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An innovative isolation system for lateral seismic control of a cable-stayed bridge with heavy deck

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Abstract

In this work, an innovative isolation system was proposed for the seismic control in the transverse direction in a long-span cable stayed bridge with heavy concrete girder. The isolation at the tower location is comprised of two elastic cables and a viscous damper, where the cables provide both the essential constraint required by the service loadings and also a large lateral deformation capacity in case of earthquakes, while the viscous damper provides the complimentary damping. At the pier locations, BRBs (Bucking Restrained Brace) is used for the vibration control and energy dissipation in the transverse direction. A three dimensional finite element model was developed and nonlinear time-history analysis was conducted for the bridge. The results show that the base bending moment in the tower column and the axial force in the piles are reduced by 40% and 30%, respectively and the base moments in the piers are reduced by 70% to 80%.

Keywords: cable stayed bridge; isolation; elastic cables; viscous dampers; BRBs.

1 Introduction

In the last decades, a large number of modern cable-stayed bridges have been built all over the world, and as one of the most popular bridge types, they provide an aesthetic and practical solution for spans up to approximately 1 km. since those long spans often constitute an integral part of local and national highway systems, the structural safety under extreme dynamic loads such as earthquakes has been mainly concerned [1-2].

So far, many previous studies have focused on vibration alleviation of cable-stayed bridge in the longitudinal direction, and it is proved that although restraining the bridge deck completely at the pier and tower locations could limit the deck displacement, it would cause excessive demands on the piers and towers in terms of bending moments and shear forces and therefore, a full- or semi-floating system associated with additional damping devices such as Fluid Viscous Dampers (FVDs), Shape Memory Alloy (SMA) cables , mild steel dampers[] and Magnetorheological Fluids Dampers (MFDs) could provide an ideal solution for earthquake resisting system of cable-stayed bridges in the longitudinal direction [3-5].

However, to avoid any unexpected vibration induced by vehicles or wind in the transverse direction under service conditions, the girders usually need to be constrained at the pier and tower locations. As a result, this may cause extremely large force demands on the substructures under earthquake conditions. Guan et al. [6] used Energy Dissipation Bearings (EDBs), which comprises E- or C-shaped steel dampers

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