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Retrofitting of Severely Damaged Concrete Piers using Ultra-High Performance Concrete

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ABSTRACT

The use of Ultra-High Performance Concrete (UHPC) is gaining popularity for bridge applications in North America. UHPC has been used both in the construction of new and retrofitting of existing bridges. In this research, a novel use of UHPC as a concrete jacket for retrofitting of plastic hinge zones in cast-in-place and precast piers is proposed. Four large-scale cantilever pier specimens, two cast-in-place and two precast, are tested under cyclic quasi-static loading to drift ratios beyond Maximum Considered Earthquake (MCE). The piers are then retrofitted with UHPC jackets in their plastic hinge zones. The design philosophy for retrofitting is to shift the plastic hinge above the damaged region of a pier, thus re-instating capacity, stiffness, and ductility to the piers. Experimental results from testing of the piers along with guidelines on retrofitting and construction techniques are presented. It is shown that UHPC is indeed a competitive solution for retrofitting of concrete piers subjected to severe earthquake damage.

Keywords: Bridge Piers, UHPC, Seismic Retrofit, UHPC Jacket

1 INTRODUCTION

The first phase of this project was to test the pipe connection of an ABC bridge bent and compare the results to a typical CIP bridge bent. A diagram showing the design of the pipe connection can be seen in Figure 1. In the first phase of the project, two half-scale bridge bents were designed and experimentally tested in the Idaho State University (ISU) Structural Lab (SLAB) under earthquake-style loading. One of the bents modelled a typical cast-in-place (CIP) bridge connection, while the other bent modelled a pier connection developed by ISU and Idaho Transportation Department (ITD). Both bridge bents were tested to failure and the results were processed and compared to one another.