Comparative Study of RC Framed Building with Isolator and Dampers

Rincy M. A
M. Tech Structural Engineering and Construction Management
Department of Civil Engineering
Christ Knowledge City, Kerala, India

Er. Shwetha Saju
Asst.Professor,
Department of Civil Engineering
Christ Knowledge City, Kerala, India

***Abstract*— Buildings have irregular configurations both in plan and elevation will be more subjected to devastating earthquakes than the building with regular configuration. So certain techniques were adopted to reduce the earthquake effect on building . Seismic improvement techniques adopted to improve the stiffness and flexibility of the structure are base isolation and provision of damping devices. Analysis of these structures is done by pushover analysis and response spectrum method with the help of finite element software. Comparative analysis of structures with fixed base, structure with damper and structure with isolator were done. Storey displacement, storey acceleration, modal time period, storey drift and performance point were analysed with the help of software.**

Keywords—Isolator; Damper; pushover analysis; Response spectrum method

I. INTRODUCTION

Earthquake is unpredictable to the engineers and after effects of such earthquake is severe. India has experienced most devastating earthquakes in the world and during this earthquake lot of people lost their lives and most structures have collapsed . Therefore it is essential to protect structures from future earthquakes. The existing building found inadequate for resisting future probable earthquake. The buildings with regular geometry and uniformly distributed stiffness and mass both plan and in elevation undergo much less damage as compared to the building with irregular configurations. To reduce the earthquake effects on building, certain seismic control techniques were adopted.

Conventional seismic design of building attempt to make buildings that not to undergo compete collapse during strong earthquake shaking, but may sustain damage to non-structural elements and structural members in the building. Special techniques are required to design buildings such that structure remaining undamaged even in a severe earthquake. Two seismic control techniques are used to protect buildings from damaging earthquake effects are Base Isolation Devices and Seismic Dampers. The provision of isolators in the structure isolate the building from the ground, such that earthquake motions are not transmitted through the building. Seismic dampers are the special devices provided in the building to absorb the energy produced by the strong ground motion during earthquake. The main concept of the base isolation and provision of dampers in building is to introduce flexibility in structures. The seismic improvement is helpful to withstand structure against collapse during severe earthquakes.

II LITERATURE REVIEW

Mohammed Asim Khan and Prof. Shaik Abdulla explained the seismic performance of the building by analysing nine models of building with two different techniques such as lead rubber bearing isolator and masonry infill walls, and the analysis is done using the software SAP2000V15. From the study asymmetric R C framed building with Lead Rubber Isolation shows better performance than building with infill walls. Base shear, torsional moments, natural period and the displacement of the building with fixed base, building with lead rubber isolator and infill wall were analysed. The study shows that natural time period increases when base isolators are provided in the structure and storey displacements get reduced by the provision of infill walls. Dhananjay A. Chikhalekar and M. M. Murudi, In this paper, ten storey structures with fixed base and structure with high damping rubber bearing and viscous damper are considered and analysis is carried out using response spectrum method and non linear static analysis . Storey displacement, storey drift, natural time period and performance point of the structure were compared using the software SAP. Study shows that performance of base isolated structure against seismic effect is high when compared to the structure with viscous damper. Swathirani.K, Muralidhara.G.B and Santosh kumar.N.B ; In this paper comparison between the fixed base building and various isolation systems such as friction pendulum isolator , high damping rubber isolator and lead rubber isolator subjected to strong earthquakes were analysed. The study shows the high damping rubber isolated frame is performing better as compared to the other isolator stiffness. Julie S and Sajeeb R studied the seismic performance of the base isolators and mass dampers in the vibration control of the building.. Displacement, story drift and base shear of the structure is compared. The study shows that base isolators are superior in controlling the acceleration response

III OBJECTIVE OF THE STUDY

To study the various seismic control techniques adopted for the protection of structure against seismic effects. To compare the response of the building such storey drift and displacement, time period performance of the fixed base

structure with base isolated and structure with damping devices. Another objective of the study is to compare the performance of building with isolators and damping devices against the seismic activity.

IV BASE ISOLATION

Seismic isolation separates the superstructure from the substructure and it prevents the transfer of ground motion from foundation to superstructure. Isolated structure has the fundamental frequency much lower than that of the fundamental frequency of fixed base structure. The technique of base isolation has been developed in an attempt to reduce response on the buildings and their contents during the earthquake attacks and has proven that it is one of the most effective methods for a wide range of seismic problems on buildings. Seismic isolation consists of the installation of mechanisms which decouple the structures from the possibly damaging earthquake-induced ground motions. Base isolators lengthen the fundamental period of the structure to be controlled.

Base isolators are flexible pads , whereas the structures protected by these devices are called base-isolated buildings. The main feature of the base isolation technology is that it provides flexibility to the structure. The isolators are designed to absorb energy and thus add damping to the system. This helps in reducing the seismic response of the building.Mainly two types of isolators; they are elastomeric bearings and sliding bearings. Elastomeric isolators use low lateral stiffness of the material to increase the fundamental period whereas sliding systems use the characteristics of a pendulum to lengthen the period. Isolators are provided at the base of the building.

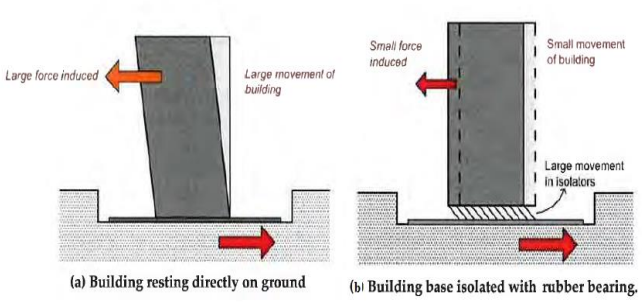

Fig 1. Base isolation principle

A. *Types of isolators*

Lead-Rubber Bearings , High damping natural rubber bearings , friction pendulum isolators commonly used type of isolators. Properties of these isolators are different and their effect on structure varies. In lead rubber bearings ,the lead core present in the isolator provides rigidity under loads and energy dissipation under high lateral loads occur during the earthquake. The entire bearing is encased in cover rubber to provide environmental protection. The high damping rubber bearing is another type of elastomeric bearings where the elastomer used are either natural or synthetic rubber which provides a significant amount of damping during lateral loading. This type of isolator has thin layers of high damping rubber and steel plates in alternative layers. Seismic vibrations is converted to low speed motion when HDR bearings are used in the structures.

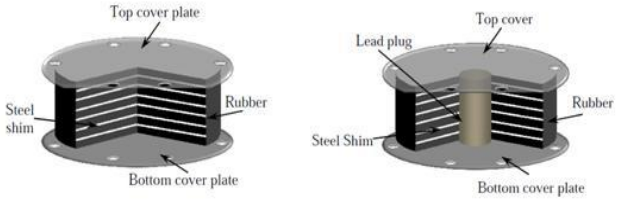

Fig 2 Laminated and lead rubber bearings

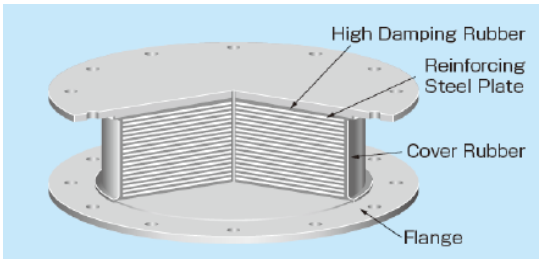

Fig 3 HRD Bearings

Friction pendulum (FP) isolators is special type of sliding isolator, which has the same principle of simple pendulum. This isolator is featured as substantial under severe environmental conditions and insensitivity to the frequency content of the ground motion during earthquake.

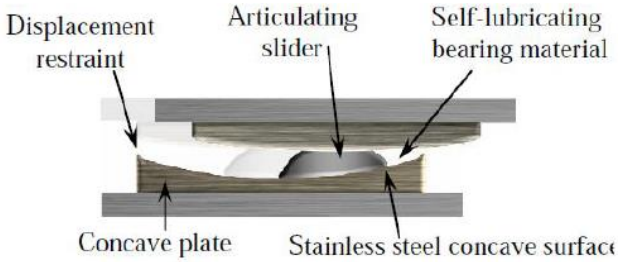

Fig 4 Friction pendulum isolators

V DAMPERS

Damping is the method that allows a structure to achieve optimal performance when the structure undergo seismic or other types of shock and vibration disturbances. During strong ground motions conventional structures deform well beyond their elastic limits, and eventually fail. The concept of supplemental dampers added to a structure assumes that the energy input to the structure from a transient will be absorbed both structure and supplemental damping elements. An idealized damper is in the form such that the force produced by the damper is such a magnitude and it function that the damper forces do not increase the overall stress in building. Properly implemented damper should be able to reduce both stress and deflection in the structure. Damping devices are suitable for tall buildings which cannot be effectively base isolated.

A. Types of dampers

Dampers are classified based on their performance as friction dampers, viscous dampers ,metallic dampers, viscoelastic dampers and mass dampers.In friction dampers seismic energy is spent in overcoming friction in the contact surfaces. Performance of this damper not depends on loading velocity and ambient temperature.

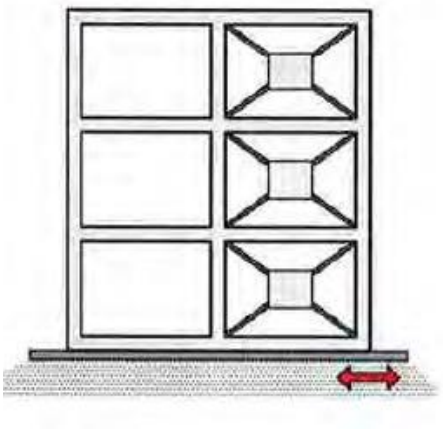

Fig 5 Friction dampers

In viscous damper, by using viscous fluid inside a cylinder, energy is dissipated. Due to the ease of installation, adaptability and coordination with other members in the structure also diversity in their sizes, viscous dampers have many applications both in designing and retrofitting .Damper is installed in the foundation or installed in diagonal braces. Visco elastic damper is a type of damper which stretch an elastomer in combination with metal parts .Energy is absorbed by the visco elastic damper by utilizing the controlled shearing of solids. In mass damper, mass is placed on a fulcrum which acts like roller and it allows mass to with move as a transfer-lateral movement to the floor. Springs and dampers are placed between mass and anchor members to the floor and the frame. These bidirectional transfer dampers are made as a spring-damper and they provide controlling the structure movement in two vertical structures.

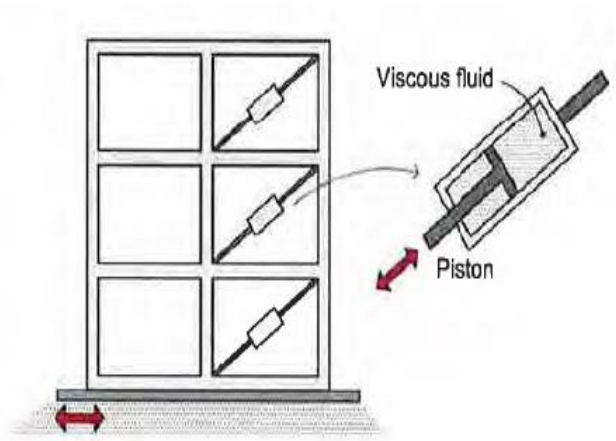

Fig 6 Viscous dampers

Fig 7 Provision of damper in building

VI PUSHOVER ANALYSIS

Pushover analysis method is a nonlinear static analysis method. The pushover analysis is a method used to observe the successive damage states of a building. This method is relatively simple to be implemented and provides information on strength, ductility and deformation of the structure and distribution of demands which help in identifying the critical members which reach limit states during the earthquake. This method also assumes a set of incremental lateral load over the height of the structure. Using this analysis local nonlinear effects are modelled and the structure is pushed until a collapse mechanism is developed. Two ways to do pushover analysis are forced controlled and displacement controlled. In forced controlled pushover analysis involves applying lateral or horizontal loads in triangular or uniform pattern to the structure i.e. pushing the structure in horizontal direction. The displacement controlled pushover analysis depends on target displacement of structure. Lateral loads are applied in the form of acceleration or displacement to the structure to reach the target displacement.

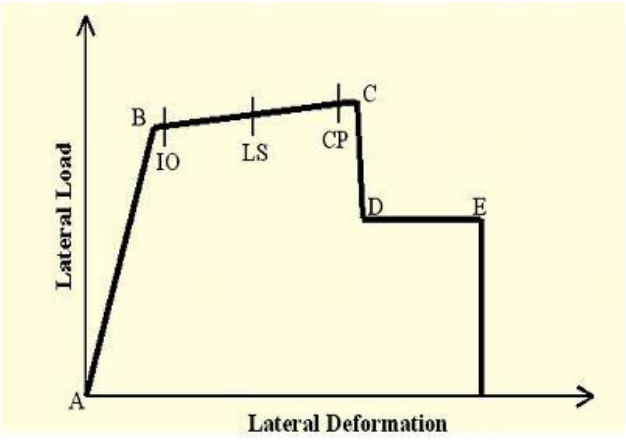

Fig 8 Lateral load versus deformation

.

VII RESPONSE SPECTRUM METHOD

Response spectrum method is done using design spectrum for different site conditions. The maximum response is plotted in a graph against the un damped natural period and damping values. The results of response spectrum analysis is in form of storey acceleration, velocity and displacement. It is also a nonlinear static analysis method.

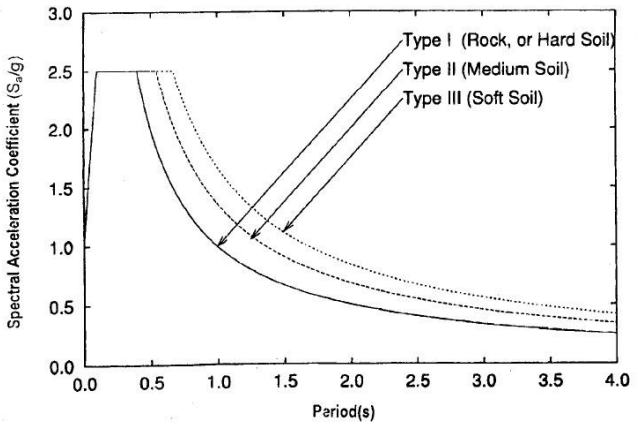

Fig 9 Response spectrum for different site conditions

VIII CONCLUSIONS

From the study it is concluded that

- Structure with isolators and damping devices perform good during seismic loading.
- In base isolated structure storey drift and storey displacement are reduced at greater extent.
- Performance point of both base isolated structure and structure with is increased as compared to fixed base structure.
- In structure with viscous damper, storey drift, storey acceleration and storey displacement are reduced.
- Viscous damper have better control effect on displacement.
- Overall there is significant reduction in values of storey displacement, storey drift, storey acceleration. Study shows that the fundamental period is approximately doubled in the isolated structure.

ACKNOWLEDGEMENT

I convey my sincere thanks to Er. Shwetha Saju, Er. Reshma Theresa (HOD of Civil Department) and my parents for their sincere support and constant guidance. At last but not least, I thank almighty for his constant blessings, showered on me.

REFERENCES

[1] Mohammed Asim Khan, Prof. Shaik Abdulla " Nonlinear Static Analysis Of 3-D RC Framed Asymmetric Building With Lead Rubber Isolator Using Sap2000v15" ISSN : 2248-9622, Vol. 4, Issue 9(Version 4), September 2014, pp.87-91

[2] Dhananjay A. Chikhalekar1, M. M. Murudi "Seismic performance of structure with fixed base, base isolated structure and structure with viscous damper" IJRET: eISSN: 2319-116 pISSN: 2321-7308 Volume: 04 Issue: 09 ,September-2015

[3] Swathirani.K.S, Muralidhara.G.B,Santoshkumar.N.B "Eatrhquake response of reinforced cocrete multi storey building with base isolation" IJRET eISSN: 2319-1163 pISSN: 2321-7308

[4] Suhail V.M, Syed Ahamed Raza "seismic analysis of RC buildings provided with HDRB isolators of various rubber thickness" ISSN : 2348 – 7550 Volume No.03, Issue No. 06, June 2015

[5] AlirezaHeysami "Types of Dampers and their Seismic Performance During an Earthquake" http://dx.doi.org/10.12944 CWE. 10. Special-Issue1.119, Vol. 10 , 2015

[6] Julie S, Sajeeb R " Performance of Base Isolators and Tuned Mass Dampers in Vibration Control of a Multistoried Building" IOSR, ISSN: 2278-1684 Volume 2, Issue 6 , Sep-Oct 2012 , PP 01-07