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Comparative Analysis of Using Rubber Isolator and Friction Isolator in G+8 Building by SAP 2000

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Abstract

Base isolation technique has become most popular that improves resistant quality during a seismic earthquake. These bases seclude moves under high pressure and they soak up an earth tremor smash by minimizing oscillating and trembling of ground. Adaptive base solitude system includes the separation system is Lead Rubber Bearing, Friction Isolators, channel Method, Laminated Rubber Bearing. Base separation is the broadly accepted seismic protected skeleton employed in any edifice in Earth tremor protectorate. Ground isolation techniques help structure to separate their super and sub structure thereby reducing the destruction during earthquakes. This Paper studied G+8 symmetrical building fabricates of materials like Reinforced cement concrete, Bracings of steel with (LRB) Lead Rubber Bearing and (FPB) Friction Pendulum Bearing by Response spectrum method in SAP-2000 software. In order to discuss the performances of modal time-period, ground base-shear, and joint-displacements are measured and difference is discussed. This can be negotiated that its far preferable to give seclude systems in tremulous regions in preference to fixed joint base and the performance of both Friction isolator and Rubber isolators for the structure is slightly different and as far as concern to modal time period it is observed that LRB isolated structure has slightly less modal period than FRB isolated structure.

Keywords: RCC, response spectrum, fixed, lead rubber bearing, friction pendulum bearing, base isolation structures, SAP-2000

INTRODUCTION

Earth tremors are natural disaster that takes place owing to the movement of plates in earth's external layer that cause people to psychological distress [1,2]. Whole mass concentrates at floor level and Inertia forces develops at the floor level due to earthquake shaking. These powers travel from slab to beam, beam to column further transferred to foundation and then to ground [3]. Therefore, lower story designed to be stronger than those above. The growing velocity possibly can be reduced by modeling the building steadily conformable. Base uncoupling was additional ongoing technique to restraint the buildings by reducing characteristic recurrence and increment damping. Therefore, the most suitable accession to accomplish flexibility is by utilizing base-isolation technique [4–7]. Structure G+8 is taken as reference model and here two kinds of base link supports are taken, first is LRB and the other is FPB base link supports [8,9]. The load of RCC structural components is high due to the huge dimensions of the building elements and high density of the material [10]. 6- LRT structures that were worked in Surabaya, were checked by SAP2000, where every of those three structures considered three of LRB (Laminated Rubber Bearing) and FPS (Friction Pendulum System). The upper-fundamental part can be given the right to nonlinear static sucker and time history analysis

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was run with information from 7 ground motions in the program to improve knowledge on the principal response of LRT structures and to confirm the insulation of certain values of the structure against tremulous activities [11]. These Systems are adopted in India, Japan, Italy and USA. This technology is an ideal system for any type of structure because of its flexibility to determine the execution of goals [12,13]. In Traditional Technique Past earthquake disasters has signified that plenty of structure and representative solutions and construction methods are deficient to protect from tremulous forces [14]. LRB models can protect structures from cumbersome earthquake disasters by increasing the natural vibration period of the building and enhancing the energy dissipation capacity of the overall system [15]. The actual objective of this study is to compare the results of displacement, fundamental time period, Base Shear of LRB and FPB used in the G+8 symmetrical RCC building model along with steel Bracings of rolled steel I-Section with the help of response spectrum method in SAP-2000 software and find out which is better [9,16,17].

RESEARCH METHODOLOGY

Lead Rubber Bearing (LRB) Approach

The cross-section of a LRB used in base isolation. LRB comprise of three basic parts – rubber, steel and lead plug which are usually laid in layers. Rubber provides flexibility and capability to move and regain its initial condition. When turbulence ends, if any edifice has not come back to its initial condition, the rubber bearings will bring it back slowly to its initial condition which may take several months [18]. Weighty damping used in vibration restraint advances and prevention devices is seen as a major source of damping shaking, improving the seismicity of a structure [19]. For retracted structures with less bearing solidity anyway massive damping, and at that time the "dampening strength" can be transformed into the required pushing strength upon a strong shock. The bearing was subjected to full structural load in uniaxial testing. Numerous buildings and extensions in New-Zealand and numerous locations assured to have lead rubber dampers. Figure. 1 shows the picture of LRB (Lead rubber bearing).

Friction Pendulum Bearing Approach

FPB type is like isolation proficiency where the super-structural system is separated from the ground foundation segment. The speed-up proportion by composition changes independently, with and without separation, from 0.231 g and 0.571 g. The confinement saw the structure expand several times. The separation framework points out improvements in the unique response of the model by eliminating sideways quenching and more extensive the damping of whole system [20].

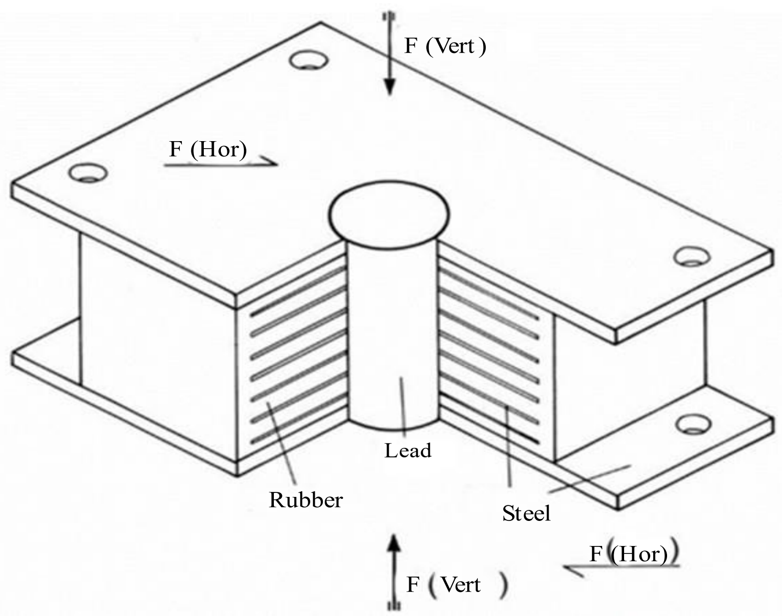

Figure 1. Lead rubber bearing (LRB).

COMPUTATIVE MODELING

The Table below is showing all the details of the model that are employed for the scrutiny and tremorous computation is accomplished as per IS 456:2000 and IS 1893-2016 make use of SAP-2000 software. Table 1 shows the Specification of the model. Table 2 depicts the structural detail and Table 3 describes the tremendous data for structural analysis.

Table 1. Specification of Model.

Frame description Type	**Number/Load/Section**
Provided floors including ground	G +8
Building Floor height	3m
Total Height of Model	27m
Flexural member count	320
Grid Lines in X-Y direction	5-5
No of Slabs	128
Slab thickness	150mm
Wall load	12.35KN/m
Used Masonry is wall	Brick
Bracing of material steel	ISHB-300
Grade of Rebar	High yield strength deformed bars 415
Grade of concrete	Beam M30, Column M30

Table 2. Structure Details.

Type of structure	**Cross-section of beam in (mm)**	**Cross-section of column in (mm)**
RCC	250×450	500×500

Table 3. Tremulous Data used for analysis.

Earthquake Zone	**V**
Zone Factor	0.36
Type of foundation soil	Medium: Type-2
IF	1
RRF	5
Factor for Damping	0.05

Consideration of Load

- *DL (self weight):* The Self weight has been taken according to IS: 875: Part-1 - 1987.
- *LL (super imposed weight):* The super imposed weight has been taken according to 875: Part-2 - 1987,
- *LLF (floor live load):* 2×10^{-3} MPa
- *FF (floor finish):* 3×10^{-3} MPa
- *UDL considered for wall*: 12.35 N/mm
- *Load considered for seismic analysis:* This Load is taken as per IS: 1893-2016 (21).

PARTICULARS OF MODEL

In this study two building models have been examined and their details given below-

1. *Model-1:* Response spectrum method of analysis (RSA) of Reinforced cement concrete building with LRB Isolator
2. *Model -2:* Response spectrum method of analysis (RSA) of Reinforced cement concrete building with FPB Isolator

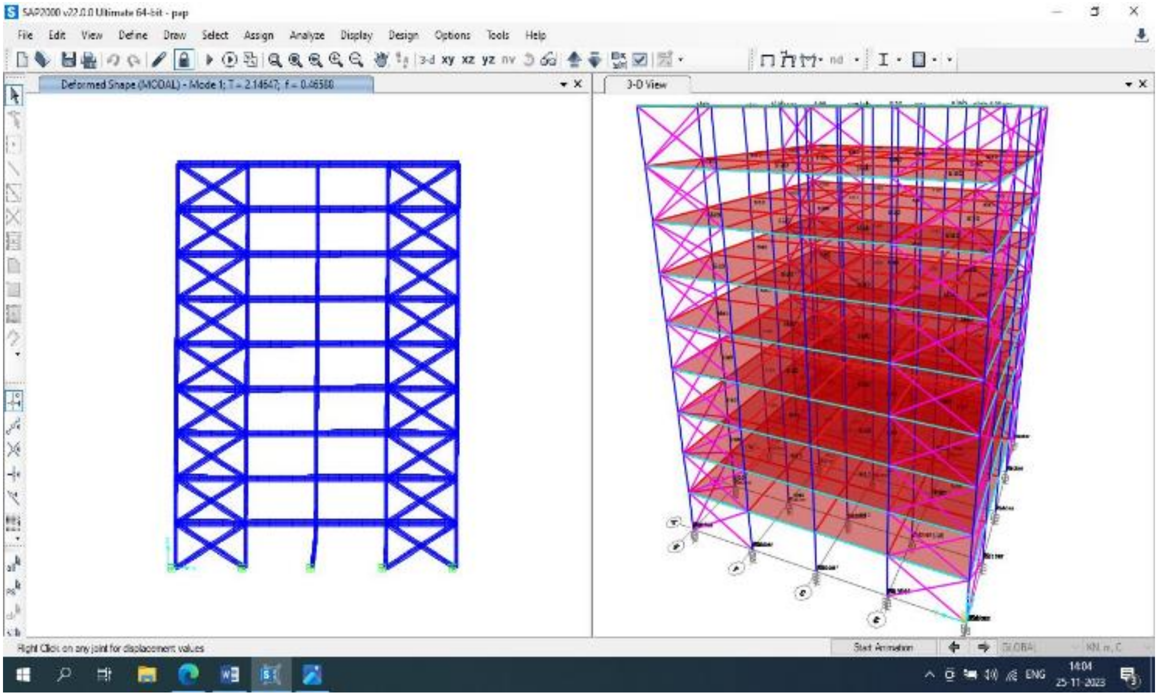

Figure 2. LRB isolator model case view deformed shape.

Figure 2 Describes running analysis of the deformed Mode-1 shape of a building. X-Z and 3-D view of a building of height 27m and each floor 3m high with base 20m in each X and Y- directions has been shown for a rubber bearing model. It was noticed a period of 2.1436 sec.

Figure 3 represents the case View of 3-D and Y-Z. Slab of thickness 0.15m with floor LL 2×10^{-3} MPa and FF 3×10^{-3} MPa. 16 slabs are located on each floor for calculating design base shear and it is calculated by running a static analysis in SAP-2000.

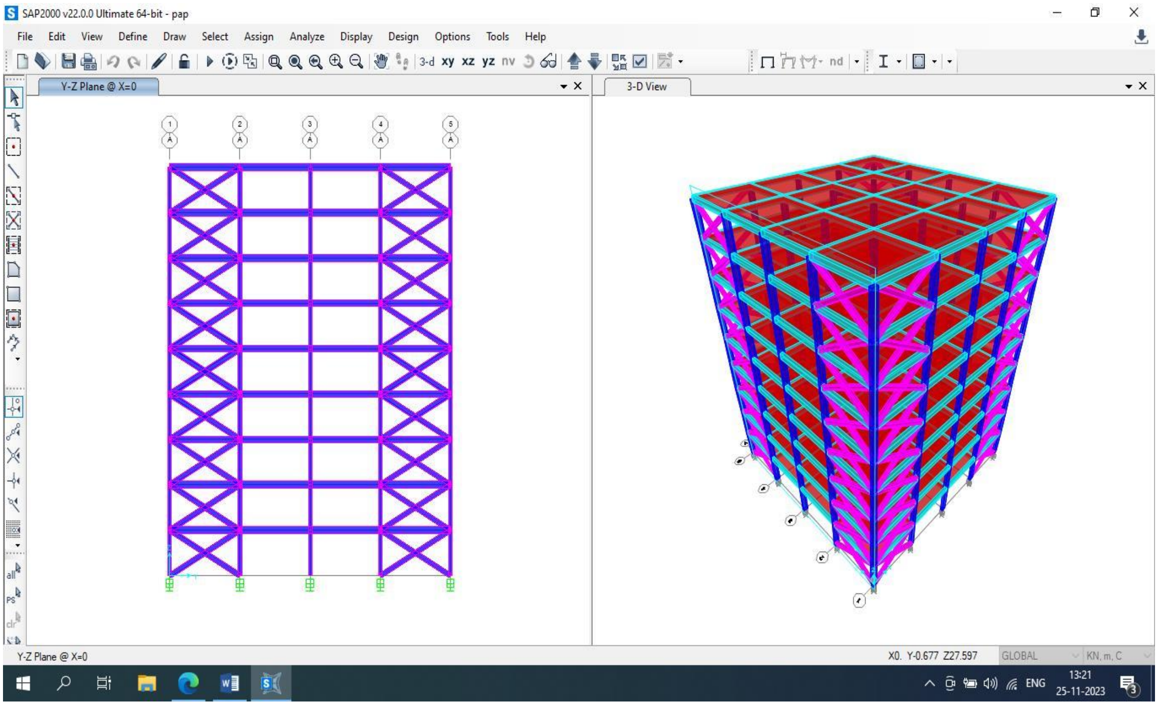

Figure 3. Model case view (y-z & 3-d).

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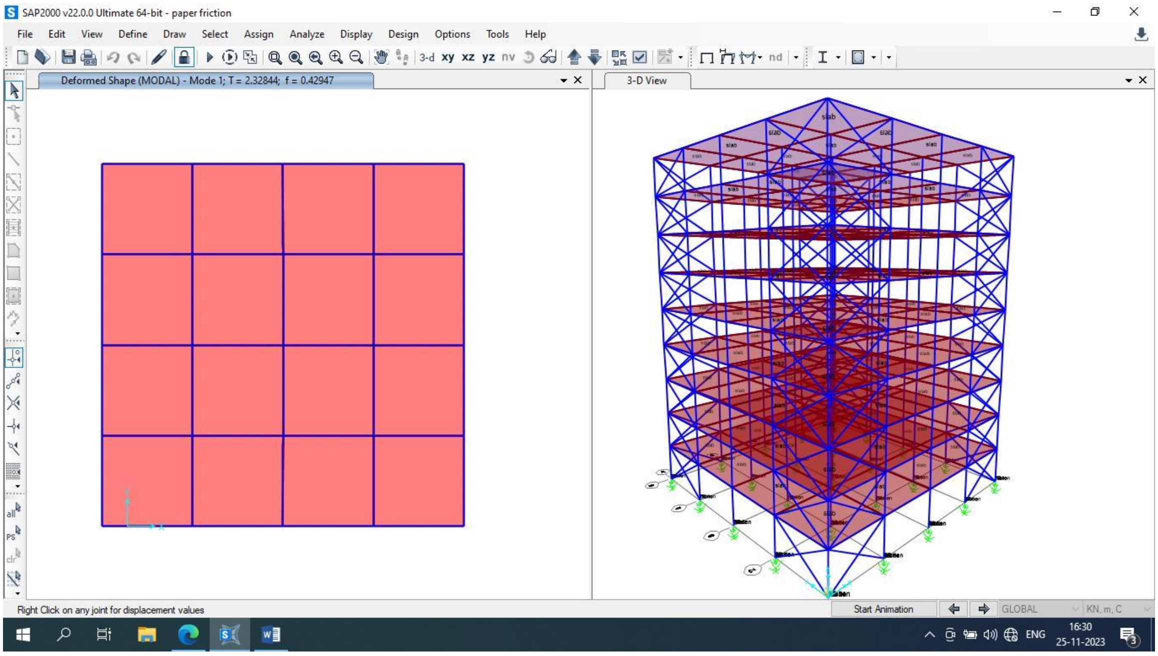

Figure 4. FPB isolator model case view deformed shape.

Figure 4 Describes running analysis of the deformed Mode-1 shape of a building. X-Y and 3-D view of a building. Beam 250×450mm with masonary load over it as 12.35 N/mm and column 500×500mm RCC is taken to check the analysis.

LRB and FPB features used in SAP 2000

FPB and LRB Isolated buildings are modeled as like support springs in G+8 Building by SAP 2000 [22]. Basic details of the FPB isolator and LRB isolator are mentioned below. Table 4 shows the characteristics of LRB isolator. Table 5 depicts the characteristics of FPB isolator.

Table 4. Characteristics of LRB Isolator.

U1 (LES)	**1600000 N/mm**
U2 & U3 (LES)	805 N/mm
U2 & U3 (Non-LES)	260 N/mm
Yield strength (U2 and U3)	82000 N
U2 &U3 (PYSR)	0.11

Table 5. Characteristics of FPB Isolator.

U1 (LES)	**1600000 N/mm**
U1 (Non-LES)	1600000 N/mm
U2 & U3 (LES)	750 N/mm
U2 & U3 (Non-LES)	1500 N/mm
Coefficient of Friction, slow (U2 & U3)	0.032
Coefficient of Friction, Fast (U2 & U3)	0.053
Rate Parameter (U2 & U3)	40
Net Pendulum Radius (U2)	2.25

RESULTS AND DISCUSSIONS

A comparison is made of various variables such as displacement, modal time period and Base Shear is concluded and the results obtained from RSA of Reinforced cement concrete building of LRB & FPB base isolated conditions.

Fundamental Time Period (FTP)

Figure 5 represents that the FTP of these two-base isolated RCC structure is slightly dissimilar and it comes out to be 2.1436 for LRB and 2.384 for FPB modelled building.

Displacement

Figure 6 Represents the Displacement U1, U2 and U3 in Global X, Y and Z directions respectively for both LRB and FPB base isolated model for a Response Spectrum case. It has been observed that LRB base isolated model has 58.343mm, 64.44mm and 1.031mm in global (X, Y and Z directions) and FPB base isolated model has 60.206mm, 20.965mm and 1.778mm in global (X, Y and Z directions). Higher displacement values have been observed in Y direction for LRB base isolated model but there is a slight difference along U1 and U3.

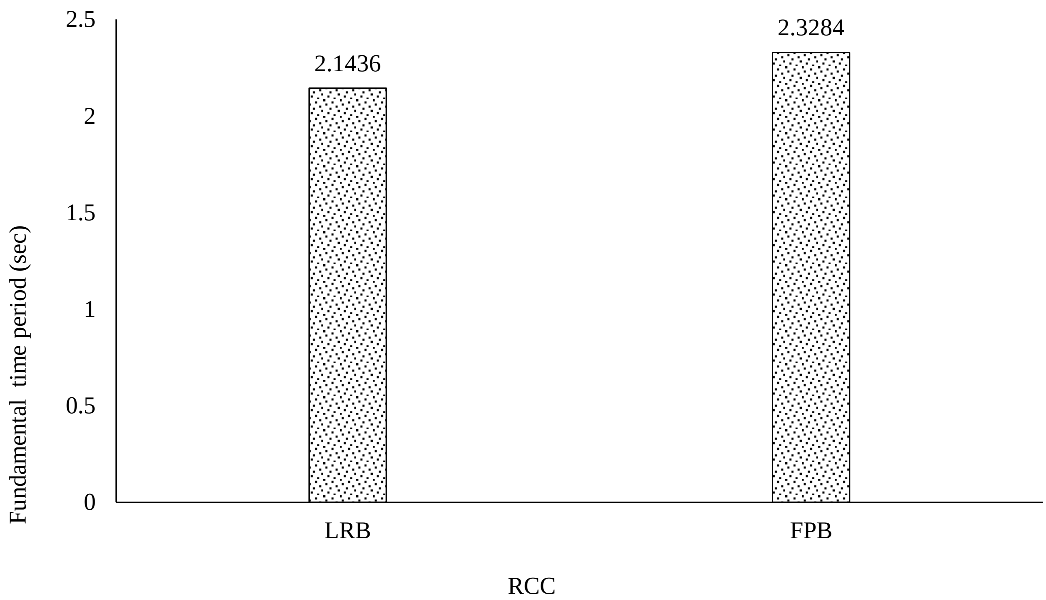

Figure 5. FTP for two Models.

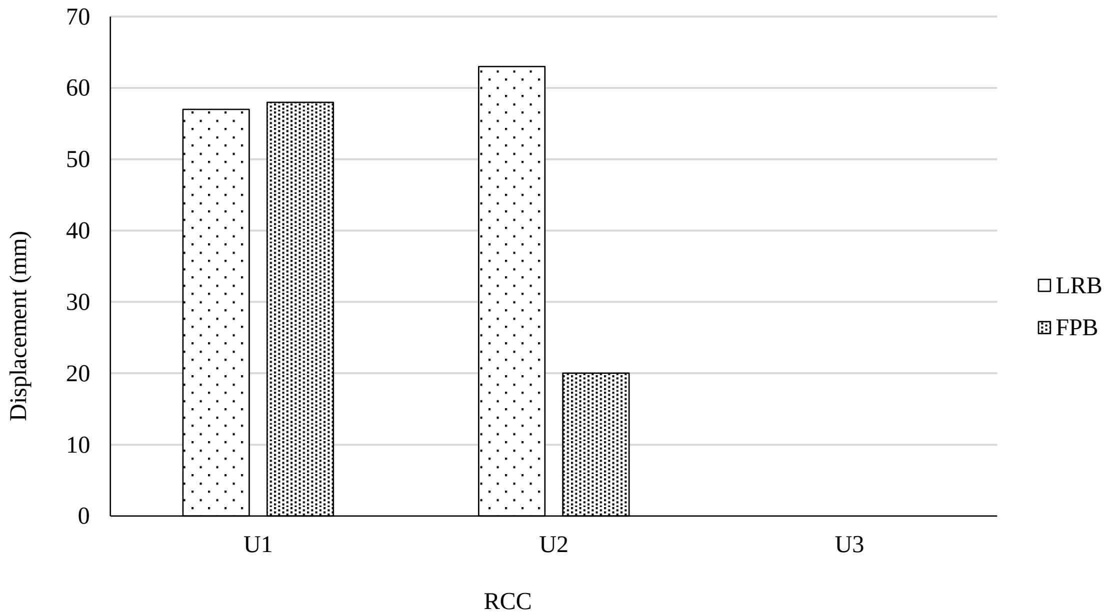

Figure 6. Response spectrum joint displacement (U1, U2, U3) for two models.

Base Shear

Figure 7 describes the Base Shear [23] in global X direction for LRB and FPB base isolated model for a Response Spectrum case. It has been found out that Base Shear for LRB and FPB based model are 904.376 KN and 888.08 KN in global X direction, so there is a little bit difference in Base shear values of both the models and having higher values for LRB link support [24–28].

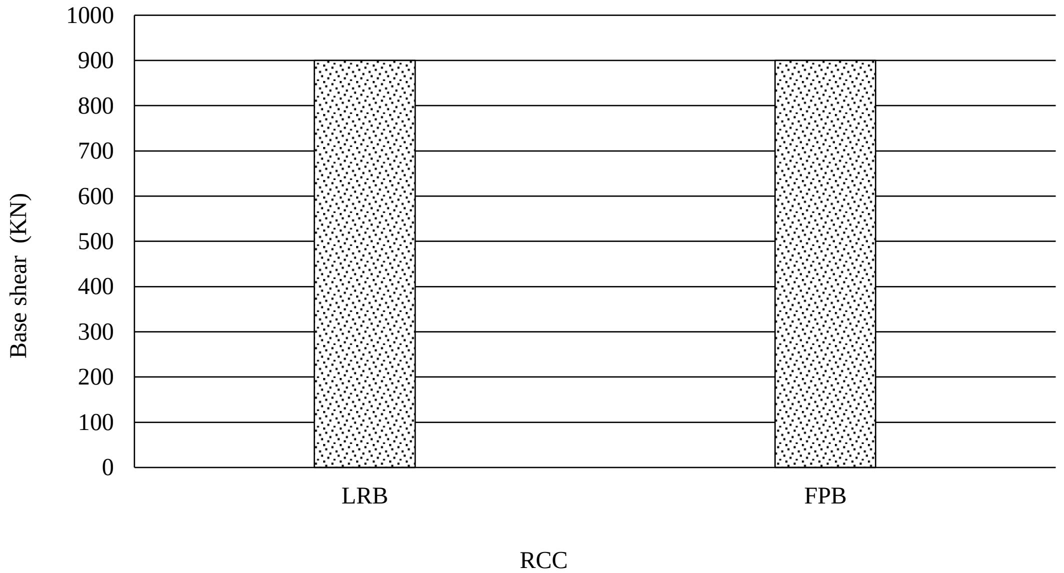

Figure 7. Base shear for two models.

Horizontal Displacement from Top to Bottom Floor Levels

Figure 8 Represents Displacement of top to bottom floor levels in U1 directions and these values are decreasing towards bottom level [29]. Greater displacement at top most level and a sudden jerk has been noticed at level-2 in both of the cases. The above line is for FPB and lower line in chart is for LRB isolated model.

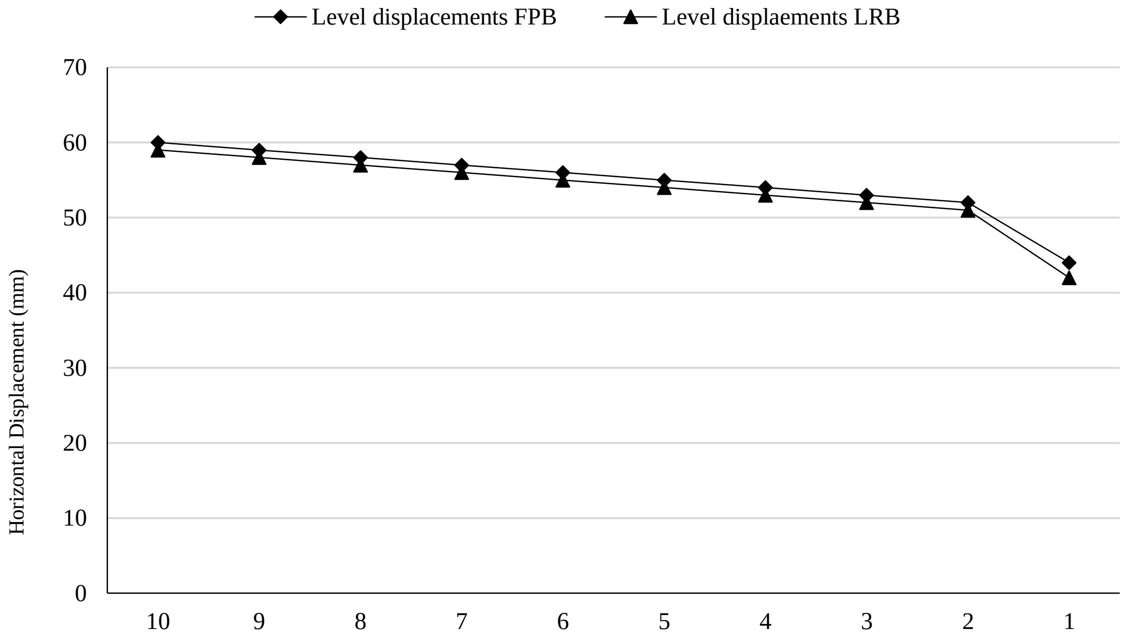

Figure 8. Response spectrum displacement from top level to bottom in U1 for two models.

CONCLUSION

An analysis is made for seismic performance of base FPB and LRB component for an earthquake. Based on the investigation. Here it is seen an expansion in modal time period for FPB as when compared with LRB base isolated building. This can be overcome by placing advanced components in a building. Among two isolated models, results also shows the displacement is having higher values for FPB than LRB isolation system but almost same except in global Y-direction, LRB base component has a high displacement in global Y-Direction. The obtained data result represents that the significant reduction takes place in rubber system. Here it is found out a very great depletion in base shear for the building. It has been found out that Base Shear for LRB and FPB based model are almost same. Examination of study shows that additional reduction in foundation shear can be attained for FPB based building. From the analysis and derive from the results, it can be established that in the group of these isolators, FPB isolated model can give better performance results compared to LRB isolated model for symmetrical RCC building. Further studies are needed for measuring other parameters.

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