Comparative Study on Seismic Analysis of RC Frame Multistorey Building with Varied Location of Soft Storey and Friction Damper

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Abstract – *Due to rapid growth and demand of commercial complex with shopping mall and parking facilities, various problems are generated in structures during earthquakes and structures with soft storey at different levels lead to partial to full collapsed of structures. In past India has faced many construction failures due to soft story effect. In this study we are trying to study the effect of soft storey at different levels on the seismic performance of building like storey drift, storey displacement, time period. Also, to reduces the soft storey effect by friction dampers using the ETABS for this study. G+10, G+20, G+30storey building with fixed plan will considered and soft story provided at various level..*

Key Words: **Soft storey, Friction damper (Energy dissipation device), Seismic Analysis, ETABS**

1. INTRODUCTION

Earthquake is the most tragic due to its randomness and huge power of destruction. Earthquakes themselves do not kill people rather the enormous loss of human lives. Building structures collapse during severe earthquakes and cause direct loss of human lives. Several research works have been directed worldwide in last few decades to investigate the cause of failure of different types of buildings under severe seismic excitations. Astronomically immense eradication of high-elevate as well as low-elevate buildings in recent devastating earthquake proves that in developing countries like India

Open ground storey (additionally kenned as soft storey) buildings are commonly utilized in the urban environment nowadays since they provide parking area which is most required. These buildings have no walls provided at its ground floor. There is consequential advantage of these category of buildings functionally but from a seismic performance perspective such buildings are considered to have incremented susceptibility. According to IS 1893 Part-1 :2016 Soft Storey is defined as: "It is the one which the lateral stiffness is less than 70 percent of that in the storey above or less than 80 percent of the average lateral stiffness of the three storeys above".

friction damper device consists of several steel plates sliding against each other in opposite directions. The steel plates are separated by shims of friction pad material. The damper dissipates energy by means of friction between the surfaces which are rubbing against each other. Need no energy source other than earthquakes to operate it. They do not require any repair or replacement after the earthquake and are always ready to do their job.

Fig:1 single diagonal friction damper

2. OBJECTIVES

(i) To study the seismic response of building with and without friction damper installed at various soft storey floors and various locations using standard analysis software ETABS To compare the performance of the building without shear wall to the building having shear wall.

(ii) To check the effectiveness of the Friction dampers in reduction of the seismic responses such as time period, storey drift, storey displacement, storey shear Comparative study of individual parameters like storey displacement, storey drift, storey shear for without shear wall building to the building having a shear wall at different locations.

(iii)

3. LITREATURE VIEW

Julius Marko (2004) [1] investigated Influence of damping systems on building structures subject to seismic effect the response of multi-storey structures under simulated earthquake loads with friction dampers, viscoelastic dampers and combined friction-viscoelastic damping devices strategically located within shear walls. There are two types of configuration dampers was fitted diagonal and horizontal configuration best performance was observed when damper were placed in the upper level, while greatest reductions in the peak values of tip acceleration were achieved when dampers were placed in the lower level.

Ali Naghshineh (2018) [2] investigated the Seismic Performance of Reinforced Concrete Frame Buildings Equipped with Friction Dampers In this paper, the seismic performance of a 14 story moderately ductile concrete frame, designed based on National Building Code of Canada (NBCC) has been carried out with and without friction dampers. There are 6 type of model Elastic, Ductile, Moderately Ductile, Elastic + Dampers, Ductile + Dampers, Moderate+ Dampers. Nonlinear dynamic time history using a set of ground motion records has been performed to determine their effects. The cost analysis as presented s that using friction dampers can improve the overall performance of the building with less cost.

Ji-Young Seong (2012) [3] investigate analytically a single-degree-of-freedom (SDOF) building structure equipped with a friction damper for assessing its vibration control effect. Friction dampers are installed between stories to reduce inter-story displacements of building structures subjected to external loading. The building single storey structure model with friction dampers is represented by mass-spring-viscous Coulomb damping system. The Building response reduction as a result of damper installation can be provided by observing equivalent viscous damping ratio rather than friction force contributed by friction dampers.

Magendra, Titiksh, Qureshi (2007) [4] Allocation and slip load of friction dampers for a seismically building structure based on storey shear force distribution . seismic design methodology of the friction dampers based on the storey shear force distribution of an elastic building structure is proposed. First, using two normalization methods for the slip-load of a friction damper, numerical analysis of various single degree-of-freedom SDOF) systems is performed systems is performed. From this analysis, the effect of the slip-load and brace stiffness is investigated and optimal stiffness ratios of the brace versus primary structure are found. it is observed that, if the slipload of the friction damper is normalized with respect to the storey shear force of the original primary structure, optimal stiffness ratios for the displacement and storey shear force become similar.

Brian G. Morgen (2013) [5] Design of Friction-Damped Precast Concrete Frame Structures This paper is on the seismic design of unbonded post-tensioned precast concrete frame structures that use friction dampers for supplemental energy dissipation. The proposed design procedure assumes that the lateral strength requirements for the frame have been obtained from a linear elastic analysis of the structure under equivalent lateral forces. Based on the multi-story frame design procedure described above, a series of nonlinear reversed cyclic lateral load pushover analyses were conducted using a six story frame structure with four different damper configuration. the friction dampers are placed locally at selected beam ends.

4. METHEDOLOGY

4.1 MODELLING OF BUILDING

Here the study is carried out for the behavior of G+10,G+20, G+30 soft storey reinforced concrete building with friction damper in squre shape and L shape plans. Floor height provided 3m. And also the properties are defined for the structure. The friction damper located in soft storey floor in all, alternate ,center ,corner

4.2 BUILDING PLAN AND DIMENSION DETAILS

The analysis was carried out by considering different parameters to understand the behavior of FD with soft storey. A standard G+10, G+20 and G+30 story buildings with FD were modelled. The analysis is carried out on the 90 models using response spectrum method in ETABs 2017. IS 1893:2002 codal provisions is considered for the analysis. The plan dimensions considered for analysis are as shown in fig. Square shape building has 30m x 30 m, L shape building has 40m x 40m plan dimensions. Each bay having 5 m.

Table -1: Considered Parameters

Parameter	Values
Concrete grade	M30
Steel grade	Fe 500
Thickness of slab	200mm
Dimension of beam G+10 G+20 G+30	. 300mm X 450mm 300mm X 600mm 230mm X 425mm
Dimension of column G+10 G+20 G+30	. 500mm X 500mm 600mm X 600mm 750mm X 750mm
Floor height	3000 mm
Thickness of exterior walls	230mm
Thickness of inner walls	115mm

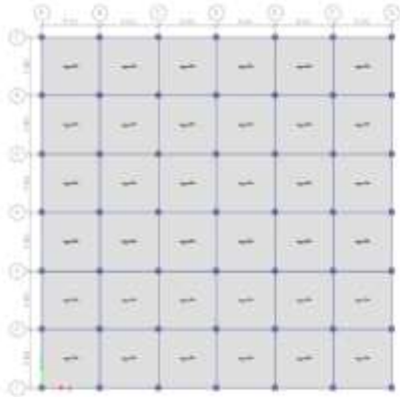


Fig 2: Square shapw

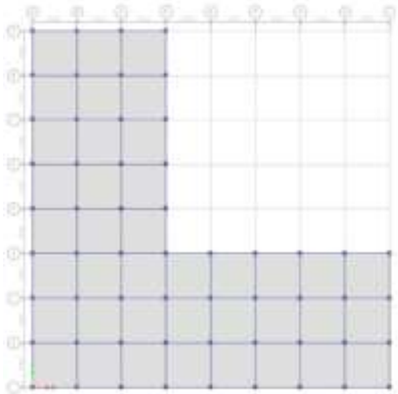


Fig 3: L shape

Fig 4: FD with soft storey building

4.3 ASSIGNING LOADS

- Dead load = 1.5 kN/m^2
- Live load = 3 kN/m^2

5. SEISMIC ANALYSIS OF BUILDING

Seismic parameters are considered as per IS 1893(Part 1):2002

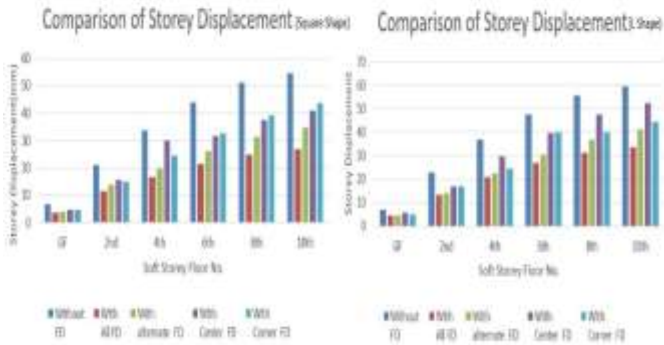
- Soil type= II
- Seismic zones = V
- Importance factor = 1
- building type = SMRF
- Response reduction factor: 5

Friction Damper properties provide by Quaketek in canada

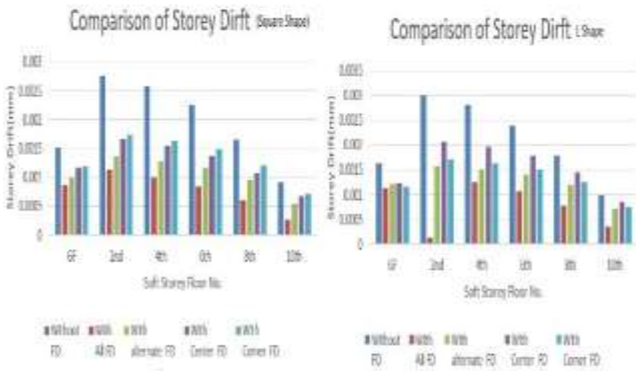
6. RESULTS

6.1 G+10

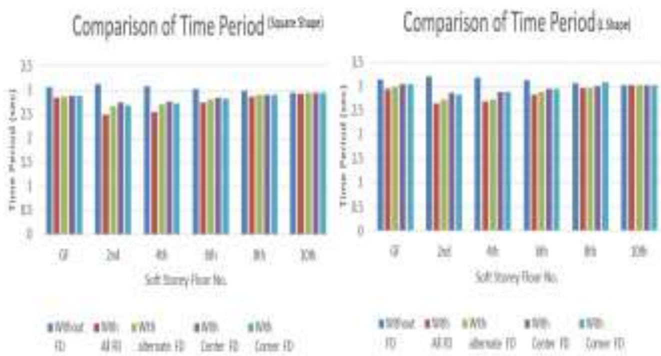
Graphical representation of G+10



Graph:1 Storey Displacement of G+10



Graph:2 Storey Drift of G+10

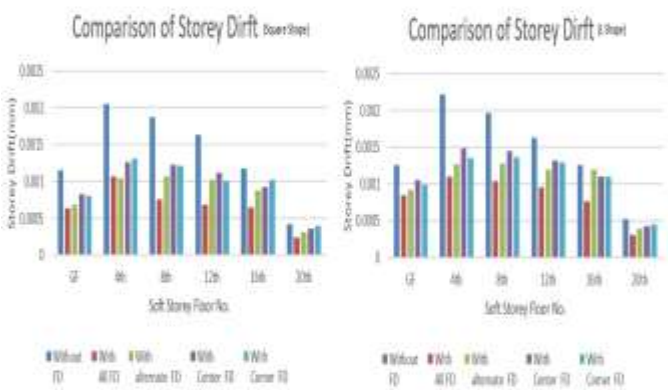


Graph:3 Time Period of G +10

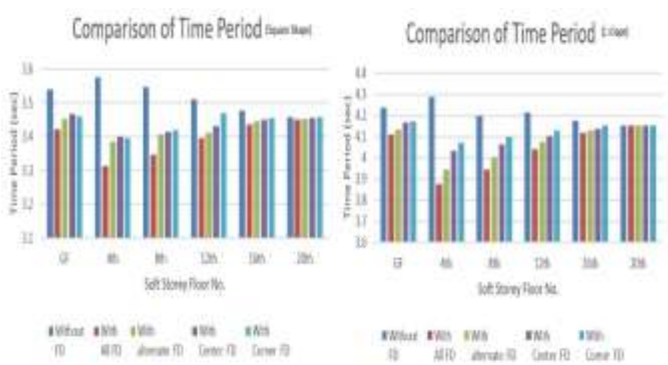
6.2 G+20

Graphical representation of G+20

Graph 4: Storey Displacement of G+20



Graph:5 Storey Drift of G+20

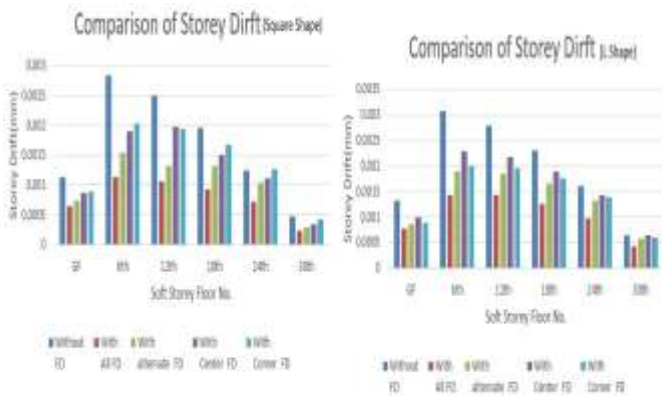


Graph:6 Time Period of G +20

6.3 G+30

Graphical representation of G+30

Graph 7: Storey Displacement of G+30



Graph: 8 Storey Drift of G+30

Graph: 9 Time Period of G +30

7. CONCLUSIONS

- The results of this investigation show that the response of the structure i.e. time period, storey displacement, storey drift can be reduced by using friction damper.
- The time period goes on increasing as the building

height goes on increasing and also when we provide friction dampers in the building the time period of the building decreases.

- The friction damper located in soft storey floor in all most effective then alternate, center and corner.
- base shear has increased due to additional mass of brace and friction damper system.

REFERENCES

[1] Julius Marko a, David Thambiratnam , Nimal Perera , (2004) "Influence of damping systems on building structures subject to seismic effect", Engineering Structures Volume 26 (ELSEVIER).

[2] Ali Naghshineh; Amina Kassem, Anne-Gaelle Pilorge, Oscar Romero Galindo, Ashutosh Bagchi (2018) "Seismic Performance of Reinforced Concrete Frame Buildings Equipped with Friction Dampers", Journal of Structures congress (American Society of Civil Engineers).

[3] Ji-Young Seong·Kyung-Won Min· Jung-Chul Kim (2012) "Analytical investigation of an SDOF building structure equipped with a friction damper", (Journal of Nonlinear Dyn), Springer.

[4] Sang-Hyun Leea , Ji-Hun Parkb , Sung-Kyung Leec , Kyung-,(2007) "Allocation and slip load of friction dampers for a seismically excited building structure based on storey shear force distribution ", Engineering Structures Volume 30 (ELSEVIER) .

[5] Brian G. Morgen1 and Yahya C. Kurama2, (2013) "Design of Friction-Damped Precast Concrete Frame Structures", Journal of structural engineering, volume 133(American Society of Civil Engineers).

[6] Shameena Khannavar, M.H.Kolhar, Anjum Algur, (2018) "A Seismic Analysis of RC structure Using Friction Dampers , International Journal for Research in Applied Science &Engineering Technology (IJRASET), vol.2.

[7] Shamshad Ali1, Farhan Malik, Tanmay Sonone, Bhushan Kalbande, Harshala Agale, (2017) "Analysis of Building with Soft Storey during Earthquake", International Research Journal of Engineering and Technology, IRJET, Volume-4.

[8] K.Vamsi Satyanarayana, Vinodh Kumar, (2016) "Seismic Response of Rc Frame Building With Soft Storey At Different Floor Levels", International Journal of Engineering Trends and Technology, IJETT Volume-42.

[9] K. Sudheer kumar, Y.Vinod , (2019) "Seismic Response Analysis of Rc Framed Structure using Dampers, International Journal of Recent Technology and Engineering (IJRTE), Volume-7.

[10] Sergio Pastor Ontiveros-Péreza,, Letícia Fleck Fadel Miguela, Jorge Daniel Rierab , (2019) "Reliability-based optimum design of passive friction dampers in buildings in seismic regions", Engineering Structures Volume 199(ELSEVIER).

[11] IS 1893 (Part 1): 2002 Criteria for Earthquake Resistant Design of Structures, Part-1: General Provision and Buildings, Bureau of Indian Standards, New Delhi.

[12] IS 1893:2016. (n.d.). Criteria for Earthquake Resistant Design of Structures.

[13] Quaketek friction dampers, canada