39th IABSE Symposium – *Engineering the Future*
September 21-23 2017, Vancouver, Canada

Dynamic Response of Adjacent Prestressed Concrete Box Beam Bridge utilizing Reinforced UHPC Shear Keys

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Abstract

Adjacent precast pre-stressed concrete box beam bridges are popular for medium and short spans in North America due to ease and speed of construction and high torsional rigidity. However, longitudinal cracks in the shear keys, which can cause reflective cracks in an overlay or in a composite deck, are one of the most critical issues with these bridges. These cracks can lead to leakage and cause corrosion of the reinforcement, and in severe cases can lead to a reduction or loss of load transfer between beams. Many solutions have been used to eliminate or reduce the cracks in the shear keys. However, some adjacent box beam bridges still exhibit longitudinal cracks. Recently, Ultra High Performance Concrete (UHPC) has been used as a grout material in the connections between prefabricated bridge elements due to the superior mechanical, bonding, and durability properties. In this paper, the dynamic response of the first adjacent precast prestressed concrete box beam bridge in the United States utilizing partial depth reinforced UHPC shear keys was investigated. Instrumentation was installed at different locations, and the bridge behavior was monitored. The dynamic response was compared with the static response. Furthermore, the dynamic amplification factor (DAF) was determined and compared with AASHTO LRFD Design Specification. The results from the moving load showed that the bridge behaved as a unit which emphasize the ability of the new connection to transversally transfer the load. The results also show that the dynamic amplification factor (DAF) from the AASHTO LRFD Design Specification is conservative compared with the measured value.

Keywords: box beam bridge; UHPC; shear key; longitudinal crack; dowel bar; connection; field test dynamic response; dynamic amplification factor.

1 Introduction

Adjacent precast pre-stressed concrete box beam bridges have often been used in medium and short span bridges. Adjacent box beam bridges are constructed by placing the box beams side-by-side and grouting a partial or full depth shear key between the adjacent beams. Transverse post-tensioning or tie rods have been used to improve the integrity of the bridge in the transverse direction. There are two types of adjacent box beam bridges: composite, using a cast-in-place concrete deck on the top; or non-composite, using the top flange as a riding surface. However, longitudinal cracking of the shear keys, causing reflective cracking in overlays or the composite deck, have been considered an issue with these bridges. The cracks allow leakage and lead to accelerated corrosion of the reinforcement.

The causes of the longitudinal cracks in the shear keys have been investigated by many researchers. The cracks, which were mostly developed at the interface between precast element and the grout materials, were found to be caused by thermal stresses and propagated after applying load [1, 2, 3, 4]. In order to reduce or eliminate these cracks, many methods have been suggested. One such method was to use different shear keys configurations and different grout materials [5, 6, 7]. Other suggestions which have been used are increase the number of diaphragms and using different magnitudes of transverse post-tensioning with or without a concrete composite deck [8, 9,

https://doi.org/10.2749/vancouver.2017.3107
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