A Review on "SEISMIC RESPONSE OF BUILDING WITH BASE ISOLATION"

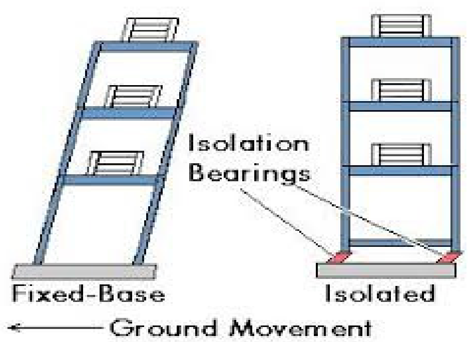
Mrs. Gitadevi B. Bhaskar[1], Mr. Mukesh L. Khanchandani[2]
[1]*Assistant Professor,* [2]*M-Tech Student (SE),*
[1,2]*Department of Civil Engineering,*
[1,2]*GHRAET, Nagpur, Maharashtra, India.*

Abstract: *Designing structures which are liable to seismic and heavy wind actions needs considerable attention towards dissipation of unwanted energy and minimization of severe responses of the structure. Many structures in seismic prone areas are equipped with energy dissipation devices i.e. active and passive control devices. Present study mainly emphasize on the use of lead rubber bearing isolator so as to protect the structure against damaging effect of earthquake, moreover they do not have any undesirable effect on the dynamic property of structure. Base isolator increases the fundamental time period of the structure i.e. making it more elastic so that energy from base excitation is well absorbed. From this paper we get a review on the comparative analysis of fixed base and isolated base structure. This paper presents non-linear time history analysis of fixed base and base isolated structure and evaluation of various damaging measures due to base excitation is done.*

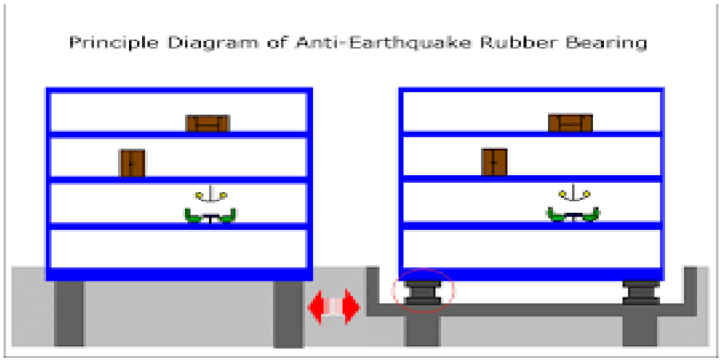
Keywords: passive energy dissipation devices, Lead rubber bearing isolator, non-linear time history analysis, damaging measure

I. INTRODUCTION

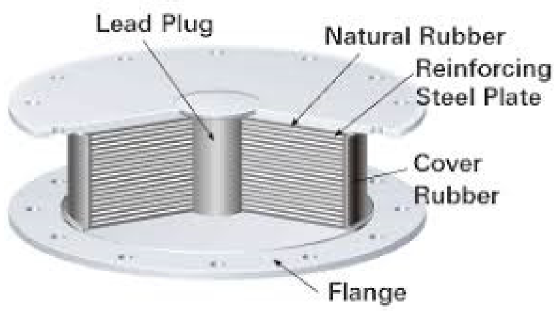
For seismic design of building structures, the traditional method, i.e., strengthening the stiffness, strength, and ductility of the structures, has been in common use for a long time. Therefore, the dimensions of structural members and the consumption of material are expected to be increased, which leads to higher cost of the buildings as well as larger seismic responses due to larger stiffness of the structures. Thus, the efficiency of the traditional method is constrained.



To overcome these disadvantages associated with the traditional method, many vibration-control measures, called structural control, have been studied and remarkable advances in this respect have been made over recent years. Structural Control is a diverse field of study. Structural Control is the one of the areas of current research aims to reduce structural vibrations during loading such as earthquakes and strong winds.



Seismic base isolation of structures such as multi-storey buildings, nuclear reactors, bridges and liquid storage tanks are designed to preserve structural integrity and to prevent injury to the occupants and damage to the contents by reducing the earthquake induced forces and deformations in the super-structure.



This is a type of passive vibration control. The performance of these systems depends on two main characteristics:

1. The capacity of shifting the system fundamental frequency to a lower value, which is well remote from the frequency band of most common earthquake ground motions.
2. The energy dissipation of the isolator.

II. LITERATURE REVIEW

"Base Isolation for Industrial Structures; Design and Construction Essentials" [1]
Todd W. Erickson, and Arash Altoontash
Reviewed the design and construction process of industrial base isolated buildings with focus on code requirements, design and analytical methodologies, and constructability challenges. Due to velocity/displacement dependent behavior of base isolation systems, the building code (IBC/ASCE-7) requires performing a Non-Linear Time History (NLTH) analysis to determine the seismic loading on the base isolated structure. However, due to the complexity of NLTH and because the superstructure must be essentially elastic, the code also permits performing a staged analysis. The staged analysis consists of: 1) Performing a linear (modal) analysis of the superstructure to determine the lumped-mass dynamic characteristics of the building, 2) Performing a NLTH analysis of the isolation system and superstructure to determine system forces, displacements, and base shears, 3) Performing superstructure design using a linear (modal) analysis with scaled base shear forces, and 4) Designing the base isolator footings and support framing to resist the system design displacements and resulting forces.

“Dynamic Responses of the Base-Fixed and Isolated Building Frames Under Far- and Near-Fault Earthquakes” [2]

H. R. Tavakoli, F. Naghaviand A. R. Goltabar

Dynamic responses of the multi-storey base-isolated and base-fixed buildings are investigated under near- and far-fault ground motions. Lead–rubber isolation bearing (LRB) is used in the examination. First, the mechanical properties for LRB isolation system are calculated. The seismic analysis of the buildings is executed by nonlinear time history analysis method for reinforced concrete two-dimensional building frames. For the purpose of analysis, three records of far-field and three records of near-fault ground motions from the same components are selected in different stations and conducted on building frames. The results of the analysis for isolated-base and fixed base frames are compared with each other under far- and near-fault ground motions. Story drift, acceleration of theeach story, base shear and base displacement are examinedas results of the analysis.

“Assessment of a rolling isolation system using reduced order structural models” [3]

P. Scott Harvey and Henri P. Gavin

Examined the performances of lightly- and heavily-damped rolling isolation systems (RISs) located within earthquake-excited structures. Six steel structures of varying height and stiffness are selected so as to represent a range of potential RIS installations. Computation models of representative frames from each of the six structures are reduced through dynamic ondensation and assembled with models for biaxial isotropic hysteretic behavior within each floor. A novel reduced order modelling approach is presented in this paper. The method combines a dynamic ondensation of a linear-elastic frame with the inelastic-push over curve for a detailed elastic–plastic frame model and a novelbi-axial hysteretic model for the net inter-story inelastic behavior.

“Dynamic Response of a Pendulum Isolator System under Vertical and Horizontal Earthquake Excitation” [4]

Alireza Jamalzadeh and Majid Barghian

Studied a pendulum isolator. This isolator has aspherical surface which is placed on the foundation and it hasan arm which is connected to the column of the building as ahinge. When the height of the arm is less than the curvature radiusof the spherical surface, and a small movement is appliedon it, a restoring force will be applied to the isolator. In thispaper the effect of horizontal and vertical component of seismic load was studied. The dynamic equation of motion was obtained for the pendulum isolator under horizontal and vertical accelerations of seismic loads. The equation was solved by steptime integration method. The comparison of the results of horizontalcomponent effect and the combined effect of horizontal and vertical components on the isolator showed that the vertical component effect increased the isolator horizontal displacement response and increased the isolator horizontal acceleration.

“Dynamic Response Changes of Seismic Isolated Building Due to Material Degradation of HDRB” [5]

Muna H. Gheryani,Hashim Abdul Razak and Mohammed Jameel

Investigated the variations in the mechanical properties of high-damping rubber bearings (HDRB) on the dynamic response of multi-story seismic base isolated building subjected to bidirectional near-fault ground motions. Variations in the mechanical properties of HDRB due to temperature, aging and scragging recovery are considered. Nonlinear response analyses of a six-story base-isolated building subjected to seven pairs of bidirectional near-fault ground motions with pulse type were conducted using finite element software. The nonlinear force–deformation behaviour of isolator is modelled using a bilinear hysteretic curve considering non-deteriorating and deteriorating properties.

"Nonlinear dynamic analysis for multi-storey RC structures with hybrid base isolation systems in presence of bi-directional ground motions" [6]

Donato Cancellara and Fabio De Angelis

Worked on three different hybrid base isolation systems are analyzed in order to protect reinforced concrete structures with regards to bidirectional ground motions. The three considered hybrid base isolation systems are the Elastomeric Spring Dampers operated in parallel with Friction Sliders, the Lead Rubber Bearings operated in parallel with Friction Sliders and the High Damping Rubber Bearings also operated in parallel with Friction Sliders. The analyzed base isolation systems have been designed in compliance to the European seismiccodes EC2 and EC8. The base isolation devices are realized by elastomeric materials and steel-teflon bearings. The highly nonlinear behavior of the composite sliding isolation systems is investigated.

"A base isolation system for structures subject to extreme seismic events characterized by anomalous values of intensity and frequency content" [7]

D. Cancellara, F. De Angelis

The purpose of the analysis is to highlight the features offered by the proposed hybrid seismic isolator (HDHSI) base isolation system compared to the traditional LRB base isolation system in the seismic protection of structures. Nonlinear dynamic analyses are performed for base isolated multi-storey RC structures. In the analysis the inputs of different seismic events are adopted which can be considered as extreme events in termsof peak ground acceleration and in terms of frequency content. The seismic records are related to seismicevents obtained by suitably amplifying the El Centro earthquake. They are characterized by their high values of the peak ground acceleration. Another seismic event considered in the analysis is the Erzincan earthquake which is characterized by high energetic content at low frequencies. Accordingly, the seismic events adopted in the analysis are characterized by anomalous values of intensity and frequency content. A nonlinear dynamic analysis is illustrated for a multi-storey RC building base isolated by the proposed HDHSI system compared with the traditional LRB base isolation system.

"Assessment and dynamic nonlinear analysis of different base isolation systems for a multi-storey RC building irregular in plan" [8]

Donato Cancellara and Fabio De Angelis

Two base isolation systems are analyzed and their seismic behavior is compared with reference to a multi-storey reinforced concrete building. The base isolation systems have been designedin compliance to the European seismic codes EC2 and EC8. A base isolated building is adopted which ischaracterized by strong irregularity in plan. A comparative analysis is presented for evaluating the behavior of the structure subject to seismic events. Two base isolation systems have been consideredin the analysis, the High Damping Rubber Bearing (HDRB) actuated in parallel with a Friction Slider (FS) and the Lead Rubber Bearing (LRB) also actuated in parallel with a Friction Slider (FS). A dynamicnonlinear analysis is performed for the three-dimensional base isolated structure. Recorded accelerograms for bi-directional ground motions compatible with the reference elastic response spectrum have been used for the evaluation of the seismic response of the structure. The seismic assessment and the dynamic nonlinear analysis of the base isolated structure are illustrated by presenting a comparative analysis of the behavior of the structure isolated by the two considered base isolation systems and the corresponding behavior of the traditional fixed base structure.

III. CONCLUSION

Following important conclusions are made after studying literature review.

1. Intrusion of base isolator shifts the fundamental frequency of the structure to a lower value which in turns makes the structure elastic.
2. Remarkable reduction in the damaging measure such as top storey displacement, storey drift etc.
3. Bearing displacement of the isolator increases which may damage the isolator's component.
4. Considerable amount of earthquake energy can be dissipated.
5. Base isolated building performs better as compare to fixed base building

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