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Tensile fatigue behaviour of Ultra-High Performance Fibre Reinforced Concrete combined with steel rebars (R-UHPFRC)

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Abstract

Ultra-High Performance Fibre Reinforced Concrete (UHPFRC) combined with steel rebars, subsequently called R-UHPFRC, is a promising building material implying a novel technology for the improvement of concrete structures. Steel rebars enhance effectively the resistance of UHPFRC while reducing variability in the tensile behaviour of monolithic UHPFRC due to variation in fibre distribution and orientation. When a thin layer of R-UHPFRC is overlaid on top of a concrete bridge deck slab, it is subjected to repeating wheel loads and fatigue limit state needs to be considered. This paper presents the results of tensile fatigue tests on R-UHPFRC elements for the determination of its fatigue behaviour. Experimental results show a fatigue endurance limit at 10 million cycles at a solicitation level of $S = 0.54$ for S being the ratio between the maximum fatigue force and the ultimate strength. Over the fatigue life of the specimens, stress was transferred from UHPFRC to steel rebars. Fatigue resistance of R-UHPFRC shows that it has a significant potential for fatigue strengthening of reinforced concrete structural elements like bridge deck slabs.

Keywords

UHPFRC with steel rebars, tensile fatigue, fatigue endurance limit, stress transfer, fatigue deformation behaviour

1. Introduction

Ultra-High Performance Fibre Reinforced Concrete (UHPFRC) is a cementitious composite material, generally consisting of cement, quartz sand, silica fume and fibres. It has eminent properties: relatively high compressive strength (≥ 180 MPa) and tensile strength (≥ 10 MPa), strain-hardening behaviour under tensile stress (given a certain volume of fibres) and very low permeability because of an optimised dense matrix. These properties make UHPFRC suitable for "hardening" those parts of structural members that are subjected to mechanically and environmentally severe actions. Since the tensile behaviour of UHPFRC depends on fibre orientation and distribution [1], it is proposed that steel rebars are arranged in UHPFRC,

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