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SEISMIC EVALUATION OF REINFORCED CONCRETE BUILDING

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Abstract - The base isolation procedure has been utilized to shield the structures from the earthquake's harming impacts. The expansion of separators at the establishment improves the structure constructions' dependability. Seismic isolation and energy dissemination systems give an effective method of improving the seismic effectiveness of constructions through a typical seismic plan. Such strategies limit seismic loads by changing the inflexibility and damping of the constructions, though customary seismic design requires extra strength and flexibility to withstand seismic loads. Perhaps the main standard in the plan of tremor safe designs is the base detachment strategy.

In this present study a G+6 story building analyzed by using Rubber bearing isolation system in seismic Zone V with the help of IS 1893:2016 Code in SAP 2000 Software package. The comparison is made between Rubber bearing system with general building for seismic parameters like story drift, shear force, bending moment, building torsion.

Key words: Seismic isolation, Rubber bearing isolation system, story drift, shear force, bending moment, building torsion.

I. INTRODUCTION

Seismic isolation is a procedure used to limit and ensure the effects of quake ground shaking on the construction and its segments from harm. Base isolation system, for example, the elastic base seclusion framework utilized in this method to limit the seismic stacking state. In this sense, seismic isolators and energy scattering gadgets are viewed as proficient arrangements that are appropriately introduced in the structure to hose seismic energy or put between the establishment and vertical underlying designs that hose seismic energy under the structure floor, consequently lessening the impacts of sidelong loads on the highest levels.

The need of earthquake resistant building design is to providing the building safety and comfort by decrease in the deflection, shear, bending and internal forces under the action of seismic loading condition. The common method we can use for decrease the ground motion is base isolation system techniques. In base isolation systems basically we will change the support conditions by using various techniques namely rubber base isolation systems. In the present study G+6 storey building model is used for the seismic analysis. Two building models namely fixed support building and Rubber base isolation building was taken for the comparison.

II. BASE ISOLATION SYSTEMS

The procedures that are centered around the partition of the design and the ground, permitting flat development on the establishments of the structure and on the course of vertical underlying individuals, are the most ordinarily utilized strategies today. In explicit, these frameworks would be called base disengagement frameworks. Since seismic isolators are situated between the superstructure and the ground, outer confinement is otherwise called this kind of seismic disconnection. Inactive control frameworks incorporate seismic segregation innovations based on this hypothesis and utilized broadly over the previous decade.

Figure 1:- Base Isolation System.

Rubber Bearing System:

In the course of the most recent 25 years, various protection gadgets, including elastomeric heading (with and without lead center), frictional/sliding direction and roller orientation, have been created and essentially utilized for seismic structure plan. The lead elastic bearing was normally utilized among the diverse base separation frameworks. It comprises of substitute layers of at least one lead plugs with elastic and steel plates which are embedded into the openings. The lead center twists because of horizontal powers, yields at low shear level anxieties of roughly 8 to10 Mpa at typical (200c) temperature, so the parallel solidness of the lead bearing is extraordinarily diminished. This pattern of construction increments accordingly. One of the qualities of the lead center is that under cyclic loadings, it will recrystallize at typical temperature and won't deal with the issues of weariness disappointment. The gadget for elastic base separation is appeared in Figure 2 below.

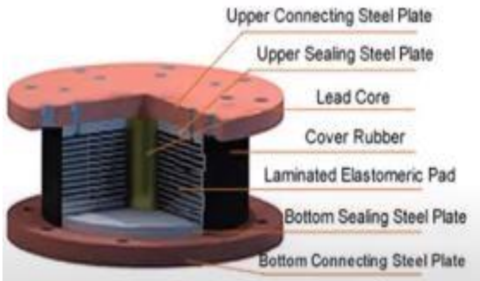

Figure 2:- Rubber Base Isolator

Basic functions of Lead Rubber Bearing (LRB)

1. Load supporting capacity: Rubber strengthened with steel plates gives structures secure help. Multilayer development offers more noteworthy vertical inflexibility for supporting a construction, instead of single layer elastic cushions.
2. Horizontal versatility work: seismic tremor movement is changed to low speed movement with the guide of LRB. As the even firmness of the multilayer elastic bearing is low, hefty vibration from the tremor is helped and the development's wavering time is expanded.
3. Job of rebuilding: LRB's flat flexibility reestablishes the structure to its unique site. In LRB, flexibility comes predominantly from the rebuilding of the elastic layers' solidarity. After an earthquake this restoring force returns the building to the original position.
4. Damping Function: Provides required amount of damping that is necessary.

III. METHODOLOGY

Response spectrum analysis is generally done with the help of IS code for seismic analysis. The IS code used for this study is IS 1893:2016 (Part 1). The values of seismic zone factor, soil type are taken from the tables of IS 1893:2016 (Part 1) code. The damping ratio is generally taken as 5% for this analysis. The response spectrum graph for medium soil condition is shown in the below graph. The graph is plotted between the Time period and Spectral acceleration coefficient (Sa/g).

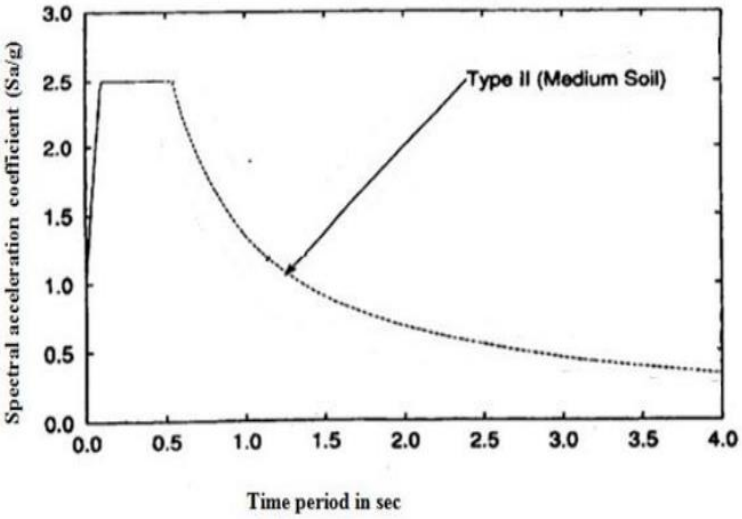

Figure 1: Response spectrum for medium soil type for 5% damping

In this we need to discover the size of powers finished for instance X, Y and Z and after that see the repercussions for the structure. Mix techniques combine the going with:

1. Absolute - crest esteems are included
2. Square Root of Summation of Squares (SRSS)
3. Complete Quadratic Combination (CQC) - a strategy that is a change on SRSS for firmly divided modes.

The output from the Response spectrum analysis is purely different from the linear dynamic analysis using the ground motions, in case of structure or building is irregular or high rise building this analysis of response is not accurate as we compared with other analysis and other method of analysis is needed, which is non linear static analysis or dynamic analysis.

In the present study I was considered a medium rise building and regular structure for the seismic loading condition for the response analysis case.

Model specifications

In the present study, analysis of G+6 multi-storied building located in Road no 2, Samathapuri colony, new nagole, Hyderabad has been done. Analysis has been carried out by assuming the building is located at seismic zone V. Three dimensional model of the building is prepared in SAP 2000 Software.

Basic parameters considered for the analysis are

- Occupancy of the building : Residential building
- Number of stories : G+6 (7 storied)
- Total Height of building : 21 m
- Shape of building : Rectangular
- Geometric details
- Ground floor height : 3 m
- floor to floor height : 3 m
- Material details
- Concrete Grade : M30 (COLUMNS AND BEAMS)
- Steel : HYSD reinforcement of Grade Fe415
- Bearing Capacity of Soil : 200 kN/m^2
- Type Of Construction : Reinforced Cement Concrete Framed structure
- Column : 0.35 m × 0.35 m

Beams : 0.25 m × 0.35 m
Slab thickness : 0.125 m

- Grade of concrete : M30
- Grade of Reinforcing steel : HYSD Fe450
- Live load : 2.5 kN/m^2(IS: 875:1987)
- Density of Reinforced concrete : 25 kN/m^3
- Seismic Zones : Zone V
- Site type : Medium (II) of IS Code 1893-2016
- Importance factor : 1.0
- Response reduction factor : 3
- Damping Ratio : 5%
- Structural class : C
- Wind design code : IS 875: 1987 (Part 3)
- RCC design code : IS 456:2000
- Steel design code : IS 800: 2007
- Earthquake design code : IS 1893 : 2016

2 dimensional and 3 dimensional models:

The below Figure 3 shows the G + 6 storey building model with fixed supports.

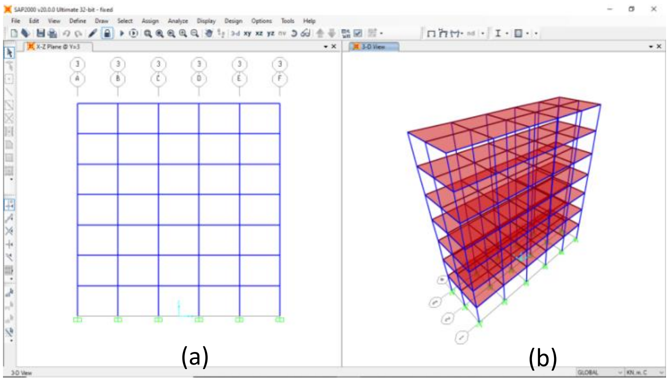

Figure 3:- Building Model with fixed supports (a) Elevation (b) Isometric View

The below Figure 4 shows the building model of G + 6 with rubber base isolation system basically the values of linear and non linear properties are considered for rubber isolation system.

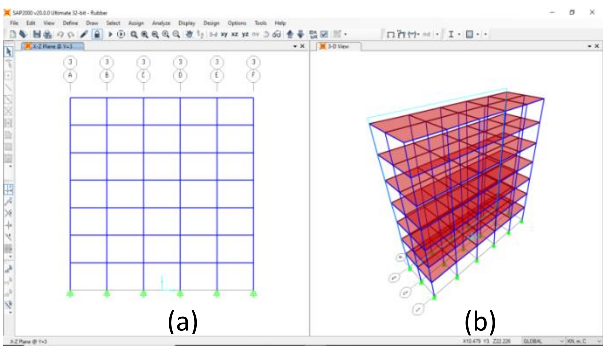

Figure 4 :- Building Model with Rubber Isolator at supports (a) Elevation (b) Isometric View

MODELLING

SAP2000 is a finite element program that performs two or three-dimensional static and dynamic analyses of structures. It has a visual interface in which the isolators are modeled with link /support elements with two nodes connected by six springs. Linear bearing, low damping rubber bearing, lead rubber bearing, flat sliding bearing, double and triple frictional pendulum bearings are some of the isolator types that can be modeled using the available features in SAP2000. It is beyond the ability of SAP2000 to model the temperature-dependent behavior of LRBs, too.

Rubber bearing type link/support element is used to model nonlinear behavior of lead rubber bearing in this study. For nonlinear rubber bearing, bilinear force deformation properties including *k*I, *fy*, and *r*, should be defined in two horizontal directions, but only linear elastic properties can be defined for the axial and three rotational directions.

Defining Link/Support Properties in SAP2000:
Use the Define menu > Section Properties > Link/Support Properties command to access the Link/Support Properties form; use that form to add, modify, or delete a link property. Link properties describe the linear and nonlinear behavior for the link objects to which they are assigned.

Drawing Link/Support Properties in SAP2000:
Use the following method to add a joint link when the model is displayed in a 2-D View:
1. Click the View menu > Show Grids command to turn the grids on.
2. Use the View menu > Set 2-D View command to set the active window to select the plane in which the joint link is to be added.
3. Click the Draw menu > Draw 1 Joint Link command to display the Properties of Object form. Use the form to specify the *Link Property* and any *offsets* (X, Y, or Z).
4. Click on a grid intersection or any other point in that plane to add a joint link.

As per the author Shameena Khannavar, M.H.Kolhar, et al (2016), the base isolation properties are taken for the current study. are shown in below table.

Table 1: Properties of Base Isolation adopted in this study

Stiffness	2602.71kN/m
Bearing Horizontal stiffness	509.79 kN/m
Vertical stiffness	292X10 kN/m^3
Yield force (F)	39.01kN
Stiffness ratio	0.1
Damping ratio	0.05

IV. RESUTS AND ANALYSIS

Comparison of joint displacements

From the below graph it was clearly observed that due to the effect of seismic loading action the values of joint displacements decreases for rubber base isolation system than fixed base systems. The building model designed with rubber base isolation system reduces the effects of earthquake loads.

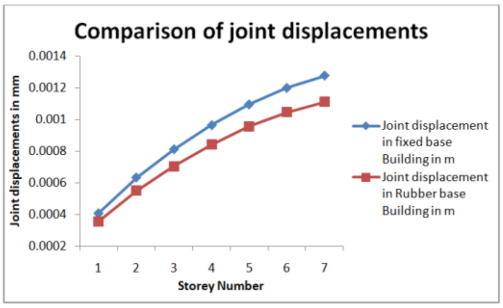

Figure 5:- Comparison of joint displacements

Comparison of Lateral load P

From the below graph it was observed that the action of lateral loads in rubber base isolation system and fixed base isolation systems are almost same there is no change in lateral loads action on buildings.

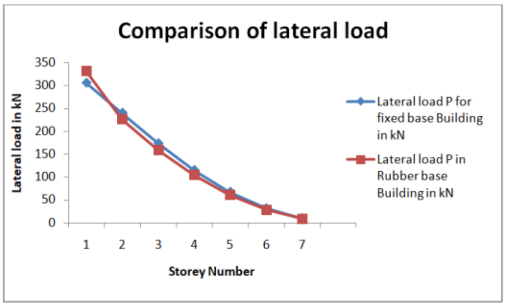

Figure 6:- Comparison of lateral load

Comparison of shear

From the below graph it was observed that due to the effect of more stability of rubber base isolation systems the Shear force value decreases for rubber base system.

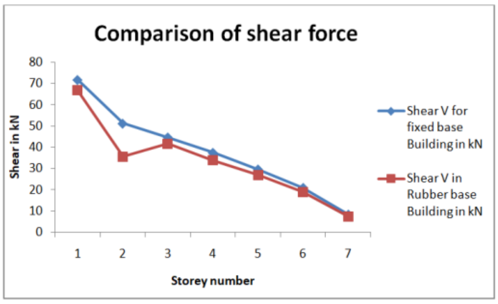

Figure 7:- Comparison of shear force

Comparison of Building Torsion T

Due to the effect of rubber base isolation technology the twisting moment is more than the fixed base isolation which is observed in the below graph.

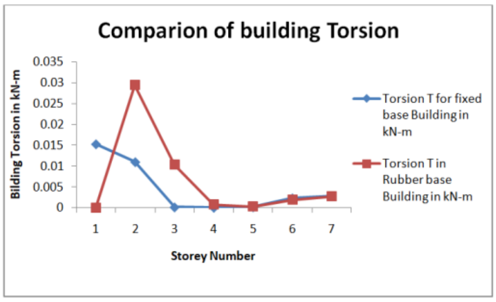

Figure 8:- Comparison of building Torsion

Comparison of Bending

The storey bending action is more in storey 1 in case of rubber base isolation system than fixed base systems and it is almost same in all the remaining stories, the lateral load action is more in storey 1.

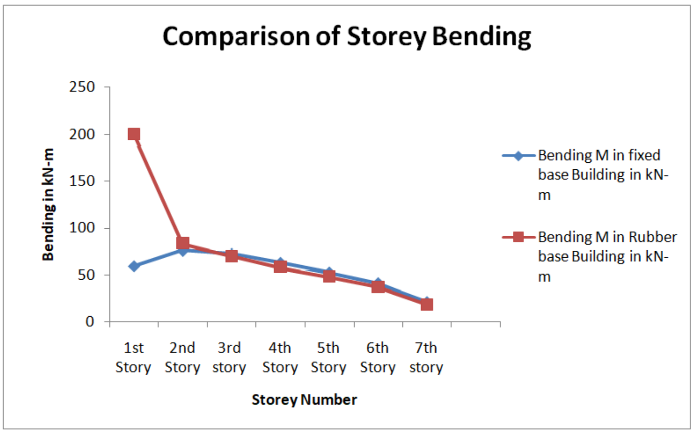

Figure 9:- Comparison of storey Bending

Comparison of Time period

Time period for rubber base isolation system is more than fixed base isolation system and it is decreases from node 1 to node 12 in both the cases.

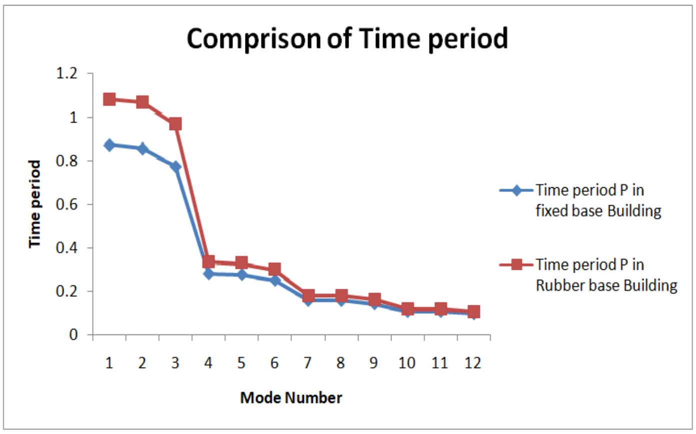

Figure 10:- Comparison of time period

Comparison of frequency

From the below graph it was observed that the frequency values are increases from node 1 to node 12 the less values are obtained for rubber base isolation system than fixed base isolation models.

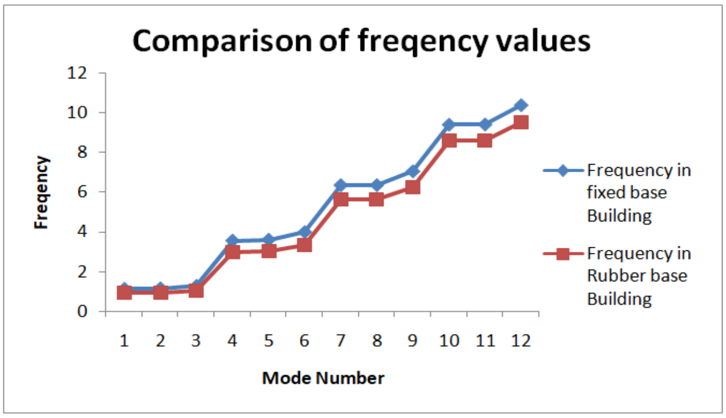

Figure 11:- Comparison of frequency

V. CONCLUSIONS

From analysis results it is observed that base isolation technique is very significant in order to reduce seismic response of both plan irregular and vertical irregular models as compared to fixed base building and control damages in building during seismic action.

1. Storey shear decreased when the building is damped with Lead Rubber isolation.
2. Storey Moment decreased when the building is analyzed with Lead Rubber isolation system.
3. Torsion decreased when the building is modeled with Lead Rubber isolation.
4. Storey Drift decreased when the building is damped with Lead Rubber.
5. Optimum control of the parameters considered was observed when the building is damped with Lead Rubber Dampers.

So from the work carried out it can be stated that Rubber base isolation system is the best supplemental damping system to control seismic loading condition.

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