Experimental Studies of Seismic Performance of Precast Concrete Columns with High-strength and Conventional Steel Rebar

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Abstract

Increasing the strength of steel rebar can improve load-bearing capacity of concrete structures and economize their cost. Precast segmental columns incorporated with high-strength rebar facilitate accelerating bridge construction and may upgrade their seismic performance. To evaluate the cyclic loading behaviors between precast circular pier columns with high-strength and conventional rebar, two column specimens with the energy dissipation bars of HRB600E and HRB400 were experimentally studied. The tests showed that seismic performance of the precast column with high-strength rebar was superior to the counterpart with conventional rebar in the aspects of equivalent yielding strength, maximum shear force, ultimate displacement, post-yielding drift increment, residual displacement, and stiffness degradation. On the other hand, precast column with conventional strength rebar dissipated more energy at the cost of substantial joint damage. Therefore, replacing conventional steel rebar with high-strength bar in precast columns can be a good and practical choice to enhance seismic resiliency of precast bridge columns.

Keywords: precast column; seismic behavior; high-strength rebar; hysteretic energy; post-yielding drift increment.

1 Introduction

Precast concrete segmental bridge columns are becoming popular because of its minimized environmental impact, increased quality, and reduced life-cycle cost. Nonetheless, the joint discontinuity between segmental pier columns is always the main concern of seismic performance [1, 2]. Accordingly in recent years many sophisticated joint constructions and materials have been proposed and investigated to enhance ductility and reduce the damage in plastic hinge under high-intensity earthquake, such as ECC or FRP jacketing, elastomeric bearing pad, SMA bar, etc.

It is worth noticing that the monolithic concrete columns incorporated with high-strength rebar (short as HSR, hereafter) in excessive of 500MPa has begun to be promoted for seismic design of building or bridge structures by some researchers. Ousalem [3], Rautenberg [4], Kelly [5], Rong [6], Su [7] conducted cyclic loading tests of monolithic concrete column with HSR, which concluded that the HSR can improve the ductility, inhibit stiffness degradation and reduce reinforcement.

Following the same line, replacing conventional steel rebar with HSR in precast concrete columns may also significantly improve the seismic capacity, without utilizing supplemental devices or materials in the potential plastic hinge region. Up

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