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# "LATERAL LOAD ANALYSIS OF RC BUILDING WITH SHEAR WALL AND BASE ISOLATION"

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**Abstract:** Earthquake is the frequently occurring vibration of earth surface which results in damaging of structures and causes loss of lives. This leads to need of structural design based on seismic responses by adopting suitable methods to increase strength and stability of structures. The concept of isolator in building at base level reduces the possibility of resonance of the structures and increases the time period of the structure giving rise to better seismic performance of the building. In this thesis an attempt is made to study the effectiveness of building G+ 10 storey with fixed base, base isolator and shear wall. A total of 4 models are prepared, analysis is carried out by Equivalent static method and Response spectrum method in seismic zone-V with soil condition medium. The lead rubber bearing (LRB) system is designed as per UBC97 and the same was used for analysis of base isolation system. The results obtained from the analysis were storey displacement, storey drift, time period and base shear. The base shear is decreases with presence of base isolation. Results time period, displacement, storey drift and base shear are compared for building with fixed base, shear wall, base isolators and base isolators with shear wall.
Keywords: shear wall, Base isolation, Equivalent static method, displacement, drift, Base shear.

## Introduction:

Isolation systems for a base typically include a bearing to permit horizontal movement, a damper to limit magnitude of any oscillations, and elements to maintain structural integrity in face of lateral forces. A stiff bearings member can transmit loads both vertically & laterally. Period of base isolation system and the super structure, including therefore whole structure, are altered by this behavior, which helps to reduce inertia forces. In conventional buildings, the reduction of inertia forces relies upon building's dynamic properties, whereas in seismically isolated structures, it depends on the form of the response spectra curve.

**1.1 Base Isolation:** It is amongst most often used methods of preventing damage to buildings during earthquakes.

**1.2 Types of Base Isolators:** The total mass as well as efficient stiffness of building must be taken into account when deciding on an appropriate seismic isolation method. Isolators may be broken down into the following categories.

**1.3 Laminated Rubber bearings (Elastomeric bearings**): It consists of a series of rubber rings with steel shim plates glued in between. Overall rubber thickness offers horizontal stiffness necessary to effect period shift, while distance between steel shim plates determines bearing's vertical stiffness. These laminated rubber bearings are of three types. 1. Natural rubber bearing 2. Lead plug rubber bearing 3. High damper rubber bearing.

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**Fig-1: Elastomeric Bearing**

**1.4 Natural Rubber Bearings:** As can be seen in Figure 2, rubber bearings consist of two steel endplates and a large number of thin steel shims interbedded with rubber. Horizontal stiffness is dictated with shear modulus of elastomer, and steel shims may offer capability of vertical stiffness. Up to shear loads greater than 100%, material exhibits a high degree of linearity with damping values in 2%-3% range, indicating perfectly linear behavior in isolators.

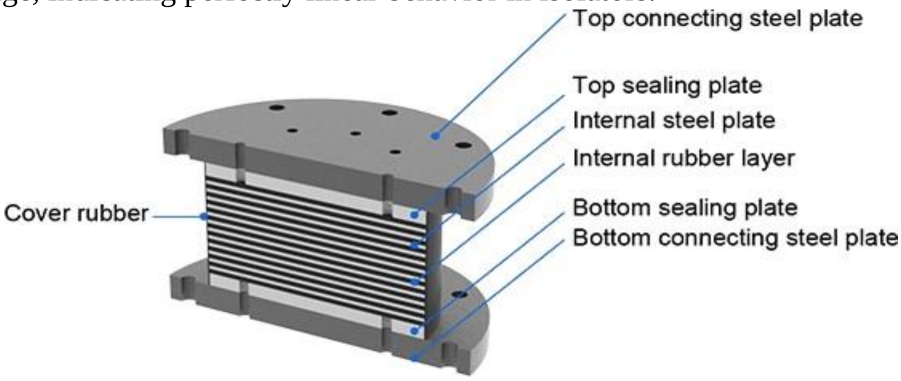


**Figure 2:- Natural Rubber Bearing**

**1.5 Lead Rubber Bearing (LRB):** Steel plates, rubber layers, & lead core are the 3 basic components of an LRB. The steel layers give vertical rigidity while rubber layers provide device with significant lateral flexibility, much as steel shims in natural rubber bearings. The lead core is component that will provide the isolators with additional rigidity & system with enough damping. Bearing LRB is seen in Fig.

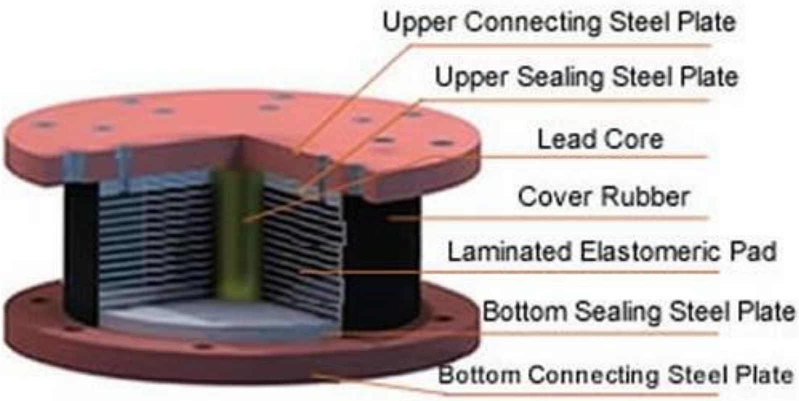


**Figure 3:- Lead Rubber Bearing**

**1.6 Shear Wall:** A shear wall is wall built to withstand shear loads caused by lateral forces. The shear wall design for tall structures is required by several regulations. When there is a discrepancy of over thirty percent between building's area & the loads acting upon structure, shear walls are installed to prevent damage. Concrete walls help to keep structure's center of mass & its center of stiffness within a 30% tolerance, meaning that lateral forces acting on it should be minimal. These shear walls are continuous from basement to the whole height of structure. Shear walls are often given throughout both length & width of structures, while they are angled vertically like broad beams

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to transport earthquake stresses downwards to foundation. Special attention must be paid to the details of shear walls in buildings situated in active seismic zones. Shear walls are straightforward to build since the reinforcing details of walls is basic and straightforward. Both structural & non-structural components may be protected against earthquake damage by erecting shear walls, which are also cost- effective to build.


**Fig 4: Shear wall**

**1.7 Functions of Shear Walls:** For withstanding against horizontal earthquake stresses, shear walls need to possess sufficient lateral strength. If shear wall is strong enough, horizontal forces shall be transferred to element below it in load path. Other shear walls, floors, or footings etc might also be comprised in loading path. Additionally, shear walls prevent the ceiling or floor above from swaying too far to one side by providing lateral rigidity. Floor & roof framing members won't be able to shift on their supports if shear walls are rigid enough.

## LITERATURE REVIEW:

**2.1 Thriveni P, Dr Manjunath N Hegde:** Results for buildings with a fixed foundation, a base isolator (rubber isolator), & shear wall are investigated. Here, a building with an irregular layout (G+7) is examined in detail. For seismic zone IV utilizing ETABS with consideration for type II (medium) soil. Both equivalent static approach & response spectrum method are used for the analysis.

**Conclusions are given as:**

When comparing construction time of a structure with fixed basis to one with a base isolator, latter shows a 31% improvement. As a result, buildings equipped by isolator fare better during earthquakes than those with a permanent basis.

When comparing the response spectrum analysis to the corresponding static method analysis, base shear is reduced in the former.

**2.2 M. Rajesh Reddy, Dr.N. Srujana, N. Lingeshwaran:** This research was conducted to examine performance differences between multi-story RC frame buildings with fix base & those with base isolation system. In the research, two buildings are taken into account, the first being a G+5structure& second a G+17structure. For this study, we used the same standards to LRB& friction pendulum system as were utilized for study of base isolation system in UBC97& ASCE07.

**Conclusions can be given as**

As shown by the findings, LRB&FPS are effective in dampening structural reactions.

When compared to permanently installed base, both isolators lessen impact of shear on foundation.

Both fixed-base and isolated structures now have longer time periods.

**2.3 Abhilash Naik,Dr. Savita Maru:** In this research, lead rubber bearings are employed to isolate the foundation from the shear wall & bracings of underlying structure. The G+30, G+35, &G+40 floor plans are examined. To investigate the performance of buildings containing lead rubber base isolation systems, static and linear dynamic (response spectrum) analyses are carried out. The design & analysis work is done in ETABSv2019.

**Conclusions can be given as**

Results from both fixed &LRB base models indicate that LRB base structure choice is preferable.

Displacement values of floors are well below allowed limitations set by code, making an LRB base structure optimum choice for tall structures.

**2.4 Ms. Minal Ashok Somwanshiet.al:** Modeling and analysis of a 13-story stiff jointed plane frame are the focus of this study. The first scenario has a constant base, whereas the second has a distinct base. The ground motion recordings from the Bhuj earthquake are modeled and analyzed with the help of E-TABS software. E-TABS analysis determines the maximum vertical response. Rubber bearings for buildings are hand-drawn with vertical.

**Conclusions can be given as:**

When comparing base isolated structure mode to fix base structure mode, it was found that maximal shear force, bending moment, storey accelerating, and base shear all decreased, but lateral displacements increased for bottom storey and subsequently decreased progressively for the top storey.

**2.5 Osama Ahmed, Dr.s.Amaresh Babu:** By observing the impacts of seismic resistance devices as shear walls, bracings, and base isolators upon seismic parameters, this research of asymmetrical structures in the near-fault zone is grounded in NL-THA. Static seismic tremor stacking & NL-THA were conducted utilising ETABS 15 on five-, ten-, and fifteen-story RCC moment restricting housings subjected to gravity loads (dead weight and living weight). The effectiveness of earthquake control devices in near deficient districts was tested using four models. Model 2 implements shear dividers, Model 3 includes a base isolator, & Model 4 finishes the bracings. Model 1 served as the fundamental model. Time series analysis employs seismic tremor information/data gleaned from a study of the "Loma Prieta (1989)" ground motion data.

**Conclusions can be given as:**

When comparing the basic model for 5, 10, and 15 stories during near-fault ground movements, asymmetric buildings with a bracing system reduced story drift by up to 27%, while increasing base shear & base torsion by upto 60%. Compared to base isolators & shear walls, bracing mechanism seems to be unsuccessful.

**2.6 Chandak N.** The primary goal of this research is to examine how dynamic analysis of a multi-story RC structure with a fixed & isolated base condition varies when various codes are utilized. A symmetrical building (SB) & unsymmetrical building (UB) having torsional irregularity are used as examples, respectively. Elastic analysis using SAP2000 is used to assess the buildings' reactivity to earthquakes. The results of research show that, regardless of whether building's foundation is fixed or isolated, the values specified by IS code are greater than those specified by Euro code.

**Conclusions can be given as:**

A longer duration ensures that a building with an isolated foundation is taken out of the earthquake's resonance range entirely.

The greater time period results in lesser acceleration acting upon structures, therefore base shear, relative drift, & torsion values are sufficient for buildings with base isolation.

**2.7 Mr. Sushant Tripathi, Mr. Sitender, Mr. Anil Kumar:** One of the most popular and commonly used seismic protection technologies is the base isolation approach. The research done so far utilizing base isolation was used to create a survey. The search for previous studies dealing only with high- rise structures is summed up in this study. Different kinds of bearings utilized for base isolation in multi-story structures & their reactions are highlighted in literature. There were analytical as well as empirical efforts published to examine various architectures with fixed base as well as isolated base, respectively. Multiple Friction Pendulum System, a suggested isolator, has been tested on shaking table and with full-scale components to determine its efficacy and durability. Shaking table experiments demonstrate as MFPS isolator reduces acceleration response by 70-90% comparing with fixed base construction when subjected to various forms of ground vibrations.

**Conclusions can be given as:**

Performance of a fixed basis or isolated base construction is clearly reliant upon kind of soil upon that it sits, as shown by literature review.

The reaction is somewhat pleasing for hard strata, but ground acceleration is amplified in soft soil, reducing energy dissipation & increasing frequency.

## OBJECTIVES OF STUDY:

1. Analysing seismic response of multi-storey building of G+10 with fixed base, shear wall, and Base isolators.
2. Determining seismic efficacy of LRB base with shear wall.
3. Comparing the parameters as Base shear, Time period, Displacement, Storey drift for seismic Zone V for building of G+10 with fixed base, shear wall, base isolators and base isolators with shear wall.

## METHODOLOGY:

In this research, we focus on G+10 (eleven-story) reinforced concrete moment- resisting frame structures that have a fixed foundation, a shear wall, and base isolation. Both case with base isolation and the one without employ the same attributes. Utilizing lead rubber bearings (LRB), the dynamic properties of base- isolated structures are studied. The Etabs program is used for the analysis. All models are put through a Response spectrum analysis. Tabulated findings are used to analyze factors such lateral movement, base shear, time, and drifts between floors.

### 4.1 ANALYTICAL MODELLING:

1. In current research effort is carried out to investigate seismic effect on RC framed building with shear wall, with and without base isolators.
2. The analysis of G+10 RC framed building is performed utilising Etabs software.
3. Lateral load analysis is carried out on different types of structures.
4. Analysis is carried out in Zone-V.
5. The type of soil is taken for analysis is medium soil.
6. After analyzing different models in Etabs software parameters like lateral displacements, base shear, Time period, inter-storey drifts& storey shear force is noted.
7. Finally, the results obtained for different models are compared.

**4.2 Description of Models:** Total 04models were prepared for seismic study of RC framed regular building.

Model-01: A RC framed building with G+ 10 storeys with fixed base.

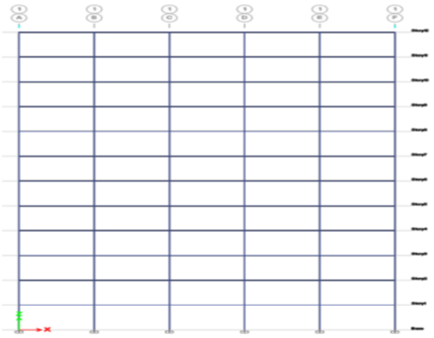
Model-02: A RC framed building with G+ 10 storey with fixed base andshear wall.

Model-03: A RC framed building with G+ 10 storey with Lead rubberbase isolation.

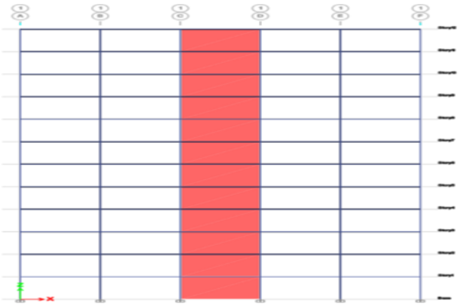
Model-04: A RC framed building with G+ 10 storey with shear wall andLead rubber base isolation.

**4.3 Modelling different types of model in Etabs:**

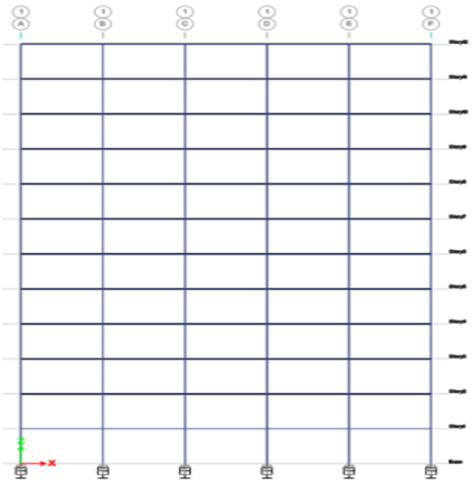
**Model-01:** A RC framed building with G+ 10 storeys with fixed base



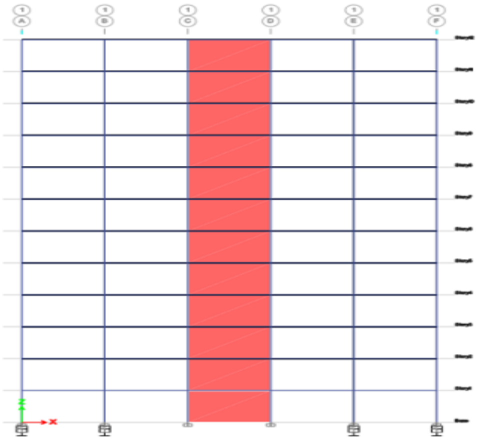
**Model-02:** A RC framed building with G+ 10 storey with fixed base and shear wall.



**Model-03:** A RC framed building with G+ 10 storey with Lead rubber base isolation



**Model-04:** A RC framed building with G+ 10 storey with shear wall and lead rubber base isolation



**4.4 Details of Structures:**

| | |
|---|---|
| Grade of concrete | M30 |
| Grade of Steel | Fe500 |
| Storey height | 3.6m |
| Beam size | 300 mm x 600 mm |
| Column size | C1-650mm x 650 mm<br>C2-550 mm x 550 mm<br>C3-500 mm x 500 mm |
| Slab thickness | 150mm |
| Wall thickness (main wall) | 230mm |
| Wall thickness (partition wall) | 100mm |
| Shear wall thickness | 230mm |
| Density of Brick masonry | 20 KN/m³ |
| Live load | 3.5 KN/m² |
| Floor Finish | 1KN/m² |
| Seismic zone | 5 |
| Importance factor | 1.0 |
| Soil type | Medium |
| Building Type | SMRF With Shear Wall |

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**4.5 Design of base isolators**: Analysis was performed using a lead rubber bearing isolator as the basic type, and design characteristics of isolator were obtained in manner described below.

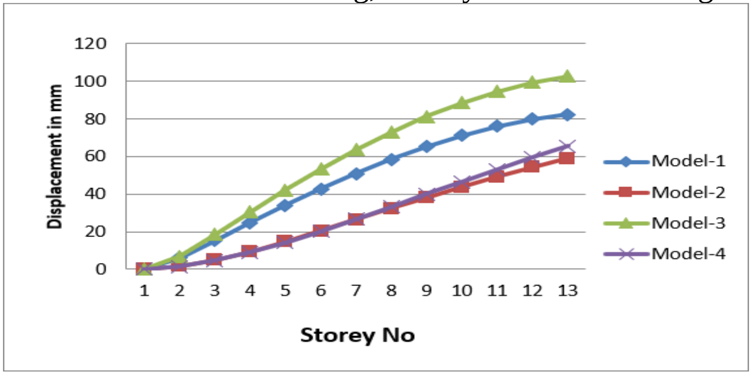
| | |
|---|---|
| Rotational Inertia | 0.154057 |
| For U1 Eff Stiffness | 3016280 KN\m |
| For U2 & U3 Eff Stiffness | 3016.280 KN\m |
| For U2 & U3 Eff Damping | 0.05 |
| For U2 & U3 Distfrom End J | 0.003294 |
| For U2 & U3 Eff Stiffness | 30433.9 KN\m |
| Yield Strength | 100.26 KN |

**4.6 Methods of Seismic Analysis:** Some of Seismic Analysis Approaches may be categorized according to linear and non-linear methods. Linear methods include linear static and equivalent static force methods & linear dynamic & response spectrum techniques. The following are some examples.

1. Equivqlent static analysis
2. Response spectrum analysis
3. Pushover Analysis
4. Time history Analysis

**RESULTS AND DISCUSSION:** For evaluation four RC building models seismic load that is equivalent static method & Response spectrum method is applied. Analysis of all distinct building models is finished via the usage of ETABs 2020 software program. The evaluation effects along with displacements, storey drifts, time period, & base shear of all constructing models are supplied and as compared.

**5.1 Displacement:** Storey displacement is defined as its displacement of considered floor with reference to base of building, usually base of a building being aground.




**Graph 1:** Displacement in mm for four models because of **Equivalent staticmethod** along X & Y direction.

From the graph its noticed as storey displacement for model-1 is 82.415mm compared to model-2. Model-1 with fixed base shows higher displacement compared to model-2 when we add shear wall in model-2 the displacement is reduced by 28.25% along X and Y-direction. When we provide base isolator i.e Lead Rubber Bearing in model-3 the displacement gets increases by 19.75%, and when we move towards Model-04 i.e shear wall with base isolator the displacement gets decreases by 20.48% compared to model-1 along X & Y- direction.

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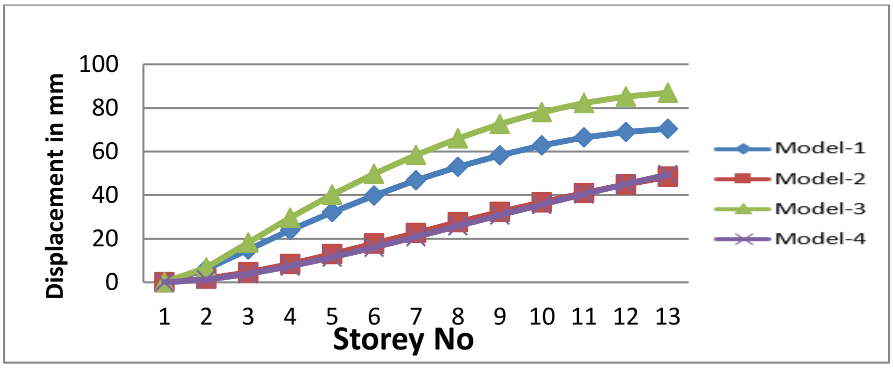
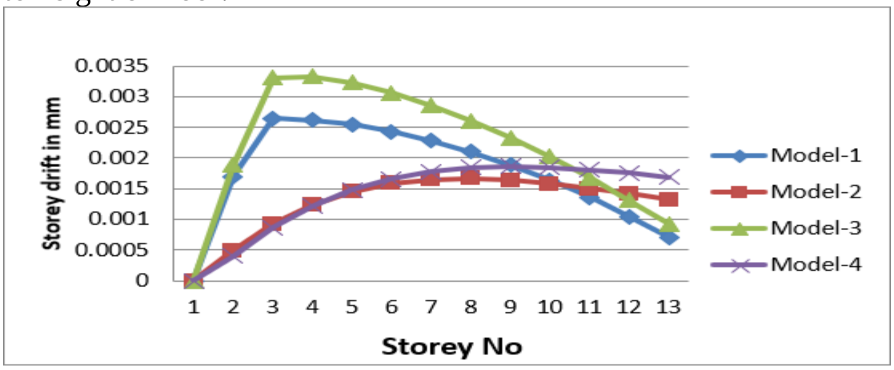



**Graph2:** Displacement in mm for four models because of Response Spectrum method along X and Y direction

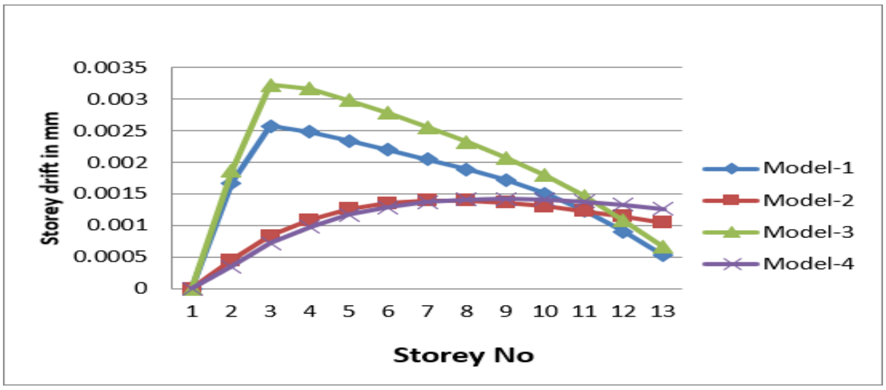
From the graph its noticed as storey displacement for model-1 is higher compared to model-2. Model-1 with fixed base shows higher displacement, when we add shear wall in model-2 the displacement is reduced by 31.20% compared to model-1. When we provide base isolator i.e Lead rubber bearing in model-3 the displacement gets increases by18.98%, and when we move towards model-4 in which shear wall and Base isolators are provided the displacement gets decreases by 28.94% compared to model-1 along X and Y direction.

**5.2 Storey Drifts:** It is outlined because the quantitative relation of movement of 2 successive floors to height of floor.




**Graph 3:** Storey drift for four models due to Equivalent static method along X & Y direction

From graph its noticed as storey drift for model-1 is lower compared to other models. When we add shear wall in model-2 the storey drift is increases by 46.49% along X and Y-direction. When we move towards model-3 in which Base isolators are provided the storey drift increases by 23.35% and when we move towards model-4 in which shear wall with base isolators are provided the storey drift gets increases by 58% compared to model-1 along X & Y direction.




**Graph 4:** Storey drift for four models because of **Response spectrum method** along X & Y direction

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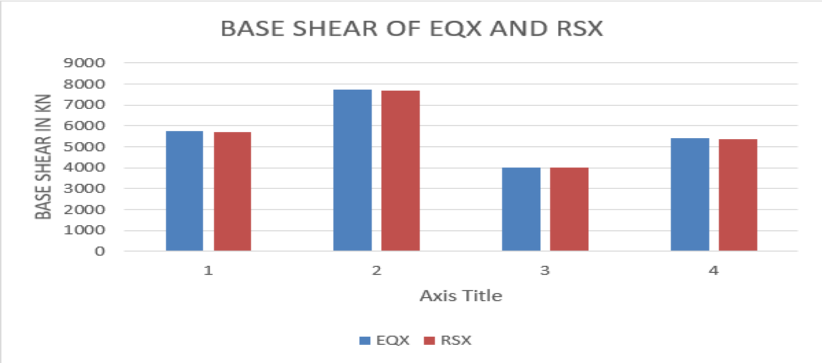
By graph its noticed as storey drift for model-1 is lower compared to other models. When we add shear wall in model-2 the storey drift is increases by 50% along X and Y-direction. When we move towards Model-3 in which base isolators i.e Lead rubber bearing is provided the storey drift gets increases by 20.78%, and when we move towards model-4 where shear wall and base isolators are provided the storey drift gets increases by 58.63% compared to model-1 along X and Y direction.

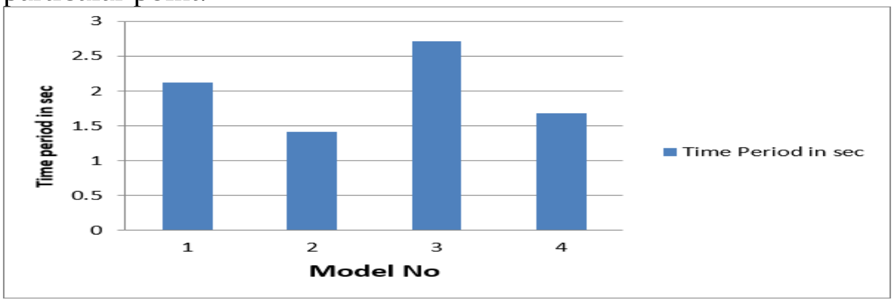
**5.3 Base shear:** It's an approximation of most anticipated lateral forces so as to arise because of seismic floor movement at the bottom of a structure.




**Graph 5:** Base shear for four models because of Equivalent static method & Response Spectrum Method

From graph it's observed as base shear for model-1 is 5747.53KN. When we add shear wall in model-2 the base shear gets increases by 25.45% compared to model-1. When we add base isolators i.e Lead rubber bearing in model-3 the base shear gets decreases by 30.02% and when we add shear wall and base isolators in model-4 the base shear gets decreases by 6.03% compared to model-1 due to EQX and RSX.

**5.4 Time Period:** Its described as time it takes for completing a cycle of vibration to move to very particular point.




**Graph 6:** Time period for four models because of Equivalent static methodalong X & Y direction.

From graph its noticed as time period for model-1 is 2.125sec when we add shear wall in model-2 time period get reduced because presence of shear wall the time period reduced by 33.50% compared to model1. When we provide base isolators i.e lead rubber bearing in model-3 the time period gets increases by 21.875% and when we move toward model-4 in which shear wall and base isolators are provided the time period gets decreases by 20.89% compared to model-1 along X and Y direction

**OBSERVATION AND CONCLUSION:**

**6.1 OBSERVATIONS:**

1. When we provide base isolators, we see that time duration lengthens.
2. Base shear value is shown to decrease when base isolators are made available.
3. When supplying base isolators, it is shown that storey drift rises.
4. The supply of base isolators is shown to enhance the observed displacement.
5. Model 4 has a base isolator & shear wall, both of which decrease movement.
6. When we provide base isolation using a shear wall, we see that time period lengthens

**6.2 CONCLUSIONS:**

1. Building's completion time was lengthened by 21.875% when a foundation isolator was installed. The improved seismic performance of the building is due to the base isolator.
2. Displacement in building is greater if a base isolator is installed as opposed to a fixed base and a shear wall.
3. Because base shear is minimized in base separated buildings comparing with fixed base buildings, the seismic response of base isolated buildings is superior eith fixed base buildings.
4. By providing base isolation in model-3 shows best performance under seismic forces as it shows less base shear compared to other models
5. Lastly, its stated as when LRB is given as a base isolation system, structure becomes more earthquake-resistant, requires less reinforcing, and is more cost-effective

**REFERENCES**

1. **Thriveni P, Dr Manjunath N Hegde** :Comparison of Seismic Behaviour of Building with Fixed Base, Base Isolator and Shear Wall International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056 Volume: 03 Issue: 10 | Oct -2016
2. **M. Rajesh Reddy, Dr.N. Srujana, N. Lingeshwaran:** Effect of Base Isolation in Multi-storeyed Reinforced Concrete Building: International Journal of Civil Engineering and Technology (IJCIET) Volume 8, Issue 3, March 2017.
3. **Abhilash Naik,Dr. Savita Maru**:Seismic Analysis of High-Rise Building Having Lateral Load Resisting Elements with and Without Base Isolation:International Journal for Research in Applied Science & Engineering Technology (IJRASET**)** Volume 10 Issue IV Apr 2022.
4. **Ms. Minal Ashok Somwanshi and Mrs. Rina N. Pantawane:** Seismic Analysis of Fixed Based and Base Isolated Building Structures:International Journal of Multidisciplinary and Current Research ISSN: 2321-3124 Available online 28 July 2015, Vol.3 (July/Aug 2015 issue)
5. **Osama Ahmed, Dr.s.AmareshBabu:** Analysis Of Asymmetrical Buildings With Base Isolator, Shear Wall And Bracing System Located At Near Fault Region Using Non Linear Time History: International Journal of Engineering Development and Research (www.ijedr.org)Volume 7, Issue 4 | ISSN: 2321-9939
6. **Chandak N. R:**Effect of Base Isolation on the Response of Reinforced Concrete Building:Journal of Civil Engineering Research 2013, 3(4): 135-142
7. **Mr. Sushant Tripathi, Mr. Sitender, Mr. Anil Kumar:**Base Isolation in Multi- storey Buildings: A Review: International Research Journal of Modernization in Engineering Technology and Science (Peer-Reviewed, Open Access, Fully Refereed International Journal) Volume:04/Issue:08/August-2022
8. **Nithin A V, Jayalekshmi R:** Seismic analysis of Multi Storey RC Buildings Supported on Single and Combined Base Isolation Systems:International Journal of Scientific & Engineering Research Volume 8, Issue 11, November-2017
9. **Ameer QasimSuhail,Dr. K. Sandeep Kumar**: Study of Effect of Shear Walls on Seismic Behaviour of High-Rise RCC Buildings by Using ETABS: International Journal of Innovative Research in Science,Engineering and TechnologyVol. 8, Issue 3, March 2019
**10.** **Mahmoud Fakih, Jaafar Hallal, Hassan Darwich and HalaDamerji**:Effect of Lead-Rubber Bearing Isolators in Reducing Seismic Damage for a High-RiseBuilding in Comparison with Normal Shear Wall System:SDHM, 2021, vol.15, no.3 **IS CODES**