

Behaviour of Building Under Earthquake With or Without Base Isolation: A Review

Chetak Shinde¹, Dr. R. K. Jain², Prof. Mrudula Patil³

¹Dept of Civil Engineering

²Principal, Dept.of Civil Engineering

³Associate professor, Dept.of Civil Engineering

^{1,2,3} Rajarshi Shahu College of engineering, Maharashtra, India.

Abstract- Seismic isolation systems are usually used to protect reinforced concrete (RC) constructions against the effects of solid ground motions. The building provides a respectable chance to study and evaluate the role of isolation systems to seismic performance of RC structures. In the present research project, to equivalence the efficiency of base Isolation in plan irregular and vertical multi-storied RC frame structure. For this study, no of Storied RC frame structure is considered and time history analysis is carried out by ETABS Software. The isolated structure was subjected to four earthquake records with cumulative strength. The concerts of the isolated structure were compared with those of the fixed-base structures in relations of lateral inter-storey drifts, peak absolute floor accelerations, and residual drifts. The laminated rubber bearings, the high damping isolation devices, collected of rubber bearings and viscous dampers, and the hybrid isolation system of rubber bearings and friction pendulum bearings were analysed. The efficiency of the three base isolation systems measured in enhancing structural performance was inspected. The results show the level of upgrading attained in seismic response by individually system. They also explain that the rubber bearings coupled with friction pendulum bearings produce best drift regulator without producing excessive horizontal displacements at the base level and without unpleasantly affecting floor accelerations.

I. INTRODUCTION

Base isolation concept was invented by engineers and scientists as early as in the year 1923 and accordingly different method of isolating the buildings and structures from earthquake forces have been urbanized world over. State like US, New Zealand, Japan, China and European countries have accepted these systems as their standard routine for many public structures and residential structure as well. Hundreds of structures are being constructed each year with base isolation technique in these states. This paper defines the progress of base isolation technique and other techniques developed around the world. As of now, in India, the practice of base isolation techniques in public or residential structures and

structures is in its start and except limited buildings like hospital structure at Bhuj, investigational structure at IIT, Guwahati, the general structures are built without base division techniques. National level rules and codes are not accessible presently for the reference of engineers and builders. Engineers and scientists have to quicken the pace of their research effort in the direction of developing and constructing base isolated constructions and come out with results which are simple in project, simple to build and rate effective as well. Many important compensations can be drawn from structure provided with seismic isolation. The reply of an isolated structure can be $\frac{1}{2}$ to $\frac{1}{8}$ of the outdated structure. Since the super structure will be subjected to smaller earthquake forces, the cost of out-of-the-way structure related with the cost of outdated structure for the same earthquake conditions will be low-priced. The seismic isolation can be provided to new as well as current structures. The structures with facility of isolators can be planned as regular or irregular in their plan or elevations.

II. LITERATURE REVIEW

- 1) H Wang and G Song, "Lmi Based Fault Detection and Isolation on Base Isolation System Model", *Earth and Space*, 2010

Fault detection and isolation (FDI) in engineering systems can provide early notices of faulty sensors and actuators in order to prevent events that lead to catastrophic failures. The key objective of this paper describes the use of FDI and fuzzy fault tolerant control techniques on base separation systems. Thus, this paper offerings a Linear Matrix Inequality (LMI) based filter design theorem and approach of fixed- order FDI. The needed and sufficient conditions for the existence of a solution to detecting and isolating faults using H formulation is provided in the planned filter design. Furthermore, a Fuzzy Fault Tolerant Controller (FFTC) for base isolation structure model constructed on the FDI filter is designed to preserve the pre-specified performance of the system in the occurrence of faults. Simulation and experimental results demonstrate that the designed filter can

successfully sense and isolate faults including displacement sensor and accelerometer, while maintaining excellent performance of base isolation technology in defective conditions.

- 2) **Mehmet Komur, Turan Karabork & Ibrahim Deneme, “Nonlinear Dynamic Analysis of Isolated And Fixed-Base reinforced Concrete Structures”, Gazi University Journal of Science, Vol.24, Pp. No. 463-475, 2011**

Earthquakes are a main threat to human lives and to the integrity of the infrastructures in seismic regions. Structures are the nastiest hit with the phenomenal damages due to ground motions consequential from earthquakes. Recent research and studies have led to new techniques to decrease the damages caused by earthquakes on structures and these methods are applied for innovative structural design. One of the techniques is the base isolation method, which is used to proposal structures against earthquake damages by using seismic isolators to change the dynamic characteristics of a structure. In this study, three bay 4- and 8-storey reinforced concrete structures are calculated as isolated and fixed-base. Lead-rubber bearing (LRB) is used as an isolation system. Nonlinear behavior of both isolation system and super-structure are considered in the modeling. The behaviors of calculated models under dynamic loads are analyzed using Ruaumoko computer software. Erzincan, Marmara and Duzce Earthquakes are chosen as the ground waves. At the end of analysis, period, storey accelerations, inter-storey deformations, base shear forces, plastic hinge locations and weighted damage histories are compared for isolated and fixed-base structures. As a result, the compensations of isolated reinforced concrete structures against fixed-base structures under earthquake are shown.

- 3) **ChauhanKalpesh M. &Dr. B. J. Shah, “Excel Spreadsheet for Design of Lead Rubber Bearing Uses For Seismic Isolation of Bridges”, International Journal of Advanced Engineering Research and Studies, Vol. 2, Pp. No. 60-62, 2013**

This paper offerings the design methodology of Lead Rubber Bearing used for seismic isolation of bridges. Bearing is one of the significant components of bridges. Instead of using traditional bearings like PTFE-POT bearing LRB is found to be effective in high seismic region and it is used in many reputable countries. However it is not started in our state because of its high cost. These devices are positioned in between super-structure and sub-structure. EXCEL spreadsheet is generally used in design office for various design related activities .EXCEL spreadsheet is arranged

considering design criteria prescribed by AASTHO ,so optimum size can be carried by doing different trials.

- 4) **V. Hadiana , A. A. Mutaliba , S. Baharoma “Seismic Behaviour Of Base Isolation System Using Lead Rubber Bearing” JurnalTeknologi (Sciences & Engineering) 65:2 (2013) 79–88 November 2013**

This research studied the objective of this study is to determine the best configuration of the LRB in the structure by calculating the response of the structure, roof level acceleration and interstory displacement based on the ground motion records. The study consists of determining the structure, calculating the weight of structure, modelling the LRB in the structure and obtaining the output from the dynamic analyses. The comparison of the inter-story displacement, drifts frames and top level acceleration response of the LRB system with the Fixed Base System (FBS) using spectrum and time history analysis shows that the base shear reduces by 65–75% in response spectrum analysis, while in time history analysis base shear reduces by 75–85%. The proposed method is based on the LRB system that reduces the response of the structure because of high damping and stiffness used in the Base Isolation System (BIS) and capable to be used for super structure located in the seismic line area. This system would help in reducing the cost in the long time and increase the safety of the structure.

- 5) **Nirav G. Patel “Study On A Base Isolation System” IJISSET - International Journal of Innovative Science, Engineering & Technology, Vol. 1 Issue 8, October 2014**

A author reviewed on, the ability of an adaptive seismic isolation system to protect structures subjected to a variety of earthquake ground motions. Seismic isolation enables reduction in earthquake forces by lengthening period of vibration of the structure. An base isolation system must satisfy four basic criteria of effectiveness, in particular, acceleration response, shear and overturning moments are reduced by a factor of four to eight for buildings mounted on isolators. A particular GAPEC type of isolation system adopted in New Bhuj Hospital that collapsed during Bhuj 2001 earthquake and completed with earthquake engineering New Zealand Technology is studied.

- 6) **S. K. Sabu, H. S. Chore & S. B. Patil, “Effectiveness of Lead Rubber Base Isolators, For Seismic Resistance of Buildings, Supported On Different Soil Stratas”, International Journal of Electrical, Electronics and Computer Systems, Vol. 2, 2014.**

Seismic Base-isolation of building is an innovative method used in recent years, for reducing seismic energy transmitted to structures, in extremely seismic prone areas,. The basic principle behind the base-isolation system is to introduce a flexible interface between the base of a building and the foundation. Laminated Rubber Bearings are the most widely used technology in seismic base isolation, because of their technical and economic effectiveness and reliability. Even though base isolation method is widely used for over 8000 structures internationally, this method is very hardly used in India in spite of the fact that India has so many highly seismically active zones. A case study comprising of the seismic analysis of a example building, in seismic zone V of India, with lead rubber bearings at the base is done in this paper. Linear static and nonlinear dynamic analysis is executed for both isolated and non-isolated buildings under code mandated bi-directional earth quake. A comparative seismic parametric study is also done with conventional design. Parametric comparison is done for the building with three categories of founding soil strata. The study reveals that for medium rise building construction, isolation can meaningfully reduce seismic response. The reduction in seismic responses is more in harder soil founding strata. In seismic vulnerable areas where the main concern is the justification of the seismic instability with the support of critical components, the study shows the efficiency of the base isolation system in terms of reduced structural responses under seismic loading.

- 7) **Vinodkumar Parma & G. S. Hiremath, “Effect Of Base Isolation In Multistoried RC Irregular Building Using Time History Analysis”, International Journal of Research in Engineering and Technology, Vol. 4, 2015**

Base isolation (BI) is a technique that has been used about the world to protect the building structures from the damaging effects of earthquake. The fitting of isolator in building at base level significantly increases the time period of the structure, which means it reduces the possibility of resonance of the structure giving rise to better seismic performance of the building. The study is performed to compare the efficiency of base isolation in plan irregular and vertical irregular multi-storied RC frame building. For this study, 15 storied R.C frame building is considered and Time History analysis is carried out using ETABS 2013 software. The Lead Rubber Bearing (LRB) is designed as per UBC 97 code and the similar was used for analysis of base isolation system. The outcomes obtained from the analysis were time period and base shear. Time period for the base isolated structures are higher than that of the fixed base structure. Due to the presence of isolator, Base shear is significantly reduced in each direction (X and Y direction) as compared to fixed

base structure. It has been found that when compared to plan irregular base isolated structure the vertical irregular building gives better presentation in high seismic prone area by using isolators at the base of the structure.

- 8) **K. SuganthaPriya, et.al. “A Study On Review Of Literature Of Asymmetrical Building With Bracings”, International Journal for Research in Applied Science & Engineering Technology, Vol. 3, 2015**

An developing demand for earthquake resistant structure provokes new trends in seismic analysis. In present days a new task of constructing asymmetrical building has higher thirst compared with symmetrical buildings. It has been proved for these buildings were able to sustain stiffness and flexibility. Bracings a vital conclusion enhances the resistances to lateral loads. This paper deals with a study on literatures assembling the need of steel braces over asymmetrical buildings. The author’s suggestions were discussed and possible ways to persuade the types of bracing over asymmetric structure were framed in this paper. It has been concluded from findings of literatures that initiating the practice of bracings on asymmetric building can effectively reduce the deflection due to lateral loads.

- 9) **M. Vijayakumar, Mr. S. Manive&Mr. A. Arokiaprakash, “A Study On Seismic Performance Of RCC Frame With Various Bracing Systems Using Base Isolation Technique”, International Journal of Applied Engineering Research, Vol. 11, Pp. No. 7030-7033, 2016**

Acceleration due to natural disaster is inevitable in tall structures. The taller of the building capture a higher rate of the acceleration than the ground floor due to gravity and resulting in structural harm. Various types of studies are in progress so as to put forward a successful model that withstands the natural calamity that effect the state of the building construction. Structural engineering plays a vital role in providing a key that safe guards the structure as such. Bracings are used to provide stability and resists lateral loads were the base isolation technology provides passive structural vibration control. X, V and Chevron bracings provided in different sides of structure and the effect of base shear in building columns is absorbed for steel bracing with and without using lead rubber bearing as base isolator. The strength impact on the structure with X, V and Chevron Bracings is measured for the simulated model for dissimilar cases using SAP2000 v18 software.

- 10) **H. Sugihardjo, Tavio& Y. Lesmana, “Behavior of A Base-Isolated Residential House in A Highly Seismic**

Region”, International Journal of Applied Engineering Research, Vol. 11, Pp. No. 8253-8258, 2016

A base isolation system is an actual engineering method for reducing seismic impacts by isolating an higher structure from soil vibration due to seismic wave. The primary concept of a base isolation system is the extension of the natural period of a structure. However, the production of isolators is very expensive, mainly when an isolator is employed as a residential house's base isolator. To alleviate the issue, a low-cost rubber base isolation system is planned. The proposed low-cost bearing system uses the perforated thin steel plates instead of solid thick ones. The study is the initial step of study on low-cost base isolation systems for residential houses in highly seismic regions. A nonlinear time history analysis (NLTHA) that is based on seven scaled-earthquake records is implemented in one-and two-storey isolated reinforced concrete (RC) residential houses by considering the effect of the isolation ratio. The results specify that the houses with isolation systems achieved well performance with regard to ductility demand and natural period due to seismic loads. The house with the higher isolation ratio achieved lesser ductility demand.

11) Asst Prof. Noor Mohammed, Mohammed Huzaifa Yaman & Shaik Mohammed Siddiq, “Non-Linear Pushover Analysis of RCC Building with Base Isolation system”, International Journal of Engineering Sciences & Research Technology, 2016

Structures are considered as per the code principles conference all specific requirements of code and assuming a linear elastic behaviour for the basic associates. Moreover, it is also required to know the behaviour of a building that were designed with older codes or which may not have been calculated for earthquake forces. During the seismic excitation the building responds well beyond its flexible and linear capacity and enters into non-linear stage. So, the existing work is future to provide a systematic procedure to assess the behaviour of a building during the seismic excitation. For studying the behaviour a non-linear static analysis process known as pushover analysis is used. The works pertaining to pushover analysis is reviewed. A Nine storey residential building situated in the Hyderabad city, which was planned and constructed for gravity loads alone, was considered for analysis. The current structure is studied using the evaluation procedures provided in ATC-40 and FEMA-273 documents. Under detailed evaluation a target displacement for Immediate Occupancy, Life Safety, Collapse Preclusion was given and the performance is checked in accordance with IS 1893:2002.

12) Naveena K & Neeraja Nair, “Review On Base Isolated Structures” International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 - 0056 Vol. 04 Issue: 06, June -2017

A author focused on, base isolation, is a design concept that presumes a structure can be significantly decoupled from potentially damaging earthquake ground motions. By decoupling the structure from ground shaking, isolation reduces response in the structure that would otherwise occur in a conventional, fixed-base building. The base-isolated buildings may be designed for reduced earthquake response to produce the same degree of seismic protection.

13) Vasu A. Shah, et.al. “Comparative Study of Base Isolation in Multistoried R.C Irregular Building”, International Journal of Advance Engineering and Research Development, Vol. 4, 2017

Now a day's designers and engineers are required to plan and design the constructions, which can withstand against the seismic masses. Therefore it became requirement to deliver passive control device “base isolation” to resist large horizontal and vertical load which principals the structure to collapse. Base isolation is single of the promising and widely known passive control devices to resist these forces by isolating the super construction from the sub structure, in this research paper the response of Base isolated building and fixed base building are evaluated for high rise building having irregularity in plan at Storey level. Response spectrum analysis and time history analysis carried out in terms of Storey Displacement, Base shear, Time period and Storey drift by ETABS software.

14) Mithranjali N. A. & Mathew C. George, “Study On Rc Building With Friction Pendulum Base Isolation System – A Review”, International Journal for Research in Applied Science & Engineering Technology, Vol. 5, 2017

Structures are very important after the natural dangers such as earthquake. Presenting base isolation techniques to progress the performance of structures. Resistance pendulum or Friction bearing is one of the greatest base isolation techniques. The key aim of these papers studies the seismic response of multi story structures with friction pendulum base isolation. FPS with different area and co-efficient of friction are included in individually papers. There different past documented earthquake are used for time history analysis and SAP 2000 software is used for modeling and analysis.

- 15) **Swapnil Ambasta, Dushyantsahu, G.P. Khare** “ANALYSIS OF THE BASE ISOLATED BUILDING (LEAD PLUG BEARING) IN ETABS” **International Research Journal of Engineering and Technology (IRJET) Volume: 05 Issue: 01, Jan-2018**

In this paper studied the Base isolator is a device which decouples a super structure from its substructure resting on a shaking ground thus protecting structural and non-structural components. This research deals with design, modeling and analysis of G+6 rigid jointed plane symmetrical RCC frames for two cases. First case is fixed base and second case is base isolated (LRB). Building displacement and acceleration are compared for that both cases. For analysis ETABS software is used and for designing of isolator and Design of seismic isolated structures.

- 16) **Dhiraj Narayan Sahoo, Dr. Prof. Pravat Kumar Parhi** “Base Isolation of Residential Building using Lead Rubber Bearing Technique” **International Journal of Engineering Research & Technology (IJERT) ISSN: 2278-0181 Vol. 7 Issue 05, May-2018**

In this paper, the base isolation of structures reduces the storey shear and acceleration and simultaneously increases the time period, storey displacement and storey drift that induces flexibility in rigid structure by dissipating the energy to the foundation. This base isolation study along with seismic analysis is done in equivalent static method using E-TABS software. Analysis of the structures are done using SMRF frame in Zone-II and response of structure like storey displacement, storey drift, storey stiffness, overturning moment, storey shear were observed, plotted in graphs. An overall comparison of G+10 and G+15 structures with isolator and without isolator were observed. Indian standard codes such as IS 456-2000, IS 1893-2002. Design of base isolator was done to find the stiffness and physical dimension of the core of LRB to be given at the base of structures.

- 17) **Pratik Patil, Ranjeet Chavan, Raturaj Thorat, Chandrakant Patil, Ashwini Yadav** “Behavior of RCC Structure with and without Base Isolation for Seismic Excitation” **International Research Journal of Engineering and Technology (IRJET) Vol. 7 Issue 2, Feb 2020**

This paper presents the base isolation is the concept in which the superstructure get separated from the substructure supports by introducing the base isolators in between them, to reduce seismic demand in other words for dissipating energy produced by the earthquake. The main objective of seismic

isolation system is to decouple the building structure from the damaging components due to the earthquake motion i.e. to prevent the superstructure of the building from absorbing the earthquake energy. By using base isolation techniques we can reduce the deflection, acceleration, storey drift of the structure.

- 18) **J. C. Ramallo, E. A. Johnson, A. M. ASCE and B. F. Spencer Jr., M.ASCE**, “Smart” **Base Isolation Systems”, Journal of Engineering Mechanics, Vol. 128, Pp. 1088-1099**

A smart base isolation strategy is proposed and shown to efficiently protect structures against exciting earthquakes without sacrificing performance during the more frequent, moderate seismic events. The planned smart base isolation system is composed of conventional low-damping elastomeric bearings and “smart” controllable semi dynamic dampers, such as magnet archaeological fluid dampers. To demonstrate the advantages of this approach, the smart isolation system is compared to lead-rubber bearing isolation systems. The efficiency of the isolation approaches are judged based on computed responses to several past earthquakes scaled to various magnitudes. The limited performance of passive systems is revealed and the potential advantages of smart dampers are demonstrated. Two- and six-degree-of-freedom models of a base-isolated building are used as a test bed in this study. Smart isolation is shown to achieve distinguished decreases in base drifts over similar passive systems with no associated increase in base shears or in accelerations imparted to the superstructure. In contrast to passive lead- rubber bearing systems, the adaptable nature of the smart damper isolation system provides decent protection to both the structure and its contents over a wide range of ground motions and magnitudes.

III. CONCLUSION

Base isolation systems are extensively used to progress seismic performance of reinforced concrete structures. It is created on the idea of decoupling superstructure from ground shaking, thereby limiting the transfer of seismic induced energy to the construction. Three different categories of base isolation systems were explored in the present research project, consisting of a rubber isolation system, high damping isolation plans that are composed of rubber isolators and viscous dampers, and a hybrid isolation system containing of rubber bearings and friction pendulum bearings. The efficiency of these isolation systems on seismic performance of reinforced concrete frame structures were measured considering a model with and without base isolation. Their performance of with base isolator is best than without base isolator building, it can be used for general

determinations or initial cost of construction increases extremely. Base isolation is a technique established to prevent or minimize harm to structures during an earthquake. But protection it should be providing at such as hospitals, police station, & public places etc. it should be provided. It is experiential that in case of without base building it is not possible to realize the Middle occupancy and Life Safety presentation level but it is possible in with base isolated structure.

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