

Case Study of Two U.S. Bridge Projects Using Prefabricated Bridge Elements Connected with Ultra-High Performance Fiber-Reinforced Concrete (UHPFRC)

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Abstract

Accelerated bridge construction (ABC) techniques were used to rehabilitate two notable bridge structures in the United States in 2016; a 16.5-meter (54-foot) long, single-span superstructure carrying U.S. Route 30 over Bessemer Avenue near Pittsburgh, Pennsylvania and; a 5-span 308-meter (1,011-foot) long historic concrete arch bridge carrying Franklin Avenue over the Mississippi River near Minneapolis, Minnesota. These projects utilized prefabricated bridge elements (PBEs) that were connected together on-site using Ultra-High Performance Fiber-Reinforced Concrete (UHPFRC). Different UHPFRC mix designs, supplied by LafargeHolcim, were used for each project. A rapid-set mix used for the Pittsburgh project allowed the single-span superstructure to be replaced during a 57-hour weekend road closure, while the Minneapolis project utilized a standard-set mix. In both cases, UHPFRC was used for its ability to rapidly achieve high strength as well as provide simple, strong, durable connections between the prefabricated elements.

Keywords: ultra-high performance concrete; UHPC; fiber-reinforced; UHPFRC; prefabricated bridge elements; PBE; closure pour; connections; accelerated bridge construction; ABC

1 Introduction

The use of ultra-high performance fiber-reinforced concrete, UHPFRC, in the United States (more commonly known as ultra-high performance concrete "UHPC" in North America) has grown substantially over the past four years. Prior to 2013, only twenty (20) bridges in the U.S. had been constructed using UHPFRC in some form. Since then, an additional 80 bridge projects have been constructed with UHPFRC in the design. The majority of these one-hundred (100) projects have used UHPFRC as the closure pour material between various types of prefabricated bridge elements (PBE) in order to accelerate the on-site construction schedule, improve the long-term durability of the PBE system, and simplify the erection and fabrication details.

In 2016 alone, more than thirty (30) of these onehundred (100) bridge projects were completed using this technology. Two of these bridge projects are presented herein. The first project to be discussed is the Franklin Avenue Bridge over the Mississippi River near Minneapolis, where UHPFRC was used as the closure pour material between precast concrete deck panels to rehabilitate the bridge deck in just four (4) months.

The second project discussed is the U.S. Route 30 Bridge over Bessemer Avenue near Pittsburgh, where UHPFRC was used as the closure pour material between prefabricated steel beam modules with precast, lightweight concrete deck. This single-span superstructure was replaced over a single weekend during a 57-hour road closure.