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SUITABILITY OF DIFFERENT BASE ISOLATION SYSTEMS ACCORDING TO LENGTH TO WIDTH RATIO OF HIGH-RISE BUILDINGS

Mr. Akshay Pankar[1], Prof. Dr. U.R. Awari[2]
M.E Civil (Structural Engineering) AISSMS Pune, India[1]
Department of Civil Engineering AISSMS, Pune India[2]

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Abstract:- Seismic isolation is a technology that decouples a building structure from the damaging earthquake motion. It is a simple structural design approach to mitigate or reduce potential earthquake damage. In base-isolated structures, the seismic protection is obtained by shifting the natural period of the structure away from the range of the frequencies for which the maximum amplification effects of the ground motion are expected; thus, the seismic input energy is significantly reduced. At the same time, the reduction of the high deformations attained at the base of the structure is possible, thanks to the energy dissipation caused by the damping and the hysteretic properties of these devices, further improving the reduction of responses of the structures. Base isolation is also an attractive retrofitting strategy to improve the seismic performance of existing bridges and monumental historic building.

To minimize the transmission of potentially damaging earthquake ground motions into a structure is achieved by the introduction of flexibility at the base of the structure in the horizontal direction while at the same time introducing damping elements to restrict the amplitude or extent of the motion caused by the earthquake somewhat akin to shock absorbers. In recent years this relatively new technology has emerged as a practical and economic alternative to conventional seismic strengthening. This concept has received increasing academic and professional attention and is being applied to a wide range of civil engineering structures. To date there are several hundred buildings in Japan, New Zealand, United States, India which use seismic isolation principles and technology for their seismic design.

Keywords— *Seismic protection, Base isolation, Idealized behavior, Hysteresis loop, Ductility, Installation technique.*

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I INTRODUCTION

General Overview

The method of base isolation was developed in an attempt to mitigate the effects of earthquakes on buildings during earthquakes and has been practically proven to be the one of the very effective methods in the past several decades. Base isolation consists of the installation of support mechanism which decouples the structure from earthquake induced ground motions. Base isolation allows to filter the input forcing functions and to avoid acceleration seismic forces on the structure. If the structure is separated from the ground during an earthquake, the ground is moving but the structure experienced little movement.

Earthquake

Earthquake is basically a naturally phenomenon which causes the ground to shake. The earth's interior is hot and in a molten state. As the lava comes to the surface, it cools and new land is formed. The lands so formed have to continuously keep drafting to allow new material to surface. According to the theory of plate tectonics, the entire surface of the earth can be considered to be like several plates, constantly moving. These plates brush against each other or collide at their boundaries giving rise to earthquakes. Therefore regions close to the plate boundary are highly seismic and regions further from the boundaries exhibit less seismicity. Earthquakes may also be caused by other actions such as underground explosions.

Purpose of base isolation:

In the branch of structural engineering, the building is designed for the earthquake resistance, not for the earthquake proof.

During the earthquake, a ground motion induces an inertia force in both directions which is a creation of building mass & earthquake ground acceleration. Therefore, it is essential that the building should have adequate strength and stiffness to resist the lateral load induce during the earthquake.

In the construction field, it is not good practice to rise the strength of the building indeterminately. In high seismicity regions, the accelerations causing inertial forces in the building may exceed one or even two times the acceleration due to gravity. In this case, base isolation technique is used to mitigate earthquake effects

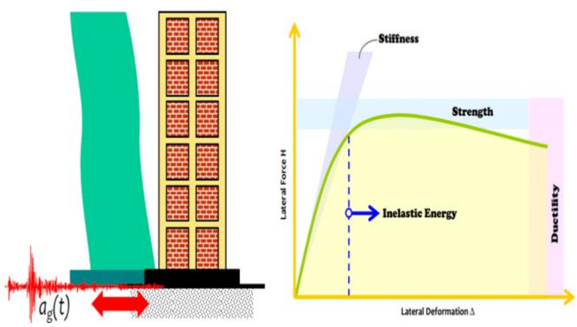

Fig1. Purpose of the base isolationand Demand during ground motions

Principle of base isolation:

The basic principle of base isolation is to transform the response of the building so that the ground can move below the building without transferring these motions into the building. The assumption of the ideal system is a complete separation between ground and structure. In actual practice, there is a contact between the structure and the ground surface.

Buildings with a perfectly stiff diaphragm have a nil fundamental natural time period. The ground motion induces acceleration in the structure which will be equivalent to the ground acceleration and there will be nil relative displacements between the structure and the grounds. The structure and substructure move with the same amount. A building with a perfectly stretchy diaphragm will have an immeasurable period; for particular type of structure, when the ground beneath the structure travels there will be zero acceleration induced in the structure and the relative displacement between the structure and ground will be equivalent to the ground displacement. In this case, structure will not change but the substructure will move.

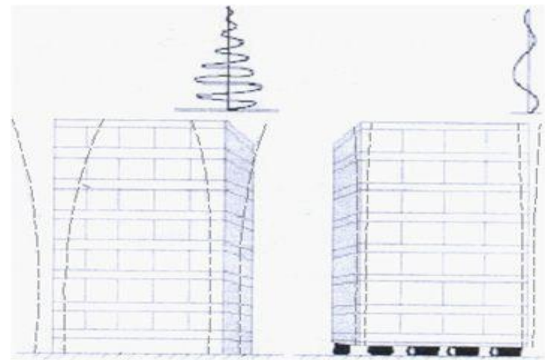

Fig2. Principle of the base isolation

Lead rubber bearings

It is designed of a lead plug force-fitted into a preformed hole in an elastomeric bearing. The lead core provides rigidity under service loads and energy dissipation under high lateral loads. Top and bottom steel plates, thicker than the internal shims, are used to accommodate mounting hardware. The entire bearing is encased in cover rubber to provide environmental protections

When exposed to low lateral loads the lead-rubber bearing is rigid both laterally and vertically. The lateral stiffness results from the high elastic stiffness of the lead plug and the vertical rigidity result from the steel-rubber construction of the bearing. The period shift effect characteristic of base isolation system developed due to at higher load levels the lead yields and the lateral stiffness of the bearing is expressively reduced. As the bearing is cycled at large displacements, such as during moderate and large earthquakes, the plastic deformation of the lead absorbs energy as hysteretic damping. The equivalent viscous damping produced by this hysteresis is a function of displacement and usually ranges from 15% to 35%

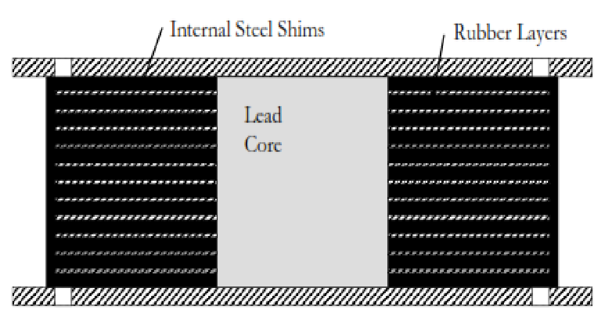

Fig3. Lead rubber bearing section

A major benefit of the LRB system is it combines the functions of rigidity at service load levels, elasticity at earthquake load levels and damping into a single compact unit. These properties make the lead-rubber bearing the maximum shared type of isolator used where high levels of damping are required or for structures where rigidity under services loads is important. As for HDR bearings, the elastomeric bearing formulations are also applicable for the design of LRBs**.**

Base Isolation Techniques

In traditional seismic design approach, strength of the structure is suitably adjusted to resist the earthquake forces. In base isolation technique approach, the structure is essentially decoupled from earthquake ground motions by providing separate isolation devices between the base of the structure and its foundation. The main purpose of the base isolation device is to attenuate the horizontal acceleration transmitted to the superstructure. All the base isolation systems have certain features in common. They have flexibility and energy absorbing capacity. The main concept of base isolation is to shift the fundamental period of the structure out of the range of dominant earthquake energy frequencies and increasing the energy absorbing capability. Presently base isolation techniques are mainly categorized into three types viz.

- Passive base isolation techniques
- Hybrid isolation with semi-active device
- Hybrid base isolation with passive energy dissipaters

Implementation of the isolator in buildings

The first question in the mind of a structural engineer is that when to use isolation in the building, the simple answer is when it provides a more effective and economical alternative than other methods of use for earthquake safety. If the design for earthquake loads requires strength or detailing that would not meet required for other load conditions then base isolation may be feasible.

When we evaluate structures, which meet this basic criterion, then the best way to assess whether your structure is suitable for isolation is to step through a checklist of items which make isolation either more or less effective.

The Weight of the Structure:

The base isolation system is more efficient for the structures which have heavy masses. To effective isolation can be achieved with the help of the long period of the response. As we know the period is an inherent property of the structure which is relative to the square root of the mass M and contrariwise proportional to the square root of the stiffness K.

The Period of the Structure:

The structures whose fundamental natural time period is less than 1 second are most suitable for the isolation system. For example, buildings which are usually less than 10 stories and for elastic types of structure, such as steel moment frames, probably less than 5 stories

Seismic Conditions Causing Long Period Waves:

Some sites have a travel path from the epicenter to the site such that the quake motion at the site has a extended period of motion. This condition most often occurs in alluvial basins and can cause resonance in the isolated period range. Isolation may make the response worse instead of better in these situations. Examples of this type of motion have been recorded at Mexico City and Budapest

Subsoil Condition:

Isolation works best on rock and stiff soil sites. The soft soil has a similar effect to the basin type conditions mentioned above; it will modify the earthquake waves so that there is an increase in long period motion compared to stiff sites. Soft soil does not rule out isolation in itself but the efficiency and effectiveness will be reduced.

Near Fault Effects:

One of the most controversial aspects of isolation is now well the system will operate if the earthquake occurs close to the structure. Adjacent to the fault, a phenomenon termed "throw" can occur. This is characterized by a long dated, high-velocity pulse in the ground acceleration record. Isolation is being used in near-fault locations, but the cost is usually higher and the evaluation more complex . In reality, any structure near to a fault should be evaluated for the "fling" effect and so this is not peculiar to isolation.

Aspect Ratio of Structural System:

Maximum practical isolation devices have been developed to operate under compression loads. Sliding systems will separate if vertical loads are tensile; elastomeric based systems must resist tension loads by tension in the elastomer. In tension, cavitation occur at relatively low stresses which reduce the stiffness of the isolator; For these reasons, solation systems are generally not practical for structural systems that rely on tension elements to resist lateral loads.

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II. PROBLEM STATEMENT

To analyse multi story building with various base isolation techniques using ETABS and perform shake table testing on best possible base isolation method after software analysis to get optimum results.

Aim of the project:

Aim of the project is to study the suitability of different base isolation system in such a way that it may withstand actual force during earthquake.

Objectives of the project:

1. To study the suitability of different base isolation systems for different length to width ratios of building.
2. Seismic analysis of symmetrical R.C.C. building with base isolation and without base isolation using ETABS software.
3. Optimization of base isolation technique (which base isolation is most effective for different length to width ratios).

Limitations of study

1. Experimentation work cannot be done for all cases as casting models with base isolation building would be very costly so we have to be dependent on software analytical study.

2. Manual calculations would be very tedious for a 3D frame building.

SCOPE OF THE STUDY

The present study focuses on the analytical investigation of the influence of the different base isolated system on the seismic response of thestructure subjected to a lateral seismic load.

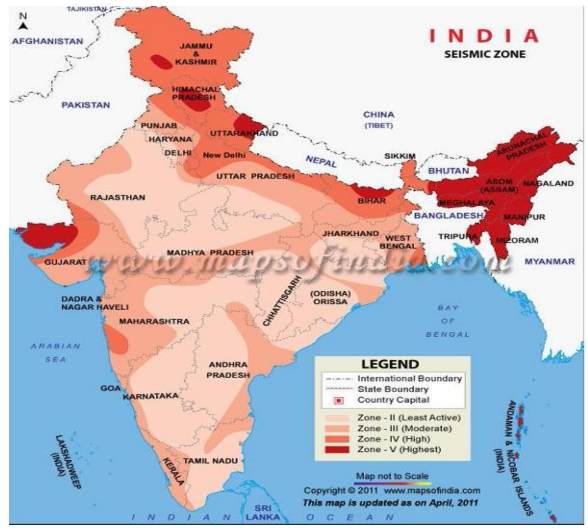
1) Study of types of base isolators, their constituent elements.
2) The present work is focused on the impact of different base isolated systems like Lead rubber bearing and friction pendulum bearing on the seismic performance of the symmetrical and unsymmetrical structure.
3) The comparative study between base isolated structure and fixed base structure is carried out by Experimental and Analytical Study using Shake Table and SAP 2000
4) The parametric study was carried out to study the linear dynamic characteristics considering different isolated systems used in the structure using Response spectrum method.
5) To design and study the effectiveness of lead rubber-bearing and friction pendulum bearing used as base isolation system.

Seismic Zones

As we all know that India is divided into 5 earthquake zones:

i. Zone 1
ii. Zone 2
iii. Zone 3
iv. Zone 4
v. Zone 5

Current division of India into earthquake hazard zones does not use Zone 1, no area of India is classed as Zone 1



Zone 5: Zone 5 covers the areas with the highest risks zone that suffers earthquakes of intensity MSK IX or greater. The IS code assigns zone factor of 0.36 for Zone 5. Structural designers use this factor for earthquake resistant design of structures in Zone 5. The zone factor of 0.36 is indicative of effective (zero period) level earthquake in this zone. It is referred to as the Very High Damage Risk Zone. The region of Kashmir, the western and central Himalayas, North and Middle Bihar, the North-East Indian region and the Rann of Kutch fall in this zone. Generally, the areas having trap rock or basaltic rock are prone to earthquakes.

Zone 4: This zone is called the High Damage Risk Zone and covers areas liable to MSK VIII. The IS code assigns zone factor of 0.24 for Zone 4. The Indo-Gangetic basin and the capital of the country (Delhi), Jammu and Kashmir fall in Zone 4. In Maharashtra, the Patan area (Koyananager) is also in zone no-4. In Bihar the northern part of the state like-Raksaul, Near the border of India and Nepal, is also in zone no-4 that "almost 80 percent of buildings in Delhi will yield to a major quake and in case of an unfortunate disaster, the political hub of India in Lutyens Delhi, the glitz of Connaught Place and the magnificence of the Walled City will all come crumbling down.

Zone 3: The Andaman and Nicobar Islands, parts of Kashmir, Western Himalayas fall under this zone. This zone is classified as Moderate Damage Risk Zone which is liable to MSK VII. and also 7.8 The IS code assigns zone factor of 0.16 for Zone 3.

Zone 2: This region is liable to MSK VI or less and is classified as the Low Damage Risk Zone. The IS code assigns zone factor of 0.10 (maximum horizontal acceleration that can be experienced by a structure in this zone is 10% of gravitational acceleration) for Zone 2.

III LITERATURE REVIEW

O.P. Gomse, S.V. Bakre (2011)

In the present study, the analysis of fixed base and base-isolated 3-D four storied building is performed. The behavior of building structure resting on the elastomeric bearing is compared with a fixed base structure under maximum capable earthquake. The isolation system consists of isolation pads between columns and foundation increase the fundamental natural period of vibration of the structure which reduces floor acceleration, inter-story drifts and base shear of the structure. It is very essential to estimate the accurate peak base displacements of the base isolated structure when it is subjected major earthquake near the location of the fault earthquake. In such cases, the isolator deforms excessively because near-fault earthquakes contain long period velocity pulses which may coincide with the period of the base isolated structures. To investigate the response of isolated structure bidirectional non-linear time history analysis were performed for G+4 storey structure designed as per UBC 97. From the comparative study, they concluded that base isolated shows best seismic response than the fixed base system. The base isolation technique is one of the best examples of the effective seismic resistance system.

A.B. M. Saiful Islam, Mohammed Jameel and MohdZaminJumaat (2011)

The base isolation takes the exact opposite approach than the design philosophy used for the earthquake resistant design. In this approach, base isolation tries to reduce the demand instead of increasing the capacity of the structure. Earthquake is transposed mechanism so we cannot control the earthquake but we can modify its demand of the structure by preventing the entry of the ground motions into the structure with the help of base isolation system. This study focuses on the practical significance of the base isolated system. The fundamental intention of seismic protection systems is to decouple the building structure from the damaging components of the earthquake like ground acceleration, i.e.to prevent the superstructure of the building from absorbing the earthquake energy. This study also focuses on the different types of the base isolation systems like Lead rubber bearing (LRB), high damping rubber bearing (HDRB), friction pendulum system (FPS) which has been critically explored. This study also addressed the detail cram on isolation system, roperties, characteristics of various device categories, recognition along with its effect on building structures and displacement and yielding are concentrated at the level of the isolation devices, and the superstructure behaves very much like a rigid body. igorous reckoning illustrated the isolation system as very innovative and suitable in buildings to withstand the seismic lateral forces and also contributed to safety ensuring flexibility of structures.

Ajay Sharma, R.S. Jangid (2009)

There are three basic characteristics of the base isolated system like increase the horizontal flexibility of the structure, energy dissipation and sufficient under small deformation. Structural response and isolator displacement are twokey parameters to decide the characteristics of an isolation system. To check isolator displacement, the stiffness of the isolation system is increased but such increase adversely affects the structural response, especially floor accelerations. They investigated the analytical seismic response of multi-story building supported on base isolation system under real earthquake motion.The superstructure is idealized as a shear-type fle ible building with lateral egree-of-freedom at each floor. The force-deformation behavior of the isolation system is modeled by the bi-linear behavior which can be effectively used to model all isolation systems in practice. The governing equations of motion of the isolated structural system are derived. The response of the system is obtained numerically by step-by-method under three real recorded earthquake motions and pulse motions associated in the near-fault earthquake motion. The parametric study is carried out using a different parameter like a variation of the top floor acceleration, understory drift, base shear and bearing displacement of the isolated under different initial stiffness of the bi-linear isolation system. It was observed that the high initial stiffness of the isolation system excites higher modes in base-isolated structure and generate floor accelerations and story drift. Such behavior of the base-isolated building especially supported on sliding type of isolation systems can be detrimental to sensitive equipment installed in the building. On the other hand, the bearing displacement and base shear found to reduce marginally with the increase of the initial stiffness of the initial stiffness of the isolation system.

R.S. Jangid (2005)

The analytical seismic response of multi-story buildings isolated by the friction pendulum system (FPS) is investigated under near-fault motions. The superstructure is idealized as a linear shear type flexible building. The governing equations of motion of the isolated structural system are derived and the response of the system to the normal component of six recorded near-fault motions is evaluated by the step-by-step method. The variation of top floor absolute acceleration and sliding displacement of the isolated building is plotted under different system parameters such as superstructure flexibilit , isolation period and friction coefficient of the FPS.The comparison of results indicated that for low values of friction coefficient there is significant sliding displacement in the FPS under near-fault motions. In addition, there also exists a particular value of the friction coefficient of FPS for which the top floor absolute acceleration of the building attain the minimum value. Further, the optimum friction coefficient of the FPS is derived for different system parameters under near-fault motions. The criterion selected for optimality is the minimization of both the top floor acceleration and the sliding displacement. The optimum friction coefficient of the FPS is found to be in the range of 0.05 to 0.15 under near-fault motions. In addition, the response of a bridge seismically isolated by the FPS is also investigated and it is found that there exists a particular value of the friction coefficient for which the pier base shear and deck acceleration attain the minimum value under near-fault motions

Fabio Mazzaand, Alfonso Vulcano (2004)

The comparative study between different base-isolation techniques, in order to evaluate their effects on the structural response and applicability limits under near-fault earthquakes, is studied. In particular, high-damping-laminated-rubber bearings are considered, in case acting in parallel with supplemental viscous dampers, or acting either in parallel or in series with steel-PTFE sliding bearings. A numerical investigation is carried out assuming as reference test structure a base-isolated five-stories reinforced concrete (R.C.) framed building designed according to Euro code 8 (EC8) provisions. A bilinear model idealizes the behavior of the R.C. frame members, while the response of the elastomeric bearings is simulated by using a viscoelastic linear model; a viscous-linear law and a rigid-plastic one are assumed to simulate the seismic behavior of a supplemental damper and a sliding bearing, respectively.

P. BhaskarRao and R. S. Jangid (2001)

The experimental shake table study for the response of structures supported on base isolation system under harmonic excitation is carried out. Two base isolation system laminated rubber bearing with steel plates and sliding bearing are designed and fabricated, these bearing are tested for their dynamic properties which are used for the design of isolated structural models of single and two storied steel frame structure. The response of the isolated structural system is compared with the corresponding response of the non-isolation system in order to investigate the effectiveness of the isolation system. The experimental results are compared with the analytical results to verify the mathematical force-deformation behavior of the isolation system. There was a good agreement between the experimental and analytical response of the structural models. In addition, the response of the isolated system is found to be less in comparison to the corresponding response without isolation system, implying that the isolation is quite effective in reducing the acceleration response of the system. The presence of restoring force device along with the sliding system reduces the base displacement without a significant increase in superstructure acceleration. In addition, the response of the structural models has also been investigated for a real earthquake ground motion and it has been found that the isolation devices are effective in reducing the seismic response of structures.

AratiPokhrel, Jianchun Li, Yancheng L, NicosMaksisd,Yang Yu (2016)

Lead rubber bearings are the improved version of laminated rubber bearing wherein a centrally located lead core is introduced. It provides in a single unit the combined features of vertical load support, horizontal flexibility and energy absorbing capacity whereas The FPS consists of a spherical stainless-steel surface and a slider, covered by a Teflon-based composite material. During severe ground motion, the slider moves on the spherical surface lifting the structure and dissipating energy by friction between the spherical surface and the slider. The parametric and comparative study between LRB and FPS is carried by considering different parameters like/roof acceleration, natural time period, drift, base shear and isolator displacement by performing time history analysis using data of the benchmark earthquake. They concluded that the base isolation system works as a flexible element as well as a sliding element that increases the fundamental period of the structure and preventsthe transmission of the earthquake force. For the structure to remain elastic, the limiting drift ratio is 0.5%. This limit value is over exceeded for all the ground motions when the structure is the fixed base. In contrast, when the structure is isolated, the superstructure remainselastic for three of the ground motions, whereas only for the Northridge 1994 ground motion the superstructure doesn't remain elastic.So, the nonlinear (inelastic)analysis is recommended.

Minal Ashok Somwanshi, Rina N. Pantawane (2015)

The aim of the base isolation technique is that it introduces flexibility in the structure. Which result, a strong medium-rise masonry or reinforced concrete building becomes extremely flexible. The isolators are designed to absorb energy and so add damping to the system which helps in further reducing the seismic response of the building. Numerous commercial brands of base isolators are available in the market, and many of them look like large rubber pads, although there are other types that are based on sliding of one part of the building relative to the other. For the most effective use of the base isolated system, a cautious study is required to identify the most suitable type of device for a particular building. Also, base isolation is not suitable for all buildings. Most suitable buildings for base-isolation are low to medium-rise buildings rested on hard soil underneath. High-rise buildings or buildings rested on soft soil are not suitable for base isolation. The comparative study between fixed and base-isolatedstructure is carried using different parameters like maximum shear force, maximum bending moment, base shear, and story drift and story acceleration. The effect of the base isolated system on the symmetrical and unsymmetrical structure is investigated under the strong ground acceleration.From the analytical study, they concluded that for all the models of the symmetrical as well as non-symmetrical buildings zero displacement at the base of the fixed building and in case of the isolated building considerable amount of lateral displacement seen at the base of the structure. As floor height increases lateral displacements of the fixed base building increase significantly as compared to the base isolated building.

Susan Paul, Dr. T. Sundararajan, Prof. Basil Sabu (2017)

The efficient seismic isolationof an actual structure is stronglydependant on the appropriate choice of the isolator devices, or systems used to provide adequate horizontal flexibility with minimal centering forces and appropriate damping. It is necessary to provide an adequate seismic gap which can accommodate all intended isolator displacements. A reasonable design displacement should be of the order of 50 to 400 mm, and possibly up to twice this amount if 'extreme' earthquake motions are considered. The expected life of an isolated structure will typically range from 30 to 80 years and its maintenance problems should preferably be no greater than those of the associated structure. The performance of different base isolation systems like lead rubber system, friction pendulum system and the combination of the system on a fourteen storied (G+13) reinforced concrete structure is carried out by using non-linear time history analysis. From the parametric study, it is observed that the displacement, acceleration, storey drift and base shear decreases whereas the time period of the base isolated structure increases when compared to the fixed base structure. FPS placed at exterior columns and LRB at interior columns are more efficient in terms of reduction of displacement, acceleration and storey drift of the multi-storied reinforced concrete structure. The base shear is considerably reduced in case of LRB than FPS and combination of both systems. LRB placed at exterior columns and FPS at interior columns efficiently increases the time period of the structure when compared to the opposite case of this combination. Friction Pendulum System isrelatively having lower bearing costs and lower construction costs than Lead Rubber Bearing, thus FPS having a greater number of friction

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pendulum bearings at the exterior columns can be provided to achieve the most efficient and economically feasible earthquake resistant structure.

IV METHODOLOGY

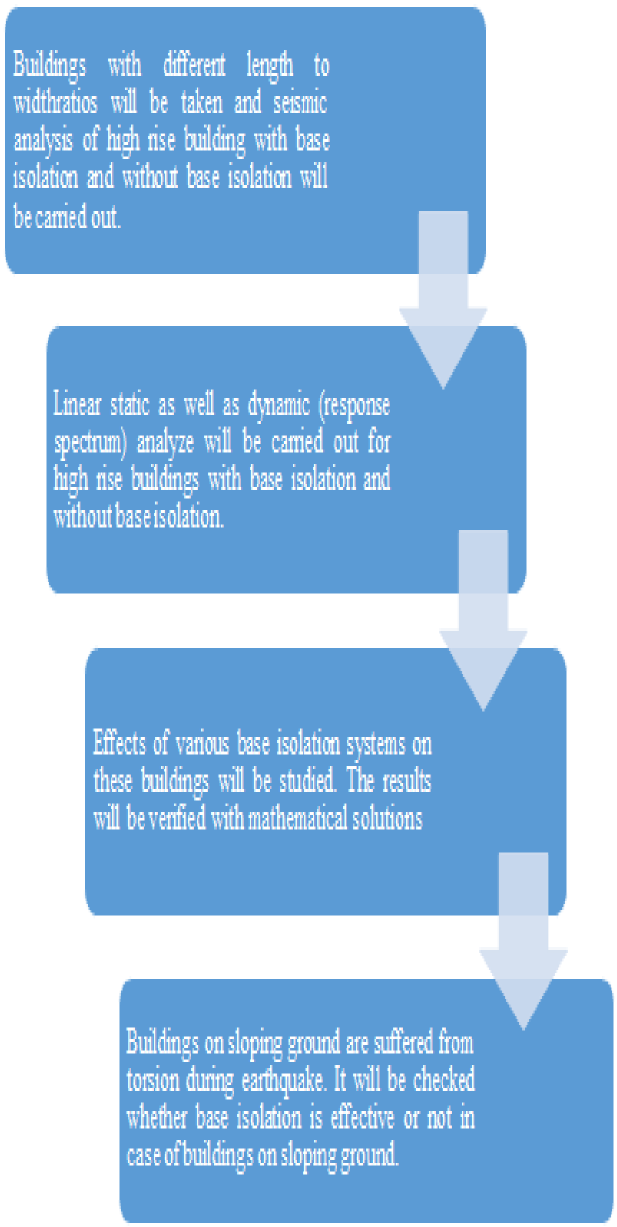


Fig: Flowchart of Methodology

V MODELLING & DESIGN

The buildings are modelled using the finite element software ETABS. The analytical models of the building include all components that influence the mass, strength, stiffness and deformability of structure. The building structural system consists of beams, columns, and slab. The non-structural elements that do not significantly influence the building behaviour are not modelled. Modal analysis and Response spectrum analysis are performed on models. In present work, 3D RC 9 storied buildings of 7 different dimension according to aspect ratio differ by 0.5 is taken which has area of 400 m^2 situated in zone III, is taken for the study in which two cases has been considered one with fixed base and second with base isolation using Lead rubber bearing.

Table 3.1 Buildings models descriptions

Model	Aspect Ratio	Sizes in Plan
Model-1	1	20mX20m
Model-2	1.5	16.3mX24.5m
Model-3	2	14.1mX28.2m
Model-4	2.5	12.6 mX31.6m
Model-5	3	11.5mX34.6m
Model-6	3.5	10.7mX37.5m
Model-7	4	10mX40m

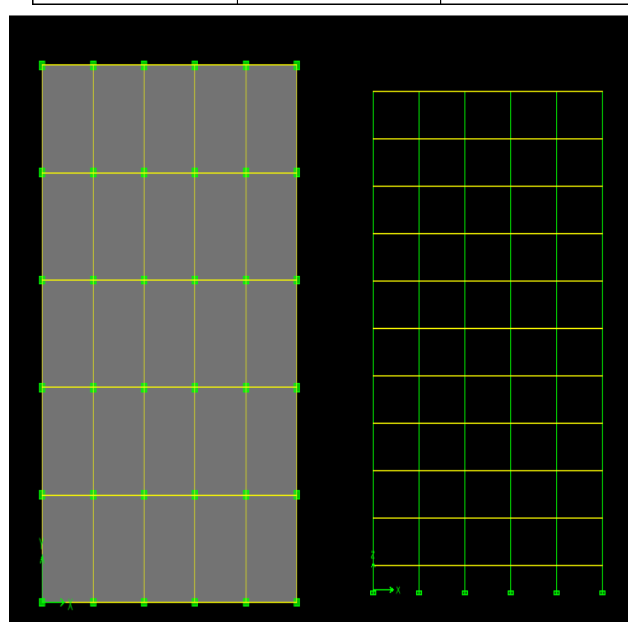
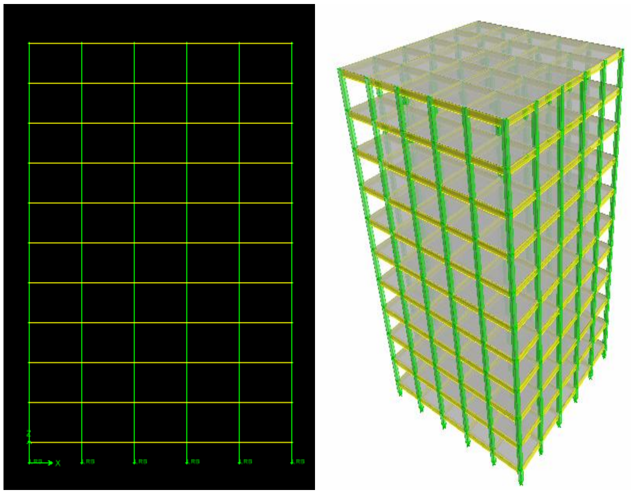
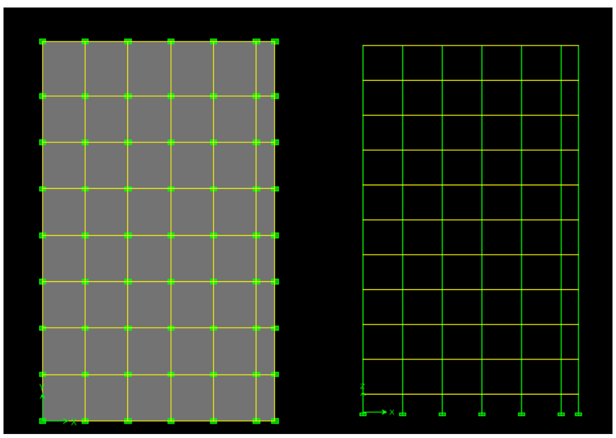


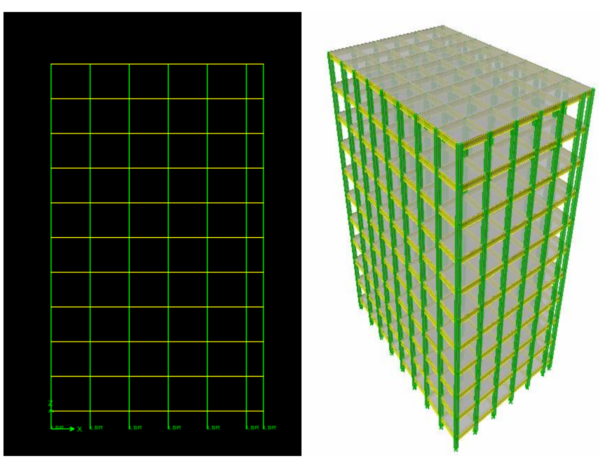
Figure Plan of Model1 Elevation of Model 1 with fixed base



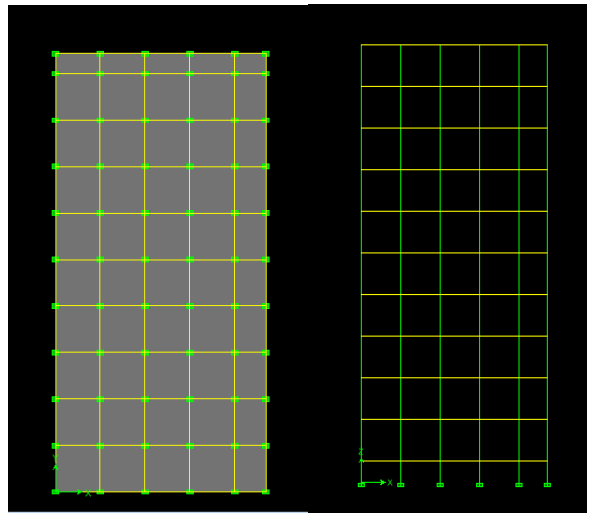
Elevation of Model 1 with isolated Base (LRB)3D rendered view of Model 1



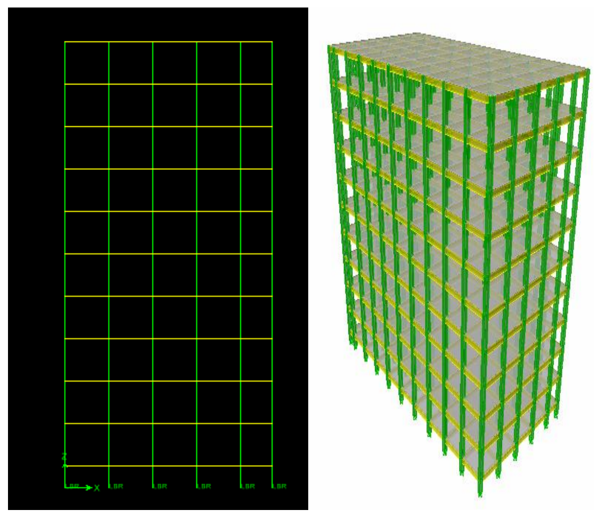
Plan of Model 2Elevation of Model 2 with fixed base



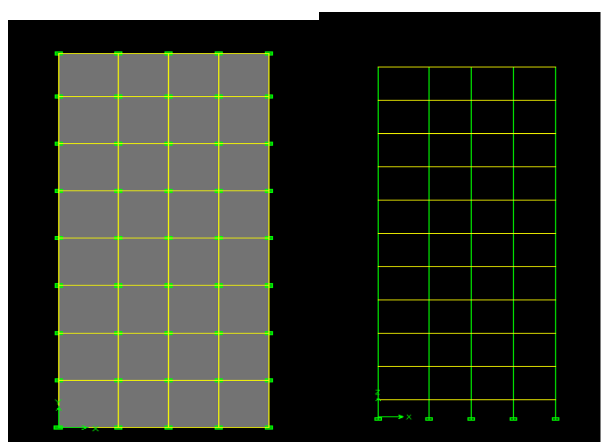
Elevation of Model 2 with isolated base (LRB)3D rendered view



Plan of Model 3Elevation of Model 3 with fixed base



Elevation of Model 3 with isolated base (LRB) 3D View



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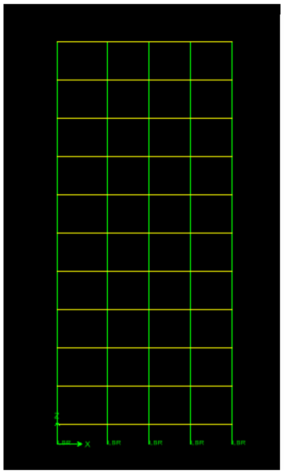
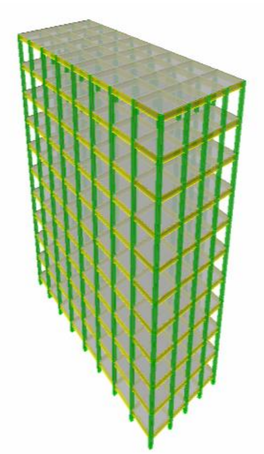
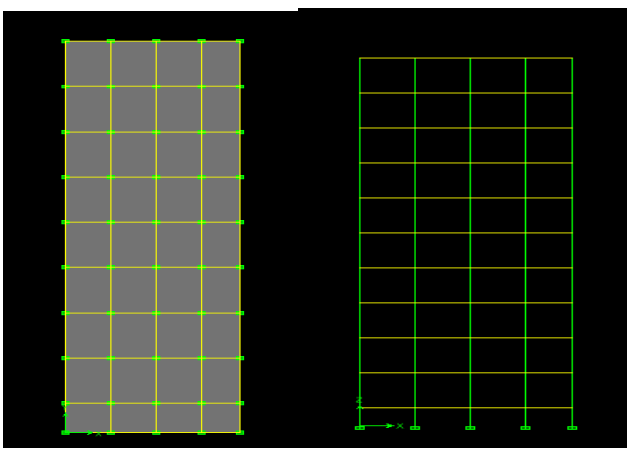
Plan view of Model 4Elevation of Model 4 with fixed base



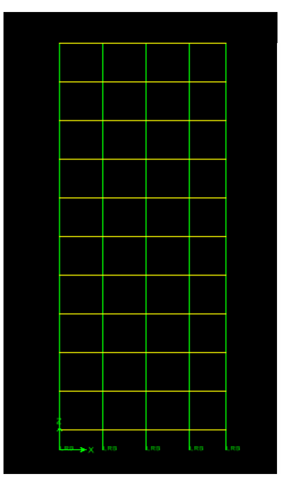


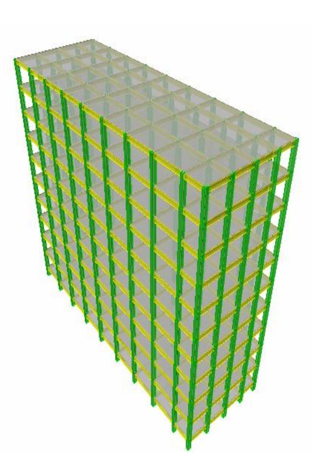
3D View

Elevation of Model 4 with isolated base (LRB)

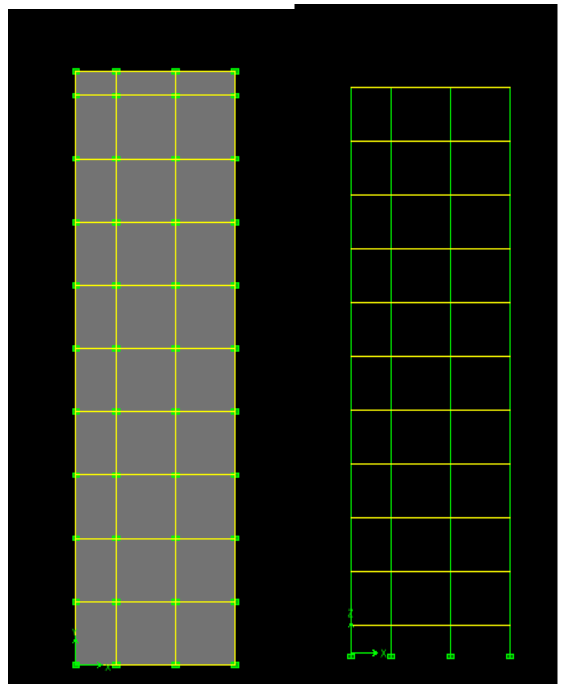


Plan view of Model 5 Elevation of Model 5 with fixed base

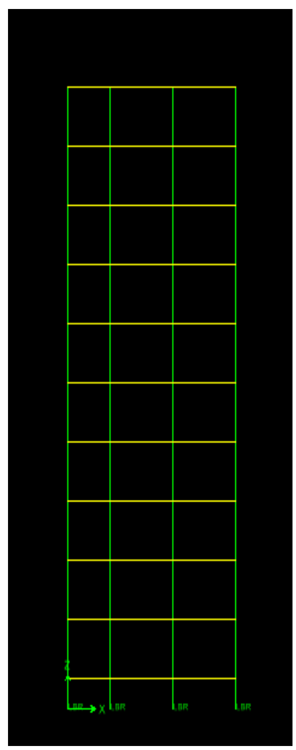


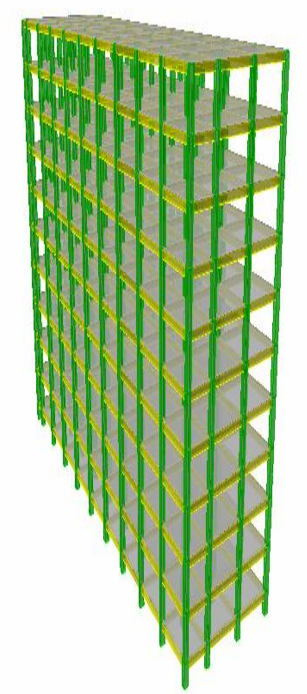


Elevation of Model 5 with isolated base (LRB)&3D

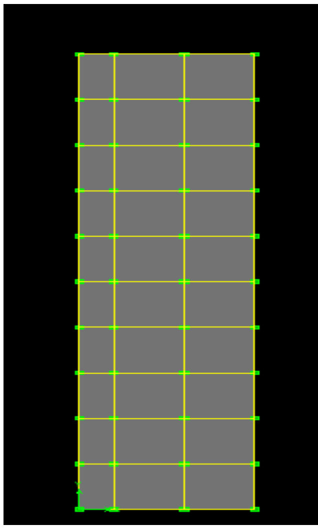
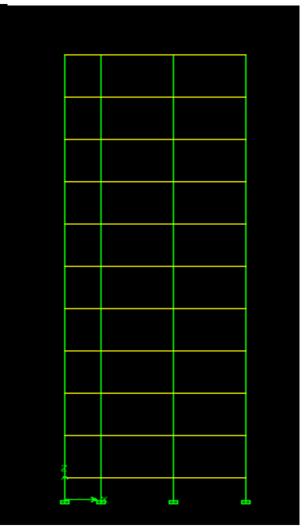


Plan view of Model 6 Elevation of Model 6 with fixed base

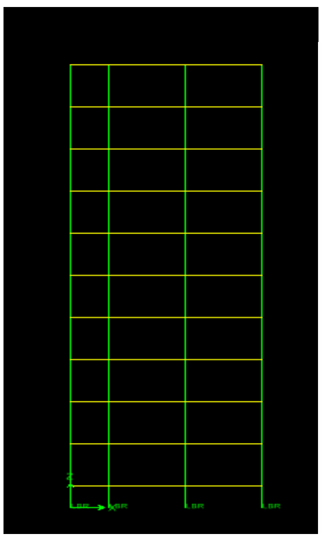
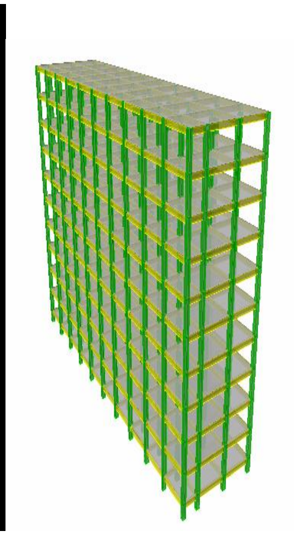




Elevation of Model 6 with isolated base (LRB)& 3D View

Plan view of Model 7Elevation of Model 7 with fixed base

Elevation of Model 7 with isolated base (LRB) &3D View

VI LOADS ACTING ON BUILDINGS

Gravity Loads

Gravity loads include self-weight of building, floor finish which is taken as 1.5 kN\m^2 and live load which is taken as 2 kN\m^2 as per IS 875(part-II) for a residential building that would be acting on the structure in its working period. We have also considered wall load as imposed load on internal beams as 7.5 kN\m^2 and on external beams 13kN/m^2

Lateral Loads

In contrast to the vertical load, the lateral load effects on buildings are quite variable and increases rapidly with increase in height. Most lateral loads are live loads whose main component is horizontal force acting on the structure. Typical lateral loads would be a wind load, an Earthquake load, and an earth pressure against a beachfront retaining wall. Most lateral loads vary in intensity depending on the buildings, geographic location, structural material, height and shape.

Earthquake Load

Earthquake loading is a result of the dynamic response of the structure to the shaking if the ground. Earthquake loads are another lateral live load. They are very complex, uncertain and potentially more damaging than wind loads. It is quite fortunate that they do not occur frequently. The Earthquake creates ground movements that can be categorized as a “shake”, “rattle” and “roll”. Every structure in an Earthquake zone must be able to withstand all three of these loadings of different intensities. Although the ground under a structure may shift in any direction, only the horizontal components of this movement are usually considered critical in analysis. The magnitude of horizontal inertia forces induced by earthquakes depends upon the mass of structure, stiffness of the structural system and ground acceleration.

Analysis Data for All Models:

1) Type of Building: RCC Framed Structure

2) Number of story: 11 (Plinth + Ground + 9 Floors)

3) Plan Size Different for each model

4) Floor to floor height: 3 m. (Total Height = 31.5 m)

5) Height of plinth: 1.5 m.

5) Depth of foundation: 3.0 m.

7) External walls: 230 mm thick

8) Internal walls: 115 mm thick

9) Height of parapet 1.5 m

10) Materials: M30, Steel Fe500

11) Loads:

a) Dead loads

i) Slab: 25 D KN/m2

D is depth (Thickness) of slab in meter.

ii) Floor finish: 1.5 KN/m2

b) Live load 2 KN/m2

12) Slab Thickness: 125 mm

13) Elastic Modulus of concrete 5000 $\sqrt{fck}$

14) Seismic zone III

15) Size of Beams 230 mm X 450 mm

16) Size of Columns 300 mm X 450 mm

17) Density of Concrete 25 KN/m^3

18) Density of brick masonry 18.85 KN/m^3

DATA VALIDATION

I. Dead load:

a) Floor Load Slab Load Self-weight of slab = 3.75 kN/m²
Floor finish = 1.5 kN/m²
Total Load = 5.25 kN/m²
Terrace Load Self-weight of slab = 3.75 kN/m²
Floor finish + Water proofing = 1.5 kN/m²
Total Load = 6.95 kN/m²

b) Wall Load External Wall of 230mm thick
Floor height = 4000 mm
Beam depth = 0.75 m
Total Load = [2 (4 – 0.75 – 0.75)6 + 2(4 – 0.15- 0.15)4] ×0.23 × 20 = 274.16 kN/m
Internal Wall of 115mm thick
Floor height = 4000 mm, Beam depth = 0.75 m
Total Load = [2 (4 – 0.75 – 0.75)6 + 2(4 – 0.15- 0.15)4] ×0.115 × 20 = 273.70 kN/m

c) Beam Load Longitudinal beam
Self-weight of beam = 25*.75*.3,
Total load = (6 × 5) × (4 – 0.75 -0.75) ×5.63 = 422.25 kN/m
Transverse Beam
Self-weight of beam = 25*.75*.3, Total load (4×7) × (4 – 0.75 -0.75) ×5.63 = 583.27 kN/m

d) Column Load
Self-weight of Column = 25*.75*.75*35, Total Load = 492.18 kN/m

e) Parapet wall
Total load = (24×2 + 16×2) ×0.115×20 = 184 KN

II. Live Load

Load on floor =24 × 16 × 0.5 ×4 = 768 KN

- Weight of floor
[2016 + 422.25 + 583.27+2×445.51+2×444.76+2×984.36]+768 =7537.85 kN
- Weight of roof
[2668.80 + 422.25 + 583.27 + 184 ×1 + 274.16 (4-0.75/2) + 273.70 (4-0.75/2) + 492.18 ×] + 0 =5732.05 KN
- Total Seismic weight of building = Weight of roof + 4*Weight of floor
= 5732.05 + 4 × 7537.85 =35883.45 KN

Seismic Load Calculation

Zone	2	3	4	5
Zone Factor	0.1	0.16	0.24	0.36
I	1.5			
R	5			
Soil Type	Soft			
h(m)	20			
W(kN)	35883.45			
Ta in X=0.075($h^{0.75}$)	0.709			
Sa/g=1.67/T	2.36			
A_h=ZI/2R*Sa/g	0.035	0.05	0.084	0.127
V_b in X=W*Ah (kN)	1255.9	2045	3014	4557

VII CONCLUSION

1) From the analysis it is found that the lateral displacement in both X and Y direction increases around 20% with LBR base isolation building as compared to fixed base building which makes building more ductile. Also lateral displacement in both directions is minimum for the aspect ratio 1.5 and 2.
2) From analysis, it has been concluded that there is decrease of around 25% in over-turning moment of isolated base as compared to fixed base. Over turning moment is least for model i.e. with aspect ratio 1.
3) From analysis results, it has been concluded that there increase in time period of isolated base as compared to fixed base of around 25% which makes structures falls out of earthquake resonance range. Model 2 with aspect ratio 1.5 has minimum time period and model 1 with aspect ratio 1 has maximum time period.
4) From above analysis results it has been concluded that maximum story drift increases for all models with base isolation as compares to fixed base case, but drift decreases considerable in upper stories which makes structures safer during earthquakes. Overall model 2 and 3 with aspect ratio 1.5 and 2 has minimum drift values.

5) Overall LBR bas isolation system increases structure response during earthquakes and with aspect ratio point of view model 2 and 3 are best suitableconfiguration with aspect ratio of 1.5 and 2From analysis, it has been concluded that there is decrease of around 20% in base shear of isolated base as compared to fixed in both X and Y directions. Model 1 i.e. aspect ratio 1 and model 7 i.e. with aspect ratio 4 has minimum base shear.

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REFERENCES

[1]. Y. Rajesh Kumar, "Comparitive Study Of Base Isolators And Viscous Fluid Dampers On Seismic Response Of Rc Structures"; Volume 9, Issue 8, August 2018, pp. 798–806, Article ID: IJCIET_09_08_081

[2]. Mohit M. Baruwala, Prof. A. R. Darji and Dr. KaushalB.Parikh, "Seismic Performance Of Building With Base Isolation, Damper And Braced System:A Review"; Scientific Journal of Impact Factor (SJIF): 4.72, Volume 4, Issue 11, November -2017

[3]. AlirezaHeysami, "Types of Dampers and their Seismic Performance during an Earthquake"; Current World Environment Vol. 10(Special Issue 1), 1002-1015 (2015).

[4]. Evaluation of Structural and Economic Implications of Incorporating Base Isolator as Earthquake Protection Device in Buildings in Dhaka [Master's Thesis]. Dhaka, Bangladesh: Bangladesh University of Engineering and Technology (BUET). p. 118.

[5]. A. B. M. S. Islam, R. R. Hussain, M. Z. Jumaat, and M. A. Rahman, "Nonlinear dynamically automated excursions for rubber-steel bearing isolation in multi-storey construction," *Automation in Construction*, vol. 30, pp. 265–275, 2013

[6]. A. B. M. S. Islam, R. R. Hussain, M. Jameel, and M. Z. Jumaat, "Non-linear time domain analysis of base isolated multi-storey building under site specific bi-directional seismic loading," *Automation in Construction*, vol. 22, pp. 554–566, 2012.