Seismic Behavior Analysis of a Novel Elastic-Plastic Structure Damping Bearing

LIU Meng, Junjie WANG

College of Civil Engineering, Tongji University, Shanghai, China

Contact: liumengsmart@163.com

Abstract

A novel elastic-plastic sphere bearing with given fusing capacity is proposed in this paper, which can simultaneously control the pier damage and the relative displacement between girder and pier. To investigate the performance of the novel bearing developed in this paper, the compression-shear tests are carried out. It shows that the robustness of shear capacity of the fusing system is validated by the experimental test results，the expected goals of displacement and energy-dissipation of steel-ring damper elements are also achieved. To further illustrate the efficacy of proposed bearing in simultaneously controlling pier damage and displacement of girder, the demonstration case using a continuous girder bridge model is presented. It shows that the seismic behavior of bridges can be controlled by using the novel elastic-plastic sphere bearing developed in the paper.

Keywords: seismic and isolation device; elastic-plastic sphere bearing; shear pin; steel-ring damper; compression-shear test.

1 Introduction

In recent years, with the continuous development of the seismic design concept, the bridge structure design method has gradually changed from the ductile seismic design of piers to the seismic isolation design. The basic principle of seismic isolation technology is to extend the natural vibration period of the structure through the isolation device, thereby reducing the internal force response of the structure caused by the earthquake; to limit the excessive displacement due to the extension of the period through the energy dissipation device [1]. Therefore, the key of seismic isolation technology is whether a new type of seismic isolation device that can effectively control the dynamic response of the structure can be developed [2].

The post-earthquake investigation of the Wenchuan earthquake found that most of the bridge substructures using plate rubber bearings did not suffer serious damage. The plate rubber bearing has excellent shear deformation ability and stable sliding behavior, which can isolate the inertial force of the superstructure, but it will cause a large displacement of superstructure [3-5]. In order to control the relative displacement between superstructure and pier within a certain limit, elastic-plastic X-shaped block and plate rubber bearing are used together [6]. The X-shaped block has good energy dissipation characteristics and can control the relative displacement between superstructure and pier effectively. Ye [7] found that if triangular steel damper and plate rubber bearing are used together, the aseismic effect is good. This kind of seismic isolation design concept is gradually recognized and studied. Gao [8]

https://doi.org/10.2749/nanjing.2022.1023
Distributed by structurae