Seismic Performance of energy dissipation devices.

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Abstract : Multistoried Buildings subjected to ground motion have became a common problem in construction. Earthquakes are devastating natural events that threatens life and property and disrupt life sustaining services. In this paper Pall Friction Dampers and Viscous Dampers have been modeled in E tabs.Various results such as base shear,drift and displacement were compared.

Index Terms **- Energy dissipation devices ,pall dampers,Viscous dampers,Earthquake.**

I. Introduction

Strong earthquakes have occurred across the world in past. These earthquakes have caused severe damages to large-scale infrastructures. To protect structures from significant damage under severe earthquakes has become an important topic in structural engineering. Conventionally, structures are designed to resist dynamic forces through a combination of strength, deformability and energy.

The structures designed are vulnerable to strong earthquake motions. In order to avoid critical damages, structural engineers are working to figure out different types of structural systems that can withstand strong motions.

Serious efforts have been undertaken to develop the structural control concept into a workable technology and energy dissipiation devices are installed in structures.

The concept of structural control is to absorb vibration energy of the structure by introducing energy dissipation devices. Various types of structural control theories and devices have been recently developed and introduced to large-scale civil engineering structures

In last few years, many essential developments in seismic codes are turned up. Utmost of the modification in the seismic design area derive from greater awareness of actual poor buildings performances in contemporary earthquakes. Due to the renewed knowledge of the existing buildings behaviour, retrofit of buildings is a paramount task in reducing seismic risk. New techniques for protecting buildings against earthquake have been developed with the aim of improving their capacity. Seismic isolation and energy dissipation are widely recognized as effective protection techniques for reaching the performance objectives of modern codes.

II. OBJECTIVES

To find the suitability of energy dissipation devices for structure using pall friction dampers and Viscous dampers.

To compare various results such as the base shear, drifts and displacements of a structure designed using the dampers.

III. LITERATURE SURVEY

(Vaseghi. J. et al. 2009)[1], in this study, the behavior of eccentric braced frame (EBF) is studied with replacing friction damper (FD) in confluence of these braces, in 5 storey and 10 storey steel frame. Two have been chosen as reference buildings for this study: 5 storey and 10 storey frame structures. The two buildings have an identical 3 bay layout in plan, 6 m span and 3 m store height. The methodology proposed in this study is based on performing a numerical parametric analysis of building structures occupied with FD system. In this study, the nonlinear dynamic analyses were performed using three earthquake records. These records include El –

Centro (1940), Tabas (IRAN, 1978 and Kobe (1995) earthquakes. Results of this study show that, roof displacement, base shear and axial loads of columns of two buildings have been decreased by using friction dampers

(Naziya Ghanchi and Shilpa Kewate 2015)[2] ,in this paper they did dynamic analysis of 25 floor rcc building with and without viscous dampers found that by adding viscous dampers in a building response of a structure get reduced by significant amount. It is seen that for response spectrum analysis in X and Y direction, the response of the structure such as the storey drift and storey displacement reduces more as compare to the storey shear. Reduction of storey drift is around 29% to 30%, reduction of storey displacement is around 20% to 23%, and reduction of storey shear is around 0% to 2%.

(D.A.Chikhalekar and M.M.Murudi)[3] , they studied about seismic performance of structure with fixed base ,base isolated structure and structure with viscous damper and found that response of the structure can be reduced by use of visous damper in structure the storey drift ,storey displacement are reduced.Base isolation techniques have been found reliable for seismic protection of multy storey structure.

Filiatrault et al. (1987)[4], in this study, a three – storey frame equipped with friction dampers was tested on a shake table at the University of British Columbia, Vancouver. Even an earthquake record with a peak acceleration of 0.9g did not cause any damage to friction damped braced frame, while the conventional frames were severely damaged at lower levels.

(Azlan Adnan, Tan Chee Wei, 2001)[5], have found out from the analysis that the structures of high-rise building with different heights behave differently under earthquake loadings. They have realized that the maximum axial load, shear and bending moments occur at ground columns. Also the results show that the effect of earthquake decreases as intensity of earthquake is reduced. The effects of earthquake are not proportional to the building height, for example, the axial load increases as the number of floors is reduced. Therefore, different building systems will behave differently and the response of the buildings are more depending on their natural period

(Avtar S. Pall, 1982)[6] found that harsh ground shaking induces lateral inertial forces on buildings, causing them to sway back and forth with amplitude proportional to the energy fed in. If a major portion of this energy can be consumed during building motion, the seismic response can be noticeably improved. The manner in which this energy is consumed in the structure determines the level of damage

Filiatrault and Cherry (1987)[7] have presented the design procedure for friction dampers that minimizes the sum of the displacement and dissipating energy by carrying out the parameter studies such as the structural fundamental period, frequency components of excitation load and the slip load of friction damper

Garcia and Soong (2002)[8] have presented the method that obtains the optimal viscosity in terms of a storey distribution by iterating the process that the inter-storey drift or the inter-storey velocity is defined as a controllable index and then installs the viscous damper at the location of maximum controllable.

Viti, et al. (2006)[9] presented both the weakening retrofit to reduce maximum acceleration and the supplemental damping devices to control structural deformations.

(Ankit Jain and Dr.R.S.Talikoti 2016)[10] in this paper they insvigated about performance of High rise structure with dampers at different locations the study describes the results of a study on the seismic behavior of a structure (G+7) with and without damper.Analysis was done in E tabs software.

Seismic Performance of building can be improved by providing energy dissipating device (damper), which absorb input energy during earthquake.

After application of damper is much better when we provide same number of damper to bottom 7th stories.

Frame is safer when damper is provided up to Floor from base as compare with other arrangement.

With deployment of damper in the structures, base shear effectively reduce.

IV. TYPES OF DAMPERS USED

Fluid Viscous Damper

Fluid viscous damper used are made by company known as Taylor Devices Inc.

fig 1 Taylor Devices courtesy www.taylordevices.com

Viscous Dampers protect almost any new or existing structure against earthquakes, simply and inexpensively. Taylor Devices' Fluid Viscous Dampers provide complete protection for buildings, bridges, towers, elevated freeways; virtually any structure that is subject to earthquake damage. It can also protect sensitive equipment inside your building, like computers and generators.

Taylor Dampers literally soak up the energy of earthquake induced motion, preventing structural damage. Compact, yet powerful, Taylor Fluid Viscous Dampers increase structural damping levels to as much as 50% of critical, the results being truly dramatic stress and deflection reduction.

Properties of Taylor Fluid Viscous Dampers:

Substantial Stress Reduction – Greatly enhanced damping lowers both stress and deflection throughout a structure. This allows the structure to remain elastic during any seismic event.

Easy to Model with Existing Codes – These dampers are completely viscous in output and will simply and efficiently raise structural damping to 20%-50% of critical, versus 1%-3% for a typical undamped design.

Easy Installation – Saving valuable time and materials, a wide range of compact sizes with linear or non-linear damping are readily available to reduce installation cost.

Peace of Mind – Totally passive dampers for extreme reliability with no dependence on outside energy sources.

Worry-Free Operation – No maintenance ever. Taylor Devices' exclusive modular design uses a minimum number of moving parts. Patented seal has a history of over 50+ years of successful performance on demanding applications. Completely self-contained; no refilling, no leakage, no problems.

Environmentally Proven Output – Thermostatically controlled, virtually unaffected by temperatures from -40 degrees F to +160 degrees F. Nonflammable inert fluid and stainless steel piston rods standard on all models.

Simple to Apply – These dampers are truly viscous, their response is out of phase with structural stresses. Available in sizes of 10 kip to 2000 kip.

Pall Friction Dampers

This damper is made by company known as Pall Dynamics Ltd.

fig 2 Pall Dynamics courtesy www.palldynamics.com

Pall Friction Dampers are simple and foolproof in construction. Basically, these consist of series of steel plates, which are specially treated to develop very reliable friction. These plates are clamped together and allowed to slip at a predetermined load. Decades of research and testing have led to perfecting the art of friction. Their performance is reliable, repeatable and they possess large rectangular hysteresis loops with negligible fade. Pall Friction Dampers are passive energy dissipation devices and, therefore, 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.Pall Friction Dampers are available for long slender tension-only cross bracing, single diagonal tension-compression bracing and chevron bracing.

Salient features of Pall Dampers

Their performance is independent of velocity and hence exerts constant force for all future earthquakes, design-based earthquake (DBE) or maximum credible earthquake (MCE).

A much greater quantity of energy can be dissipated in friction than any other method involving the yielding of steel plates, viscous or viscoelastic dampers. Therefore, fewer Pall Friction Dampers are required to provide the required amount of energy dissipation.

In a typical un-damped structure, the inherent damping is merely 1-5% of critical. With the introduction of Pall Friction Dampers, structural damping of 20-50% of critical can be easily achieved.

Pall Friction Dampers are customized to suit site conditions and allow greater adaptability than is possible with other systems. These dampers can be bolted or welded into place.

Pall Friction Dampers provide a practical, economical and effective approach for the design of structures to resist major earthquakes. Low cost of Pall Friction Dampers suggests wide application for all sectors of society - public, private and developer.

V. RESEARCH METHODOLOGY

The building is a G + 6 storied building with a total height of 18m height.

It is an RCC framed single moment resisting frame. The model is as shown below.

The modal was made using E tabs 2015. It consist of six floor building having

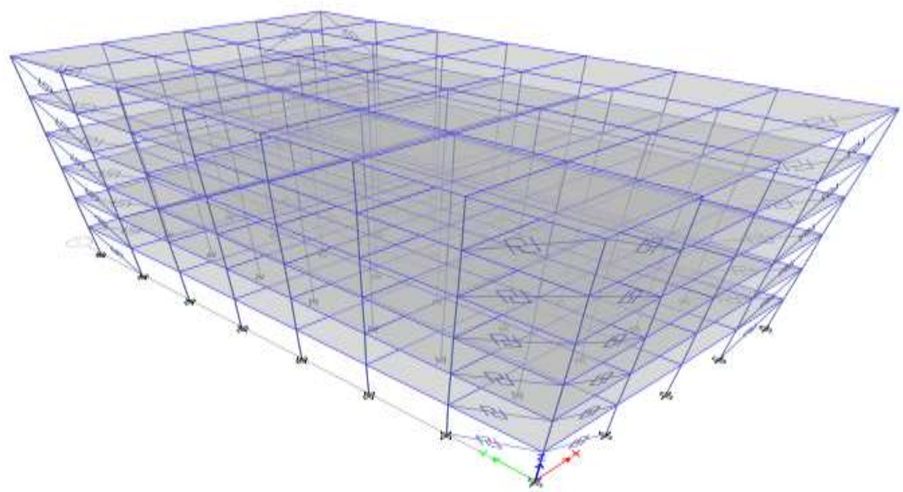

Fig 3 Damper Modal

Frame Sections

Table 1 - Frame Sections - Summary

Name	Material	Shape
Beam 230X450	M25	Concrete Rectangular
Column 230X650	M30	Concrete Rectangular

Slab

Table 2 - Slab Sections

Name	Design Type	Element Type	Material	Total Thickness mm
Slab1	Slab	Shell-Thin	M25	125

The modal is made using Pall friction damper and Fluid viscous Dampers in E tabs for Zone 5 .To compare the relative merits and demerits of the model, the design of the structure was carried out.The results and conclusions are discussed.

IV. RESULTS AND DISCUSSION

Comparison Of Storey forces of building

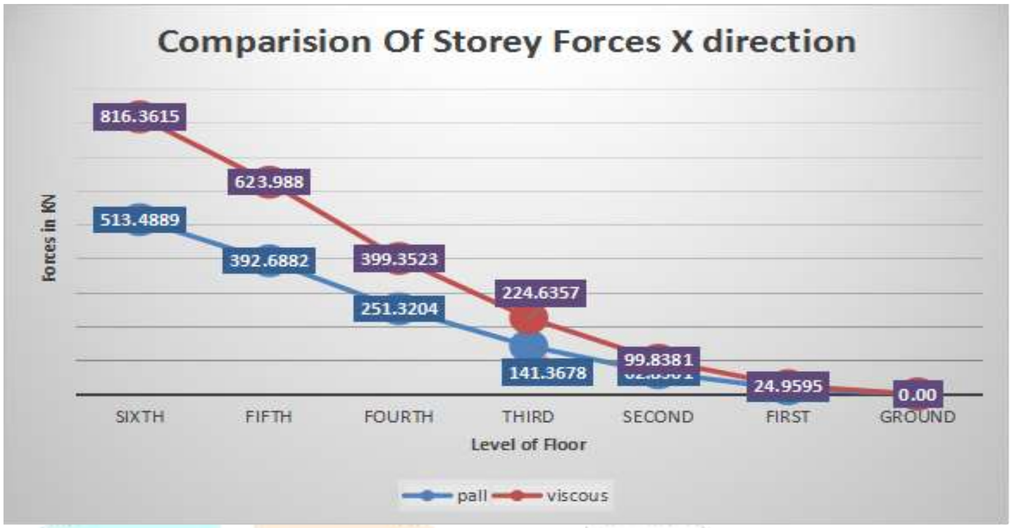

fig 5.17 Comparison of storey forces in X direction

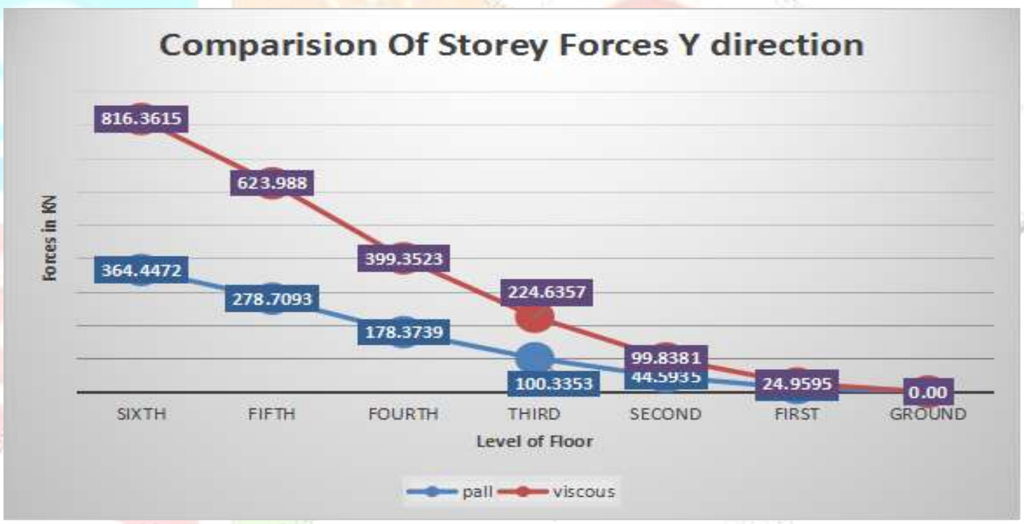

fig 5.18 Comparison of storey forces in Y direction

Comparison of Drift for Fluid viscous damper and Pall dampers

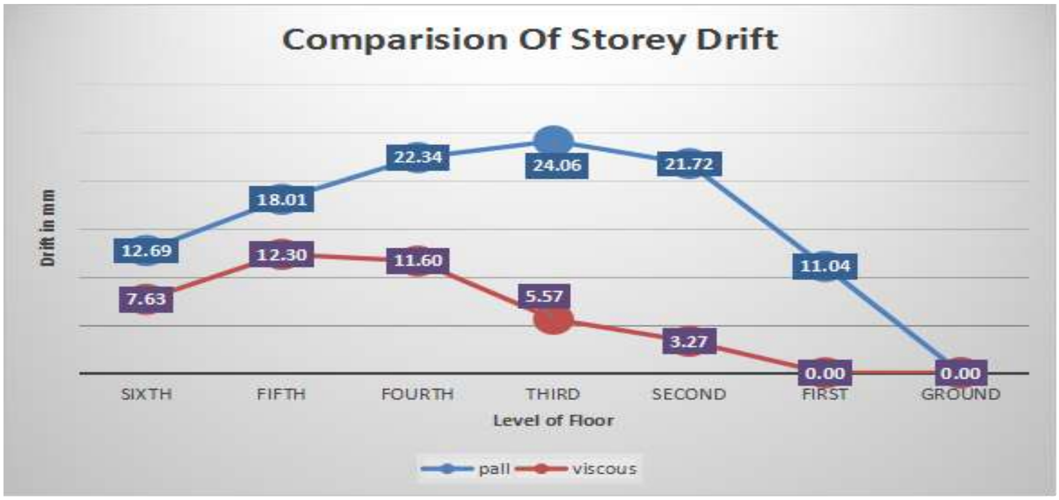

fig 5.19 Comparison of Storey drift

Comparison of Displacement of the Building

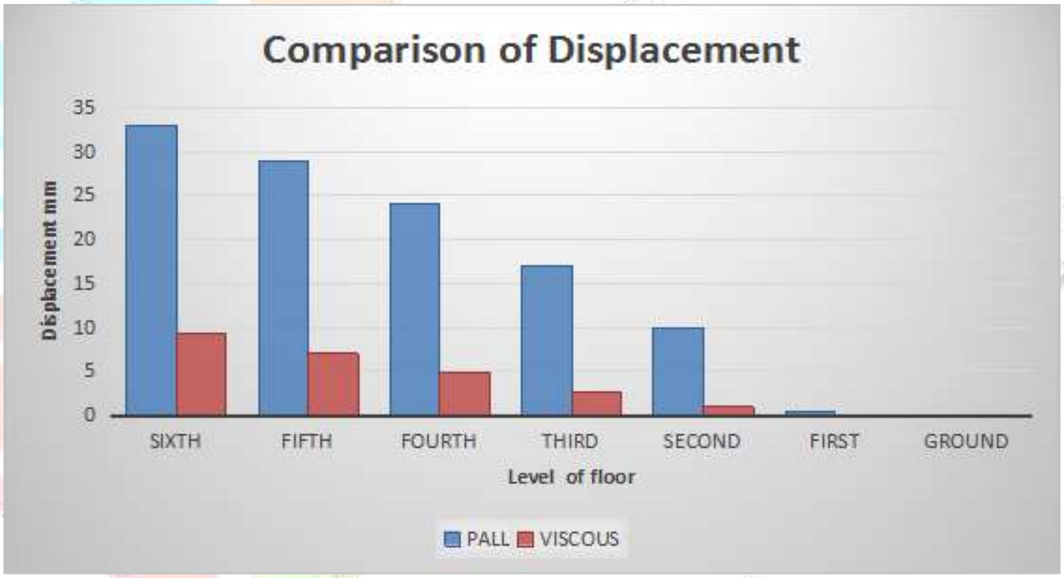

Fig Comparison Of Displacement

VI. CONCLUSIONS

For a structure, the base reaction is its horizontal acceleration co-efficient multiplied by the weight of the building. The acceleration co-efficient is dependent upon the importance factor of the building, the spectral accelerations, the site class and the Response Reduction Factors. Since these are constant for all the above models, there is no variation in the base reaction in any case.

It can be concluded that the model designed using the Viscous damper has more control over the drift and maximum displacement of the structure.

The load cases where the maximum inter-storey drift occurs is different for each case in this case study. The maximum storey drift occurs for a Pall dampers.

LIMITATIONS OF CONCLUSION

Increasing storey level may lead to different conclusions.

Use of different cross section of members may lead to change in the result obtained from this study

Position of dampers matters a lot while arriving at particular solution.

The conclusions and results are relevant to process of dwelling evolution in progressive development projects.

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