Hybrid Spherical Rollers Used in Super Structure and Sub Structure

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Abstract—An experimental study of base isolated structures with spherical roller balls was carried out. A comparison study on Base isolated at Sub-structure and Base isolated at Super structure is carried out in this paper. The period of friction pendulum using the pendulum principle can be adjusted by changing the radius of the sliding surfaces. The friction Pendulum also provides a restoring force due to gravity. At base isolated, Displacement, Acceleration, and Velocity result for Sub-structure frame model compared by Spherical Rollers to base isolated super structure frame using shake table testing machine. As reducing super structure damages in sub-structure base isolated frame by spherical rollers decreases drastically as compared to the super structure base isolated frame, we expected the result 50% but we archived the result of 70.30%.

Index Terms— Pendulum principle, Hybrid spherical roller, Sliding bearing, Horizontal shake table.

I. INTRODUCTION

About the last 207 years (1817) earthquake resistance structures research, our civil engineers resulted in adopting various techniques such as Elastomeric bearing, Friction pendulum bearing, Supplemental damping devices, Fluid dampers, Friction dampers, viscoelastic dampers, hysteric dampers, Building restrained braces, Base isolation. Base isolation is one of the best alternatives for this issue. Hence, to mitigate the response of earthquake on structures, many engineers and architects trying to find out the best application method to decrease the response given to ground motion by the structure. Design of structure as thought courses tends to consist of guessing the size of members and assumptions required in a given structure and analyzing them in order to check the resulting stresses and deflection against limits set out in codes of practice.

Aravinthan K, Ramu R (2016), published paper on the use of Harmonic Shake table test on Hybrid spherical rollers by comparison between the base isolated frame structure and non-isolated structure in hinged frame structures. As reducing super structure damage in the base isolated frame by spherical roller balls decreases using shake table test machine. He concluded that reduction values in Displacement-94.68%, Acceleration-90.53%, Velocity-94.57%, Base shear-98.16%, and Storey drift 90.95% [1].

The review paper Ashish R. Akhare and Tejas R. Wankhade (2014), Published paper on the use of High Density Rubber Bearing (HDRB) and Friction Pendulum System (FPS) as an isolation and then to compare various parameters between fixed base condition and base isolated by using SAP2000v14 software. He concluded that reduction in base shear in X-direction by 70% in HDRB & 94% in FPS and Y-direction by 71% in HDRB & 85% in FPS. Base isolation structure and in this method has given to a reliable method of earthquake resistance design [2].

In the paper by P.L.Y.Tiong and A.Adnan (2013), insisted that the main seismic plan philosophy of a fixed-base structure is that slight structural damage is acceptable as long as the structure does not collapse. Hence seismic base isolated providing an improved alternative in earthquake structural design. This paper present finite element analysis carried out investigate the believability of applying locally produced elastomeric rubber bearing base isolated in seismically isolated non-ductile precast concrete walls structures from earthquake excitations. He concluded base isolated had successfully reduced most of the critical structure responses such as floor acceleration up to 33.8% and base shear from 18.8% to 54.9% relative inter-story drift reduced as compared to fixed base structure was not significant [3].

Takaoka *et al*, performed shake table tests of a slender 1/9 length scale structure with lead rubber bearings, varying the structure slenderness ratio and the bearing aspect (diameter to height) ratio to engage different bearing failure modes. Bearing rupture was reported under extreme cases of buckling, tension, and combinations of tension and shear. Buckling rupture, accompanied by a "sinking" deformation of the bearing, occurred after the horizontal deformation had exceeded the diameter of the bearings. Large tension occurrences were accompanied by a notable increase in horizontal acceleration at the roof level when the uplifted structure landed on the bearings [4].

Sliding bearings support the weight of the structure on a bearing that rests on a sliding interface. The sliding interface is designed with a low coefficient of friction, which limits the resistance to horizontal forces. Most sliding bearings use polytetrafluorethylene (PTFE) type material and stainless steel for the bearing material at the sliding interface. Restoring force is provided either by added springs or through geometry as with the Friction Pendulum TM (FP) bearing [5].

Extensive shake table testing of base-isolated buildings has been conducted over the past 30 plus years, which has paralleled the development of suitable isolation devices for large scale structures and the evolution of base isolation practice in the United States and other countries. The earliest tests focused on verification of different isolation devices and served mostly as proof-of-concept tests, without rigorous standards for evaluation of the building response. Elastomeric bearings matured more quickly than friction-based sliding systems. Several of the earliest systems were evaluated by shake table testing at the University of California's Earthquake Engineering Research Center (EERC). These systems included lightly damped elastomeric bearings, elastomeric bearings with steel dampers [6].

II. METHODOLOGY

A. Horizontal Shake Table Machine Specification

Shake table machine with eccentric cam specification

Motion : Simple Harmonic,
Axis : Single axis of Horizontal,
Max load : 30 Kg,
Motor : 1 Hz,
Resolution : 1 mm,
Frequency : 0 to 10 Hz,
Amplitude : 0 to 10 mm,
Frequency control: ± 5%,
Sliding table dimension of 400 mm x 400 mm, Circular Mounting plate dimension 390 mm.

B. Loading condition

Sub-structure Base isolated frame Dead Load 11.5 kg, and live load on First floor 5 Kg (particular area only will applied on loads).

Super Structure Base isolated frame Dead Load is 11.5 Kg, and live load on First floor 5 Kg (particular area only will applied on loads).

C. Model Frame structure Figures

Sub-structure frame and super structure frame. Fig.1
Roof area: 350 mm x 350 mm x 2 mm,
Floor height: 298 mm (each floors),
Total height: 900 mm,
Square Column: 25 mm x 25 mm x 2 mm.
Spherical Roller Ball: 22mm

Base Isolated Frame Models Fig.1

III. SETTING METHOD OF BASE ISOLATED STRUCTURES

Model frames testing on Horizontal shake table test machine and setup on Hybrid spherical roller balls and pendulum principle.

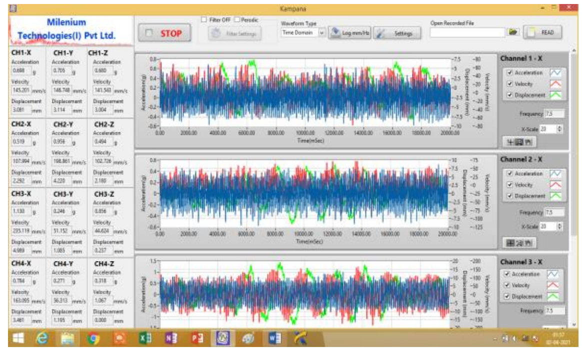
Sub-Structure base isolated structure frame. Fig.2

Super Structure base isolated structure frame. Fig.3

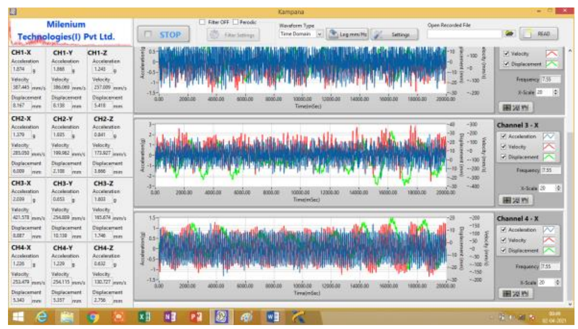
IV. RESULTS AND DISCUSSION

This value is taken from the harmonic shake table test machine (single horizontal axis) in software response on computerized frequency 7.5Hz reports. In this study, the comparison between the Sub-structure base isolated frame Fig.4 and Super structure base isolated frame Fig.5.

The aspects such as Displacement, Acceleration, Velocity.



Sub-structure Frequency-7.5Hz Fig.4



Super-structure Frequency-7.5Hz Fig.5

A. *Displacement*

The reduction in displacement 70.308% at the Sub-structure base isolated frame in comparison with Super structure base isolated frames.

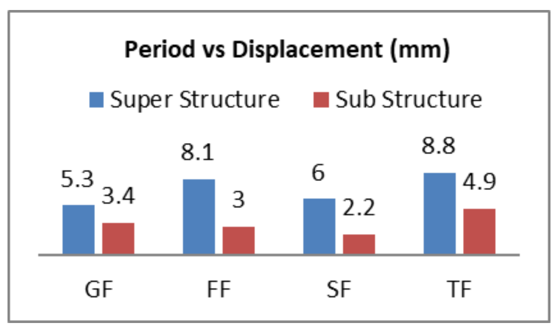


Fig.6

B. *Acceleration*

The reduction in Acceleration 70.142% at the Sub-structure base isolated frame in comparison with Super structure base isolated frames.

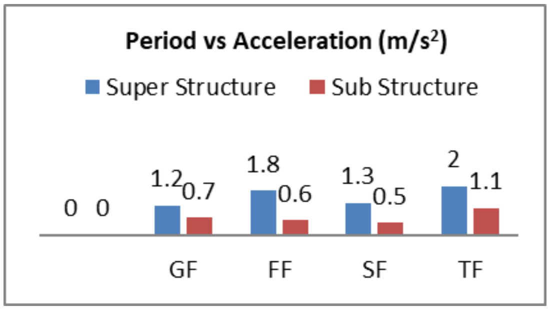


Fig.7

C. Velocity

The reduction in Velocity 47.254% at the Sub-structure base isolated frame in comparison with Super structure base isolated frames.

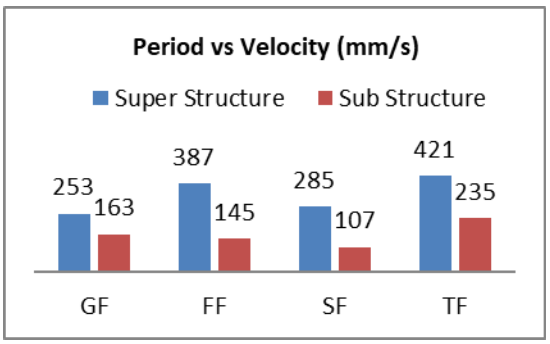


Fig.8

CONCLUSION

This Sub-structure base isolated frames reduction the displacement is 70.308%, Acceleration is 70.142%, velocity is 47.254% in comparison with super structure base isolated frames.

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