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Effect of Base Isolation System on Seismic Response of A RC Building –a Numerical Study

Ashish R. Mhashakhetri
Mtech KITS, Ramtek

Asst. Prof. S. K. Mahajan
Mtech KITS, Ramtek

***Abstract*:- The basic problem in most of the design of building structure does not have the resistance capability of Seismic forces, it create an adverse effect on the building and leads to destroy at the time of earthquake, base isolation is the ultimate solution here found which distribute the forces by lengthening the fundamental period of structure it reduces acceleration and the seismic forces induced in the structure, the study has been done by comparative analysis without and with base isolation system.**

Keyword: Base Isolator, Seismic Energy

I. INTRODUCTION

A common perception on how to resist an earthquake force is by strengthening the structure. The traditional engineering design strategy based on increasing the design capacity and stiffness to accommodate foreseeable lateral forces may not be the most efficient solution. The problem with the latter is that all seismic forces from the foundation will be absorbed by the superstructure. The base isolation technique is exactly the opposite of traditional engineering design strategy.

Base isolation is a system that protects a building from the damaging effects of a seismic movement. If the structure separates from the ground during an earthquake, the ground is moving but the Structure is still dormant. However, this scenario is not realistic. The current technology that is active and expanding is the introduction of a low lateral stiffness support that isolates the structure from the ground movement. [1]

The objective of base isolation system is to decouple the structure from the ground. It lowers the effect of ground motion transmitted to the structure. Behavior of multi-storey buildings during earthquake motion depends on distribution of weight, stiffness and strength in both horizontal and vertical planes of building. Conventionally, seismic design of building structures is based on the concept of increasing the resistance capacity of structure against earthquakes by employing, for example, the use of shear walls, braced frames and moment resistant frames. However, these traditional methods often results in high floor accelerations or large inter-storey drifts for buildings. Because of this, the building contents and non-structural components may suffer significant damage during a major earthquake even if the structure itself remains basically intact. [2]

Seismic isolation enables the reduction in earthquake forces by lengthening the fundamental period of structure. Lengthening the fundamental period of the structure reduces acceleration and the seismic forces induced in the structure. However, it increases the displacement of the structure, but mostly concentrated in the base isolation system. In addition the added damping by the isolation system allows the seismic energy inputted to be absorbed by isolation system thereby reducing the energy transmitted to the structure.[3]

2. RELATED WORK:

Various literatures have collected and review based on analysis of structure with base isolation system. The literature review for some literature is given below

Su L. et al. (1989) [4] present a comparative study of effectiveness of various base isolators. These include the laminated rubber bearing with and without lead plug and several frictional base isolation systems. The structure is modeled as a rigid mass and the accelerograms of the NOOW component of the El Centro 1940 earthquake and the N90W component of the Mexico City 1985 earthquake are used. The performances of different base isolation devices under a variety of conditions are evaluated and compared. Combining the desirable features of various systems, a new design for a friction base isolator is also developed and its performance is studied. It is shown that, under design conditions, all base isolators can significantly reduce the acceleration transmitted to the superstructure

Lin B. C. et al.(1990)[5] described comparison of the performances of three different base-isolation systems, the laminated rubber bearing system, the New Zealand system, and the resilient friction base isolator system, is made under same Set of criteria. Conclusions pertaining to the ranges of the applicability of the systems for three earthquake sizes, M 6.0, 6.7, and 7.3, are obtained for a site located in the vicinity of the earthquake source (nominal source-to-site distance = 10 km). Two different seismological models of the earthquake source were used in modeling the spectral content of the earthquake input. The stochastic response of one story and five story base isolated structures is computed. The equivalent linearization technique is used to linearize the equations that govern those systems that are nonlinear. This study confirms the conclusions reached in previous studies by demonstrating again that friction plays an important role in energy absorption. This is the reason for the apparent superior performance of the resilient-friction base isolator system. However, more studies are needed to assess the feasibility of this system and to better understand its behavior by testing.

Ferritto J. M. (1991)[6] Described the applicability of base isolation to structures. The Navy is evaluating the potential use of base isolation for essential structures that must remain functional in a post-earthquake environment. The paper reviews preliminary building-selection criteria and structural design criteria. For low rise regular frame construction situated on a rock or stiff site and housing sensitive equipment, base isolation of the columns offer the potential for significant damage reduction. The paper presents a comparison of analysis techniques treating the isolator as a nonlinear hysteretic element and as linear elements with and without nodal damping. The results indicate that for the case studied, significant differences in displacement and drift result while moments vary by about 10%. Vertical acceleration effects were found to cause an increase in maximum moment by about 15%.

Shenton and Lin (1993)[7] compared the performance of code designed fixed-base and base-isolated concrete frames in a quantitative manner. Time-history analyses were conducted for three ensembles of recorded earthquakes. Analysis considered the nonlinear behavior of the isolation system and superstructure. Base-isolated concrete moment frame designed to between 25% and 50% of the code-recommended base shear performed comparably to the fixed-base design, when based on: (1) Extent of superstructure yielding; (2) average relative roof displacement; (3) average first-story drift; and (4) average time of first yielding in the superstructure.

Makris N. and Deoskar H. S. (2009)[8] recorded response of a base-isolated structure excited by the 1994 Northridge earthquake is utilized to validate existing computational methodologies. The isolated structure is located at 1955 1/2 Purdue Avenue in Los Angeles, California and is a three-story braced-steel-frame residential building supported on helical steel springs and viscoelastic-fluid dampers. The procedure developed during the construction of the building by one of the writers to model the isolation system using generalized derivative constitutive models is utilized to predict the response of the structure. Subsequently, it is shown that the peak values of the response can be satisfactorily predicted using an approximate procedure based on modal analysis. The importance of the isolation system is discussed.

Matsagar V.A. and Jangid R. S. (2012)[9] described analytical seismic responses of structures retrofitted using base isolation devices are investigated and the retrofit schemes are illustrated. Different types of isolation devices, such as elastomeric bearings and sliding systems are evaluated for their performance in the retrofitting works. The response of the retrofitted structural system is obtained numerically by solving the governing equations of motion under different earthquakes and compared with the corresponding conventional structure without any retrofit measures, in order to investigate the effectiveness of base isolation in retrofitting of structures.

Charmpis D.C. et al. (2014)[10] presented this work is concerned with the seismic retrofit of multi-storey buildings by installing isolation devices at various levels along their height. The design of an effective retrofit solution of this type requires the selection of the appropriate number of isolation levels to introduce in a building, the elevations at which to place these isolation levels and the properties of each of the isolators to install. The task of identifying configurations of isolators vertically distributed over the height of a building that yield favorable structural behavior is handled in the present paper with a specially developed optimization procedure.

3. RESEARCH WORK:

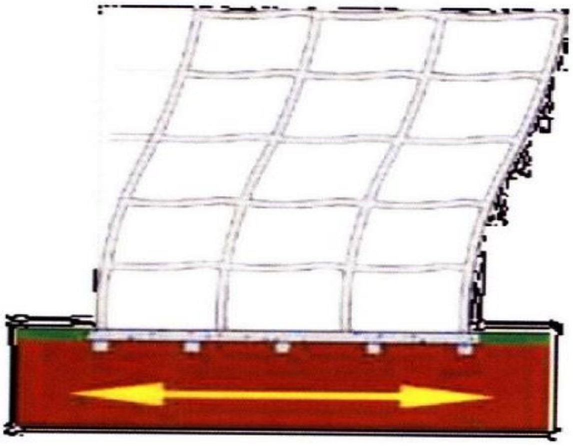

Fig.1.1 Displacement of fixed base structure

From survey it is observed that without base isolation the seismic forces transmitted through out the structure whose energy distribute on every parameter which leads to destroy the building as shown in fig.1

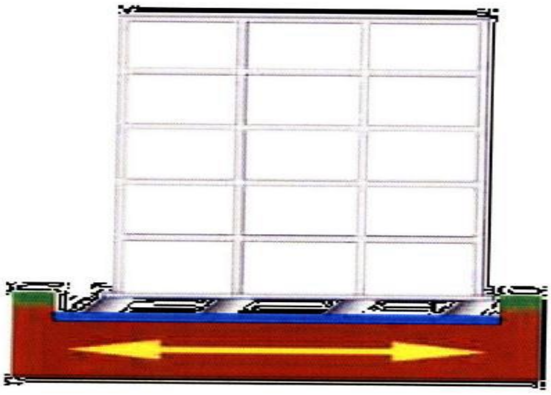

Fig.2.Displacement of base isolated structure

If the base isolator installed in building it absorb all the seismic forces and it dissipate through the structure the benefits of this to keep building as it is without any damage as shown in fig.2

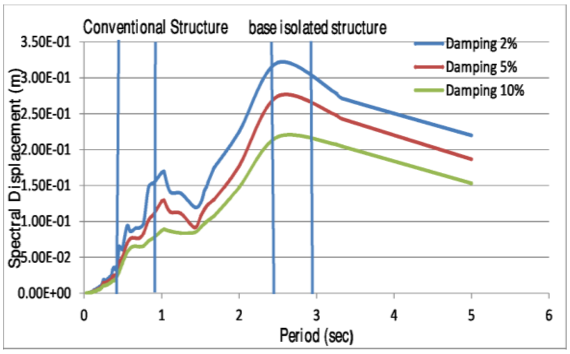

Fig.3.Spectral Displacement v/s Period

The earthquake induced ground shaking is generally represented in the form of acceleration response spectra or displacement response spectra. Fig.3. shows a response spectrum curve for Spectral Displacement respectively. The spectra are plotted for the three damping ratios i.e. 2%, 5% and 10%. For a time period of 0.5sec and damping of 2%, displacement is equal to 0.05m. Similarly for a time period of 1sec and same damping displacement increases to 0.16m. From these results it is clearly seen that for normal fixed base structures, displacement is low. But, for a time period of 2.5sec displacement is increasing to 0.32m, which shows that as time period increase displacement increases for structural flexibility. Due to base isolation the time period of building increases which increases displacement.

3. CONCLUSION ON LITERATURE REVIEW

Based on the literature review presented the concluding remark obtained as when we shifts the rubber isolators at above levels from plinth level more significant reduction in failure is possible. Therefore, it is possible to arrive at optimum location of the isolator so as to get the maximum benefit of base isolation. The task of identifying configurations of isolators vertically distributed over the height of a building that yield favorable structural behavior is possible with a specially developed optimization procedure, which can automatically and effectively explore the huge set of potential retrofit solutions formed by all possible combinations of isolator numbers, locations and properties.

Base isolators are the most effective method to reduce vibrations transmitted from ground to the structure. And also there is change in base shear, acceleration response, displacement response , storey drift. Time periods or natural frequency of building increases with decreasing or reducing of Inertia force due to earthquake.

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