Ultra-High Performance Concrete Connections for Prefabricated Bridge Elements





Ultra-high performance concrete (UHPC) can be used to create the simple, strong, long-lasting connections needed for successful construction using prefabricated bridge elements (PBE).

Prefabricated bridge elements are structural components of a bridge that are built offsite then brought, ready to erect, to the project location. Prefabricated bridge elements not only shorten onsite construction time—minimizing traffic impacts and increasing traveler and worker safety—but also offer superior durability.

The durability of prefabricated spans, and how quickly they can be constructed, relies on the connections between the elements. Field-cast UHPC has emerged as a solution for creating connections between prefabricated concrete components with more robust long-term performance than conventional PBE connection designs.

UHPC is a steel fiber-reinforced, portland cement-based, advanced composite material that delivers performance far exceeding conventional concrete. As UHPC performance exceeds that normally predicted from a field-cast connection, it allows the behavior of the joined prefabricated components to surpass that of conventional construction.

UHPC connection details make using prefabricated bridge elements simpler and more effective for accelerated bridge construction.

Compared to many solutions in current use, UHPC allows for small, simple-to-construct connections that require less volume of field-cast concrete and do not require post-tensioning. The mechanical properties of UHPC also allow for redesign of common connection details in ways that promote both ease and speed of construction. This makes using prefabricated bridge elements simpler and more effective.

STATE OF THE PRACTICE

Technical advancements and policy developments related to UHPC are enabling implementation of prefabricated bridge elements for accelerated bridge construction on a national basis. These deployments are demonstrating the constructability, field performance, and robustness of these systems in bridge inventories across the country.

New York, Pennsylvania, and New Jersey have done work to develop standards for using UHPC PBE connections. The Federal Highway Administration (FHWA) published design and construction guidance for UHPC connections in 2014. In addition, U.S. production of the steel fiber reinforcement commonly used in making UHPC began in 2013, creating more opportunities for use on federally funded transportation projects under FHWA's Buy America requirements.

The third round of Every Day Counts (EDC-3) focused on demonstrating the advantages UHPC offers as an option for connecting prefabricated bridge elements, and this effort is continuing under EDC-4. The EDC implementation team is providing technical assistance and training, including peer exchanges, webinars, and workshops.

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BENEFITS

- **Speed.** The mechanical properties of UHPC allow for redesign of common connection details in ways that promote both ease and speed of construction.
- **Simplicity.** UHPC connections are inherently less congested, simplifying fabrication and assembly.
- **Performance.** Field-cast UHPC between prefabricated bridge elements results in robust connections that can provide better long-term performance than connections constructed by conventional methods.

RESOURCES

EDC-4 Ultra-High Performance Concrete Connections for Prefabricated Bridge Elements:
https://www.fhwa.dot.gov/innovation/everydaycounts/edc_4/uhpc.cfm

FHWA Ultra-High Performance Concrete:
https://www.fhwa.dot.gov/research/resources/uhpc/

EDC-4 Summit Breakout Session: Fall 2016
https://www.youtube.com/watch?v=QQdVVLk4ljE

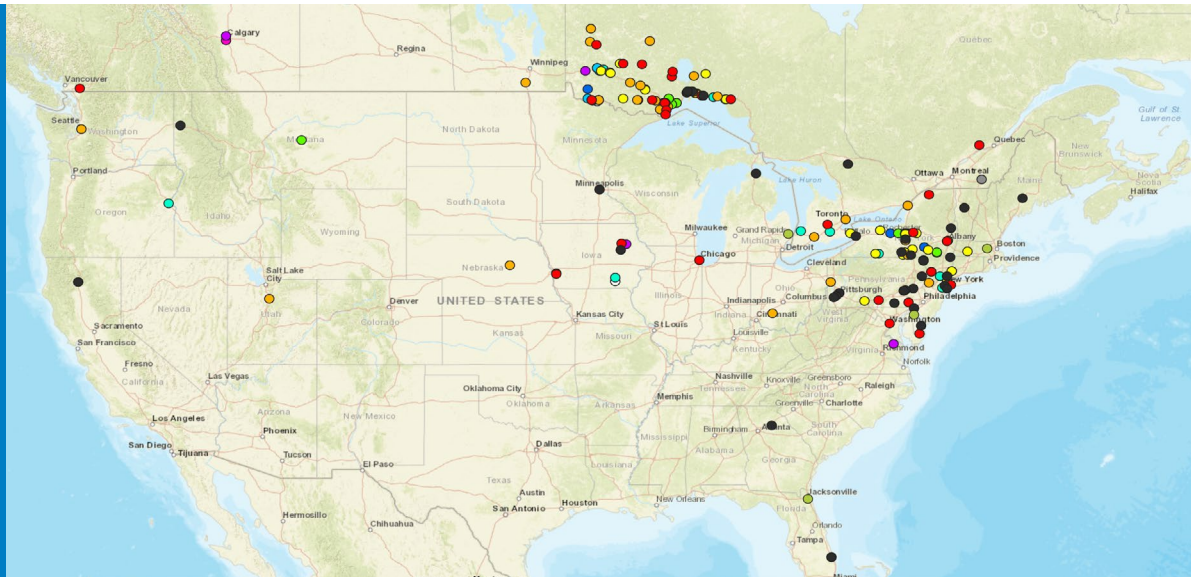
Turner-Fairbank Research on UHPC

Research completed by FHWA's Turner-Fairbank Highway Research Center has demonstrated that UHPC has exceptionally high mechanical strength and durability properties. UHPC can improve PBE connections by allowing for significant simplifications in the design of the connections, while at the same time affording enhanced durability and simplified construction practices.

Synopses and guidance are available in FHWA TechNotes, including *Design and Construction of Field-Cast UHPC Connections* (HRT-14-084).

North American Bridges Using UHPC

2017	2010
2016	2009
2015	2008
2014	2007
2013	2006
2012	2005
2011	1997



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U.S. Department of Transportation
Federal Highway Administration

Every Day Counts (EDC), a State-based initiative of FHWA's *Center for Accelerating Innovation*, works with State, local and private sector partners to encourage the adoption of proven technologies and innovations aimed at shortening and enhancing project delivery.