Structural Analysis of Seismic Friction Dampers

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Abstract– *In the last decade,many energy dissipating systems have been proposed to raise the seismic design of structures. Among these, friction damping has shown great potential. Friction dampers are designed in such a way that there moving parts slide over each other during a major earthquake. Major reason of sliding is to create a friction that uses some of the energy from earthquake that goes in thebuilding. Damper plays an important role in design of earthquake resistant structures. The main task of the structure is to bear the lateral loads and transfer them to the foundation. Using Push over analysis, the Response of the RC building is evaluated.*

In these studies, the importance of dampers in the buildings have been illustrated. There are various types of dampers that plays an important role in various types of buildings. Such type of damper is a Pall friction damper. Pall friction dampers are very attractive due to its simplicity and low cost of construction. These types of dampers can be easily hidden in internal partitions. In the present study the software SAP 2000 v20.2.0 have been used. The method of analysis used is push-over Analysis. and analysis is done on the basis of IS 1893-2016(Part 1).

Key Words: Friction Dampers, Push over analysis, response spectrum analysis, Energy dissipation, Square column, Rectangular column.

1.INTRODUCTION

Over the last fifty years, the earthquakes are categorized in two groups of near field earthquake and far field earthquakes based on the distance of the place of recording the earthquake from the fault. Over the recent years, the research studies concentrated on the study of impacts of ground motion in near field earthquake. The devastative effects of the recent earthquake as Northridge Earthquake (1994) and Kobe earthquake (1995) with regards to the close location of many of the cities of India to the active faults indicates the significance of the research.New techniques for protecting the buildings against earthquakes have been developed for improving its capacity. As part of the research programmer, a quest was done for a means to apply friction dampers to buildings with braced rigid frames.

Under the action of horizontal wind forces the building acts as a braced frame. When the ground acceleration reaches the initiating design value, the slipping occurs, energy is dissipated and the natural frequency changes.

In friction dampers, seismic energy is spent in overcoming friction in the contact surfaces. The friction dampers are installed in parallel to the bracing. Because of its simple behavior and easy to install, these types of dampers are most commonly used in earthquake buildings.

Other type of damper that is commonly used is PVD dampers. Basically, it is a type of Friction damper. PVD Damper can be used to create necessary damping for flexible structures. PVD Damper acts effectively on low displacements and it does not require maintenance and does not have any lubrication.

Another type of friction damper is Pall Friction Damper. These types of damperare installed in the middle of Bracing.

Some other types of dampers are Metallic dampers, Lead injection dampers, Viscous dampers, Mass dampers etc.

During the life of the building, if there is no seismic activity the structure will behave as an elastic system. The dampers play an important role in earthquake buildings. The dampers lie in the plane of the bracing. Each damper is manufactured to slip at a specified force, within a specified tolerance.

1.1 OBJECTIVES

When the structure has much absorbing capacity than the seismic energy, then it can withstand the structural damage. Clear understanding of damping is required for incorporating its effect to the structure. The main objectives of these projects are as follows:

a) To compare the seismic response of buildings with square and rectangular plans, with square and rectangular column cross sections.

b) To determine displacements variations in the structure.

c)To compare analysis of buildings with and without dampers by Push over Analysis.

d)To study the results obtained after the analysis of buildings.

1.2 Methodology

The process involved in this study to achieve the above stated objectives is:
a) First, model two same horizontally regular shaped building models of same height with Damper and without Damper.

b) Then, perform Push over Analysis on each taken models.
c) Analysing and comparison of the result of seismic analysis.
d)Presentation of results in the form of graphs and tables.
e) Detailed discussion on the results with the help of graphs and tables considering all the parameters.

2. LITERATURE REVIEW

Y. g. Zhao and T. Onoin (2001) mentioned about "Moment methods for structural reliability" in which they said, to perform an accurate analysis a structural engineer must determine such information as structural loads,geometry, support conditions and material properties. The results of these type of analysis includes support reactions, stresses.

In (2013) Vajreshwari Umachagi et.al presents an overview about the dampers for the control of vibration of the structures. This overview includes different types of dampers like metallic dampers, fluid viscous dampers etc. In this paper the focus is on choosing the best damper that can reduce vibration in the structure. It can reduce vibration by increasing structural safety, serviceability. The experimental and analytical investigations carried out by various researchers clearly tells about seismic control method for improving the seismic performance of structures.

Durgesh C. Rai (2000), In these papers he deals with the future trends in earthquake resistant design of the structures.It is well known that earthquakes will continue to occur. But for the engineer, the ultimate goal will remain same to design the structure but cost effective in manner. The development of new structural systems and devices will continue for the base isolation, passive energy and active control systems. The main focus on the friction damper is carried out by doing various analysis like push over analysis and response spectrum analysis. In response spectrum analysis, there is a function defined and then the graph is plotted for the values of RSX and RSY. In Push over analysis the hinges are defined, the supports are fixed. The push over values are obtained for PUX and PUY. The appeal of fluid dampers is due to some interesting features: i) low maintenance required; ii) they may be used for several severe earthquakes without damage. In this paper a new form of amplification mechanism is proposed. Analysis is conducted with time histories of earthquakes and with the stochastic analysis.

Gang Li and Hong- Nan Li (2013) This paper presents the comparative analysis on the seismic performance of building structural systems having passive damping devices-viscoelastic damper. Dynamic behavior of the structure for wind and earthquake loading with respect to response spectrum analysis is carried out. Changes in the responses of displacement, velocity, acceleration and drift for the damped structure are demonstrated illustrating the efficiency of dampers. The model was analyzed using SAP200 v20.2.0. He also carried out a new type of metallic damper and result carried out for the respective directions of wind and earthquake forces against displacement, drift, velocity and acceleration. When combination of various loading was considered. Prior to the analysis of this model a 20 storey building was worked on. The results show that the displacement and acceleration were around 15% and19% respectively. So, the efficiency of dampers increases with elevation. Some other results that, the response of structure can be dramatically reduced by using viscoelastic damper without increasing the stiffness of the structure.

W.S. Pong, C.S. Tsai and G.C. Lee (1994), he explains that a typical building normally has an internal structural damping of 1 to 3 percent of critical. Optimal performance of a building with fluid viscous damping is achieved with damping in the range of 20 to 25 percent of critical. Again, using the comparison with an automobile, most conventional auto use dampers with 20 to 30 percent of critical damping. Friction Dampers are also very effective in reducing the building deflections under wind loadings without changing the stiffness of the building. The result was estimated that friction dampers are better than fluid viscous dampers.

Imad Mualla, Borislav Belev,the paper introduces the basic types of damping devices and summarizes the benefits of implementing supplemental damping systems for seismic protection of buildings and other structures. He also introduced that friction dampers are the most significant dampers among various types of dampers. The seismic protection is a more advanced alternative approach which aims at reducing significantly or completely eliminating the ductility demand and related damage to the primary structural members. The test building was a steel moment-resisting frame structure with 3.3 m storey height and 4.5 m bay width in the direction of shaking. The result was that the passive damping systems are now a mature and reliable technology for seismic protection. He also introduces the square column and rectangular column with and without dampers.

3. STRUCTURAL MODELLING

For these study,two buildings of same horizontal plan are taken. One building is modeled with damper and another building is modeled without damperusingSAP2000v20.2.0. Each building is a 6- storey building and height of each story is 3.3m. There is a comparison between these two buildings with and without dampers.

The plan of these two building models is given Below: -

1. Model 1 – A Rectangular building with rectangular column with damper is taken.
2. Model 2- A Rectangular building with rectangular column without damper is taken.

Table-1: Design details

S. No	Particulars	Dimension/Value
1	No. of Stories	G+5
2	Floor to Floor height	3.3 m
3	Beam Size	230mmx500mm
4	Column Size	700mmx700mm
5	Thickness of Slab	125mm
6	Height of Building	19.8m
7	Wall Thickness	230mm
8	Grades of Concrete	M25 (For Beam and Slab), M30 (For Column)
9	Grades of Steel	Fe415
10	Response Reduction Factor	5
11	Importance Factor	1.2
12	Seismic Zone	IV (0.24)
13	Live Load	4KN/m^2
14	Floor Finish	1.8KN/m^2
15	Wall Load	15.18 KN/m^2
16	Earthquake Load	As per IS-1893-2016 (Part -1)
17	Analysis Method	Push Over Analysis, Response spectrum Analysis
18	Software Used	SAP2000 v20.2.0

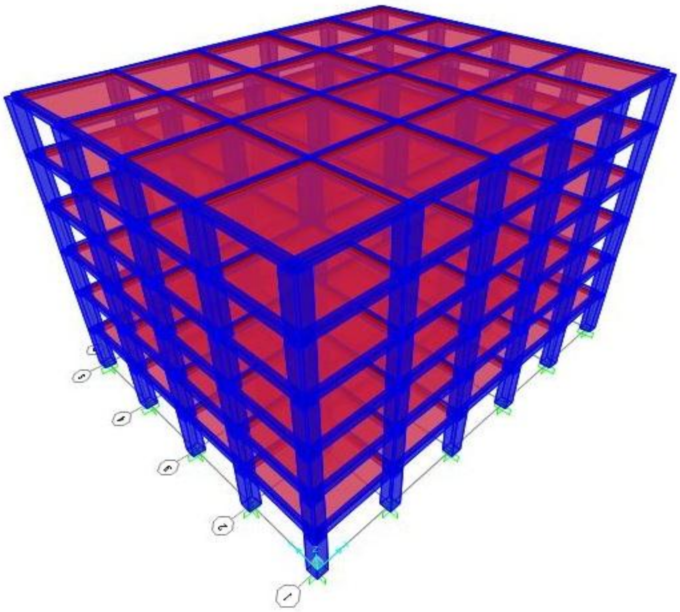


Fig-1: Rectangular Building without Damper(3D)

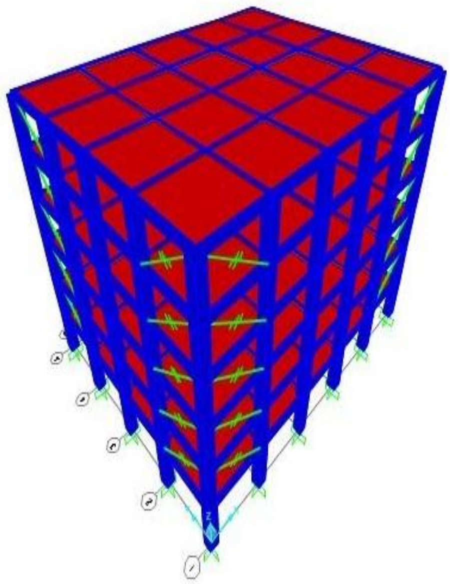
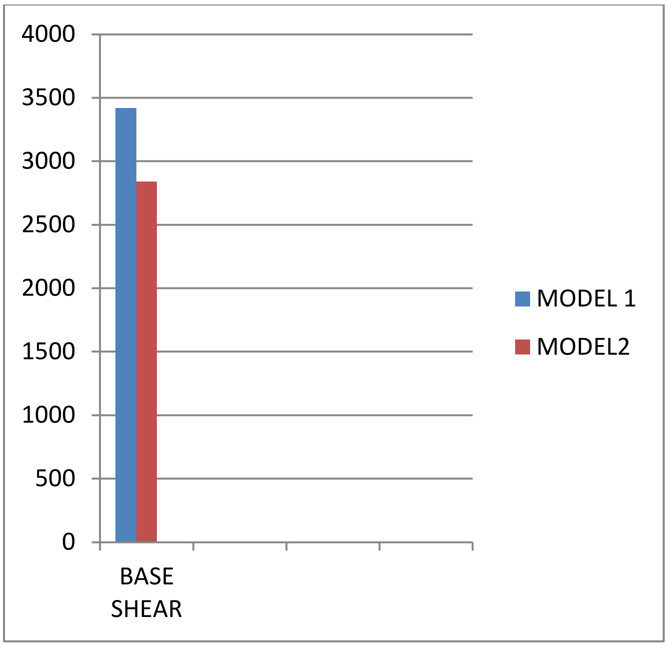


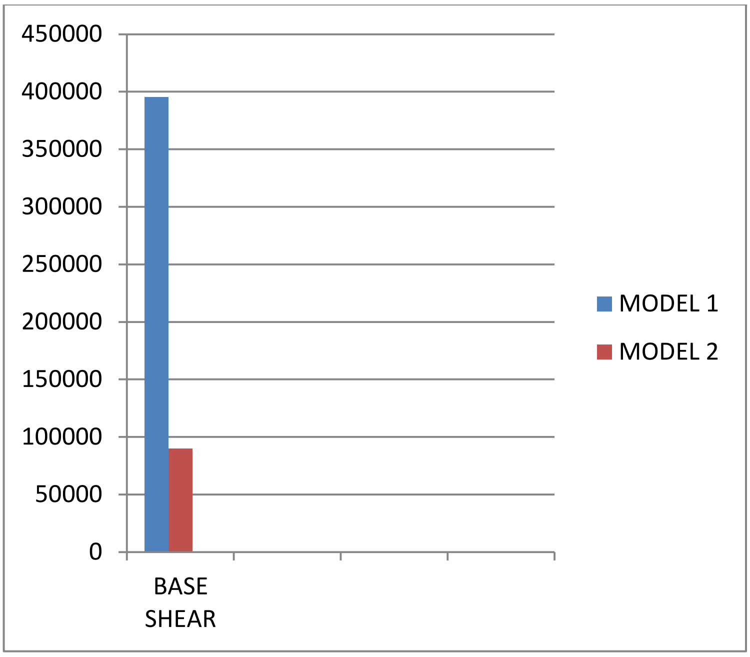
Fig-2: Rectangular Building with Damper(3D)

4. RESULTS

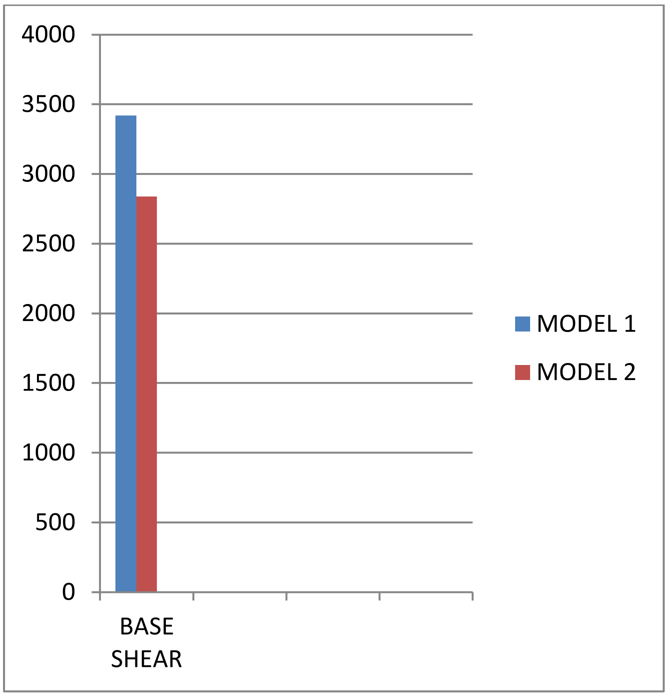
BASE SHEAR FOR EQX (KN)



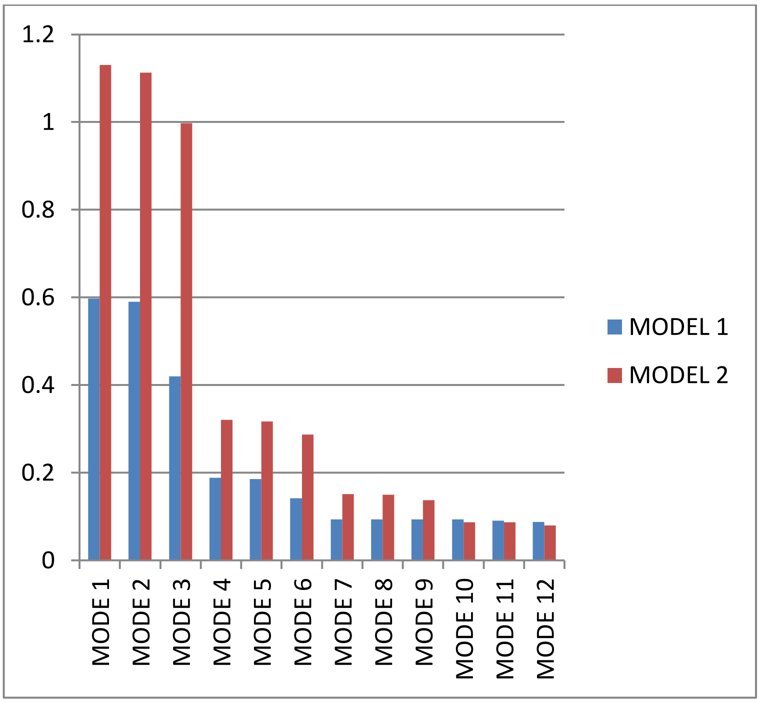
BASE SHEAR FOR PUSHX(KN)



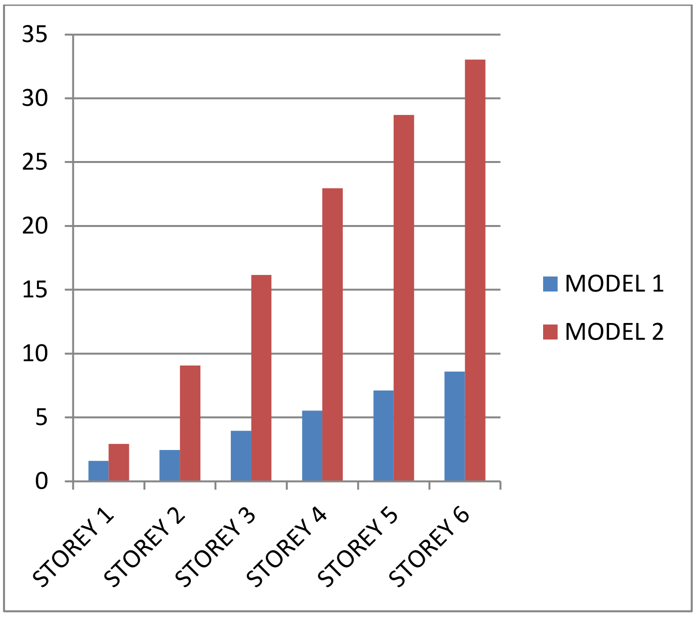
BASE SHEAR FOR EQY(KN)



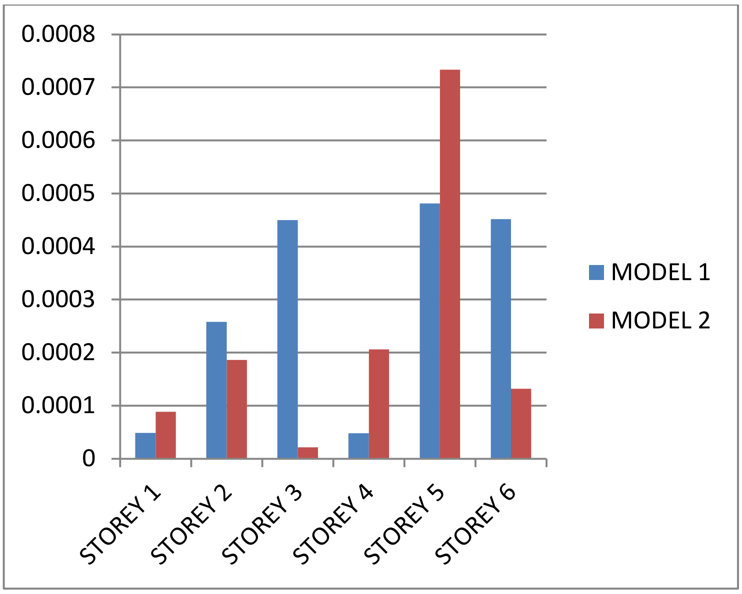
TIME PERIOD(SECONDS)



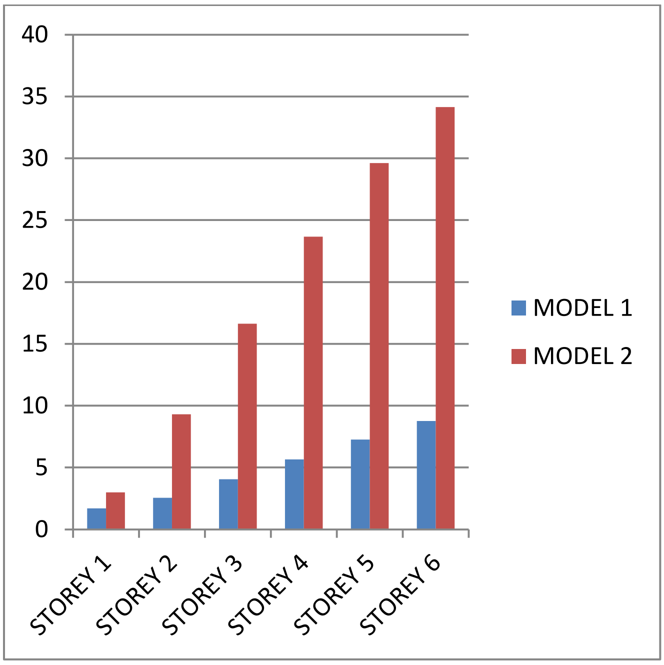
LATERAL DISPLACEMENT IN X DIRECTION FOR EQX(MM)



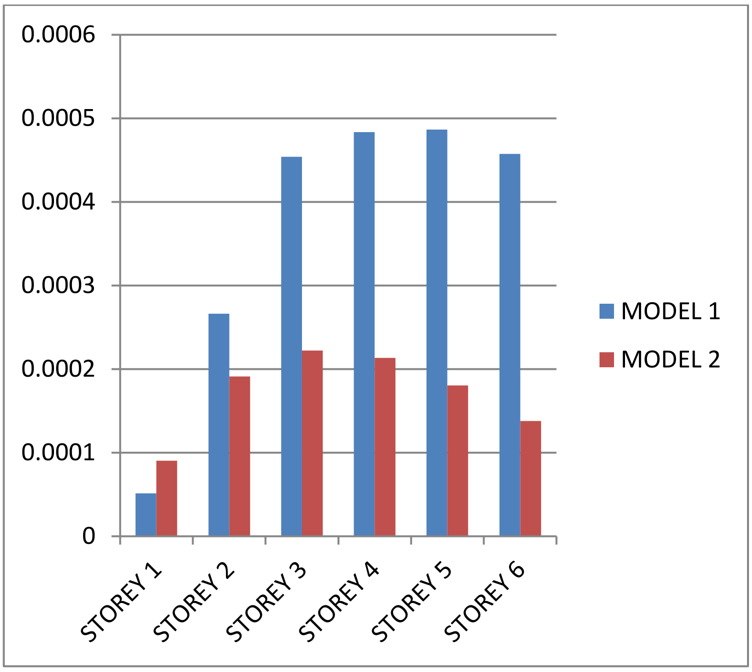
STOREY DRIFT IN X DIRECTION FOR EQX(MM)



LATERAL DISPLACEMENT IN Y DIRECTION FOR EQY(MM)



STOREY DRIFT IN Y DIRECTION FOR EQY(MM)



5. CONCLUSIONS

The following conclusion are drawn from the results:

1. The lateral displacement of Rectangular Building without damper is maximum than lateral displacement of Rectangular Building with damper for values of EQX, EQY.

2. The value of Base Shear for building without damper is maximum than building with damper.

3. The value of Storey Drift for rectangular building with damper is maximum than Storey Drift for rectangular building without damper for EQX, EQY.

4. The value of Time Period is decreasing as the mode number increasing.

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7. BIOGRAPHIES

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