Seismic Vulnerability Study of Precast Segmental Piers with Bonded Tendons

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Abstract

The widely applications of precast segmental bridge piers in high-seismicity areas are hindered for their insufficient capacities of energy dissipation. In this study, precast segmental piers' seismic behaviours were investigated, focusing on the connection of "grouted sleeves/bonded tendons". Four piers were cyclically loaded, of one cast-in-place pier, one precast segmental pier, and two prestressed precast segmental piers. Experimental results showed that bonded tendons apparently enhanced the pier's lateral strength, ductility, energy dissipation capacity and reducing residual drift. Of particular, bonded tendons prevented the shear-induced slip between the shaft and footing segments. Furthermore, seismic vulnerability assessments of the bridge piers are obtained in terms of fragility curves. Residual drift is adopted to define the limit states. It is suggested that bonded tendons could significantly ameliorate the fragility curves of precast segmental piers.

Keywords: precast segmental; cyclic; prestressed; pier.

1 Introduction

Precast segmental piers are gaining engineers' favours due to strengths of accelerated construction, reduced traffic disturbance and enhanced quality control [1], compared to the cast-in-place counterparts. From aspects of seismic design, dividing a pier into several segments could mitigate massive concrete spalling/crushing and excessive residual drift [2], and therewith, enhance the seismic resilience. However, it is acknowledged that this technique is hindered in high-seismicity regions, due to insufficient capacity of energy dissipation [3].

Balancing seismic resilience and energy dissipation is vital to accelerate precast segmental piers into high-seismicity areas. Over the past few years, researchers have proposed various connection types between segments, e.g., high-strength rebars [4], high-performance concrete [5] and prestressing tendons [6]. Among them, prestressing tendons, either unbonded or bonded, could rise the energy dissipation capacity and reduce the excessive residual drift to a remarkable level simultaneously. Although numerous experiments have been performed, it is still necessary to further explore the seismic behaviours of precast segmental piers, especially with the "grouted sleeves/bonded tendons"

https://doi.org/10.2749/nanjing.2022.1799
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