STUDY OF SEISMIC PERFORMANCE OF THE BUILDING WITH LEAD-RUBBER BASE ISOLATION

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ABSTRACT

The following study represents how the effectiveness of the performance of the tall building is enhanced by introducing base isolation.

In the current situation it is a most important to find out the proper solution to safeguard the tall building against the seismic forces so, to achieve this we are introducing 'Lead-Rubber base isolation' in G +10 story building and we are going to analyses this building by using 'Etabs 2013 Software' used. The analysis is done by using IS 1893-2016.

The main aim of this study is to analyses the effect of the applied base isolation on the seismic performance of the building through drift base reaction and column moment.

Keyword : - : *Lead-Rubber Base isolation,, Limit Static Method, Dynamic Method, Moment, Storey Drift, Displacement, Base Isolation.*

INTRODUCTION:

1.1 Introduction of the project work:

Base isolation is one of the most popular means of protecting a structure against earthquake forces. It is one of0020the most powerful tools of earthquake engineering pertaining to the passive structural vibration control technologies. It is easiest to see the principle at work by referring directly to the most widely use of these advanced techniques, known as Base Isolation. A base isolated structure is supported by a series of bearing pads, which are placed between the buildings and the building foundation

The concept of base isolation is explained through an example of building resting on frictionless rollers. When the ground shakes, the rollers freely roll, but the building above does not move. Thus, no force is transferred to the building due to the shaking of the ground; simply, the building does not experience the earthquake.

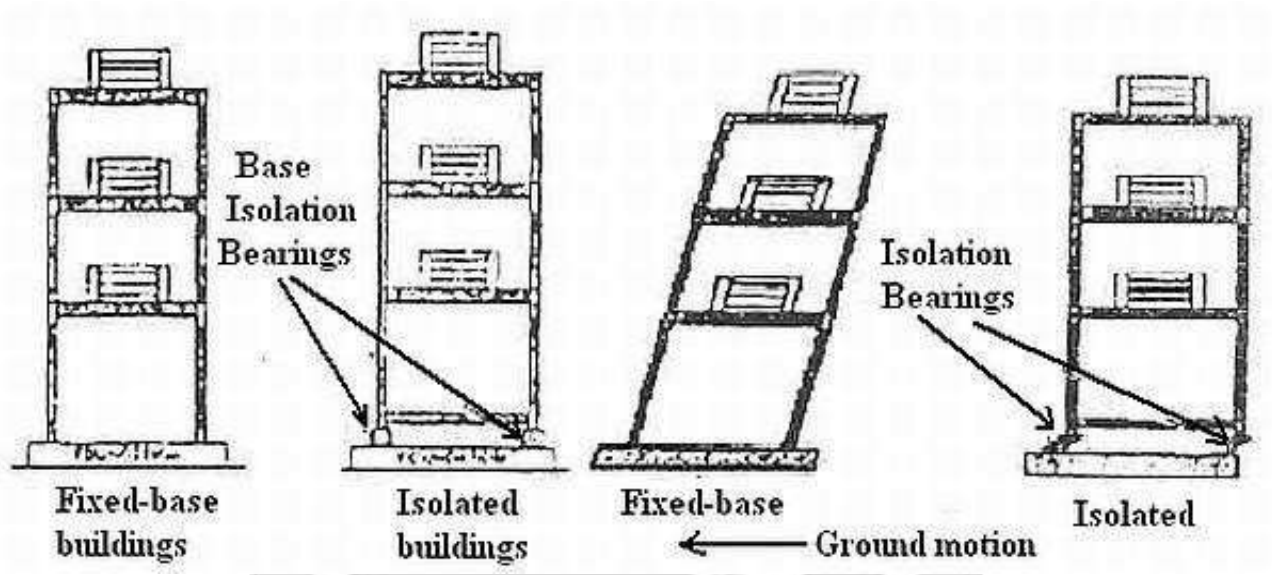


Fig. Building Movement

Now, if the same building is rested on the flexible pads that offer resistance against lateral movements, then some effect of the ground shaking will be transferred to the building. If the flexible pads are properly chosen, the forces induced by ground shaking can be a few times smaller than that experienced by the building built directly on ground, namely a fixed base building. The flexible pads are called base-isolators, whereas the structures protected by means of these devices are called base-isolated buildings. The main feature of the base isolation technology is that it introduces flexibility in the structure. As a result, a robust medium-rise masonry or reinforced concrete building becomes extremely flexible. The isolators are often designed, to absorb energy and thus add damping to the system. This helps in further reducing the seismic response of the building. Many of the base isolators look like large rubber pads, although there are other types that are based on sliding of one part of the building relative to other. Base isolation is not suitable for all buildings. Mostly 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.

Applications Lead-Rubber Base Isolation:

- Bridges
- Buildings
- Historic Structure

Advantages of Lead-Rubber Base Isolation:

- Reduces the seismic demand of structure, thereby reducing the cost of structure.
- Less displacement during the earthquake.
- Improves safety of the structure.
- Reduce damages caused during the structure.

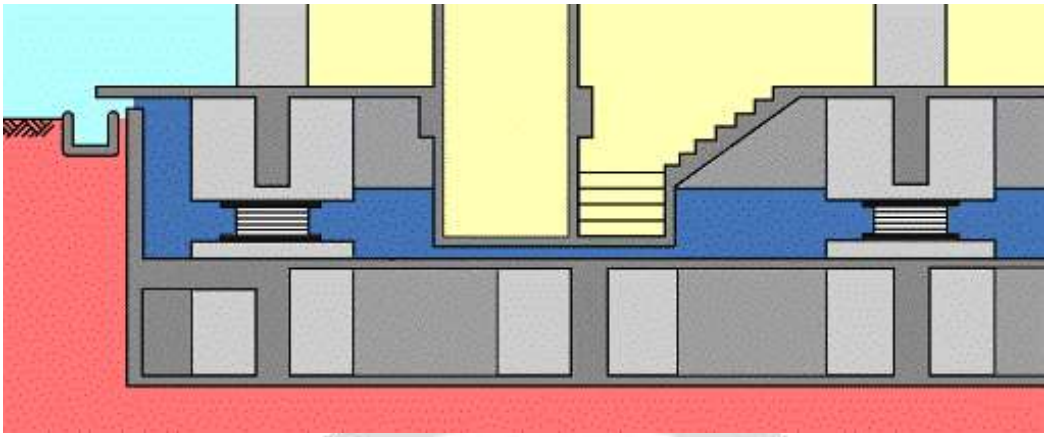
Disadvantages Lead-Rubber Base Isolation:

- Challenging to implement in an efficient manner
- Inefficient for high rise buildings
- Not suitable for buildings rested on soft soil.

Working principle Lead-Rubber Base Isolation:

A movement of building with lead rubber bearing during earthquake.

Fig. Working principle of lead rubber base isolation



The lead rubber bearing has same mechanical properties with laminated rubber bearing. Besides, it has high damping property.

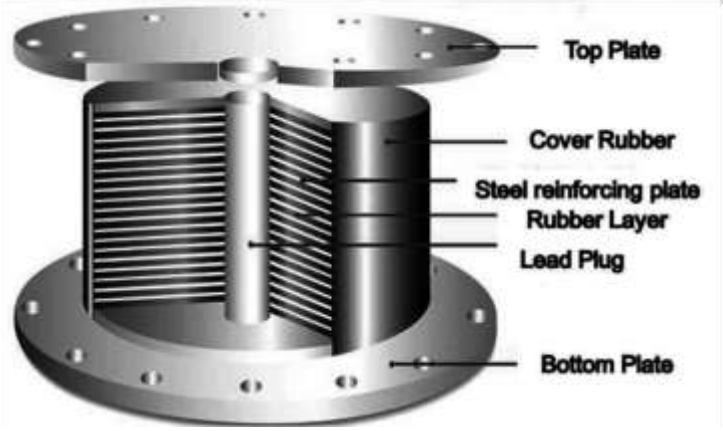
As we all know, the laminated rubber bearing has large displacement deformation in horizontal direction.

During earthquake, this structure can separate top and bottom structure vibration, enlarge self-vibration cycle and reduce seismic force. Besides, the lead core will be squeezed and yielded during the shear process to dissipate Seismic force.

After the earthquake, the lead rubber bearing can help building to restore the normal position through dynamic recovery and recrystallization of lead core and shear strain of laminated rubber bearing.

Vertical loading transfer process: beam → top embedded steel plate → top connecting steel plate → top sealing steel plate → laminated rubber bearing with lead core structure → bottom sealing steel plate → bottom connecting steel plate → pier.
Horizontal loading transfer process: pier → bottom anchor bolts → bottom connecting steel plate → top sealing steel plate and shear tenon → top connecting steel plate → top embedded steel plate → anchoring components.

Function of lead-rubber bearing pad:



1) Top and bottom plates: transfer loading and constraint deformation of lead core.
2) Lead plug: dissipate energy and decrease displacement.
3) Steel reinforcing plates: increase vertical stiffness and constraint deformation of lead core.

4) Internal rubber layers: support structure weight, accommodate rotation and displacement, recover moving bearing to the original position.
5) Rubber cover: protect reinforced steel plates and rubber layers.
6) Lead core quantity: single or multiple.
7) Shape: rectangular and round.

Problem Statement:

- The destructive effects of earthquakes are from landslides, tsunamis, fires, and fault rupture.
- Ground Shaking & Structural Failure. Ground shaking is the vibration of the ground during an earthquake.
- Surface Rupture & Ground Displacement.

Lead-Rubber Base Isolation Useful Benefits:

- It is very soft laterally but very stiff vertically.
- Lead-Rubber Isolation Bearings are specially designed Elastomeric Bearings that isolate structures from ground movement.
- Lead-Rubber Isolation Bearings consist of three components: rubber, steel plates and a lead core.

1.1 Objectives

2 To study the seismic performance of the building without base isolation.

3 To study the seismic performance of the building with lead and rubber base isolation.

4 To study the difference between the performance of the above buildings.

5 To contribute to the efficient design of structural base isolated techniques for building.

6 To model and investigate a behavior of building with base isolation.

1.2 Scope of the Project work:

a. Conducting literature review on previous work, and codes of practice to structural behavior of Base Isolated Buildings.
b. Carrying out finite element modeling (FEM) study on two identical building with different base conditions.
c. Conducting literature review on previous work, and codes of practice to structural behavior of Base Isolated Building with different base conditions.

CHAPTER 2- METHODOLOGY

- To analyze performance of all the building by observing Drift, Displacement, Moment etc.
- Literature survey.
- Problem statement.
- Analysis of normal building.
- To study the working principal of Lead-Rubber Base Isolation.
- Results.

- Discussion.
- Conclusion.

Data Analysis Methods:

1) Limit State Analysis:

- Limit State Design (LSD), also known as Load And Resistance Factor Design (LRFD), refers to a design method used in structural engineering.
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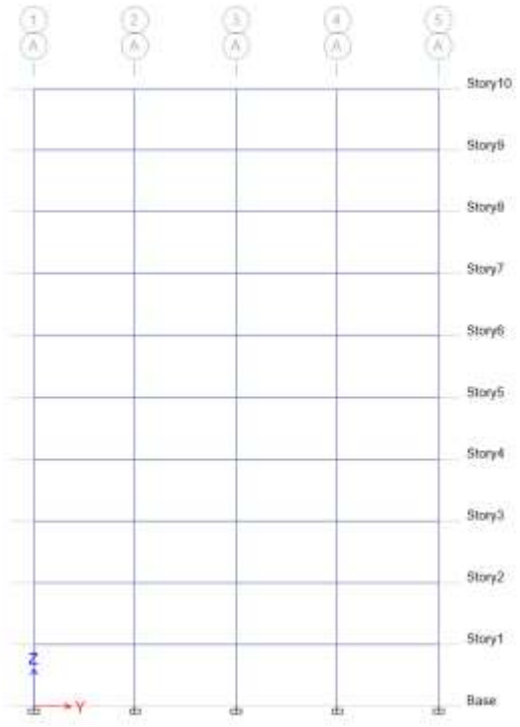
- A degree of loading or other actions imposed on a structure can result in a 'limit state', where the structure's condition no longer fulfils its design criteria, such as; fitness for use, structural integrity, durability, and so on.

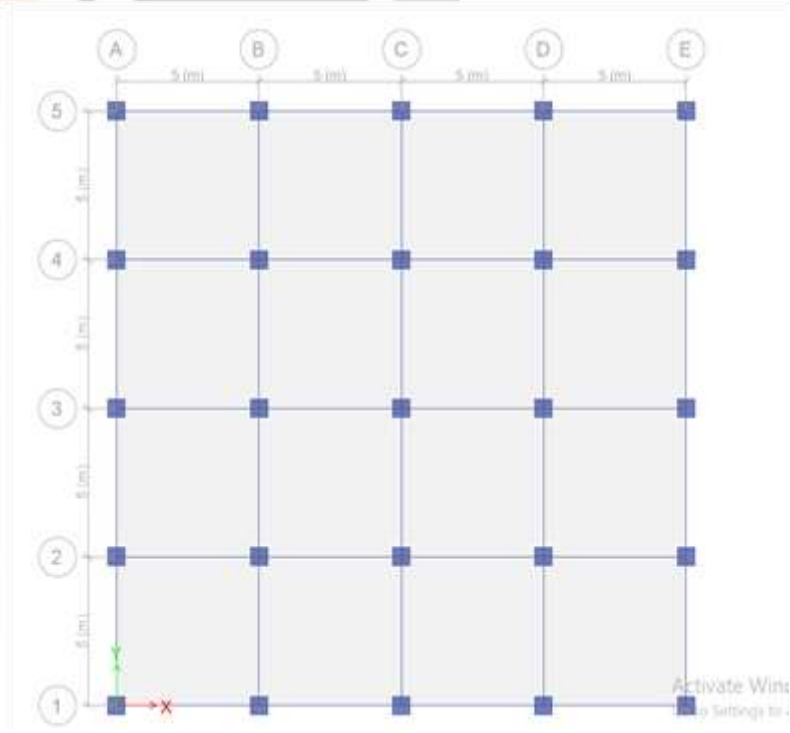
2) Dynamic Analysis:

- Dynamic analysis is conducted to obtain either a linear (elastic) or a nonlinear (inelastic) structural response.
- When elastic analysis is conducted, an empirical assessment of in- elastic response is made, since the design philosophy is based on nonlinear behavior of buildings under strong earthquakes.

BUILDING WITHOUT LEAD-RUBBER BASE ISOLATION:



LOAD LINE PLAN OF THE BUILDING:



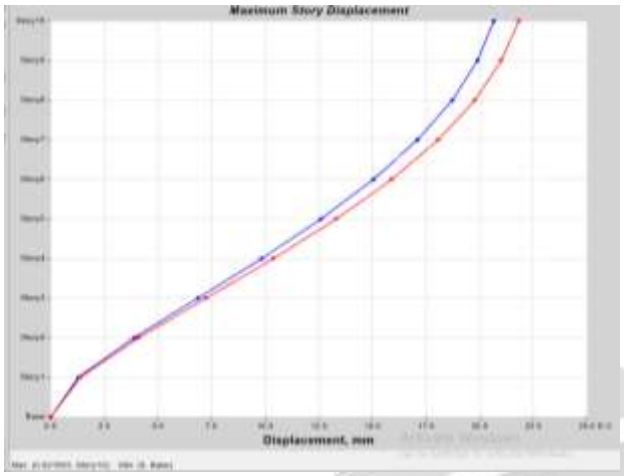
From above building,

- This building is without lead-rubber base isolation and it is having 10 storey
- In this building each floor having 3m height.

From above plan,

- In this plan in x-direction having 4 bays and y-direction having 4 bays.
- Each bays or section having 5 meter in x-direction and y-direction

UPPER MAXIMUM STOREY DISPLACEMENT GRAPH (1) :

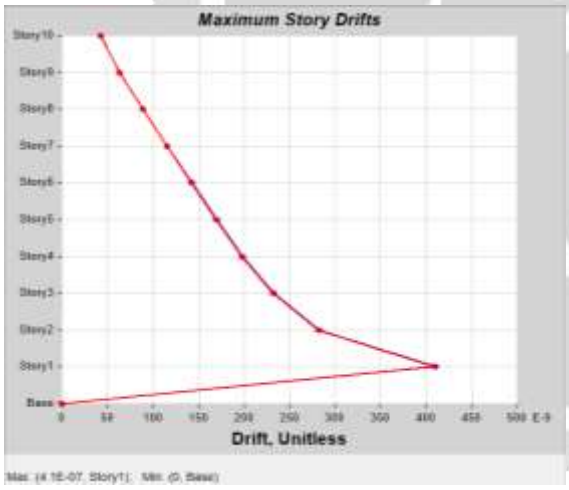


UPPER MAXIMUM STOREY DISPLACEMENT GRAPH (2) :

From Above graph (1) & (2)

- In (1) graph, the upper maximum displacement of normal building is getting about 0.021803.
- In (2) graph, the upper maximum displacement of building with lead-rubber base isolation is getting about 0.015869.
- After comparing, graph (1) & (2) the displacement is reduced in percentage of about 27.21%.

MAXIMUM STOREY DRIFT GRAPH (1) :



MAXIMUM STOREY DRIFT GRAPH (2) :

From Above graph, (1) & (2)

- In (1) graph, the maximum drift of building without base isolation is getting about 0.000001.
- In (2) graph, the maximum drift of building with lead-rubber base isolation is getting about 4.1×10^-7.
- After comparing, graph (1) & (2) the drift is reduced in percentage of about 59%.

From Above graph, (1) & (2)

- In (1) graph, the storey overturning moment of building without base isolation is getting about 20.64.
- In (2) graph, the storey overturning moment of building with lead-rubber base isolation is getting about 3.61.
- After comparing, graph (1) & (2) the storey overturning moment is reduced in percentage of about 82.50%.

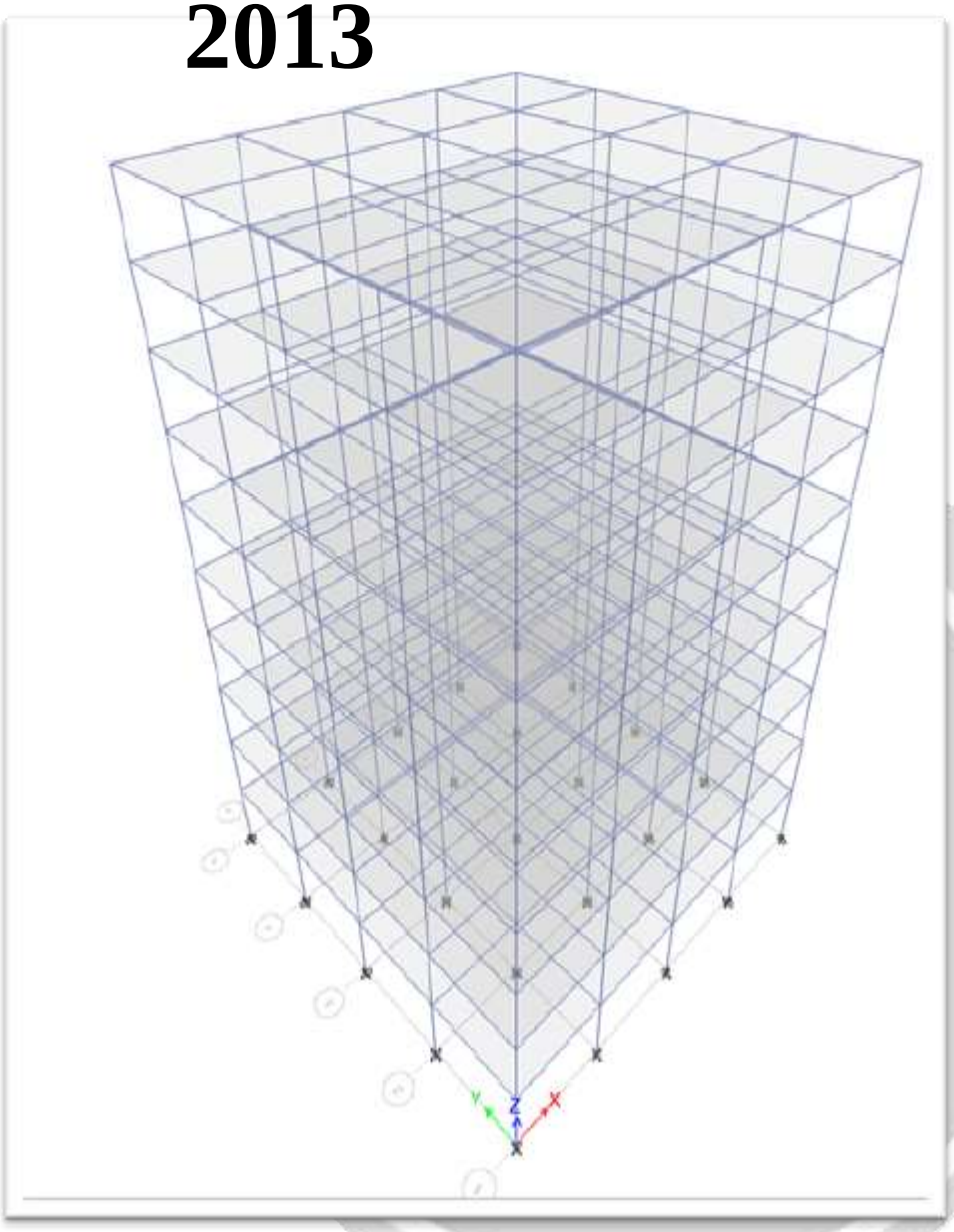
Structure properties:

SR.NO	STRUCTURE	DIMENSION
1.	SLAB	125mm
2.	BEAM	230×450mm
3.	COLUMN	600×600mm

Details of Materials:

SR.NO.	MATERIAL	QUANTITY
1.	CONCRETE	M30 IS 456-2000
2.	STEEL	Fe415

Basic 3D Model of Square Shape Building:



From above building,

- This is a 3D model of the building and t is designed by using etabs 2013 software.
  In this building OMRF frame is used

Geometric Materials :

SR.NO.	PARTICULAR	MEASUREMENT
1.	WIDTH	30M

2.	LENGTH	30M
3.	HEIGHT	30M
4.	BAY IN X-AXIS	4
5.	BAY IN Y-AXIS	4
6.	FLOOR TO FLOOR HEIGHT	3M

Calculation:

Calculate Wall Load:

Wall Load =ɣ=18 KN/m
Wall Thickness =0.23m
Floor to Floor Height =30m
Formula = ɣ × t × h

h =Floor to Floor Height
= 3000 – 450
=2550 mm

Formula = ɣ × t × h
= 18 × 0.23 × 2.55
=10.56 KN/m

Calculate Time Period:

= 0.09 × H /Under root of d

= 0.09 × 30 /under root of 20

= 0.604.

User Defined = 0.604

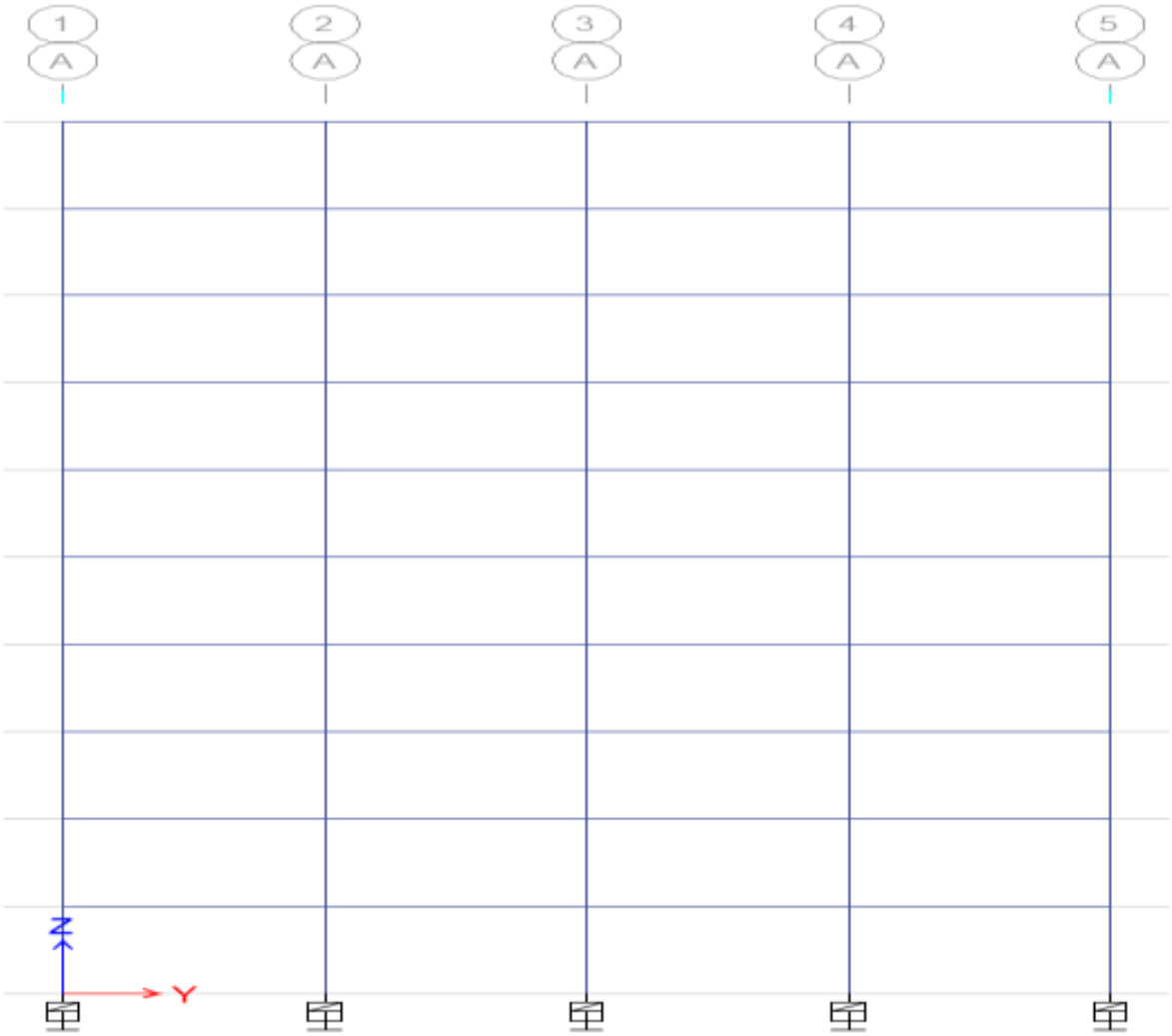
DETAILS OF FACTOR:

SR.NO.	PARTICULAR	FACTOR
1.	Important Factor	1.5
2.	Reduction Factor	5
3.	Damping Factor	5
4.	Seismic zone-3	0.16

LOAD COMBINATION ANALYSIS

SR.NO.	LOAD COMBINATION
1	1.2[DL+IL + (ELx +0.3ELy)]
2	1.2[DL+IL - (ELx -0.3ELy)]
3	1.2[DL+IL+ (ELy + 0.3 ELx)]
4	1.2[DL+IL- (ELy- 0.3ELx)]
5	1.5[DL+(ELx+0.3ELy)]
6	1.5[DL- (ELx - 0.3ELy)]
7	1.5[DL+(ELy+0.3ELx)]
8	1.5[DL-(ELy-0.3ELx)]
9	0.9DL+1.5(ELx+0.3ELy)
10	0.9DL-1.5(ELx-0.3ELy)
11	0.9DL+1.5(ELy+0.3ELx)
12	0.9DL-1.5(ELy-0.3ELx)

DESIGN LEAD-RUBBER BASE ISOLAION:



From above building ,

- This building provided isolation as a Lead-Rubber base isolation.
  This building is 10 storey building which is considered to be located in Nashik.

CHAPTER 3- RESULT:

SR.NO.	PARTICULAR	BUILDING WITHOUT BASED ISOLATION	BUILDING WITH LEAD RUBBER BASED ISOLATION	PERCENTAGE (%) DIFFERENCE

1.	Upper storey Displacement (m).	0.021803	0.015869	27.21
2.	Maximum storey Drift (m).	0.000001	4.1×10^-7	59
3.	Base shear (kN).	73845.3449	41608.8980	43.65
4.	Storey overturning Moment(kN-m)	20.64	3.61	82.50

CHAPTER 4- CONCLUSION:

From the above result, we concluded that

- Providing base isolation to the building increases the safety and life of a building.
- It reduces the displacement, moment, drift and base shear of a building.
- There is a reduction in the overturning moment of a building, when Lead- Rubber base isolation is provided.
- So, we caimed to the conclusion that providing base isolation to the building is very essential.

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