A Review: On Base Isolation System

Monika Jain[1], S. S. Sanghai[2]
[1, 2] GH Raisoni College of Engineering, Nagpur

Abstract-*from the past few year base isolation has become one of the most popular tool for earthquake resistant design of structure. The concept of decoupling of building with the help of base isolation is being invented from a century. Many researchers has been worked on base isolation system that it is become acceptable as a whole in engineering field. However so many types of isolation systems are being invented but amongst them few has become accepted thoroughly. Now a days full scale testing is being performed on shake table to test the various characteristics of different isolators. Present review summarizes literature and theoretical aspect available on base isolation system. Some of the papers also deals with the effectiveness of different available isolator and their applicability. The main aim of the present paper is to focus on the background of isolators and also to provide useful guideline in making appropriate choices among the large number of available isolators.*

Keywords-Base isolator, theoretical.

I. INTRODUCTION

Base Isolation is one of the passive energy dissipation technique for earthquake resistant deign of structure. It is useful to control the energy which is passed from foundation or ground to the upper stories. To achieve this a flexible layer of isolator is fix up between the superstructure and substructure. This will shift the fundamental natural time period of structure and the frequency of vibration ultimately reduces. This will avoid the resonance condition between the ground acceleration and structural vibration. The main use of isolation system is to reduce the displacements, base reactions and member forces in structure. Different types of isolation systems and their uses has been discussed by Kelly [18-19] and Buckle and Mayes [21].Two main type of commonly used bearings are Rubber bearings and friction bearings. Both the rubber isolators and frictional isolators are divided into sub-types of isolators based on the material and the functions. Usability of isolator will be depend on its flexibility and the amount of energy it can dissipate. Hence the isolator should be a single unit that should effective to lengthen the natural time period of structure also should reduce the response of structure [22].The lead rubber bearing is one of the most effective bearing which gives horizontal flexibility and were invented in 1970s.The performance of structure during earthquake is depends on the type and characteristics of base isolation. It needs proper modeling to study the non-linear behavior of the isolator. The force-displacement relationship of a typical LRB is nonlinear. [23-25].

The simple friction isolator consist of large deformation of surface. Hence for better performance of friction sliding bearing it is good to introduce any recovering mechanism. For example the mid and the outer rubber cores in resilient-friction bearings (R-FBI) provide restoring mechanism.

The various studies has been performed on structural isolation system. To understand the difference between the responses of fixed base and isolated base structure, to determine the effectiveness of different isolator and to study the isolator properties in detail the brief review of some papers is given in this article.

II. LITERATURE REVIEW

The brief review of various base isolated buildings by different researchers is discussed below:

- **Lin Su et.al.[1],** performed analysis on a new combination of base isolator obtained after combining the properties of electricity de France (EDF) base isolator and resilient base isolator(R-FB1) device. Hence a new isolator has been formed named as sliding resilient base isolation system(SR-F). For this isolator response spectra, a curve is generated and compared with that which is obtained by EDF and R-FB1 isolator system. The results obtained were also compared with fixed base system. Base shear, spectral acceleration, spectral displacement has been found out for various conditions and various earthquake records. The various results obtained from this different earthquake records were then compared with SR-F new proposed isolator. The peak response of all earthquake for EDF and R-FB1 were recorded and results were compared with SR-F system. Hence maximum responses were reduced without large base displacement. The peak response of this isolator was also not that much severe in frequency and amplitude content.

- **A.N.Lin et.al.[2**], presented the seismic results of rigid base and base isolated concentrically brace and special moment resistant steel frames. Different codes were referred to design the base isolation and fixed base frames.

Fixed base frames are designed according to 1990 structural Engineering association of California (SEAOC) for recommended design base shear. while the base isolated building was designed for 100%, 50% and 25% of SEAOC recommended lateral forces.54 different ground motion record records used for study purpose. On-linear time history analysis has been performed for different results like roof displacement, collapsed frames etc. along with these yielded frames, yielded elements, total relative roof displacement was found out. The results so obtained for different condition showed that the 50% of SEAOC recommended lateral force gives compatibility superior performance then other combination. For peak obtained response comparative study was done for fixed and isolated moment resulting braced steel frame.

- **H.W. Shenton III [3]**, compared and analyzed relative results of fix based and base isolated structure. The concrete fix base structure was designed by referring structural agencies association of California (SEAOC). The base-isolated response was compared with fixed base response. The base shear was varying according to the SEAOC recommendation. Three different type of time history, post-earthquake record were selected to perform nonlinear dynamic analysis for fixed base and base isolated structure. Results were compared to 25% and 50% of the specified lateral force by SEAOC. The performance of building was checked for different lateral forces.

- **Todd W Erickson [4],** presented response of the industrial structure under seismic forces, building was designed according to IBC code. The results of superstructure under dynamic loading was found out for an elastic response. Present work shows that three industrial buildings rest on one isolation slab. All problems related to design, analysis, placement of isolator are comparatively discussed.

- **J. Enrique Luco [5],** determined the soil structure interaction effect on base isolated building. The results showed that the deformation of an inelastic structure is higher when soil effect has been taken into consideration. When soil structure interaction was neglected an undammed vibration was considered, critical harmonic excitation occurs after which the behavior of structure and isolator was unbounded. The results obtained depended on damping of the isolator .The resonant response of isolator and superstructure has been increased when SSI was taken into account.

- **Donato Concellara et.al. [6],** describes the comparison of lead rubber isolator and friction slider. Isolator was composed of lead rubber bearing in combination with friction slider (FS) and that isolation was named as high damping hybrid seismic isolator. The seismic response of high damping hybrid seismic isolator was compared with lead rubber isolator response. The same structure or building was examined under different seismic activity in the form of frequency and intensity.

The paper basically focuses on HDHSI with a comparison of lead rubber isolator. This two different type of isolator were fixed in building and nonlinear time history analysis has been performed. Different seismic activity was taken into account. The results were compared as in the form of base shear, shear force, displacement at the base of the super structure. The comparative result shows HDHSI provide better protection for severe seismic activity then other.

- **Boya Yin [7],** studied in his work about the soil structure interaction effect. Base isolated linear soil model was prepared and base isolation was assembled in that as on linear state space. Ground motion was recorded and transient response of earthquake was computed by using the nonlinear equation with a constant time step. The far near ground soil condition were generated for the test.The effect of soil function and compliance in isolation was evaluated. Large hysterics frictional forces were less effective in achieving seismic isolation goals. Due to base isolation large amount of displacement has been produced on stories. The nonlinear liquefied model was prepared for determination of SSI effect. Liquefying model of soil was prepared for the response to base isolation with SSI effect. Different varying properties like base shear, PGA, PGV were determined and results were compared with the isolated base building.

- **Y. Li and J. Li [8],** showed in the paper about base isolator with variable stiffness and damping, modeling design and experimental testing of the new isolator. Sometimes the effect of the earthquake is severe that the passive nature of rubber is not able to sustain the energy arises due to seismic activity. Hence smart base isolation with adoptive and controllable properties was developed with varied stiffness and damping properties of the isolator. The paper shows design and experimental testing, dynamic modeling of smart rubber.

- **J. Enrique Luco [9],** determined the soil structure interaction effect on base isolated building. The results showed that the deformation of an inelastic structure is higher when soil effect has been taken into consideration. When soil structure interaction was neglected an undammed vibration was considered, critical harmonic

excitation occurs after which the behavior of structure and isolator was unbounded. The results obtained depended on damping of the isolator .The resonant response of isolator and superstructure has been increased when SSI was taken into account.

- **M.K. Shrimali et.al. [10],** showed that use of control devices for a seismic vulnerability is being increased now a days. The paper focuses on hazardous cause due to pounding effect of nearby buildings. For reducing this damage use of controlled devices has become essential. The study based on comparative analysis of damper and isolated system. The further study states that the hybrid system of seismic hazard control gives better results from semi-active control. Again more concentration has been given to find out the varying parameter of control devices.

- **A.Swetha*, Dr. H. Sudarsana Rao [11],** has performed dynamic analysis on G+4 story building. The dynamic analysis was done by using new mark beta method. For getting ground motion acceleration, records of El Centro earthquake values were taken. Static analysis was carried out and comparison was done for peak lateral forces, shear force, displacement of each force. The design was done according to IS1893 (part1):2002. The comparison was done and inferences were drawn toward the effectiveness of ground story and week buildings due to the critical effect of an earthquake.

- **Sekar and Kadappan [12],** showed about the comparison of base isolated bearing and rigid base reinforced concrete building with the effect of soil, earthquake zone and on normal as well as sloping ground. For this study, he has taken a multistoried RC building with normal and sloping ground surface and designed it with and without an isolator. Different story height ranges from 1 to 10 were taken with different seismic zones and plan of the building was rectangular having size 12x16m along with seismic zone.

  Dynamic linear analysis has been performed by using response spectrum method. The different results were obtained with the different condition of terrain and zone. As with the introduction of the isolator, the fundamental natural time period of structure increases but base shear reduces. Enter story drift of building also increase. As due to different terrain condition results were going to change as base isolator make the building as rigid building with the higher time period.

- **Shu-lu Wang1 et.al.[13],**works on the problem of the isolator and introduced a new type of metal rubber isolator as day by day more vibration problem were going to arise in the isolator and to accept the new situation. Paper describes the history of metal rubber and various researches that have been performed on metal rubber material of isolator. A different aspect of metal rubber isolator with the experimental study was taken into account. Dynamic modeling and parameter of isolator and results obtained after vibration control of response were taken. At the last, the future scope and its usability have been discussed in this paper.

- **Farzad hatami et.al. [14],** presented a paper on seismic base isolation and soil structure interaction.A case study has been selected for that a ten story base isolator actual structure designed according to IBC-2009 was selected. A model was prepared for given effects of soil structure present around the building premises. Nonlinear dynamic time history analysis has been performed with two past recorded earthquake i.e. Loma preita and north ridges for the soil structure interaction effect. Three different soil model for the different time period, base shear and other parameter are found out on isolated building with each of soil model. The result showed that there was hardly any change in response of structure if the underlying soil was hard or stiff but there is considerable change if the soil beneath was soft or medium hard. Also, the time period of structure gets influenced due to soil type.

- **Donata Concellara et.al. [15],** Donata Cancellara et.al. [1], carried out experimental work on two base isolation systems with RCC multistoried building designed as per European code. The study is based on plan irregularity and hence irregular plant was chosen for it. The comparison is done and inferences are drawn on high damping rubber bearing (HDRB) in parallel to friction bearing and lead rubber isolator laid in parallel with friction slider. Results are recorded according to accelerogram with ground motion acceleration. Time history analysis was taken out and results were compared. The comparison was done on the basis of response and behavior of normal rigid base building with an isolated building.

- **Athanasios A.Makore et.al. [16],** presented his paper on hybrid base isolation system under earthquake excitation. Two building were taken for study to find out the governing parameter, features or physical property of hybrid base isolation system. The building were isolated in salarino Sicily, optimization techniques has been used for isolator property design two types of system were made namely high damping rubber bearing for the two bearing two different separate mathematical model were generated with bilinear as well as trilinear base system along with

this for friction slides bearing special columb model was prepared for hybrid base isolation system. Different analytical model was checked for different earthquake forces and acceleration over past history by using nonlinear dynamic analysis the result were found out to focus on the performance of the hybrid bearing system for different earthquake vulnerability and different location and type.

- **S.D.Darshale et.al. [17],** investigated about the response of the base isolated structure. There is so Base isolation is one of the types of energy dissipation system. It is a passive system of energy control. Isolator basically isolates the superstructure and foundation and it partially reflects and partially absorb the part of the energy. Due to the introduction of lead rubber isolator, the horizontal movement of the building increases i.e. fundamental natural time period increase and horizontal stiffness of building decreases. The inner story drift after introduction of isolator is reduced up to certain level.G+14 regular RCC building is taken into the study for comparison of rigid base and base isolated structure. The fundamental natural time period of the structure is approximately 1.7 where in for isolated structure is 4.3sec.As the natural time period increases the energy dissipation also increases and response reduces. Due to isolation inner story drift, base shear acceleration is reduced.

III. DISCUSSION

The characteristics and type of base isolation system plays a vital role on the performance of structure during the effect of earthquake. The other factors like mass asymmetry, interlaying ground condition, geometry of structure and height of super structure also defines the response of structure during shocks. The effect of soil structure interaction is the widest area of research.

IV. CONCLUSION

Based on the above literature survey it is clear that the performance of fixed base and isolated base structure is depends on the type of underlying soil on which the structure rests. For hard strata the response is comparatively satisfying but Soft soil amplifies the ground acceleration hence the energy dissipation of the structure reduces and frequency increases. The efficiency of isolators is good for low to medium height buildings. The response of structure is varying if the type of isolator changes as due to change in material properties of isolator.

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