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The State of the Art on Seismic Isolation of Shear Wall Structure using Elastomeric Isolators

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Abstract - *Base isolation refers to the principle which introduces flexibility to the supports of the building in the horizontal plane and ensures the period of the buildings lie outside that of the earthquakes acting on it. In this paper, the suitability of type of elastomeric base isolators and their effectiveness to reduce interstorey drifts and accelerations of the buildings is studied. The effect of shear walls on base isolated buildings is also studied. A brief idea about base isolation and its different types is needed beforehand. This is a review paper prepared as a part of the thesis work.*

Key Words: **Base isolator, Shear wall, High Damping Bearing, Lead Plug Bearing**

1. INTRODUCTION

Seismic Isolation means basically isolating the structure with respect to the seismic waves produced by the earthquake. It aims to mitigate the seismic demand on a structure by shifting the natural period of vibration of the isolated structure beyond the high-energy period range of earthquake ground motions. It therefore serves as an additional means of energy dissipation. The concept of seismic isolation is more efficient and is adopted extensively rather than increasing the earthquake resisting capacity of a building.

Shear walls are structural walls that are specially designed for resisting lateral loads. Shear walls can be composed of different materials and concrete shear walls are most commonly used in high rise structures. The use of reinforced shear wall has become more efficient as it ensures lateral stability of the tall structures and reduces lateral sway. Seismic performances of shear walls are guaranteed under small earthquakes. In order to withstand large earthquakes, shear walls with seismic isolators are provided.

The isolator device needs to be flexible in the lateral direction while being able to carry a large vertical load. The near incompressibility and low elastic modulus inherent in elastomers have made elastomeric isolators the most common type of seismic isolator in use.

2. THEORY OF SEISMIC ISOLATION

There are mainly 2 types of base isolation systems; sliding systems and elastomeric bearing systems. Sliding systems work by limiting the transfer of shear across the isolation interface. Many sliding systems have been proposed and some have been used. One commonly used sliding system is spherical sliding bearing. In this system, the building is supported by bearing pads that have low friction and a curved surface. During an earth-quake the building is free to slide on the bearings. Since the bearings have a curved surface, the building slides both horizontally and vertically.

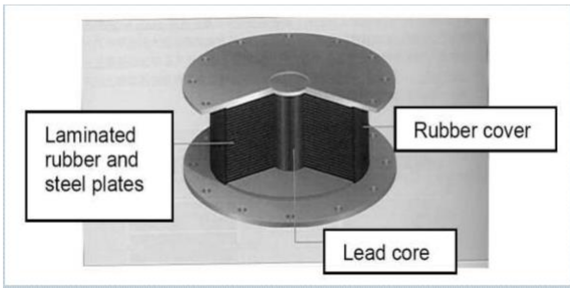

Fig 1: Elastomeric Isolator

By using Elastomeric bearing systems, the building or structure is decoupled from horizontal components of earthquake ground motion by substituting a layer with low horizontal stiffness between the structure and the foundation. Conventionally, steel plates are used as reinforcing material. Its function is to provide vertical stiffness to the isolator to take the weight of the structure. Bearings using steel as reinforcing material are known as steel reinforced elastomeric bearings(SREI). Thin sheets of steel are interspersed in between layers of rubber.

Shear walls are structural walls that are specially designed for resisting lateral loads. They are basically vertical elements of horizontal force resisting system. Concrete shear walls are commonly used in high rise structures. The use of reinforced shear wall has become more efficient as it ensures lateral stability of the tall structures and reduces lateral sway.

3. LITERATURE REVIEW

The literatures that were reviewed on the various base isolation techniques is presented in this chapter. A number of works have been performed on base isolation using different types of isolators and their combined action. A review of literatures is presented in brief summarizing the work done by different scholars and researchers on the seismic response of multistorey structures using these techniques.

Gomase O.P, Bakre S.V (2011) studied the effect of base isolation on a four storied reinforced concrete building using El Centro, Kobe and Northridge earthquakes. High damping rubber bearings are designed according to UBC-97 for near fault earthquake. The force deformation behaviour of isolator is modelled as a Bi-linear hysteretic type. The analysis results and results from the design calculation was found to be same. The Floor accelerations and Storey drifts were reduced for base isolated building when compared to fixed type building.

Dia Eddin Nassani, Mustafa Wassef Abdulmajeed (2015) studied the effects of base isolation systems using high damping rubber isolation system installed at the foundation level of regular and irregular buildings. The time history analysis is performed on three earthquakes, El Centro, Loma and Coyote using finite element software SAP2000. A five storey reinforced school building with fixed and base isolated conditions are modelled for studying the variation of seismic responses. Based on the results it is found that base isolation system reduces the base shear and storey drifts with respect to fixed base structures. However, the displacement values were increased for the base isolated buildings.

Zaheer and Ravichandra.R (2015) did a comparative study on performance of Multi-Storey Structure using Lead Rubber Bearing and Friction Pendulum Base Isolation Systems on an irregular RC building of G+10 storeys and analysed with and without base isolators using SAP 2000 software. Both Equivalent Static Analysis and Time History Analysis were carried out using El-Centro earth-quake. Storey displacements and drifts at earth-quake zone V using 15% damping in both isolators and found that Lead Rubber Bearings has lesser displacements and variations with respect to Friction Pendulum System. The base shear was found same of the vertically irregular L shaped building with both isolators.

Darshale S.D and Shelke N.L (2016) studied the seismic behaviour of a G+14 regular RCC building by time history analysis and response spectrum analysis using Lead Rubber Bearings. Here mass irregularity, stiffness irregularity and vertical geometric irregularity were studied. For El centro earthquake excitation was taken for time history analysis. The parameters like shear force, maxi-mum bending moment, base shear, storey acceleration and storey drifts were reduced for base isolated building. Hence base isolation effectively reduces the seismic responses. The fundamental time period increases for base isolation as the stiffness of the buildings reduces using base isolation.

Donato Cancellara et al (2016) adopted a combination of two different types of passive base isolation systems along with a friction slider. Two base isolation systems which are considered are High Damping Rubber Bearing (HDRB) is used along a Friction Slider (FS) and the Lead Rubber Bearing (LRB) with a Friction Slider (FS). The fast nonlinear dynamic analysis algorithm (FNA) is used for the numerical solution of the dynamic response of the structure. A comparative analysis is done to find the effectiveness of the considered base isolation systems when the RC building is subjected to bi-directional ground motions. The time history analysis of the base shear, the peak values of the base shear, the base acceleration, the base displacements of the superstructure and Storey drift is done so that a complete assessment can be performed of the seismic behaviour of the base isolated structure. The results show that the LRB isolators show a greater dissipative capacity com-pared to HDRB isolators but this needs to be con-trolled as it creates higher Storey drifts. The studies also show that LRB isolators are more robust and stable in their hysteretic cycles when com-pared to the hysteretic cycles of the HDRB isolators.

Nitya M and Arathi S (2016) performed non-linear time history of a base isolated building of G+6 storey using El Centro Earthquake. Analysis was done by finite element software SAP2000. An irregular RC building of plus shape located in the seismic zone V was selected. Here Rubber bearings and friction pendulum bearings were used as the isolation systems. The base shear, time period and storey displacement were compared for each model. It was found that time period was in-creased for base isolated buildings, reducing the induced forces due to earthquakes. The displacement variation between stories were reduced using base isolation technique.

Venkatesh, Arunkumar H.R (2016) compared the seismic responses of fixed and isolated buildings using response spectrum analysis. An Eleven storey RC building frame was isolated using Lead Rubber Bearing. The design of isolators was carried out according to UBC 1997. The parameters like storey shear, base shear, storey drift were reduced for base isolated buildings. The time periods were increased for isolated models.

Agim Seranaj et al (2015) analysed the effect of isolation location a ten storey reinforce concrete Box structure is considered. The structure is analysed in three different conditions: the first model is fixed base, the second model with isolators on the base and third model with isolators on the middle story. Elastomeric rubber bearing isolators are used. The analysis shows the influence of isolators location on the dynamic properties of building structure and its influence on the dis-placement and internal forces of structural elements. Based on the analysis results, it has been concluded that the location of isolators can be selected in every story of the building based on the interested parameters to be modified.

Anusha R Reddy and V Ramesh (2015) carried out detailed seismic analysis on RC framed base isolated building. Two buildings are considered first structure is G+13 storey building and second is G+5 storey building which is analysed in E TABS 13.2.1 software. Lead rubber isolator are provided to both the structures and then time history analysis and linear response spectrum are carried out for both fixed base and base isolated buildings under zone v and soil type II i.e.

medium soil (according to IS 1893(part 1):2002). The mode period, acceleration, base shear, and dis-placement are compared for response spectrum and time history analysis for fixed base and base isolated buildings. It is found that the mode period is increased after providing rubber isolator due to the flexible property of the isolator. When com-pared with fixed base structure, the base shear is reduced in base isolated structures, thus the response of building is good in base isolated structures than fixed base structures.

P. P. Chandurkar et al (2013) performed a study to determine the solution for shear wall location in multi-storey building. Effectiveness of shear wall has been studied with the help of four different models. Model one is bare frame structural system and other three models are dual type structural system. Seismic loads are applied to a building of ten stories located in zone II, zone III, zone IV and zone V. Based on the analysis results, it was observed that changing the position of shear wall will affect the attraction of forces, so that walls must be in proper position. Also providing shear walls at adequate locations substantially reduces the displacements due to earthquake.

Many other literatures are referred and reviewed and an idea of the state of the art is obtained.

8. CONCLUSION

The concept of base isolation is not a recent topic and recent developments in full-scale shake table testing and advancement in accurate software oriented analysis has made this technique more acceptable. This technique ensures a simultaneous reduction acceleration and drift responses of the building even under a large and unpredictable seismic event. However, there are still gaps in the research to be filled like seismic isolation cannot ensure a complete protection of buildings, challenges are still there like how to protect components of buildings subjected to vertical excitation, mitigation of overturning forces in slender structures which causes local uplifts and superstructure yielding in extreme events. This paper attempts to summarize the effectiveness of base isolators and also determines the efficiency of shear walls used in a building.

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