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TIME HISTORY ANALYSIS OF FIXED BASE AND BASE ISOLATED REINFORCED CONCRETE BUILDING

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Abstract – *Base isolation is one of the most widely accepted seismic protection systems used in building structures in earthquake prone areas. The base isolation system separates the structure from its foundation and primarily moves it relative to the upper structure. The purpose of this study is to decrease the base shear, story acceleration, story drift and column and beam forces due to earthquake ground excitation, applied to superstructure of the building by installing base isolated devices at the foundation level and then to compare the different concerts between the fixed base condition and base isolated condition by using ETABS 2016v software. In this study, G+14 symmetrical RCC building is used as test model. Lead rubber bearing and high damping rubber bearing is used as base isolation structure in this study. Nonlinear time history analysis is used on both fixed and base isolated buildings. Comparative study is contains two portions. They are comparisons between fixed and base isolated buildings and comparative study of performance by two different time history data like El-Centro and Bhuj. Finally, base shear, displacement, acceleration, story drift and column and beam forces are compared from two time histories analysis between fixed and base isolated condition. It is found that displacement is increased with base isolated building. Base shear, acceleration, story drift and column and beam forces are decreased in base isolated than fixed base building.*

Key Words: *Base Isolation, RC Building, Lead Rubber Bearing, High Damping Rubber Bearing, Nonlinear Time History Analysis.*

1. INTRODUCTION

During earthquake attacks, earthquake causes substantial loss of life and property especially to man-made structures. In last two decades considerable movement have been accomplished in the area of seismic protection of structures. But from last few years earthquake resistant design of structures has been largely based on ductility design concept. The performances of ductility design structures during major earthquake have been proved to be unsatisfactory. Now a day's there is most widely adopted and accepted seismic protection system is isolation.

The concept of isolation has become practice since it was used in the elementary school in Skopje, Yugoslavia by rubber isolation system to protect school from earthquake. At present multilayer isolation bearings are used which are made by vulcanization of sheets of rubber to thin steel reinforced plates. These bearing systems are very stiff in vertical direction and carry the vertical load of the structure, very flexible in horizontal direction to move in lateral direction under strong ground motion.

The earthquakes happen and are uncontrollable. So, in that sense, we have to accept the demand and make sure that the capacity exceeds it. The earth quake causes inertia forces as that ground accelerations increases, the strength of the building, the capacity, must be increased to avoid structural damage. In high seismic zones the accelerations causing forces may exceed one or even two times the acceleration due to gravity. It is easy to visualize the strength needed for the level of load, strength to resist; means than the building could resist gravity applied sideways, which means that the building could be tripped on its side and held horizontally without damage.

2. OBJECTIVES

- Modeling and analysis of fixed base and base isolated buildings using ETABS software and then study the effect of earthquake ground motions on these models.
- To design and study the effectiveness of lead rubber bearing and high damping rubber bearing which is used as base isolation system.
- To carry out comparison between fixed base and different types of base isolated buildings using different time history data's on the basis of their dynamic properties like maximum bending moment, maximum shear force, story displacement, story drift, story acceleration, base shear and time period.
- To study the behavior of earthquake resisting base isolated buildings.

3. METHODOLOGY

The modeling of fixed base and base isolated building is done by ETABS 2016 software. G+14 stories RCC building is considered with fixed base and base isolated with two different isolators like lead rubber bearing and high damping rubber bearing. Time history analysis is done using El-Centro and Bhuj time history data.

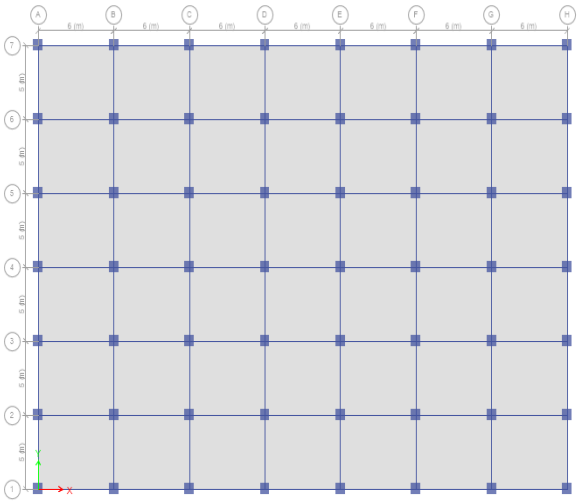

Fig-1: Plan

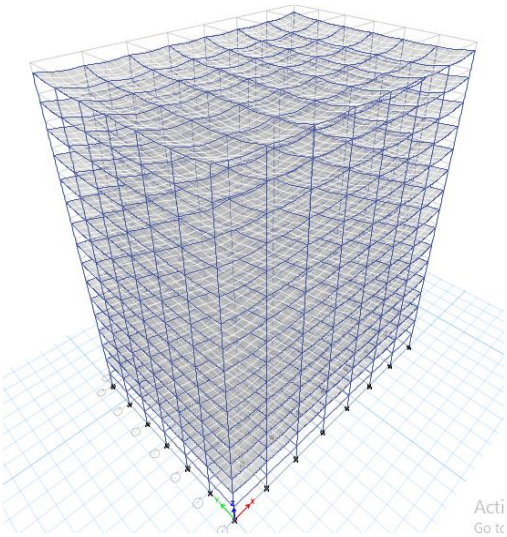

Fig-2: 3D Model

3.1 Building details

Number of stories	= G+14
C/C distance in X-dir	= 6m
C/C distance in Y-dir	= 5m
Foundation level to ground level	= 3m
Floor to floor height	= 3.2m
Wall thickness	= 200mm
Live load on all floors	= 3kN/m^2
Materials	= M30andFe415
Size of column	=900x900mm
Size of beam	= 300x600mm
Depth of slab	= 150mm
Seismic zone 4, i.e. Z	= 0.24

3.2 Design result: dimensions of LRB:

Diameter of the bearing, D	= 100 cm
Total height of the bearing, h	= 61.5 cm
Number of rubber layers, N	= 33
Thickness of individual layers, t	= 1.3 cm
Diameter of the lead core, dp	= 12 cm
Number of steel plates, Ns	= 32
Thickness of steel plates, ts	= 3 mm
Thickness of top & bottom Cover plates	= 4.5 cm

3.3 Design result: dimensions of HDRB:

Diameter of the bearing, D	= 100 cm
Total height of the bearing, h	= 24.7 cm
Number of rubber layers, N	= 10
Thickness of individual layers, t	= 1.3 cm
Number of steel plates, Ns	= 9
Thickness of steel plates, ts	= 3 mm
Thickness of top & bottom Cover plates	= 4.5 cm

4. ANALYSIS REULTS

4.1: Story Displacement

The floor level versus displacement graph has been plotted for both fixed and isolated base model for both El-Centro and Bhuj time history data in both X and Y direction. From the graph it is shown that there is a decrease in story displacement of isolated base building compared to fixed base building.

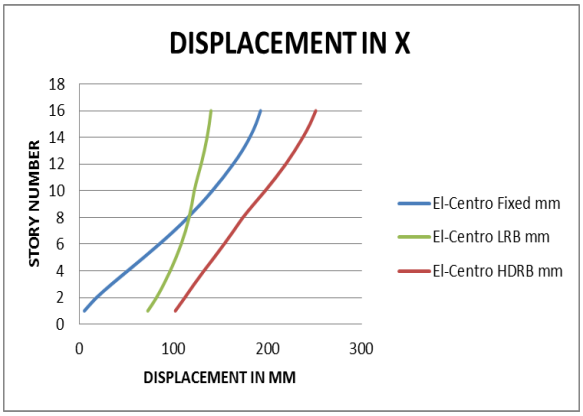

Fig-1: X-Displacement

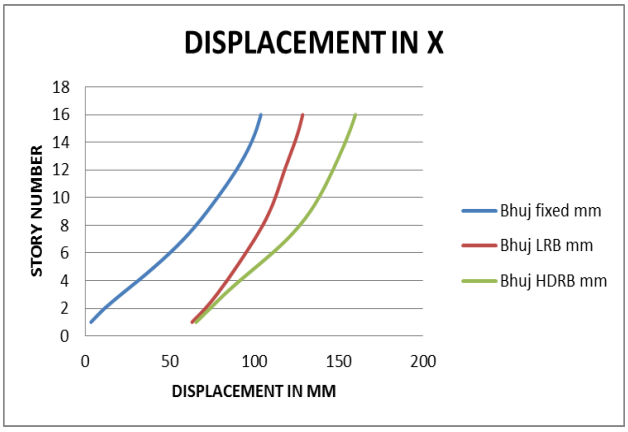

Fig-2: X-Displacement

Displacement of isolated building has been increased than fixed base. But base shear and story drift have been decreased in base isolated building.

4.2: Story Drift

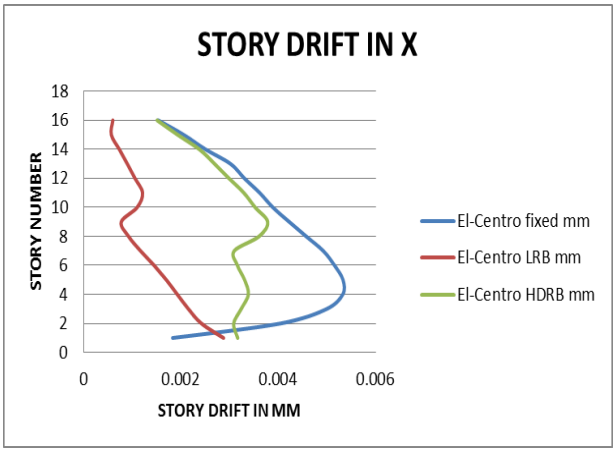

Fig-3: X-Story drifts

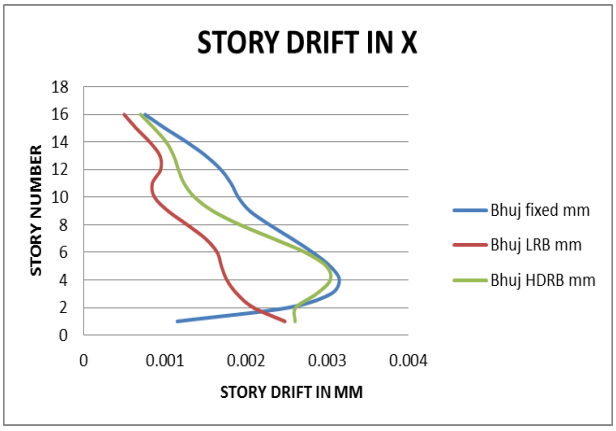

Fig-4: X-Story drifts

There is a decrease of values in story drift in both lead rubber bearing and High damping rubber bearing building than fixed base building. Here story drift is decreased in base isolated building than fixed base.

4.3 Story Acceleration

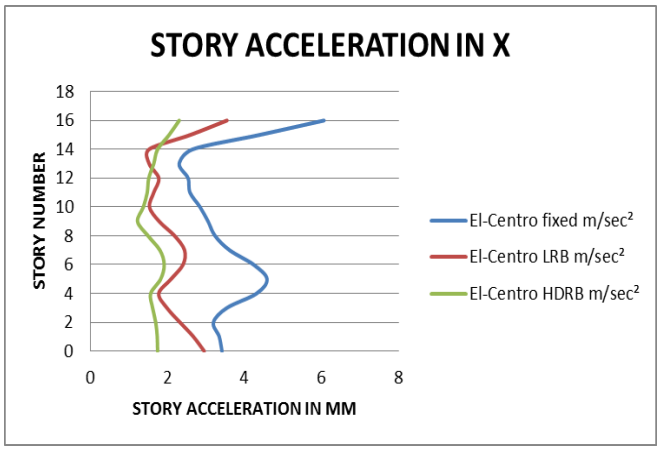

Fig-5: X-Acceleration

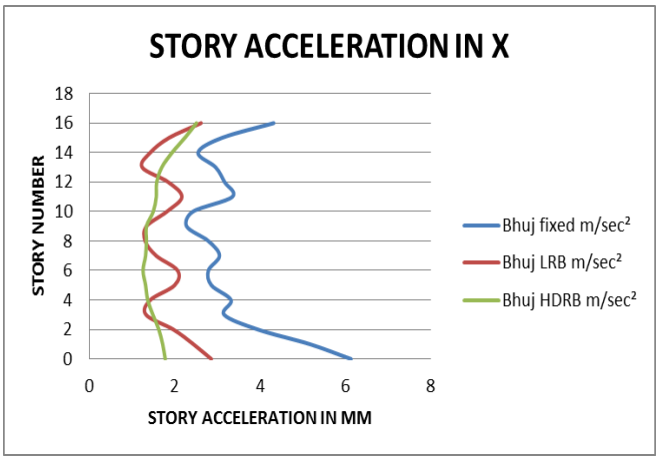

Fig-6: X-Acceleration

Story acceleration in lead rubber bearing and high damping rubber bearing isolator building is decreased compared to fixed base building.

4.4 Story Forces

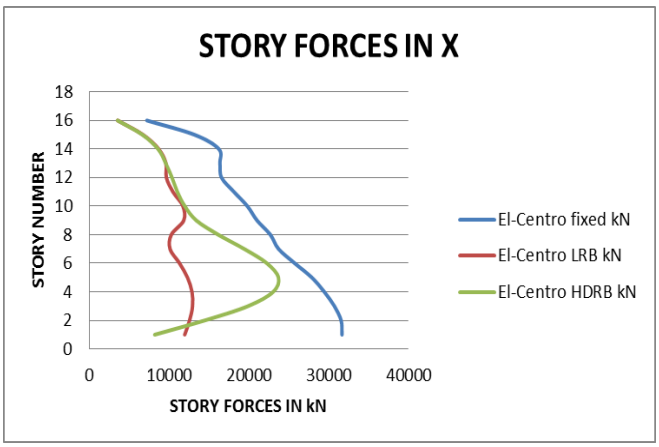

Fig-7: X-Story forces

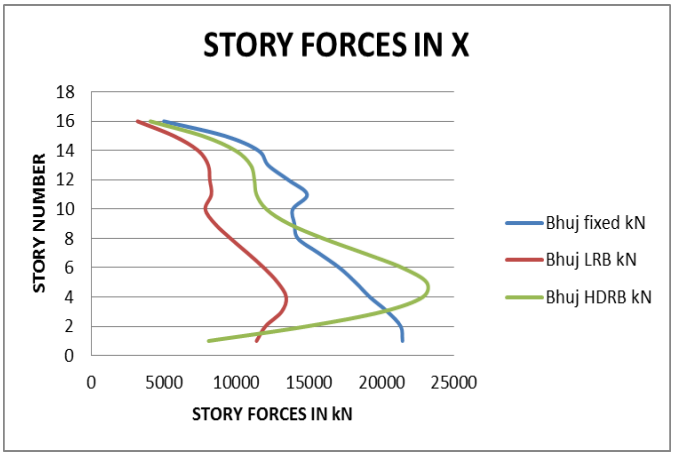

Fig-8: X-Story forces

Here the story force decreased in base isolated building. There is maximum decrease in base shear for high damping rubber bearing.

CONCLUSION

- Base isolators controls structural response in which the building or structure is decoupled from the horizontal component of the earthquake ground motion.
- The Base isolation substantially increases the displacement of the building and hence correspondingly reduces base shear, story drift and story acceleration.
- From base shear in Fig 7 and Fig 8 is observed that high damping rubber bearing gives less base shear compared to lead rubber bearing and fixed base.
- From acceleration values in Fig 5 and Fig 6 HDRB value is reduced more compared to LRB and Fixed base.
- Story drift in Base isolated building is reduced compared to fixed base building.
- From the analytical results, it is observed that how effective seismic isolation works but considering various aspects such as: base shear, story drift, story acceleration, Story displacement etc. Analysis results of the study suggest that high damping rubber isolator is better compared to lead rubber bearing isolator.

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