Extending span ranges and accelerating construction of spread slab beam bridges

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Abstract

A new class of spread slab beam bridges has recently been developed and implemented in Texas. The research questions addressed in this paper are: how long can such a low profile bridge system span in either a simply supported or continuous form? And, can construction operations be accelerated, by design? An effective way to extend the span length is to utilize post-tensioning and to make the bridge continuous over several spans. In order to explore the maximum span limit, the design of a multi-span prestressed concrete spread slab beam bridge is investigated. In addition, a thicker and longer precast prestressed concrete panels (PCPs) that uses concentric pre-tensioned prestress is developed to facilitate accelerated bridge construction by reducing the need for field placement of deck reinforcement. It is shown that the span length may be extended from 15 m to 21 m as a continuous shallow profile bridge. The new solution for PCPs is verified to speed up field operations as compared to the traditional deck with stay-in-place PCPs and cast-in-place toppings.

Keywords: extended span limit; accelerated bridge construction; spread slab beam bridge; precast prestressed concrete panel.

1 Introduction

The simply supported spread slab beam bridge configuration has been successfully designed for up to a 14.2 m long span. To date two viable examples have been implemented and constructed in Texas: (i) the Texas A&M University Riverside Campus experimental bridge, and (ii) the US 69 bridge in Denison, Texas [1]. The in-service performance and load distribution behaviour of these two bridges have also been investigated through experimental testing and computational analysis [2-4]. However, the span limit of the continuous spread slab beam bridge configuration remains in question. While the two bridges have similar span lengths, the cross sections differ markedly. The Texas Department of Transportation (TxDOT) designed US 69 Bridge has six slab beams, whereas the Riverside Bridge only has four slab beams. For the latter case, the design of prestressed concrete slab beams is at its limit for an eccentric pre-tensioned system – all viable prestressing strand locations are used. Moreover, the full use of eccentric pre-tensioned prestressing strands resulted in excessive camber, which remains problematic. Therefore, to further increase the span length several actions could be adapted: (1) use harped prestress to overcome the end eccentricity and partially balance gravity loads; (2) use supplemental post-tensioned prestress; (3) use one or more additional slab beams in the cross section; (4) make portions of the bridge continuous. This paper investigates the viability of (1) and (2) above in the context of continuity (4).

Nowadays, highway bridge deck systems in Texas are normally constructed with stay-in-place (SIP) precast prestressed concrete panels (PCPs) and cast-in-place (CIP) toppings. TxDOT has provided PCP standard drawings for precaster usage, in

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