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Recent Developments on Seismic Resistant Technologies for Accelerated Bridge Construction

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1 Abstract

The paper provides an overview of the technologies and connections proposed and tested for accelerated bridge construction (ABC) in seismic regions from New Zealand and the United States in the last seven years. These solutions can be divided in terms of emulative and non-emulative cast-in-place connections. Emulative cast-in-place connections aim to achieve a similar seismic performance to that of conventional cast-in-place construction during an earthquake. A variety of emulative connections have been tested in New Zealand and in the United States, with some being implemented in actual bridges. These connections include grouted ducts, member socket, pocket, splice-sleeve, and other connections. Similarly, various non-emulative connection were tested using large-scale specimens. These include dissipative controlled rocking, hybrid sliding-rocking, shape-memory alloys, and pre-tensioned rocking. From these, only the dissipative controlled rocking and shape-memory alloys, have been recently implemented in construction of actual bridges in seismic regions in New Zealand and in the United States, respectively. The paper discusses the aspects associated with emulative and non-emulative connections.

Keywords: accelerated bridge construction; precast concrete; seismic technologies; low-damage; dissipative rocking; bridges; bridge piers; dissipaters; unbonded post-tensioning.

2 Introduction

One of the main challenges in application of accelerated bridge construction (ABC) in seismic zones has been the performance of the connections between precast elements in the bridge substructure. The connections should be strong enough to withstand seismic forces and thus, provide acceptable level of performance for the bridge similar or better than cast-in-place connections.

In a typical cast-in-place bridge, formation of plastic hinges is expected during a large earthquake. The hinges are located in the columns and are detailed such to provide sufficient ductility and strength for the bridge. After the earthquake, the bridge may have been damaged, but it should remain open albeit with reduced functionality. The bridge could be repairable or would have to be replaced for long-term service. When precast elements are used to form the substructure for the bridge, two types of connections could be utilized 1) emulative cast-in-place and 2) non-emulative cast-in-place. These connections are described in more detail in the subsequent sections.

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