Shake Table Studies of Precast Bridge Columns with a Novel UHPC Connection

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Abstract

A novel lap splice connection by ultrahigh-performance concrete (UHPC) was proposed to connect bridge columns with footings. The bond strength between UHPC and reinforcement was quantified by the genetic programming-orthogonal least squares tool. Then, an approach was advanced to guide the design of the proposed connection. Further, a 1/3.5 geometrically scaled bridge specimen was designed and tested on shake tables to validate the effectiveness of this connection designed by the proposed approach and to analyze seismic responses of the specimen. Test results revealed that the precast columns damaged in a flexural pattern reached a drift of 3.2% under the peak ground acceleration of 1.4 g. Moreover, most inelastic deformation and damage occurred above the column-footing connection segments which, designed by the proposed approach, remained barely damaged. Meanwhile, the strain concentration effect at the column bottom was less significant.

Keywords: accelerated bridge construction; lap splice connection; ultrahigh-performance concrete; genetic programming-orthogonal least squares; shake table test.

1 Introduction

To date, accelerated bridge construction (ABC) has gained popularity in low seismic zones by virtue of fast construction, stable quality, and less interference in traffic. Meanwhile, the advent of ultrahigh-performance concrete (UHPC), which owns a compressive strength of as much as 200 MPa and excellent post-cracking tensile behavior, offers opportunities to develop new connections for ABC. One of the most prevailing connections is the UHPC-based lap splice connection due to its friendly tolerance in construction. Nevertheless, its most critical problem is guaranteeing enough bond strength between UHPC and reinforcement to develop an expected reinforcement strength. Thus, many studies, including pullout tests [1-4] and quasi-static element tests [5-7], have been conducted to reach this purpose. Although some quantified guidelines have been made through pullout tests to develop a certain reinforcement strength, this strength is somewhat arbitrary and

https://doi.org/10.2749/manchester.2024.1234