Investigation of seismic response of rocking column with a novel mechanical connection device

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Abstract

The rocking column is a kind of excellent seismic-resistant and resilient structure. However, during the rocking process, local pressure on the rocking interface may result in spalling and crushing of concrete at the toe. In order to reduce the local damage of the rocking interface, as well as accelerate the connection between prefabricated column and footing, a kind of mechanical connection device (MCD) was proposed in this research. The MCD is used at the bottom of column and ofters rapid connection of the column to the footing. The recentering force of MCD column is provided by PT strands and axial force of superstructure, and the energy dissipation is provided by U-shaped dissipaters. A simplified analytical method based on interface section analysis is proposed to study the hysteretic behavior of column with MCD. The results suggest that the MCD column has stable hysteretic behavior and can achieve small residual drift after earthquakes by appropriate design.

Keywords: resilience; rocking column; mechanical connection device; local damage

1 Introduction

The traditional design approach for ductile bridges allows the formation of plastic hinges and input earthquake energy is dissipated mainly through plastic hinges [1, 2]. Although this approach avoids the collapse of bridges, a large residual deformation exists and maybe need to be demolished. In order to restore function after the earthquake, more and more researchers investigate resilient bridge.

The rocking column has excellent earthquake resistance and post-earthquake recovery capability, and is very suitable for the application of prefabricated assembly technology [3]. However, during the rocking process, local pressure on the rocking interface may result in spalling and crushing of concrete at the toe [4]. In order to limit the damage of the rocking interface, the following solutions have been developed: (1) Enhance the ultimate compressive strain of concrete by better confinement. The most common method to confine concrete is by using stirrups [5, 6]. Other researchers also utilized steel armoring or dual steel shell to provide improved confinement [7, 8]. FRP or CFRP jacket can be a kind of good alternative confinement material due to its lightweight, high strength, good corrosion resistance, and ease of installation [9, 10]. (2) Use low damage material to replace the concrete in plastic hinge region. Motaref et al. investigated the seismic performance of using the elastomeric pad and ECC respectively as plastic hinge [10, 11]. Wang Z. et al. used UHPC as replaceable cover plates in plastic hinge region [12]. Other low damage materials include fiber-reinforced concrete [13],

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