

Using UHPC Connections for Precast Concrete Bridge Decks

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The use of precast concrete components has been shown to produce very high-quality and extremely durable bridges. Ultra-high-performance concrete (UHPC), whose mechanical and durability properties far exceed those of conventional concretes, presents an opportunity to significantly enhance the performance of field-cast connections. Of particular interest, UHPCs can exhibit both exceptional bond when cast against hardened concrete and can significantly shorten the development length of embedded steel reinforcement.

Field-Cast Connection Details

Field-cast UHPC connections between prefabricated bridge components have been implemented in nine bridges in Ontario, Canada, and two bridges in the United States. These bridges use a range of details to connect multiple types of precast concrete components, including adjacent box beams, full-depth precast deck panels, and deck bulb-tee girders. The connection designs

used to date have tended to mimic noncontact lap splice connections with a female-female shear key profile. The UHPC concept provides good performance and allows for small, simple connections without requiring the use of post-tensioning or the use of large volumes of field-cast concrete.

Physical Testing Program

The Federal Highway Administration (FHWA) recently completed an experimental study focused on the performance of field-cast UHPC deck-level connections. A summary of the study and results can be found in FHWA-HRT-11-022, available at <https://www.fhwa.dot.gov/publications/research/infrastructure/structures/11022/index.cfm>. The full study results are in NTIS-PB2011-101995, available at www.ntis.gov.

The results of this test program, in combination with the experience gained through field deployments, have demonstrated the viability of the system for precast modular bridge deck

components. The system emulated behaviors that would be expected from a monolithic concrete bridge deck. Noncontact, lap-spliced reinforcement in the transverse and longitudinal UHPC-filled connections was not susceptible to debonding under cyclic and static loadings. The most severe cyclic test concluded with the metal fatigue failure of a series of straight, uncoated No. 5 steel reinforcing bars, which were lapped over a 5.9 in. length in a noncontact lap splice configuration. There was no evidence of the reinforcing bars debonding from the field-cast UHPC, nor water leaking through the UHPC joints during the fatigue testing.

Future Implementation

The concept of using field-cast UHPC to connect precast concrete bridge components is gaining interest. The Ontario Ministry of Transportation and the New York State DOT are continuing to use this technology as appropriate projects arise. The Iowa DOT is planning to construct two projects in 2011. Other states are also considering the benefits of this technology as they move toward increased usage of modular components and other accelerated bridge construction technologies.

Further Information

For further information, readers are encouraged to contact the author at 202-493-3122 or benjamin.graybeal@dot.gov.

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EDITOR'S NOTE

For more information about this concept, see the Route 31 Bridge over Canandaigua Outlet article in the Fall 2009 issue of *ASPIRE*[™], page 28, and the FHWA articles on UHPC in the Spring and Summer 2010 issues, pages 46 and 50, respectively.

Placement of UHPC into the longitudinal connection between deck bulb-tee girders. Photo: New York State Department of Transportation.

