Behaviour of Lead Rubber Bearing and Friction Pendulum System in Basement Storied Structure

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Abstract- *In a Last few years, Base isolation is an alternate approach than the specified ones. It depends on the idea, which decreasing the seismic requests as opposed to expanding the earthquake resistance limit of the structure. Then again, use of base isolators to the structure is decrease flexible base shear by moving time of the structure and give better performing structure that will remain elastic in vast earthquakes. The paper discusses about behaviour of isolators in symmetric buildings with underground stories. It is only focuses on comparison made about lead rubber bearing isolators and friction pendulum system placed at basement of buildings and linearity behaviour of isolators in symmetric building with basement stories.*

Keywords- lead rubber bearing isolator, friction pendulum system, base shear, maximum story displacement, time period, story drift

I. INTRODUCTION

There are two types of isolators given in detailed in literature review.

1. Lead Rubber Bearing Isolator: The LRB was invented in New Zealand in 1975 and has been utilized broadly in New Zealand, Japan and United States. The steel plates in the bearing power the lead connect to distort to shear. This bearing gives a flexible re-establishing power and furthermore, by choice of the fitting size of lead attachment, produces required measure of damping. As appeared in Figure 1. Performance of LRB is kept up amid rehashed solid seismic tremors, with appropriate sturdiness.

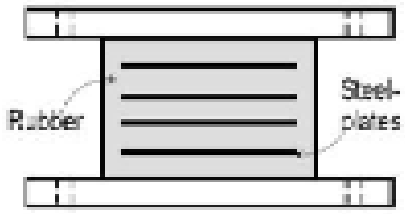

Figure 1. Lead Rubber Bearing

2. Friction Pendulum System: Sliding friction pendulum isolation system is one type of flexible isolation system suitable for small to large scale buildings. It combines a sliding action and a restoring force by geometry. The significant components of the bearing are the stainless steel concave surface and self-lubricating articulating slider shown in Figure 2. The surface is generally coated in Teflon, which provides a low friction coefficient and there by decreases the effective lateral stiffness, achieving required period shift. The outer edge of the sliding surface has a steel lip which restrains slider displacement to a specific range.

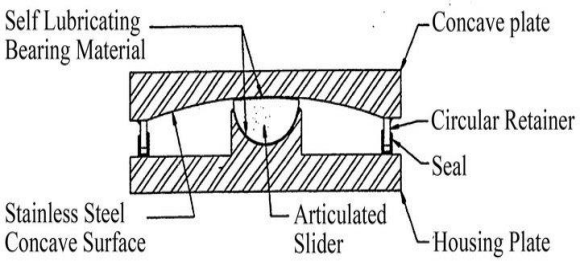

Figure 2. Friction Pendulum System

II. LITERATURE REVIEW

(1) Atila Zekioglu, Huseyin Darama:

These authors describes the performance-based seismic design of the Sabiha Gocken1 International Airport (SGIA) Terminal Building (with one basement) in Istanbul, Turkey utilising seismic-isolation concept with triple-friction-pendulum gadgets with an area over a 160,000 rectangular meters and 252 seismic friction pendulum isolators.

(2) Takao Nishizawa;

The author stats choice of retrofitting strategies of constructing with 6 floors, 1 basement, 1 penthouse & unfold foundation 1 basement as its investigations and diagnoses performed found out that the primary constructing become lacking in seismic overall performance. For the seismically isolated memories, laminated rubber isolators containing a lead plug, rolling supports, and lead dampers were represented

via a bilinear model and incorporated right into a single spring.

(3) Huseyin Darama, Atila Zekioglu, Simon Rees, Chas Pope and Rory McGowan:

These authors describes the overall performance-based totally seismic layout of the building with single storey the irregularity of a building brought about the decision to apply Friction Pendulum

(FP) kind isolators. These are taken into consideration to have higher structural overall performance in comparison to alternatives due to higher damping and decrease base shear forces, less difficult connection detailing on the isolation aircraft, and inherent self-centring behaviour.

(4) Koji Tsuchimoto, Yoshikazu Kitagawa, Kazuo Yoshida, Yozo Shinozaki, Ichiro Nagashima, Yoichi Saui, Hiroyasu Komatsu, Takahide Kobayashi:

These authors introduces an instance of using base isolation system combining variable oil dampers with the conventional passive base isolation system. The machine became advanced to enhance habitability via decreasing acceleration in the course of small and medium-sized earthquakes. Subsequently, the effects of a time records response analysis inside the event of an earthquake is provided, and the effectiveness of the gadget in lowering acceleration is indicated. The seismic isolation system for this building includes rubber bearings and oil dampers.

(5) C. Giarlelis, C. Kostikas, E. Lamprinou, M Dalakiouridou:

Their paper describes isolation system behaviour for building with the substructure consists of 9 floors housing mechanical plant rooms, parking and garage areas. At the parking areas, slabs are inclined to allow visitors drift. Access to those areas is provided by unbiased round ramps supported by way of an internal and an outside circular wall. It is tested dynamic reaction spectrum aiming to: (a) verify the fundamental length (b) Calculate maximum displacements (c) check for uplift. Analysis became accomplished thru the use of code ETABS with fps type isolator.

(6) Stefano Sorace and Gloria Terenzi, Analysis:

In this paper they used double friction pendulum (DFP) sliders had been adopted as keeping apart gadgets. A general of 59 elements had been included, 57 of which on pinnacle of the basement columns.

III. MODELLING IN E TABS

This section present details of building taken for the comparison and modelling criteria in e tabs.

Here, 6 types of building analysed with LRB and FPS systems.

1. G+4 with 2 storied basement with 0.75 aspect ratio
2. G+4 with 2 storied basement with 1 aspect ratio
3. G+4 with 2 storied basement with 1.25 aspect ratio

Where, aspect ratio = total height of building to total width of building ratio.

The summarise data about building geometry is given below.
Grade of concrete = 25 N/mm2
Yield strength of steel = 415 N/mm2
Floor load = 3 kN/m2
Slab thickness = 200 mm
Wall thickness = 200 mm
Floor height = 4 m
Bay width = 4 m
Size of beam = (300 X 450) mm2 for G+4 building with 2 storied basement.
Size of column = (450 X 450) mm2 for G+4 building with 2 storied basement.

The link property for the both type of isolator systems are derived and input the same in e tabs for analysis. Following are the linear and nonlinear property of isolators.

As we know the hysteretic loop for the behaviour of this systems gives,

1. Effective stiffness (Keff),
2. Effective damping (Cb),
3. Post yield stiffness ratio (Yr),
4. Yield strength (Fy)
5. Effective vertical stiffness (Kv).

Following are the link property data in terms of linearity and non-linearity for the G+4 building with 2 storied basement with aspect ratio 1.25.

Table 1. Link Property of LRB and FPS

LRB	Keff (kN/m)	Cb (kNs^{-1}/m)	Fy (kN)	Yr	Kv (kN/m)
	1148.19	185.18	28.27	0.11	8273885
FPS	Keff(kN/m)	Cb(kNs^{-1}/m)			
	1040.94	14.08			

The generated model and link property data inputs in E tads are as follow

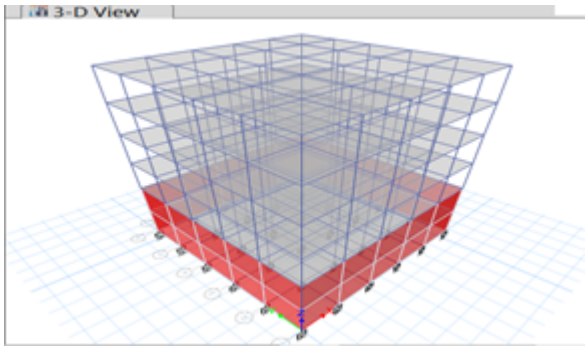

Figure 3. Model in E tabs

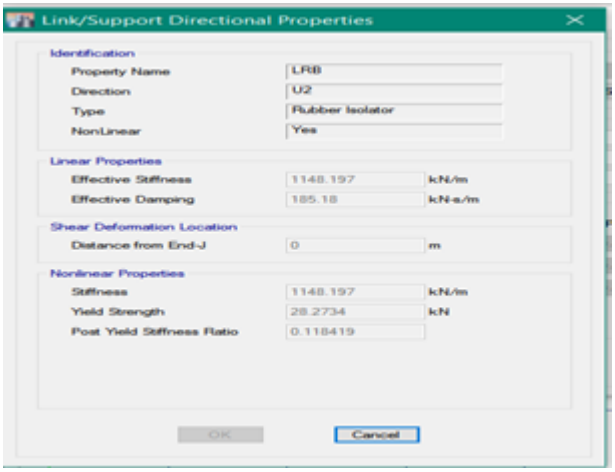

Figure 4. link Property of LRB

IV. ANALYSIS RESULTS

The results on comparison of LRB and FPS is given below for all type of structures.

Storey Displacement

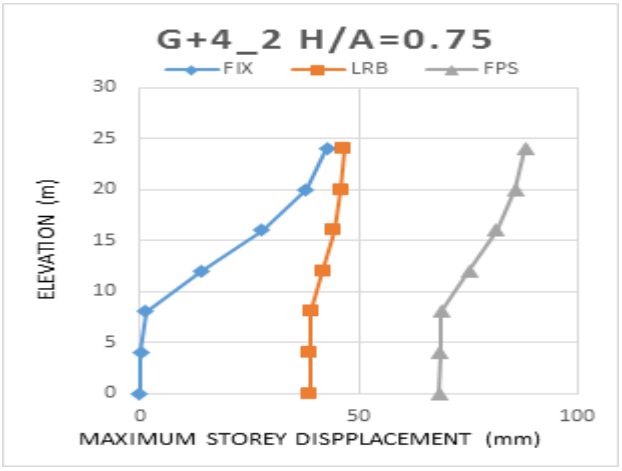

Figure 5.

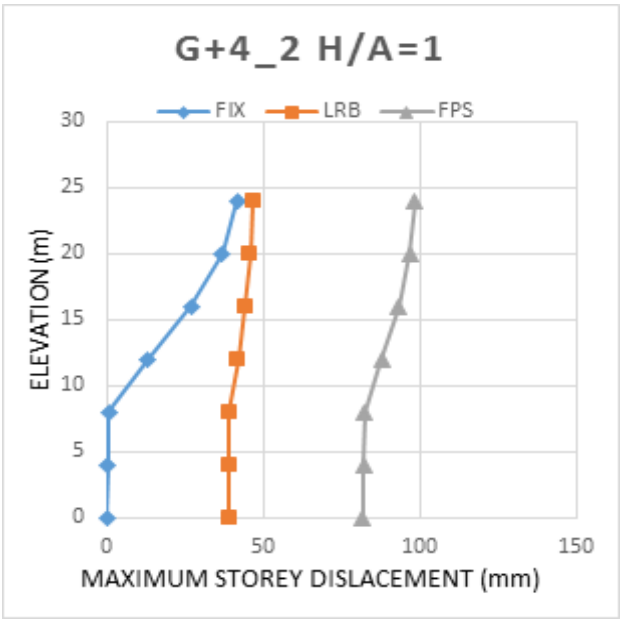

Figure 6.

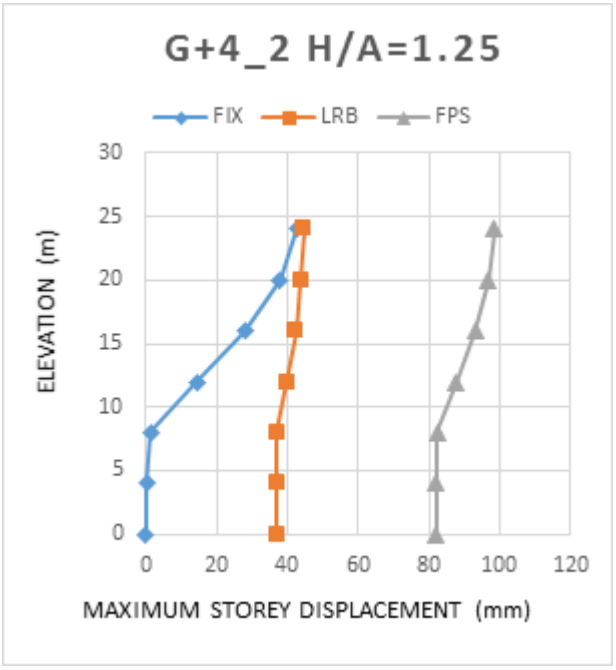

Figure 7.

Storey Shear

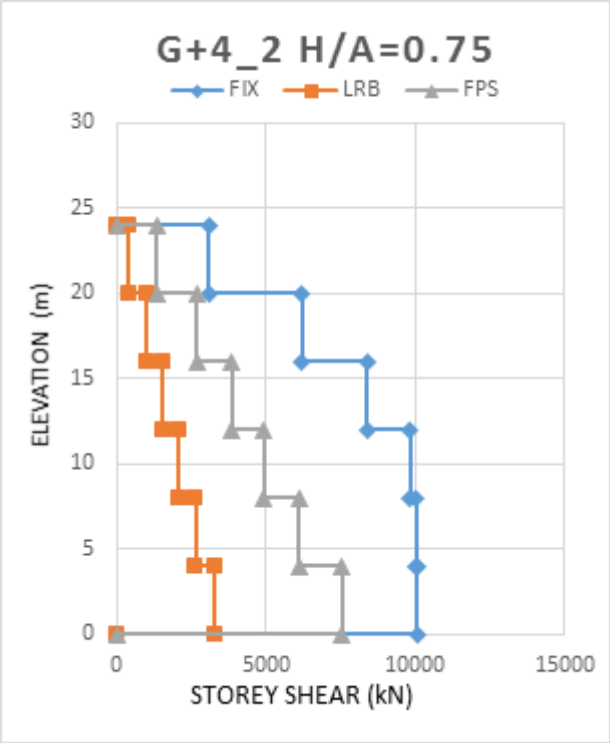

Figure 8.

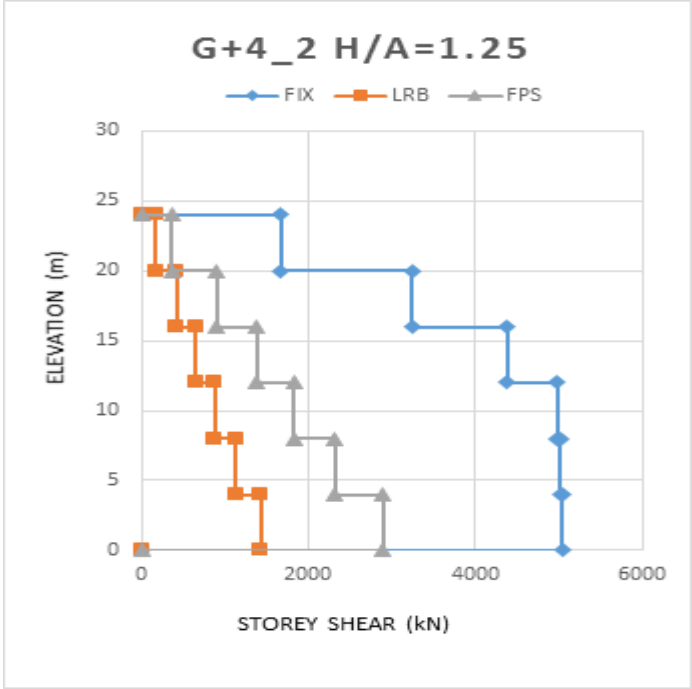

Figure 10.

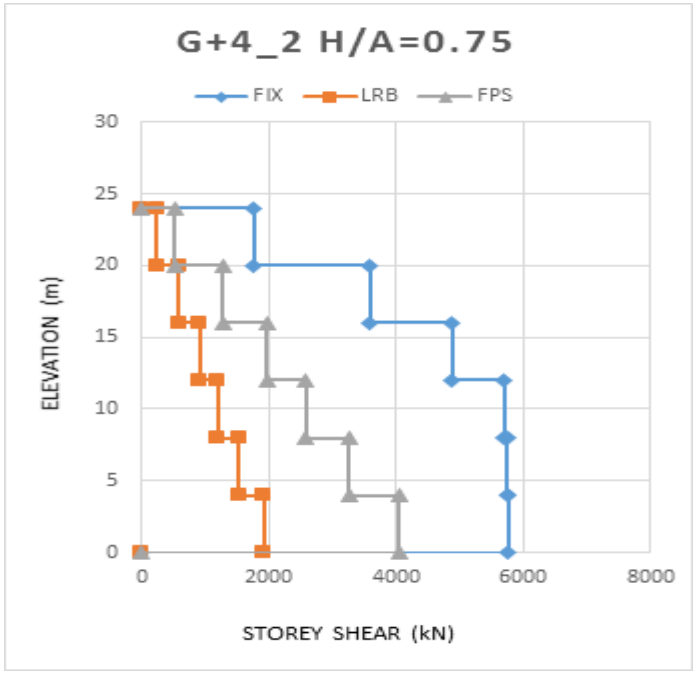

Figure 9.

Maximum Storey Drift

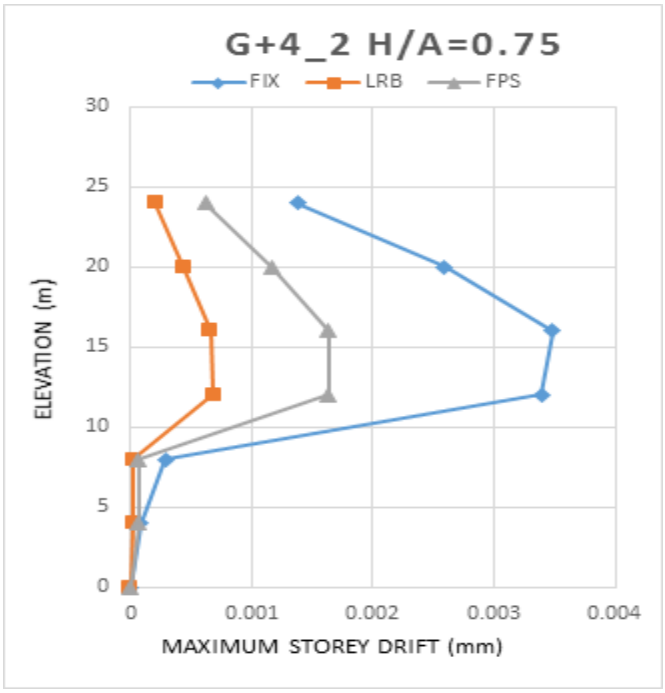

Figure 11.

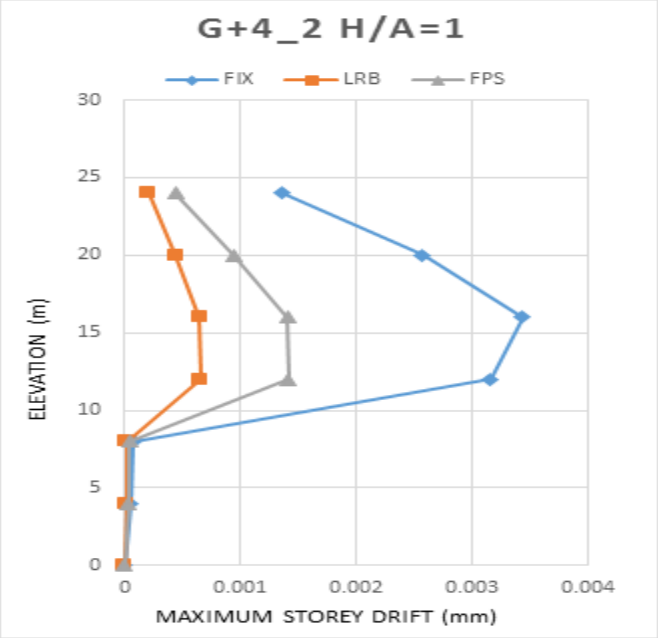

Figure 12.

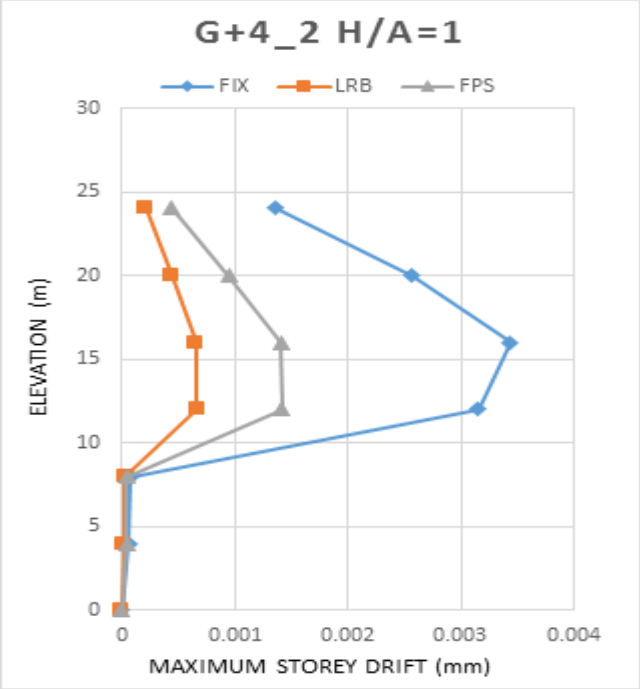

Figure 13.

V. CONCLUSION

- As shown in all results the behaviour of FPS is better than fix base and LRB system with the building of basement stories.
- In a detailed observation, there is considerably decrease in base shear about 57.22% and 49.9% in LRB and FPS systems with compare to fixed base structure.
- The storey displacement in FPS system is better than LRB system with the basement storied building.
- There is 2% difference in time period in both systems.
- The symmetry of building does not affect the linear and non-linear behaviour of hysteresis loop of rubber isolator.so we can design all LRB system with a linear property in e tabs.
- It is proved that in symmetrical structure with basement stories storey drift reduces with the LRB compare to FPS system in a different aspect ratios with same storey height.

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