

Restrained concrete shrinkage effect on Concrete Elements strengthened with UHPFRC layers

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1 Abstract

Ultra-High Performance Fibre Reinforced Concrete (UHPFRC) is a relatively new material with superior mechanical properties. Recent published studies have confirmed the beneficial contribution of the addition of UHPFRC layers for the structural upgrade of existing Reinforced Concrete (RC) elements.

In case of structures strengthened with additional concrete elements, one of the crucial parameters for the performance and the durability of the strengthened elements is the restrained concrete shrinkage of the new material. The new concrete layer tends to shrink, but due to the connection with the existing structural elements, tensile stresses are induced to the new layers which may lead to the initiation of cracks, while slip is also induced at the old-to-new concrete interfaces. So far, there are not any published studies on the effect of restrained concrete shrinkage on composite UHPFRC-to-normal concrete elements. In this study, experimental work has been conducted on concrete prisms strengthened with UHPFRC layers. Shrinkage strain recordings have been conducted for the composite prisms alongside with relevant recordings for the free shrinkage measurements of standard UHPFRC prisms. The degree of restrained has been calculated and correlated with the induced stresses, and the beneficial contribution of the steel fibres has been highlighted. Flexural tests of the strengthened beams have also been conducted and the results show significant enhancement of the flexural performance of the examined specimens and very good connection between the new UHPFRC layer and the existing concrete substrate.

Keywords: UHPFRC; restrained shrinkage; concrete layers; strengthening.

2 Introduction

The majority of the existing structures worldwide and especially in earthquake prone areas need to be strengthened either because they are already damaged or because they have been designed using old code provisions. Strengthening of existing structures with additional Reinforced Concrete (RC) layer or jackets is one of the most commonly used techniques and the effectiveness of this technique is highly affected by the connection between the new and the existing elements [1].

One of the main issues in strengthening applications is the restrained concrete shrinkage of the new concrete layer which may lead to debonding and cracking. The new concrete tends to shrink but the connection with the existing substrate restrains to free shrinkage [2, 3]. This leads to the development of high tensile stresses and potential cracks may appear, while slip may also occur at the interface [2, 3].

In the last few years, the use of novel high performance cementitious materials such as the Ultra High Performance Fibre Reinforced Concrete