

TOWARDS A NEW GENERATION OF DURABLE STRUCTURAL BRIDGE OVERLAYS USING ECC/EDM AND WATERGLASS TECHNOLOGIES

A large portion of the bridge inventory in California and other States is 40+ years old and many are specifically due for deck repair, rehabilitation or possible replacement. Typical deck deterioration includes spalling, delamination, cracking of the concrete, and reinforcement corrosion as shown in Figure 1. Removal and replacement of the deck from bridges in-service can result in elongated traffic shutdowns and in some cases, significant stress reversals as in post-tensioned box girders for instance. An accelerated bridge construction (ABC) approach would be preferred for such cases to allow for standard in-service stage construction with reduced traffic disruptions or acceptable traffic flow reduction on the bridge without the need for falsework or shoring.

In the past decade, the bridge engineering community has progressively tapped into advanced construction materials such as ultra-high performance concrete (UHPC), engineered cementitious composites (ECC) or engineered ductile mortars (EDM) for accelerated bridge construction (ABC) and repair. Other technologies like waterglass sealers and concrete densifiers are also becoming more available. Although UHPC overlays have been considered for deck rehabilitation applications both nationally (e.g. Laporte bridge in Iowa shown in Figure 1) and internationally (e.g. Chillon Viaduct in Switzerland shown in Figure 2). Yet, robust UHPC mixes are expensive, proprietary, and might need special expertise for mixing and furnishing. In this study, the feasibility of a simpler deck rehabilitation methodology that uses structural ECC/EDM overlays enhanced with waterglass-based solutions is explored as a potential solution to apply new generation of overlays directly to existing deteriorated decks without the need for full deck replacement.



Figure 1. Examples of bridge deck distressed regions from Laporte Road bridge in Brandon, IA, before installation of UHPC overlay (adopted from: Haber et al. 2018)

To establish an enhanced ECC/EDM overlay deck rehabilitation methodology, several critical knowledge gaps need to be addressed at the material and small-structural scales. On the material part, we propose to conduct various tests to quantify durability aspects of ECC/EDM with and without waterglass treatment, bond between ECC/EDM and aged concrete substrates with and without waterglass treatment, and basic mechanical characteristics such as flexural and compression strength of such materials. At the structural level, flexural tests of small-scale

subassemblies of concrete beams/slabs enhanced with various ECC/EDM overlay designs will be conducted. The proposed designs would consider varying the reinforcement in the ECC/EDM layer to explore negative moment capacity enhancement with or without reinforcing steel. Other design variables will include waterglass densification and treatment for both old concrete substrates and overlay layers.

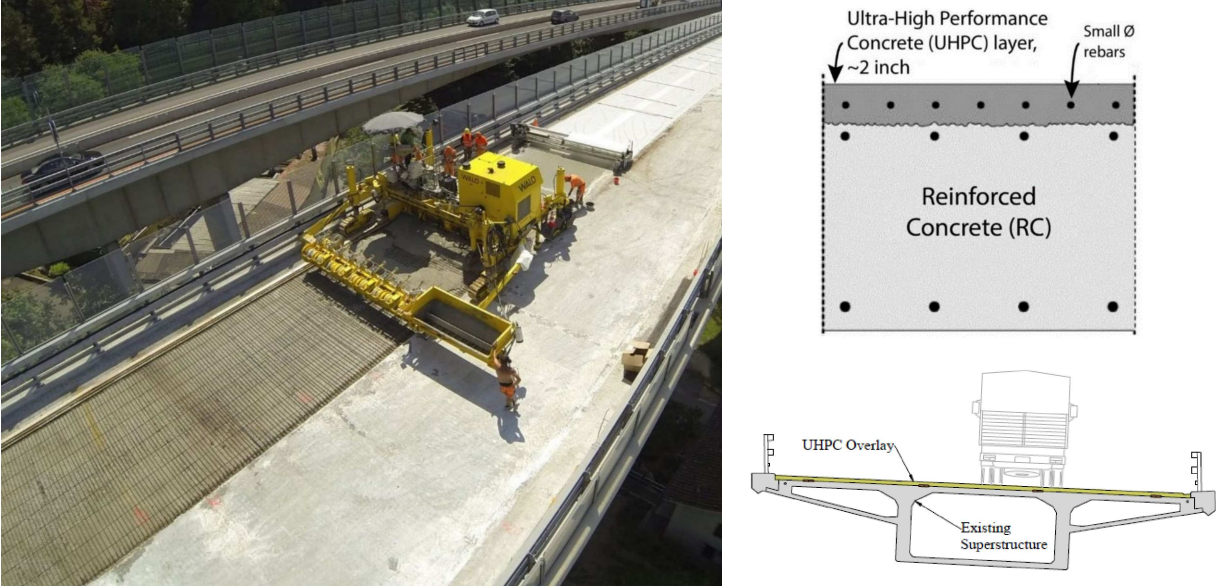


Figure 2. Accelerated bridge rehabilitation of Chillon Viaducts in Switzerland using structural UHPC overlays (WALO USA: <https://walo.com/services/structural-uhpc-rehabilitation/>)