Near-fault Isolation of Cable-stayed Bridge in Longitudinal Direction using Linear Friction Damper

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Abstract

In the current research, an innovative linear friction damper is proposed to control the seismic responses of cable-stayed bridges in longitudinal direction under near-fault ground motions. The working mechanism and force-displacement relationship of this new device are introduced in detail. The numerical model of the bridge is established by OpenSees platform. 12 earthquake records with velocity pulses selected from PEER website are adopted as input ground motions. The seismic responses of the bridge with and without this dampers are obtained after conducting a series of nonlinear time histories analysis. The numerical results reveal that this new type friction damper can effectively limit the relative displacement between the superstructure and substructure of the bridge in longitudinal direction to a reasonable range. Thus, pounding between deck and abutment can be mitigated.

Keywords: near-fault; cable-stayed bridge; passive control; nonlinear analysis; friction damper.

1 Introduction

In recent decades, cable-stayed bridges have been favored by bridge engineers due to their aesthetic configuration, fast and economical construction, and efficient utilization of materials. However, bridges of this type are susceptible to the seismic excitation attributing to their low damping ratios and flexible components. In order to isolate the superstructure of this type bridge from horizontal seismic excitation, full floating system is usually employed for cable-stayed bridge. This elongate the fundamental period of cable-stayed bridge, therefore, the input seismic forces on bridge may be decreased. As a result, the relative displacements between deck and pylon (or abutment) will be increased， compared with its counterpart whose deck is connected to pylon. Large displacements of deck will increase the risk of the bridge under severe earthquakes. Consequently, some measures should be taken to control the deck moments of cable-stayed bridge subjected to serious seismic excitation.

Passive control, as an effective seismic mitigation strategy, has been frequently used for seismic isolation of cable-stayed bridge in recent years. The isolation systems can be approximately divided into four types: isolation bearings, cable restrainers, dampers, and innovative devices. Various isolated bearings have been investigated, including lead rubber bearing (LRB) [1,2], high-damping rubber (HDR) [3,4], friction pendulum system (FPS) [3-6]. The seismic isolation of these bearings is attributed to lengthening the fundamental period of structure and reducing the transmitted acceleration into the superstructure. The differences of these two strategies are that for the former one, the total input seismic energy is reduced by shifting the fundamental period of a structure away from the dominant periods of seismic excitation, but for the later one, seismic energy is mainly dissipated by isolation bearing. Cable restrainers [7] have been adopted to control the relative displacements between the deck and pylon of cable-stayed bridge in longitudinal or transverse direction. Dampers [8,9] including frictional sliding, yielding of metals, deformation of viscoelastic fluids, and so on, are frequently installed at long cable-stayed bridges because of their high ability of energy dissipation. In recent years, some innovative devices have been

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