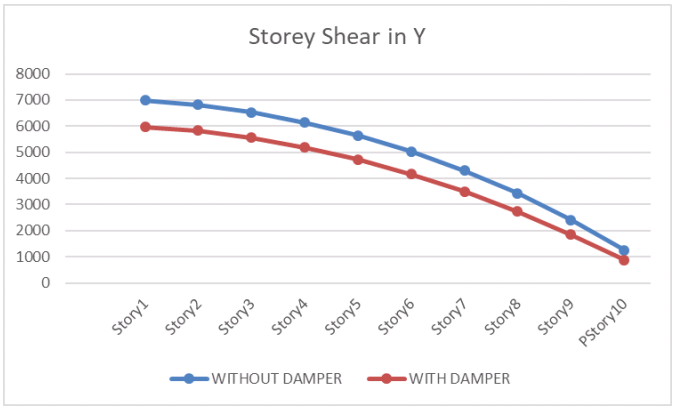


Fig -4: Comparison of Shear in X and Y Direction

While comparing the shear values, the Building Model without Friction Damper is found to be having 11025.52 kN in X direction and 6989.26kN in Y direction, when comparing with that of the Building Model with Friction damper, the value is found to be 7765.14 kN in X direction and 5987.10kN 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..

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