INTERNATIONAL JOURNAL OF PURE AND APPLIED RESEARCH IN ENGINEERING AND TECHNOLOGY

A PATH FOR HORIZING YOUR INNOVATIVE WORK

SPECIAL ISSUE FOR
NATIONAL LEVEL CONFERENCE
"Recent Trends and Development in Civil Engineering"

COMPARATIVE STUDY OF LEAD RUBBER BEARING AND FRICTION PENDULUM SYSTEM ON BUILDING STRUCTURE WITH BASEMENT STORIES

ASST. PROF. VEDIKA SHAH[1], ASST. PROF. MITTAL PATEL[2], LECTURER. VINAY JAISINGHANI[3]

1. Civil Department, SVBIT, Gandhinagar, Gujarat
2. Civil Department, SVBIT, Gandhinagar, Gujarat
3. Civil Department, SVBIT, Gandhinagar, Gujarat

Accepted Date: 27/01/2018; Published Date: 01/03/2018

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

Corresponding Author: ASST. PROF. VEDIKA SHAH

Access Online On:

www.ijpret.com

How to Cite This Article:

Vedika Shah, IJPRET, 2018; Volume 6 (7): 45-51

PAPER-QR CODE

INTRODUCTION

The basic objective with seismic isolation is to introduce horizontal flexible, but vertically stiff systems at the base of a building to substantially uncouple the superstructure from high frequency earthquake shaking. The basic concept of a base isolation system is lengthening the natural period of the base building. Following are the basic introduction of isolators.

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.

Figure 1 Lead Rubber Bearing (source: internet)

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.

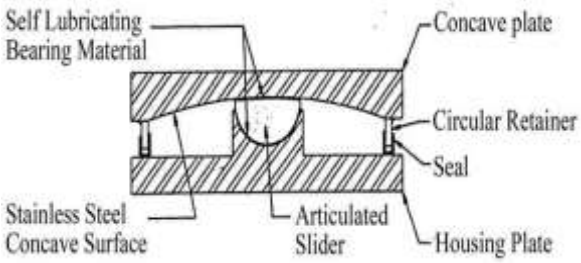

Figure 2: Friction Pendulum System (source: internet)

OBJECTIVES

The scope of work generally set the background of the comparison and to determinate base shear, storey drift and displacement.

Following are the path of study.

For analysis of base isolation with basement storied structure, defining the building aspect ratios for symmetry of structure, where h = height of building with basement height, a = base width. h/a = 0.75; h/a= 1; h/a= 1.25

Here, 4 storied super structure with 3 storied basement type building with relevant to aspect ratios are taken for comparison. For each structure there is a corresponding height to base width ratio defined. These selected structures are analysed through the response spectrum method (linear dynamic analysis) with Isolators in ETabs 2015 for comparison between, fixed base, lead bearing isolator, and Friction pendulum system. The numeric values of all systems in terms of insulator property and isolator dimension are derived. That value is used in the input data in software as link properties.

This section present details of the building taken for the comparison and modelling criteria in E tabs. All link properties are determined through IS 1893 2002 part I. Here, 3 types of building analysed with LRB and FPS systems. Here stated abbreviations of types of buildings.

- G+4 with 3 storied basement with 0.75 aspect ratio (G+4_3_0.75)
- G+4 with 3 storied basement with 1 aspect ratio (G+4_3_1)
- G+4 with 3 storied basement with 1.25 aspect ratio (G+4_3_1.25)

Where, aspect ratio = total height of building to the total width of building ratio. The summarized data about building geometry is given below.
Grade of concrete = 25 N/mm^2, Yield strength of steel = 415 N/mm^2, Floor load = 3 kN/m^2, Slab thickness = 200 mm, Wall thickness = 200 mm, Floor height = 4 m, Bay width = 4 m, Size of beam = (300 X 500) mm^2. Size of column = (500 X 500) mm^2 .

The link property for the both type of isolator systems are derived and input the same in e tabs for analysis. Following is the linear and nonlinear property of Isolators.
As we know the hysteretic loop for the behaviour of this systems gives,

1. Effective stiffness (K_{eff}),
2. Effective damping (C_b),
3. Post yield stiffness ratio (Y_r),
4. Yield strength (F_y)
5. Effective vertical stiffness (K_v)
6. Radius of curvature (R_{fps}).

Following are the link property data in terms of linearity and non-linearity for the G+4 building with 3 storied basement with aspect ratio 1.25.

LRB	K_{eff} (kN/m)	C_b (kNs^{-1}/m)	F_y (kN)	Y_r	K_v (kN/m)
	1263.85	179	28.36	0.12	17068184
FPS	**K_{eff}(kN/m)**	**C_b(kNs^{-1}/m)**	**R_{fps} (m)**		
	1502.21	277.17	1.23		

Table 1: Link Property of LRB and FPS

The generated model and link property data inputs in E tads are as following images.

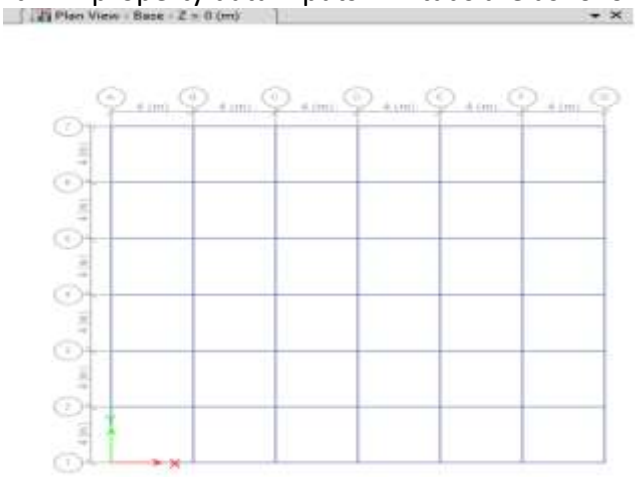

Figure 3: plan view of G+4 building with 3 storied basement with aspect ratio 1.25. (Source: etabs2015)

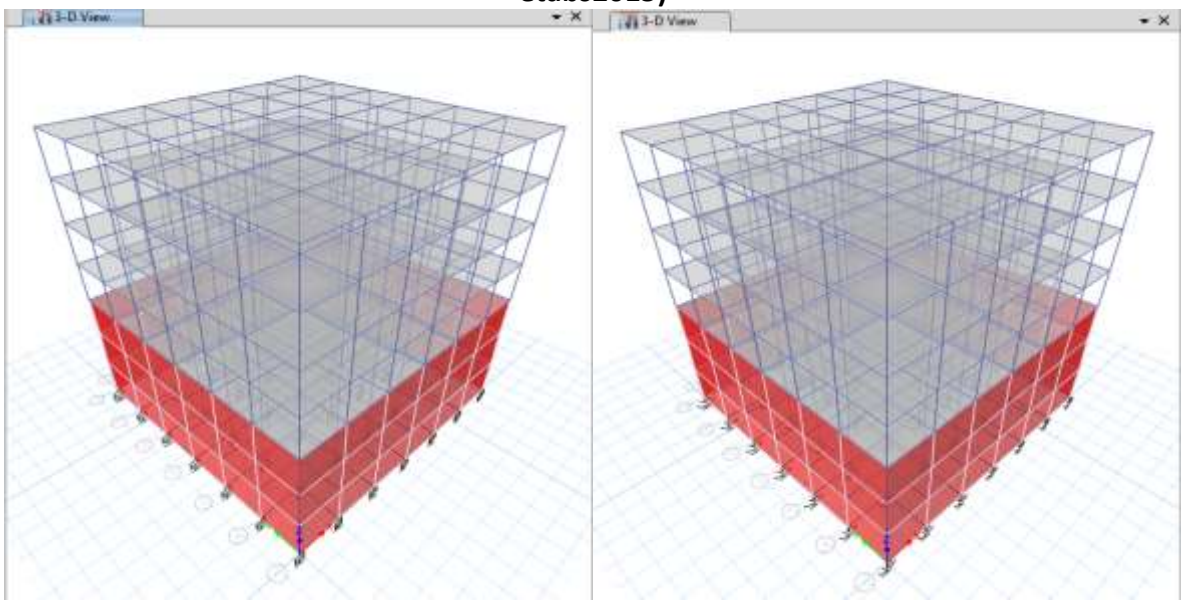

Figure 4: 3-D view of G+4 building with 3 storied basement with aspect ratio 1.25. (Source: etabs2015)

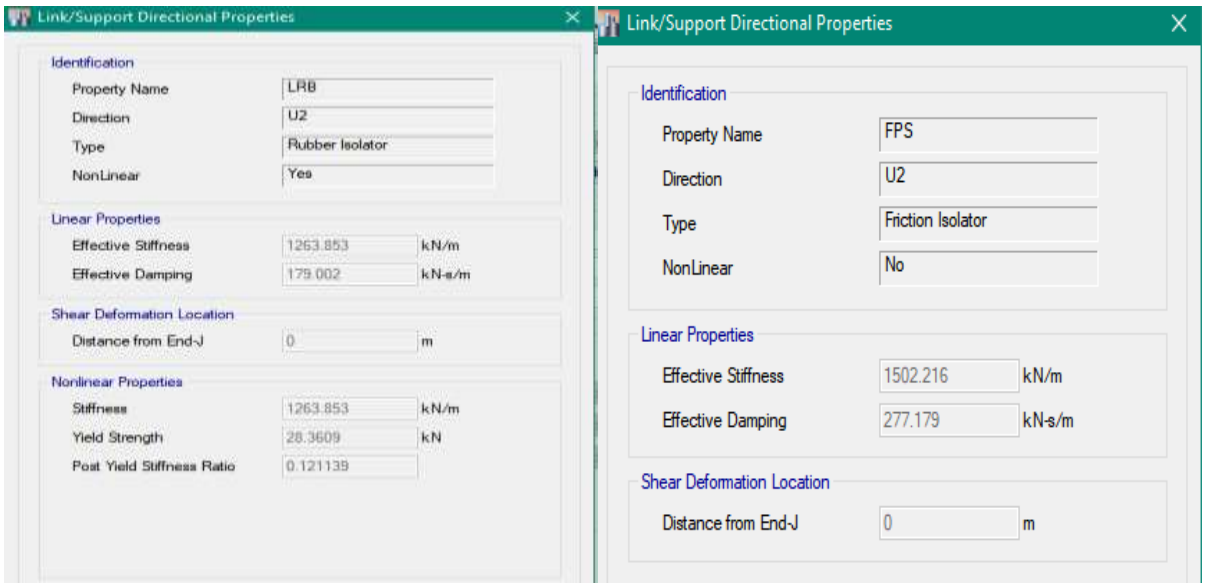

Figure 5: LRB & FPS link property of G+4 building with 3 storied basement with aspect ratio 1.25. (Source: etabs2015)

RESULT AND DISCUSSION

The results on comparison of LRB and FPS is given below for all type of structures given below in terms of storey displacements, storey shear, and storey drifts. It is remarkable that, time period of both systems for a particular building type are same. Following are the all graphs regarding outputs of Etabs.

Figure 6(a) **Figure 6(b)** **Figure 6 (c)**

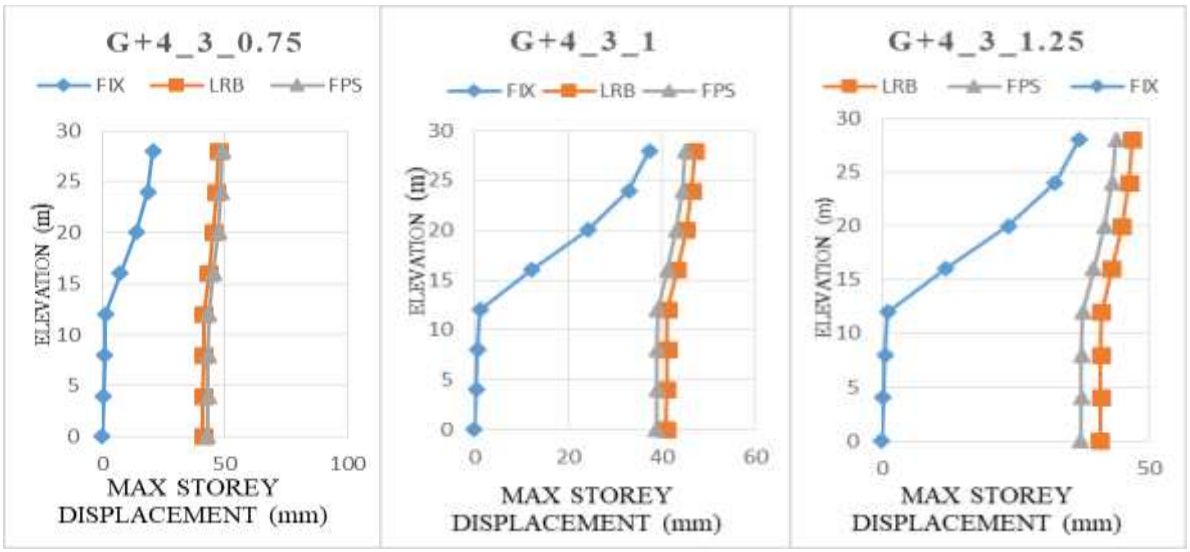

Figure 6 (a, b, c): Comparison of Max storey Displacement in G+4_3 buildings

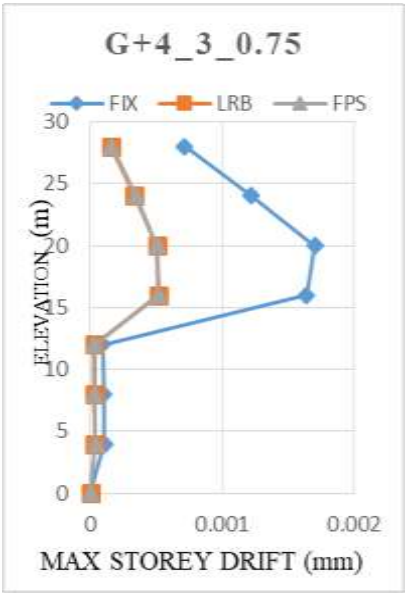

Figure 7(a)

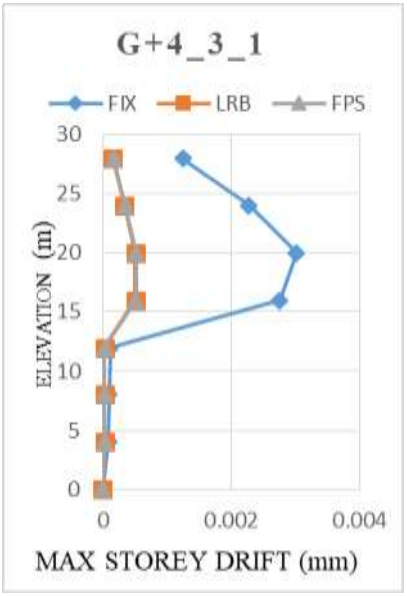

Figure 7(b)

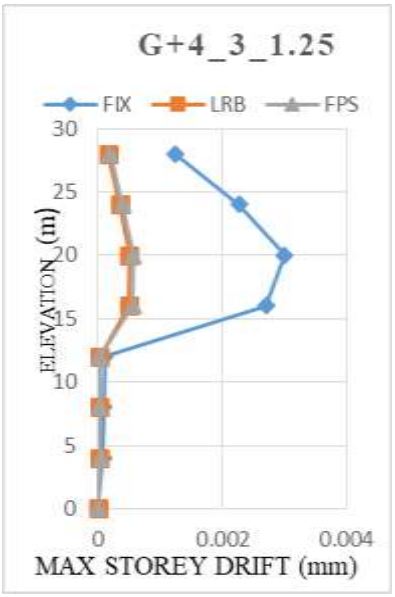

Figure 7(c)

Figure 7 (a, b, c): Comparison of Max storey Displacement in G+4_3 building

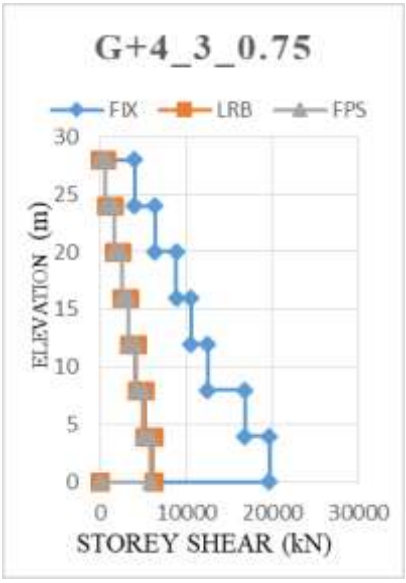

Figure 8(a)

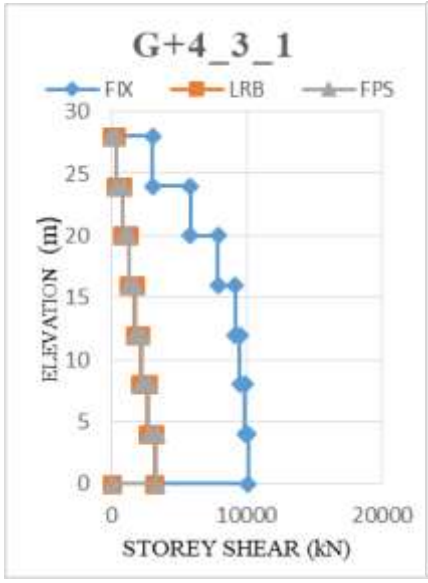

Figure 8(b)

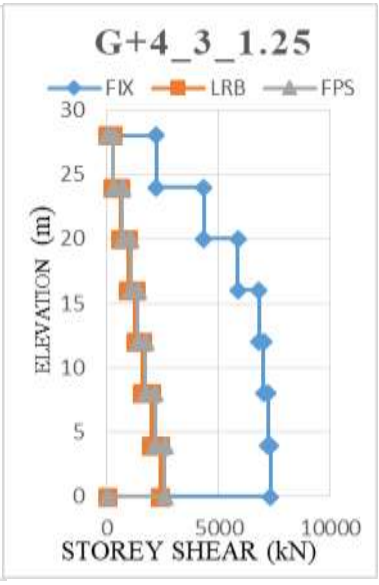

Figure 8(c)

Figure 8 (a, b, c): Comparison of storey shear in G+4_3 building

A storey displacement is analysed in FPS than LRB systems in all set of building structure are equivalent. So for a same time period, friction pendulum system is as convenient as LRB systems in terms of linear behaviour. Both systems have proved more suitable in a storey shear characteristic in all set of taken structure. In terms of storey drifts, both systems also have achieved desired values in all set of structure.

ACKNOWLEDGMENT

This research paper is made possible through the help and support from everyone, including: parents, teachers, family, friends, and in essence, all sentient beings.

REFERENCES

JOURNAL ARTICLES

1. M. Sarkisian, E. Long, D. Shook, A. Diaz, A New Paradigm for Residential Construction in Regions of High Seismicity, 1st Residential Building Design & Construction Conference – February 20-21, 2013 at Sands Casino Resort, Bethlehem, PA PHRC.psu.edu
2. Stefano Sorace and Gloria Terenzi, Analysis, Design, and Construction of a Base-Isolated Multiple Building Structure, Hindawi Publishing Corporation Advances in Civil Engineering Volume 2014, Article ID 585429
3. Arathy S., Manju P.M, Analysis of friction pendulum bearing isolated structure, International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056 4. Volume: 03 Issue: 08 | Aug-2016
4. Yogesh P. Patel , Prof. P. G. Patel, Comparative study of seismic response of structure with different base isolator, International journal for scientific research & development (IJSRD) Volume 04, Issue 03, 2016