Experimental Study on Ductility and Hysteretic Energy of CIP and Precast Bridge Piers with High Strength Rebar

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Abstract

In order to minimize the construction cost and improve the seismic performance of structures, the high strength steel bar (≥500MPa) with sufficient ductility has begun to find application in construction industry around the world. Taking the cast-in-place and the precast segmental bridge piers with HRB600E into consideration, the pseudo-static experimental study of four large-scale specimens was carried out in this paper. The results showed that two types of the reinforced pier columns with HRB600E and different reinforcement ratio exhibited typical flexural failure mode where column bottom appeared concrete crushed seriously at the compressive toes or even extended into the core concrete encased by stirrup, and longitudinal bars buckled and subsequent fractured. The hysteretic loop for the CIP piers was plumper than the precast ones, but the resilience of precast pier was better than the CIP piers. The energy dissipation of the CIP piers for each cycle measured was larger than the one of the precast piers, which had relatively severer damage. The displacement ductility of the precast piers was relatively larger than the CIP piers. The energy dissipation bars fractured earlier in the cast-in-place piers than in the precast segmental ones when the reinforcement ratio was low.

Keywords: seismic design; bridge piers; high strength steel bar; reinforcement ratio; hysteretic energy dissipation.

1 Introduction

Segmentally precast pier columns are part of the prefabricated bridge elements and system (PBES). However, the joints between assembled parts may arouse concerns about its seismic performance. A new type of high-strength and ductile steel reinforcement as energy dissipation rebar (refer to as ED bar hereinafter) used to connect precast segments can enhance its seismic resiliency, i.e., post-quake quick recovery capacity, including reduced residual displacement, less damage, more ductility, minimized repair cost and time, etc. In addition, high-strength bars can reduce the quantity of bars, and thus expedite the joint construction and minimize the congestion for concreting.

Up to now, investigations on cast-in-place and precast piers with conventional strength bars (⩽400MPa) can be found in many literatures[1-5], but only a few researches adopted bars with strength higher than 500MPa or more to replace the conventional ones[6-8].

Bridge piers with circular columns are frequently used in practice. Two kinds of circular column piers, cast-in-place and precast, are experimentally studied in this paper. The research

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