

## **UHPC Overlay at Multiple Bridge Interchange in Elsmere, DE**

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### **PROJECT BACKGROUND**

The 'Elsmere UHPC Bridge Overlay' project features three Delaware Department of Transportation (DelDOT) owned bridges: BR 1 600, BR 1 601, and BR 1 604 located within the SR 141 and SR 2 interchange near Elsmere, DE, or a few miles west of Wilmington, DE. Two of the bridges, BR 1 600 and BR 1 601, incorporate a 180-ft. long two-span continuous steel superstructure. The third bridge, BR 1 604, incorporates a varying length simple span steel superstructure with an approximate average span length of 80-ft.

These structures were constructed in 1973 and the steel superstructures are in good condition. However, two aging original bridge decks and one prematurely delaminating overlay at the interchange (BR 1 600) require rehabilitation to ensure long term serviceability. In addition, these bridges have failing transverse roadway joints resulting in abutment end diaphragm deterioration and significant areas of spalled and delaminated concrete at the abutment stems.

Construction is set to begin in the spring of 2020 and all project work will be completed by the end of the calendar year.

### **BRIDGE ASSESSMENT & REHABILITATION OBJECTIVES**

An impact-echo study was performed as a non-destructive assessment of the bridge decks. It was determined that the bridge decks were in overall satisfactory condition with the worst defects at the end of the decks near the existing failing transverse roadway joints. The ensuing field inspection confirmed the failing BR 1 600 overlay and deteriorating abutment end diaphragms at all three bridges. This was particularly concerning at BR 1 600, where the end diaphragms had been replaced as part of a 2012 rehabilitation effort.

A final assessment concluded that the bridge decks can remain in-service. However, the decks, as well as the end diaphragms, bearings, and substructure components, should be better protected from water infiltration.

The objective of the rehabilitation is two-fold: to significantly reduce future maintenance costs (and future traffic impacts) on these structures and to significantly increase their remaining service life. Due to the high volume of commuter traffic at this interchange, accelerated bridge construction (ABC) techniques were necessary to minimize specific disruptive work activities, such as ramp closures, as well as overall project duration.

As such, WRA and DelDOT determined that the rehabilitation project will repair all defective concrete components, relocate the transverse abutment bridge joints away from and off of the bridge superstructures, and seal and protect the bridge decks with a machine-placed UHPC overlay.

## **PROJECT SCOPE**

DelDOT is sensitive to traffic impacts at this heavily used commuter interchange, increasing the complexity of this project beyond the scope of using an innovative, yet promising, overlay material. As a result, the design team implemented a maintenance of traffic (MOT) plan using ABC techniques to minimize disruption to the public and bring value to the project. Ramp closure durations, traffic detour signage, and road-user costs were studied in equal measures to deck preparation techniques, machine-paver capabilities, and UHPC on-site batch production and placement.

The project is completed in two main MOT phases. The MOT plan dictates bridge construction staging on the SR 141 mainline, the divided ancillary collector-distributor lanes, and an on-ramp to SR 141 southbound. The MOT plan includes a liquidated damages incentive on two critical MOT sub-phases to curtail crucial traffic impacts on intersection ramps. These work activities are at the forefront of the main MOT phases and subsequently traffic restrictions will be lifted as soon as construction is complete in these critical areas.

The UHPC's rapid strength gain, used in conjunction with an expedited placement via machine-paver, is a great ABC tool for completing the construction of this project in staged work zones. The machine-paver capabilities were studied to develop construction stage layouts that will optimize its use. Careful consideration was given to the ultimate placement of UHPC overlay joints between machine-paver passes. To ensure a smooth and expeditious construction operation, the contractor is required to provide a detailed placement plan and to complete a trial pour prior to overlay placement.

## **OVERLAY DETAILS**

The UHPC overlay forms a superior bond with the underlying concrete material, however, it is imperative to remove unsound concrete in the existing deck and to prepare a bonding surface with a roughened amplitude.

FWHA research shows that premature failure will occur within the existing substrate below the bond interface if all deleterious material is not removed. Mechanical milling and hydrodemolition will be used to prepare the existing deck surface at all bridges - even at BR 1 601 and BR 604 where less removal is required. The mechanical milling will allow for higher quality hydrodemolition and will ultimately provide a faster and cleaner removal operation. The bonding surface will be prepared with a 1" amplitude to provide a mechanical connection to the overlay-deck interface in addition to the material adhesion at the micro-level.

The UHPC overlay material will be placed in two (2) thicknesses: 2 $\frac{7}{8}$ " average at BR 1-600 and 1 $\frac{1}{4}$ " average at BR 1-601 and BR 1-604.

A separate, primary pour of conventional deck concrete was considered to limit the thickness of the UHPC overlay at BR 1 600. While this would reduce the volume and expense of the UHPC, ultimately this concept was dismissed due to a longer construction time and the undesirable resulting second material interface near the roadway surface.

Finally, much consideration was given to mixing, construction transport, placement, and finishing of the UHPC overlay. This project will feature a dozen or so UHPC pours from early spring to the end of the year. The specifications dictate when the contractor can and cannot place UHPC with respect to ambient- and mix- temperatures and includes provisions for heating to maintain satisfactory in-situ temperatures for strength gain and curing after placement.



Project Location Map – SR 141 & SR 2 interchange near Elsmere, DE