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Punching resistance of flat slabs strengthened with an added layer of UHPFRC

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Abstract

Existing Reinforced Concrete (RC) slabs often show insufficient punching shear resistance when verified for updated loads. A simple and fast method to strengthen these slabs is casting a layer of Ultra-High Performance Fiber Reinforced cement-based Composite (UHPFRC), with or without reinforcing bars, on its top surface. This method has been shown to be very efficient, as the layer of UHPFRC does not only increase the flexural resistance of the slab but it also carries part of the shear.

This paper presents a recently developed model to predict the punching shear resistance of composite slabs strengthened with an added layer of UHPFRC. In this model, the contribution of the RC section is estimated with a new punching resistance model based on plasticity and fracture mechanics. A method is proposed to calculate the contribution of the UHPFRC layer to the punching resistance.

Keywords: composite slabs; flat slabs; punching resistance; Ultra-High Performance Fiber Reinforced cement-based Composite (UHPFRC); strengthening; near interface cracking; triaxial stress state; compression zone; plasticity.

1 Introduction

Existing Reinforced Concrete (RC) structural elements submitted to high shear forces combined to bending moments, such as structural systems with hogging moments, often show insufficient resistance when verified for updated loads. To increase the ultimate resistance of these elements without increasing significantly the self-weight of the structure, it is possible to add a layer of 25 to 50 mm of Ultra-High Performance Fiber Reinforced cement-based Composite (UHPFRC) with or without small diameter steel reinforcement bars, thus creating a composite section [1] as shown in Figure 1. The layer of UHPFRC acts as a tensile reinforcement for the RC section and, thanks to its outstanding behavior in tension with long hardening and softening phases, significantly increases the bending and shear resistances of the section [2–5].

This original concept developed in 1999 by Brühwiler has been an object of extensive research and development over the past decades which has proven that it can be an efficient method of reinforcing existing structures. The technology has already been applied to numerous

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