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Behaviour of Building under Earthquake with or without Base Isolation by Varying Thickness of Lead Rubber Bearing

Chetak Sambhaji Shinde
Department of Civil Engineering,
JSPM's Rajarshi Shahu College of Engineering,
Pune, Maharashtra, India

Dr. R. K. Jain
Department of Civil Engineering,
JSPM's Rajarshi Shahu College of Engineering,
Pune, Maharashtra, India

Prof. M. M. Patil
Department of Civil Engineering,
JSPM's Rajarshi Shahu College of Engineering,
Pune, Maharashtra, India

***Abstract*— A base-isolated building may sometimes show signs of an undesirable large response to long- duration, long-period earthquake ground motion and an connected building system without base- isolation may show a large response to a near-fault earthquake ground action. The installation of base isolation in building at base level significantly increases the time period of the structure, this means it reduces the possibility of resonance of the building giving rise to well seismic performance of the building. The research study is performed to compare the effectiveness of base Isolation in plan unbalanced and vertical multi-storied RC frame building. For this research study, number of Storied RC frame building is well thought- out and time times gone by analysis is conceded out using ETABS Software. The lead rubber bearing is designed as per IS code and the same was used for psychotherapy of base isolation system. The outcomes obtained from the analytical analysis were time period, base reaction, story drift and story acceleration. Time period for the base isolated buildings are higher than that of the permanent base building. Due to the existence of base isolation, base shear is significantly Reduced in each direction (x and y direction) as compared to fixed base structure. It has been found that when related to plan base isolated structure gives better performance in high Seismic prone zone by using isolators at the base of the building.**

I. INTRODUCTION

The buildings constructed with decent techniques and machines in the current past have fallen prey to earthquakes leading to massive loss of life and property and untold sufferings to the survivors of the earthquake hit area, which has compelled the engineers and scientists to think of innovative techniques and methods to save the buildings and structures from the destructive armed forces of earthquake. The earthquakes in the recent past have provided an adequate amount of evidence of performance of similar type of structures under different upheaval conditions and at different foundation conditions as a food for consideration to the engineers and scientists. This has given birth to different type of techniques to save the structures on or after the earthquakes.

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. Various country like US, New Zealand, Japan, China and European countries have accepted these techniques as their standard routine for many public buildings and residential building as well. Hundreds of structures are being constructed each year with base isolation technique in these countries. This research paper defines the development of base isolation technique and other techniques developed approximately the world. As of now, in our country, the use of base isolation techniques in public or residential buildings and structures is in its inception and except few buildings like hospital structure at Bhuj, investigational structure at IIT, Guwahati, the general buildings are built without base division techniques. National level strategies and codes are not available presently for the reference of engineers and builders. Engineers and scientists have to accelerate the step of their research work in the direction of developing and constructing base isolated structures and come out with solutions which are simple in design, simple to build and cost actual as well.

A. Base Isolation of Structures

It has often been recommended that base isolation of buildings may be achieved by presenting base supports with large elastic flexibility for horizontal motions. While such isolators may operate acceptably during type 1 (impulsive) earthquakes they would allow the cyclic build-up of without a solution base translations, and of significant loads on the structure, during the longer type 2 and type 3 earthquakes. A base-isolated building with a fundamental period of less than 1.0 second may be represented approximately by a single mass by means of a flexible hold up, for the purpose of computing its dynamic answer to earthquake attack. This models is relatively accurate for structures with periods of less than 0.5 seconds. Since all the masses of a base-isolated structure have similar accelerations the deformed shape of the building is almost the same as for "uniform" horizontal loads that is loads proportional to building weights. The total accumulation may then be taken at the centre of enormity of the structure, and its support should allow it the same translations as the centre of importance. This may be achieved by a support which gives an effective period of T e = 0.85 T, where T is the fundamental period of the structure. (The connection may be derived from Raleigh's period formula when suitable approximations are made). The accuracy of the single-mass model is increased by large inelastic deformations of the isolator, and the model is not invalidated through moderate inelastic deformations of the building. When the utmost base shear has been obtained by

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dynamic analysis then the maximum associate loads and the maximum deformations may be single-minded accurately by static reckoning, with the base shear force distributed uniformly over the building.

The behavior of base-isolated structures during an earthquake is highly affected by the uniqueness of the base isolation system. The base isolation system split up the structure from its foundation and primarily moves the natural frequency of the structure away from the dominant frequency range of the excitation via its low stiffness relative to that of the upper organization. Construction of base-isolated structures has increased, especially after the recent strong earthquakes in the United States and Japan. Despite the limited number of recorded seismic response data, vigorous studies to evaluate the actual behavior of base isolated structures during strong earthquakes have been conduct. Nonlinearity in structural response is often due to the restoring force character of the base isolation system, i.e., variations in structural stiffness and damping during strong earthquakes. Seismic Base-isolation of building is an innovative practice used in recent years, for reducing seismic energy transmitted to buildings, in highly seismic prone areas.

The uncomplicated opinion behind the base-isolation system is to introduce a flexible interface between the base of a structure and the foundation. Laminated Rubber Bearings are the most widely used knowledge in seismic base isolation, because of their technical and economic efficiency and reliability. Even though base isolation method is widely used for over 8000 structures globally, this process is very rarely used in India in spite of the fact that India has so many highly seismically active zones.

B. Need of Research

Base isolation has been widely used over the last periods for the protection of structures against earthquakes. The idea behind base isolation is the foreword of a flexible layer between the superstructure and its groundwork. The area of base isolation is simply to reduce the broadcast of energy from the earth to the superstructure. To this end, the mechanism behind an isolation system are a flexible support in order to elongate the natural period of the structure, energy dissipation in order to control the relative displacements and adequate rigidity under service loads to avoid unnecessary motion. The first mode of an isolated building involve only deformations in the region isolation level, while the higher modes do not contribute to the response due to orthogonality conditions.

II. LITRATURE REVIEW

A. Base Isolation Techniques

Structures are very significant after the natural hazards such as earthquake. Introducing base isolation techniques to improve the performance of structures. Friction pendulum or Friction bearing is solitary of the greatest base isolation techniques .The key aim of these research papers investigates the seismic response of multi story buildings with friction pendulum base isolation. FPS with varied radius and co-efficient of friction are incorporated in each papers. There dissimilar history recorded earthquake are used for time history analysis and SAP 2000 software is used for modelling and analysis.

B. Comparative Study of Base Isolation in Multi-storeyed R.C. Irregular Structure

Now a day's architects and engineers are essential to plan and design the structures, which can withstand touching the seismic masses. Therefore it converted condition to provide spontaneous control device "base isolation" to struggle large horizontal and vertical load which leads the building to collapse. Base isolation is one of the promising and extensively accepted passive control devices to resist these forces by isolating the super structure from the sub structure, in this study paper the response of Base isolated building and fixed base structure are evaluated for high rise building having irregularity in plan at Storey level. Response spectrum analysis and time history analysis passed out in terms of Storey Displacement, Base shear, Time period and Storey drift using ETABS software.

C. Behavior of a Base-Isolation

A base isolation system is an current engineering method for reducing seismic impacts by isolating an upper structure from soil vibration due to seismic motion. The main concept of a bottom isolation system is the extension of the natural period of a building. on the other hand, the production of isolators is very expensive, for the most part when an isolator is employed because a residential house's base isolator. To lessen the issue, a low-cost rubber base isolation system is planned. The future inexpensive bearing system uses the perforated thin steel plates instead of solid thick ones. The study is the initial step of investigate on low-cost base isolation systems for built-up houses in highly seismic regions. A nonlinear time the past analysis (NLTHA) that is based on seven scaled-earthquake records is implemented in one-and two-storey isolated reinforced concrete (RC) residential families by considering the influence of the isolation ratio. The results indicate that the houses with isolation systems reached better performance with look upon to ductility demand because well as natural period due to seismic loads. The family with the higher isolation ratio achieved lower ductility demand.

III. MATERIAL AND METHODS

A. Concept of base Isolation

The basic role of a wide range of basic frameworks utilized as a part of the building kind of structures is to exchange gravity stacks fruitfully. The large amount generally recognized loads coming about because of the force of gravity are dead load, live load. Further than these vertical loads, buildings are likewise subjected to horizontal burdens caused by wind, impacting or quake. Lateral loads can produce high anxiety, deliver influence development or cause shaking. It is energetic for the structure to have acceptable quality against vertical loads together with satisfactory solidness to be in opposition to lateral (seismic) loads. Reinforcing of buildings turns out to be a superior choice taking into economic considerations and immediate shelter issues as opposed to substitution of structure. Seismic retrofitting or reinforce of building is one of the most significant aspects for mitigating seismic danger particularly in quake prone areas.

Base isolation system is an outstandingly industrious, highly effective and economical technique for opposing

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lateral (horizontal) forces in an RCC frame structure. Base isolation system has been applied to balance out horizontally most of the world tallest building structures and furthermore one of the major retrofit measures.

B. Base Isolation

Base isolation is definite as a flexible substantial which is provided at base to reduce the seismic forces of any structure. Why base isolation is provide at the underground room level for the inspiration that the base isolation reduces earth pressure group conveyed to the superstructure above the isolator, reducing the response of a typical structure and the matching load. They are located deliberately among the underpinning and the building structure and are designed to lower the magnitude and frequency of seismic distress permitted to cross the doorsill the building. They deliver both mechanism and energy absorbing characteristics.

The idea of protecting a building from the damaging belongings of an earthquake by introducing a quantity of nature of grasp up that isolates it from the shaking ground is an attractive one, and many mechanism to attain this result have been forthcoming.

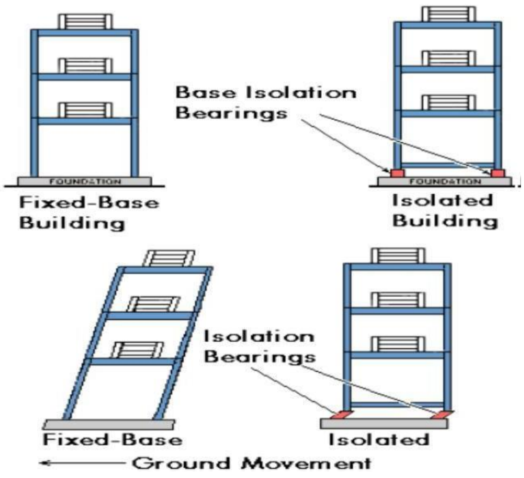

Figure 3.1: Fixed base v/s Base-isolated building

C. Principles of Base Isolation

A structure that is beautifully rigid will have a zero period. At the point when the ground moves the speed up actuated in the structure will be equivalent to the ground acceleration and there will be zero relative displacement between the structures in adding together to the ground. The building and ground move the same sum.

A structure that is excellently flexible will have an never-ending period. For this sort of structure, when the ground underneath the structure moves there will be zero increasing speed incited in the arrangement in addition to the relative displacement between the structure and earth will be equivalent to the ground displacement. The building won't move the ground will.

An isolated system does not ingest the vibrating strength, yet rather redirects it through the motion of the system. It extends the regular time of shaking of the structure so that the responses are extraordinarily decreased. Sometimes a passive damper may additionally use to control inordinate displacement.

D. Types of Base Isolators

Many different forms of practical base isolation systems have been urbanized to provide seismic protection for buildings.

- Elastomeric Bearing
- High Damped Rubber Bearing
- Lead Rubber Bearing
- Friction Pendulum system

E. Earth quake History in India

The Indian subcontinent has a past of distressing earthquakes. The shaking memories of high asset earthquakes of Bhuj and lathur are motionless alive inside our minds. Still now there are frequent occurrences of earthquake in the Kashmir and Himalayan region. The major reason for the high occurrence and intensity of the earthquakes is that the Indian cover is driving keen on Asia at a rate of just about 47 mm/year. Geographical data of India shows that almost 54% of the ground is vulnerable to earthquakes. The isolation system dissociates the structure from the horizontal mechanism of the ground motion and reduces the possibility of resonance. This decoupling is achieved by ever-increasing the suppleness of the system, jointly with fitting damping by providing isolator at the basement level of the arrangement.

F. Material Used For Base Isolator

1) Lead rubber bearing with earthquake resistance Lead rubber bearing, applied to structure and bridge constructions, is a practical and cost-effective choice for seismic isolation. It is collected of laminated elastomeric bearing pad, top and bottom sealing & connecting plates and lead plug inserted in the middle of the bearing as shown in the following figure. Delivery of lead rubber bearing is well- ordered than high damping rubber comportment because as time period increase in high damping rubber bearing, acceleration also increases which is undesirable to protect building during earthquake. This state is exactly reverse in case of lead rubber bearing.
2) Component of lead rubber bearing

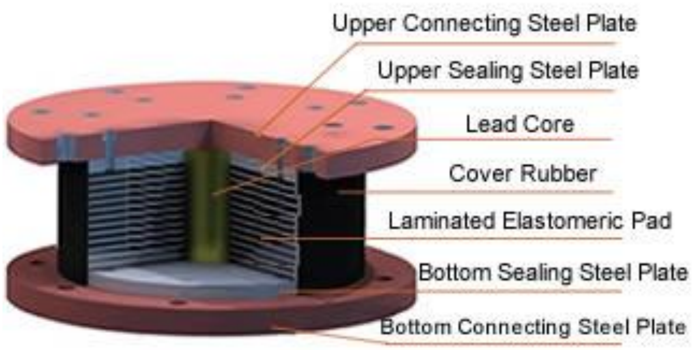

Figure 3.2: Component of Lead Rubber Bearing (LRB)

3) Features of Rubber Bearing

- Stiff and strong in vertical course but flexible in horizontal direction.
- Engage earthquake-generated force by changing the bearing's shape.
- Allow the buildings to retain their innovative shapes and position owing to the high elastic force of rubber.

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- Capable to regulate damping amount just by changing the number of lead plugs.
- Outstanding vertical load capacity ranging from 5 tonf to 2000 tonf

IV. MODELING RESULTS AND ANALYSIS

a) Peak Inter-storey Drifts:

The peak inter-storey drift, defined as the maximum relative lateral displacement at each floor level divided by the floor height, is an indicator of both structural and non-structural damage. Normally, the building experiencing a drift ratio up to .5% practically develops no damage in structural and non- structural elements. If drift ratio is 1.0% to 2.0%, major non- structural damage as well as minor to moderate structural damage is expected. The structure is considered seriously damaged when the drift ratio is over 2.0%, and likely experience partial collapse when the drift ratio is in excess of 4%. In following table shows that the max story go with the flow with and without base isolation, in which story 18 has max drift percentage that is 6.39. And minimum percentage of base story in negligible is -0.088. The average percentage difference of story drift is 3.6156.

Story	With	Without	Percentage Difference
Story20	0.00007	0.000421	5.01
Story19	0.000053	0.00038	6.16
Story18	0.000051	0.000377	6.39
Story17	0.000051	0.000376	6.37
Story16	0.000051	0.000374	6.33
Story15	0.000052	0.000373	6.17
Story14	0.000054	0.000374	5.92
Story13	0.000086	0.000463	4.38
Story12	0.000341	0.001329	2.89
Story11	0.000586	0.001945	2.31
Story10	0.00079	0.002628	2.32
Story9	0.000956	0.003178	2.32
Story8	0.001086	0.003613	2.32
Story7	0.001185	0.003943	2.32
Story6	0.001257	0.004183	2.32
Story5	0.001305	0.004344	2.32
Story4	0.001335	0.004439	2.32
Story3	0.001355	0.004482	2.30
Story2	0.001544	0.004525	1.93
Story1	0.005143	0.004686	-0.088
Average			3.6156

Table 4.1: Max Story Drifts at With and Without Isolation

b) Max Storey Drifts of Different Thickness of Base Isolation:

In following table shows that the max story drift of different thickness of base isolation, in which 550 thickness shows the maximum drift that is 0.00436. And minimum drift 450 mm thicknesses is 0.00366.

Story	350	450	550
Story20	0.001094	0.001909	0.001351
Story19	0.001539	0.002266	0.001725
Story18	0.001839	0.002653	0.002141
Story17	0.002213	0.002933	0.00253
Story16	0.002551	0.003233	0.002881
Story15	0.002851	0.003461	0.00319
Story15	0.003114	0.003672	0.003462
Story14	0.003343	0.003849	0.003696
Story13	0.00354	0.003993	0.003895
Story12	0.003842	0.004093	0.004117
Story11	0.003952	0.004193	0.004197
Story10	0.004038	0.004233	0.004384
Story9	0.004101	0.004254	0.004441
Story8	0.004145	0.004247	0.004777
Story6	0.004175	0.004213	0.004498
Story5	0.004216	0.004154	0.004536
Story4	0.004398	0.004072	0.004743
Story2	0.005641	0.00397	0.006007
Story1	0.013826	0.004134	0.016275
Average	0.003917	0.00366	0.00436

Table 4.2: Max Story Drifts of Different Thickness of Base Isolation

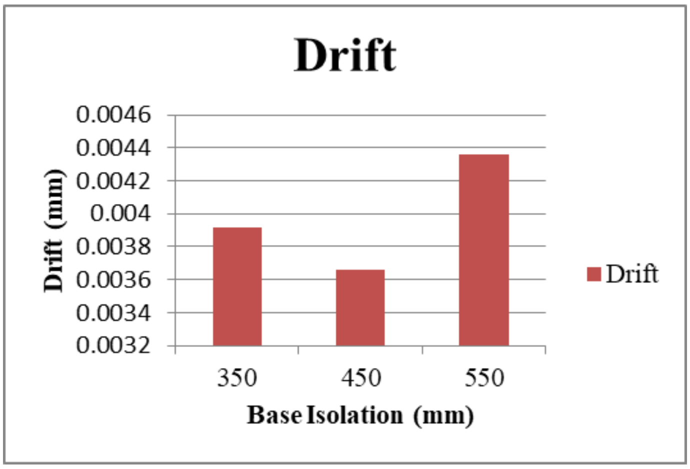

Fig. 4.1: Max Story Drifts Different Thickness of Base Isolation

c) Base Reaction:

Two building models were considered to investigate the performance of the prototype frame building. These consist of a bare frame without the base isolations, and the building as designed with base isolations interact with the frames. The presence of base isolations resulted in a considerable stiffness increase, reducing the first mode period by in the district of. The base answer of poles apart breadth of isolation is given below table. In which the maximum for 450 mm thickness of base isolation that is basic reaction is 1213400.

Base Isolation Thickness in mm	Base Reaction in KN/m
350	832340.4
450	1213400
550	846841.2

Table 4.3: Base reaction of Different Thickness

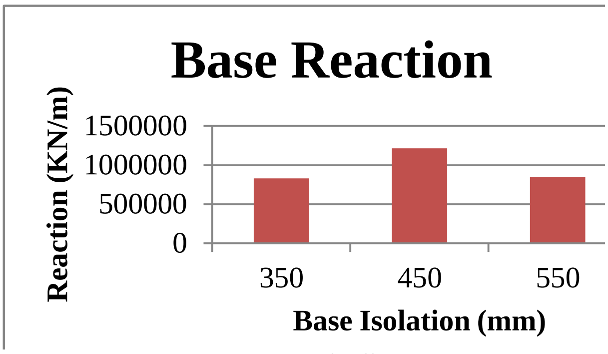

Fig. 4.2: Base reaction of Different Thickness

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d) *Acceleration:*

The subsequent table is acceleration of different thickness of base isolation are given with of 20 story building, difference between the average acceleration of different thickness are shown in graph. The maximum acceleration is 0.009 of 350 mm thickness base isolation and minimum acceleration is 0.003238 of 450 mm thickness base isolation.

Story	350	450	550
Story20	0.004	0.002	0.003
Story19	0.006	0.002	0.005
Story18	0.008	0.002	0. 007
Story17	0.009	0.002	0.008
Story16	0.009	0.002	0.008
Story15	0.008	0.002	0.007
Story14	0.007	0.002	0.006
Story13	0.007	0.002	0.006
Story12	0.008	0.002	0.007
Story11	0.008	0.002	0.007
Story10	0.008	0.002	0.007
Story9	0.007	0.002	0.006
Story8	0.006	0.001	0.005
Story7	0.007	0.001	0.006
Story6	0.008	0.001	0.007
Story5	0.009	0.001	0.007
Story4	0.008	0.001	0.007
Story3	0.006	0.001	0.005
Story2	0.003	0.001	0.003
Story1	0.008	0.001	0.007
Base	0.045	0.036	0.038
Average	0.009	0.003238	0.007714

Table 4.4: Acceleration of Story

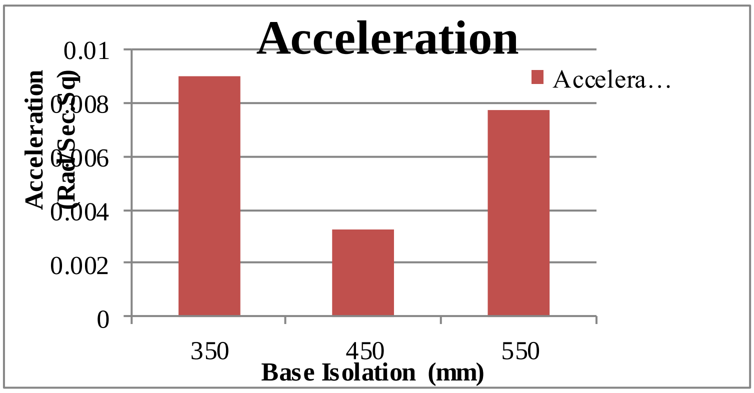

Fig. 4.3: Acceleration of Story

V.CONCLUSIONS

In this dissertation the behaviour of building under trembling with and devoid of base isolation by varying thickness of LRB has been studied. The main focus of this research was to find an optimum thickness of lead rubber base isolation. To study the of building under earthquake with and without base isolation by varying thickness of LRB different types of thickness were used 350, 450,and 550. The story drift, base reaction and acceleration were plotted for each of different breadth of base isolation. A number of conclusions are drawn from the in attendance examine work and the same is recognized in this section with future scope for other researchers.

- The behaviour changes are shown by using the with different thickness of base isolation.
- Base isolation is capable in supporting the structure against horizontal earthquake load.
- The max story drift of different thickness of base isolation in which 550 thicknesses shows the maximum drift that is 0.00436 and minimum base story 450 mm thicknesses are 0.00366.
- The base reaction of different thickness of isolation in which the base reaction maximum for 450 mm thickness that is basic thickness are 1213400.
- The average acceleration of different thickness in which the utmost acceleration is 0.009 of 350 mm thickness base isolation and minimum is 0.003238 of 450 mm thickness base isolation.
- The different thickness of base isolation shows the different behaviors of building under the earthquake conditions.

By the investigation it is experiential that base isolation increases the flexibility at the base level of the building.

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