Sustainable salvation of deficient RC bridges by means of the UHPFRC Technology

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Abstract

Structural application of impermeable, tensile strain hardening UHPFRC (Ultra-High-Performance Fibre-Reinforced-Cementitious Composite) follows two fundamental concepts: 1) Rehabilitation and strengthening of existing bridges by adding a layer of UHPFRC, and 2) Construction of new bridges in UHPFRC. This paper presents recent UHPFRC project realized in Switzerland using UHPFRC for the salvation of deficient reinforced concrete bridges, to improve their structural resistance and durability, as well as to extend their service duration. This allows to avoid the common practice consisting in the material and cost invasive "demolition-replacement" still largely applied. In this way, the UHPFRC Technology using a small amount of a novel building material provides a significant contribution towards sustainability since UHPFRC allows to preserve the existing bridge, its original materials and embodied energy.

Keywords: UHPFRC; cementitious fiber reinforced composite material; rehabilitation; structural strengthening; existing structures; existing bridges; sustainability.

1 Introduction

The problems of insufficient durability of reinforced concrete bridges are known for several decades already, in particular in regions using deicing salts in winter and in marine environments. So-called "retrofit" implies traditional repair methods, often leading to high intervention and user costs as well as limited durability. Novel intervention methods are urgently needed to improve existing reinforced concrete bridges.

UHPFRC stands for Ultra-High-Performance Fiber Reinforced Cementitious Composite material. UHPFRC is composed of cement and other reactive powders, additions, hard fine particles, low amount of water (W/C≈0.15), superplasticizers and very high amount of relatively short and slender steel fibers (15/0.2mm). The composition of UHPFRC is optimized with respect to compaction of particles leading to a waterproof material up to a tensile strain of about 0,1 %. The tensile strength of UHPFRC typically is about 12 MPa and the material shows significant strain-hardening behaviour in tension. UHPFRC has compressive strength typically of 150 MPa. UHPFRC is nowadays used in many countries, mostly in the domain of new construction [1].

The author and his team have developed the UHPFRC rehabilitation and strengthening technology over the last 25 years by means of scientific research and applications [2,3]. In Switzerland (8,7 million inhabitants, area of 41'000 km^2) there are currently more than 400 reinforced concrete structures, mainly bridges, that have been improved using the UHPFRC Technology, since 2004. This is the by far highest UHPFRC application rate in the world with respect to the size of the country.

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