Computational modeling of flat slabs with openings reinforced with HPFRC under punching shear stress

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Abstract

Flat slab structures have been largely studied over the last decades since its structural behavior presents complex phenomenon, particularly the punching shear. The implement of openings near the columns is a common procedure and can affect the slab punching shear capacity. The high/ultrahigh-performance fiber-reinforced concrete (HPFRC/UHPFRC) has been demonstrated an alternative for structural reinforcement and connections. In this context the study of reinforcing the shear punching region with HPFRC has been carried out and showed positive results in terms of punching shear strength. This research carried out the simulation of a flat slab structure with openings reinforced with HPFRC in the punching region. The validation of the numerical model is done by comparing it with the results obtained from the experimental test and the behavior of the slab in relation to the shear caused by the punching. The numerical model will be developed by the commercial finite element software ATENA. Finally, a parametric study was conducted to evaluate the influence of the slab opening and the improvement in this behavior with the presence of HPFRC reinforcement in the column region.

Keywords: Reinforced concrete; Flat slabs; Parametric structural design; Punching shear; HPFRC.

1 Introduction

Over the past few years, concrete technology has been developing different types of concrete with the presence of fiber that improve their mechanical properties. And among these materials are high/ultra-strength concrete with fiber reinforcement (HPFRC/UHPFRC), being a new type of concrete with unique characteristics, such as a low wat-binder ratio, the inclusion of pozzolanic materials, high tensile strength and low permeability. The use of these concretes with advanced characteristics has been used in various structural applications aiming to design slender, lighter and more sustainable structures due to the possibility of minimizing material consumption.

Due to its high tensile strength and good toughness, it has proven to be an excellent solution for reinforcing structural elements subjected to shear stress, such as slab-column connections in flat slabs where there is a high concentration of shear stress and bending moments in a small area of the structure. Isufi and Ramos [1] carried out a study reviewing tests carried out using HPFRC as structural reinforcement in flat slabs subjected to punching, and a better final performance in the ultimate limit state and serviceability of the slabs was observed, increasing their capacity of shear resistance and better control of cracking in the internal region. Recently, Isufi et al. [2] investigated the behavior of large flat slabs with the hybrid use of normal strength concrete (NSC) and HPFRC. The results of these experimental tests showed better

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