Second International Interactive Symposium on Ultra-High Performance Concrete
Extended Abstract (no paper submission)

Repair of concrete structures exposed to severe conditions using UHPFRC

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Extended Abstract

For many years, ultra-high performance fiber-reinforced concrete (UHPFRC) has been used in North America for accelerated bridge construction where the new bridge deck consists of precast concrete slabs linked by UHPFRC connections cast in the field. The dense and fibrous material has interesting mechanical properties for reducing the width of joints in the field and the durability parameters exhibited by UHPFRC ensure extremely durable connections. Durability of the structures is a key element for new construction today, but this factor also remains essential in the North American concrete repair industry. More specifically in Canada, the government has been investing significant amounts of money for years in order to extend the lifespan of structures in service that have been highly damaged by severe exposure conditions or even to correct errors made during initial construction.

A Canadian authority awarded a concrete repair pilot project in 2018. for the rehabilitation of different components of an existing viaduct. UHPFRC was specified by the authority in order to achieve thin repairs (less than 2 inches) that were both aesthetically pleasing and durable. As it was desired to complete the repairs within a short time window, avoid cold joints in the repair, to evaluate the potential placement method for larger volumes and there was limited access to formwork, it was decided that the UHPFRC should be pumped in-place. Off-site mockup trials were organized in order to evaluate numerous aspects of the project such as material performance, handling and placement of the material, the curing regime, the substrate preparation and the formwork design.

The proprietary UHPFRC selected for the application had a specified flow ranging from 180 mm to 250 mm (7.1” to 9.8”) as per ASTM C1856. The ultimate compressive strength and the ultimate tensile strength

of the material indicated by the manufacturer were respectively 120 MPa (17.4 ksi) and 9.5 MPa (1375 psi). At 28 days of age the selected UHPFRC provided a freeze-thaw durability factor of 100% when tested in accordance with ASTM C666, a salt scaling visual rating of 0 and mass loss of 0.02 kg/m^2 (0.004 lb/ft^2) when tested in accordance with ASTM C672 and a chloride ion penetrability of less than 100 coulombs (negligible) when tested in accordance with ASTM C1202.

The material characterization (plastic and hardened properties as well as durability parameters) was achieved by adopting current standards used in Canada (CSA and ASTM). A modified test method was implemented to evaluate the tensile behavior of the UHPFRC (ASTM C1609 [modified] complimented by a reverse analysis calculation) and the bond strength of the material (direct tensile test) to the substrate was evaluated following CSA A23.2-6B.

On-site the UHPFRC was batched using several pan-mixers and a skid-steer vehicle with a mobile mixer attachment was used to transport the material from the mixers to the concrete pump to ensure continuous placement of the material into the formwork (Figure 2).

The purpose of this presentation is to discuss and highlight different phases of the project. Although pumping UHPFRC is not a common practice, it was successfully achieved thanks to countless efforts displayed by all of the parties involved in the pilot project.

Figure 1 - Bottom view of the viaduct (bottom flange concrete has been removed

Figure 2 – UHPFRC discharged in mixer