Summary of the development of FPS isolation system

Xiaoqiang Tian

North China University of Science and Technology, Hebei 063200, China.

447936521@qq.com

Abstract

The application and research status of FPS isolation bearings at home and abroad are analyzed. The damping performance of various kinds of friction pendulum isolation bearings is evaluated.

Keywords

Isolation technology, FPS isolation bearing,Damping performance.

1. Introduction

FPS (Friction Pendulum System) is a friction and slip isolation system with good effect. Due to its good limited reset function, anti-torsion ability, and low cost, convenient construction, and convenient processing and mass production, so there are a large number of scholars to study. In recent years, with the continuous research progress of isolation system, FPS system has been widely used in building, reinforcement and bridge isolation, and has gradually become a kind of isolation bearing with development prospects. At present, many scholars continue to study the isolation system in depth. This paper briefly introduces the development and research of FPS isolation system, and puts forward some development directions of FPS isolation bearing.

2. The development of FPS isolation system

2.1 Research progress of FPS isolation bearings

Luciana [1], Nikolay [2], Mokha [3] and others conducted a controlled experiment on the seismic response of the friction pendulum isolation structure and the non-isolated structure. The results show that the friction pendulum isolation system has obvious effects, which significantly reduced the seismic acceleration during the transmission process. Li Dawang [4], Shi Zhixiao [5], Hu Canyang [6], Jiang Ting [7] and others based on the friction pendulum (FPS) isolation shear structure, established the nonlinear vibration differential equation, the dynamic analysis, the oscillation state of FPS isolator system and studied the seismic response, such as, prove the FPS isolator system has a good effect, effectively reduce the maximum acceleration and displacement between floors of the structure response. Li Dawang, Zhou Xiyuan, Huo Da et al. [8] proved that FPS has good stability and limit reset function by establishing simplified model and dynamic calculation, and the larger the earthquake, the better the isolation effect.

Dicleli [9], Leblouba and Husfeld [10] conducted a comparative analysis of the friction pendulum system, traditional rubber isolation bearing and mixed isolation system. The results show that compared with other systems, the hybrid isolation system can not only control the displacement amplitude of the isolation support, but also make the basic vibration period of the structure longer, thus reducing the seismic force and making the isolation effect better.

Another common type of isolation system is the additional damping device, which can consume more energy, but may increase the structural deformation of the upper part and increase the absolute acceleration, which will affect the isolation effect. Providakis [11], Madden [12], Wongprasert [13]

and others to assess the isolation system with adaptive damper, and the results show that increase of variable fluid viscous damper can make the foundation and the superstructure displacement to implement real-time self-adjusting, not only limits the response of the upper structure, and the displacement of the isolation system under control, vibration isolation effect is improved. Ye Deqin discussed the use of mass damper and mass brake to inhibit structural displacement, so as to improve the effect of FPS [14].

Li Dawang, Li Guiqing et al. established the horizontal and vertical coupling vibration differential equations of the multi-layer shear structure of FPS isolation system, and calculated the time-history response, proving that FPS has a good isolation effect and can effectively suppress the whipping effect [15].

Based on the semi-active control of seismic response of space rod structure with piezoelectric friction damper, Zhu Xiyu studies the combination of piezoelectric material and friction pendulum system, and realizes the optimal configuration of damper. The experimental results show that the semi-active control of seismic response of space strut structure of piezoelectric friction damper makes it effective [16].

2.2 Friction complex pendulum (double concave friction pendulum) isolation structure

Dend Xuesong Gong Jian [17] to build up a double concave type friction pendulum isolation bearings of the three-dimensional entity unit model used the numerical simulation, and combining with related theory knowledge, to double concave friction pendulum isolation bearings under low reversed cyclic loading, the hysteretic performance and ability to since the recovery of large displacement has carried on the comparative study, and further discusses the coefficient of friction, spherical radius of double concave type the response mechanism of the friction pendulum isolation bearings as well as the effect of energy dissipation system.

2.3 Multi-stage (triple) friction pendulum isolation structure

Yan Ping studied the triple frictional pendulum support, compared and studied the response characteristics of the triple frictional pendulum multiple high-rise isolation structure, and analyzed the impact of vibration type on the isolation structure. The results show that the mechanical properties of triple tribological pendulum support are related to curvature radius and friction coefficient. The triple friction placed at different sliding stages presents different stiffness and damping, showing adaptive function. Therefore, it can be used to optimize the design of regions that meet multi-segment seismic fortification targets [18].

3. Conclusion

Friction pendulum (FPS) isolation technology has been developed for a period of time, which has high safety, applicability, reliability and other advantages, and has attracted the attention of scientists. The technology of friction-pendulum isolation started relatively late, but developed rapidly, and rich research achievements have been obtained. I now propose some new research directions for FPS isolation systems:

(1) Considering the interaction between the frictional pendulum and the electromagnetic force, the electromagnetic force is used to increase the friction force and thus increase the energy consumption of seismic waves.

(2) Considering the combined effect of different dampers on FPS, the isolation system was optimized.

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