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COMPARISON BETWEEN FRICTION PENDULUM SYSTEM AND LAMINATED RUBBER BEARING ISOLATION SYSTEM

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Abstract - *Base isolation systems have become a significant element to enhance reliability during an earthquake. In recent years base isolation has become an increasingly applied structural design technique for buildings and bridges in highly seismic areas. The commonly used isolation system are Lead Rubber Bearing, Laminated Rubber Bearing, Friction Pendulum, trench Method, Pile Method and Damper. In this research paper there is detail about all five isolation systems and comparison between Friction Pendulum and Laminated Rubber Bearing for a 10 storey building and conclusion about which is the best isolation system for the two.*

***Key Words*: Base Isolation System, Isolation system, Lead Rubber Bearing, Friction Pendulum System.**

1.INTRODUCTION

"A fixed base structure which is built directly on the earth surface and will move (horizontally-vertically in both direction) with an earthquake's motions and can sustain extensive damage as a result. When a structure constructed on flexible bearings but not a direct contact with the earth surface, which are known as Isolators, and hence the structure will not move during an earthquake". Isolation is a technique to prevent the damage the buildings during an earthquake. This technique is used in New Zealand, India, Japan, Italy and USA.

2. VARIOUS ISOLATION SYSTEM

Past earthquakes has demonstrated that many buildings and typical methods of construction are lacking basic resistance to earthquake forces. This resistance can be achieved by simple, inexpensive principles of building construction. Adherence to these rules will not prevent all damage in moderate or large earthquakes, but life threatening collapses can be prevented, and limit damage to repairable proportions.

3. TECHNIQUES OF EARTHQUAKE RESISTANCE

There are particularly 3 methods for isolation:

1. Lead Rubber Bearing
2. Laminated Rubber Bearing
3. Friction Pendulum System

3.1 Lead Rubber Bearing:

Lead Rubber Bearing or LRB is an isolation which employs heavy damping invented by William Robinson, from New Zealand. Heavy damping mechanism used in vibration control technologies and isolation devices, is considered a valuable source of suppressing vibrations, improving a building's seismic performance.

For isolated structures having low bearing stiffness but high damping, then the "damping force" may become the main pushing force at a strong earthquake. The bearing is made of rubber with a lead core. In uniaxial test the bearing was under a full structure load. Many buildings and bridges, in New Zealand and other places, are protected with lead dampers and lead and rubber bearings.

The LRB having steel shims between rubber layers, uses its flexibility to deflect seismic waves. Through plastic deformation, energy is absorbed from the vibrations. Its lead core further dissipates the energy. The steel component of the LRB is treated as an elastoplastic material, the rubber as a hyperplastic material, and the lead as an elastic perfect plastic model.

3.2 Friction Pendulum Systems:

Friction Pendulum Bearings is one type of isolation system where the superstructure is isolated from the foundation using specially designed concave surfaces and bearings. These allow sway under its natural period during the seismic occurrences. This study presents development of isolation system physically demonstrating the concept of Friction Pendulum in the laboratory for earthquake engineering study.
Measurements are made of the responses of degree of freedom system with and without isolation. These are then compared for free and forced vibrations using the accelerometers attached to the top of these structures. The maximum acceleration experienced by the structure was 0.23g and 0.57g with and without isolation, respectively.
The damping of the system was found to be increased by 5 times due to isolation. The isolation system showed improvement in dynamic response of the model structure by reducing the lateral acceleration and simultaneously increasing the damping of the system.

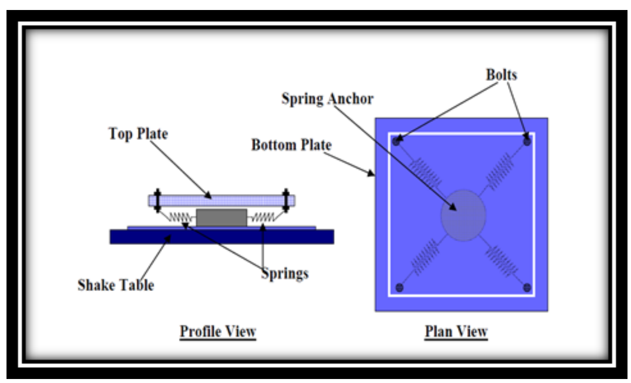

Fig1. Friction Pendulum Bearing

3.3 Laminated Rubber Bearing:

Laminated Rubber Bearing Isolators are placed between the superstructure and foundation, to reduce the horizontal stiffness of the structure. It increases the period of the structure and decreases its spectral acceleration. The superstructure acts like a rigid body, thus inter storey drift is reduced. Such type of isolators are used in practice in India, yet a proper design procedure based on IS code is unavailable.

The design procedure for LRB requires different input parameters like fundamental period and damping of the fixed base structure, axial load on the column, seismic zone, and type of soil and hardness of rubber. These enables the designer to easily achieve seismic isolation. Using the charts, case study has been done using SAP2000.

Model with and without isolator are compared for Building displacement and acceleration. Comparative study of linear and non-linear base isolators has also been carried out. Linear and non-linear time history analysis has been done using El Centro earthquake.

4. ANALYSIS &COMPERISION OF FRICTION PENDULUM AND LAMINATED RUBBER BEARING FROM VARIOUS EARTHQUAKE DATA AND GRAPHS RELATED TO IT:

Table

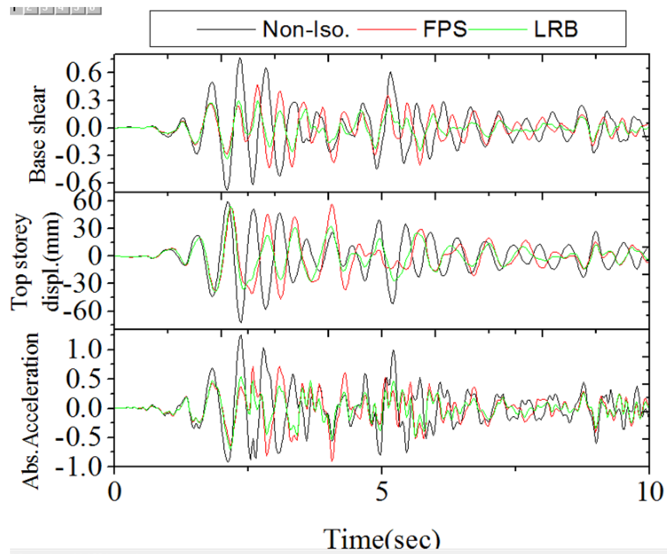

Fig3. BHUJ GRAPH

5. CONCLUSION:

Here a ten storey building is designed with both Laminated Rubber Bearing and Friction Pendulum Isolation system and was tested in Matlab software for Bhuj earthquake data given in above table and graphs of Base Shear v/s Time, Top Storey Displacement v/s Time and Acceleration v/s Time are generate

Time	Top story displacement	base shear		
0.005	3.70E-08	-3.72E-06		
0.01	2.98E-07	-1.07E-05		
0.015	1.01E-06	-1.99E-05		
0.02	2.41E-06	-3.03E-05		
0.025	4.71E-06	-4.09E-05		
0.03	8.17E-06	-5.11E-05		
0.035	1.30E-05	-6.07E-05		
0.04	1.95E-05	-6.98E-05		
0.045	2.78E-05	-7.87E-05		
0.05	3.83E-05	-8.75E-05		
0.055	5.13E-05	-9.64E-05		
0.06	6.70E-05	-1.05E-04		
0.065	8.58E-05	-1.14E-04		
0.07	1.08E-04	-1.22E-04		
0.075	1.35E-04	-1.30E-04		
0.08	1.66E-04	-1.37E-04		
0.085	2.02E-04	-1.45E-04		
0.09	2.45E-04	-1.52E-04	max top story displacement	4.04E+01
0.095	2.95E-04	-1.59E-04	min top stry displacement	-2.88E+01
0.1	3.55E-04	-1.65E-04		
0.105	4.29E-04	-1.72E-04		
0.11	5.19E-04	-1.78E-04	max base shear	1.45E-01
0.115	6.32E-04	-1.83E-04	min base shear	-1.70E-01
0.12	7.75E-04	-1.88E-04		
0.125	9.57E-04	-1.93E-04		
0.13	1.19E-03	-1.98E-04		
0.135	1.48E-03	-2.02E-04		
0.14	1.85E-03	-2.06E-04		
0.145	2.30E-03	-2.09E-04		

d.From these graphs it can be concluded that Laminated Rubber Bearing isolation system is better than Friction Pendulum System has it has minimum top storey displacement has compared to Friction Pendulum system.

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BIOGRAPHIES

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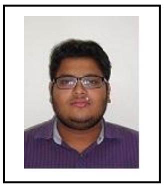

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