Project submitted: **Chillon Viaducts** - March 20, 2017

Project Information

Please choose the category for your project: [Repair and Restoration]
Name of Project [Chillon Viaducts]
Address []
Country [Switzerland]
City [Veytaux]
State - Postal Code [CH-1820]
Project Size (Dimensions, Area, Span) [total length of 2 210 m, deck surface of 53 000 m^2, longest span of 104 m, highest pile of 90 m]
Concrete Quantity - Volume Area Tonnage [6 000 T of Ductal® UHPFRC]
Concrete Work Duration [Ductal® UHPFRC overlay: 6 weeks in 2014 + 4 weeks in 2015]
Date of Project Completion [October 27, 2015]
Overall Project Description
Chillon Viaduct, built by prestressed box girder segmental construction, was constructed in the late 1960s. Recent examination of structural performance revealed the need to increase the shear, bending and fatigue resistance of the deck slab for future traffic requirements, although structural safety requirements currently can be fulfilled. Furthermore, the box girder concrete shows signs of initial alkali silica reaction (ASR). The chosen strengthening concept is adding a layer of ultra-high performance fiber reinforced concrete (UHPFRC) additionally reinforced with steel rebars on the top surface of the deck slab, also serving as waterproofing layer. The new 45mm (1.7 in.) thick UHPFRC layer on the bridge deck provides an effective and significant improvement of the structural performance of the viaducts.
This operation is a worldwide record of in situ casting of UHPFRC, under high controlled conditions (up to 2000m^2 of overlay, a thickness tolerance of ±5mm), with regard to the strong constraints of climate and operation.

Description

Chillon Viaduct located on the Swiss National Highway on the East end of the Lake of Geneva, was constructed in the late 1960s. The variable height box girder structure, with single spans ranging from 92 m (302 ft.) to 104 m (341 ft.) over a total length of 2 210 m (7 250 ft.), was built by prestressed segmental construction with epoxy-glued joints which was a world novelty at the time.
A structural assessment showed that the governing failure mode at Ultimate Limit State is punching of wheel loads through the 18 cm (7 in.) thin deck slab. In addition, bending and fatigue resistance was found to be insufficient given to future traffic demands, although structural safety requirements could just be fulfilled for current requirements. Further investigations revealed that the concrete is prone to alkali-aggregate reaction (AAR). The latter is expected to lead to significant concrete strength reduction in the future, with an associated reduction in shear and also bending resistance.

As the replacement of the waterproofing on the deck slabs was planned for 2014-2015, its combination with a strengthening intervention was investigated. It was decided to improve the performance of the viaduct's structure by casting a 40 to 50 mm (1.6 to 2 in.) thin layer of UHPFRC (Ductal®) which was additionally reinforced by steel rebars, on the previously hydro-jetted top surfaces of deck slabs.
The choice for the intervention concept consisting in using UHPFRC as a strengthening material was motivated by the relatively low intervention costs and technically the outstanding mechanical properties of UHPFRC. These consist on its high tensile and compressive strengths and its important deformation capacity due to the high amount of incorporated steel fibres in the cement-based matrix of the material. In addition, the very low porosity of UHFPRC prevents moisture exchange and ingress of aggressive chemical substances such as chloride ions from the surrounding atmosphere. Consequently, the UHPFRC layer provides the waterproofing and will thus limit AAR and prevent steel rebar corrosion.
The UHPFRC designed for this project had to meet the following general requirements: medium high compressive strength, high tensile strengths, strain hardening in tension, very low permeability, self-compacting fresh mix with the ability to be cast with a slope of 7%. Moreover, due to the newly machine paving method developed by the general contractor (WALO®), tests had been performed to check the compatibility between the UHPFRC mix, the process and its influence on the orientation of the fibres.

In summary, the groundbreaking Ductal® UHPFRC technology paired with the innovative machine-paving process led to an effective improvement of the Chillon Viaducts in terms of both cost and technical performance providing a new service life to sustain future increasing traffic demands. The non-invasive, smart intervention had no visual impact on the viaducts that are considered as a heritage structure with high cultural value and unique aesthetics.

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Sponsoring Chapter: ACI Paris Chapter

Name of Chapter Contact (Name of the representative of the Sponsoring Chapter who invited the submitter to submit the entry)
[François Toutlemonde, president of ACI Paris Chapter]

Photographs

Photo 1: [Construction of the viaduct with prestressed box girder segments]

Photo 2: [Overview of the Chillon viaduct]

Photo 3: [On-site ready mix plant for the production of UHPFRC]

Photo 4: [UHPFRC machine paving developed by the general contractor]

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Photo 5: [Casting of thixotropic UHPFRC]

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Photo 6: [Overview of the casting]

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Photo 7: [Overview of the casting]

Photo 8: [Project completed]