Dimensioning of Structures made of UHPFRC

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Summary

Ultra high performance fibre reinforced concrete (UHPFRC) is a new construction material that enables the construction of slender and aesthetically appealing structures. First applications in structural engineering demonstrate the potential of this new building material. Most promising in that respect is the use of UHPFRC in combination with steel reinforcement. For this reason, the behaviour of UHPFRC tension chords reinforced with different types of steel has been experimentally investigated. In this paper an analytical model is presented which allows the calculation of the behaviour of reinforced UHPFRC tension chords. Based on a parametrical study failure modes and minimum reinforcement requirements are studied. Considering applications, significant benefits can be achieved with regard to the aesthetics by using filigree trusses. The possibilities are outlined with help of an example girder made of UHPFRC.

Keywords: Ultra high performance fibre reinforced concrete, tension chord, high-strength reinforcing steel, filigree trusses.

1. Introduction

Ultra high performance fibre reinforced concrete (UHPFRC) is a new construction material that enables the construction of slender and aesthetically appealing structures and thus, opens a field of new applications. UHPFRC is characterized by a high compressive strength usually in the range of 200 MPa and improved durability characteristics compared to normal strength concrete. Tensile strength and cracking behaviour are specifically affected by the addition of short steel fibres. For structural application it is recommended to add reinforcement in the form of steel bars or prestressing to obtain ductile failures in tension.

First applications in structural engineering demonstrate the potential of this new building material. Significant benefits can be achieved regarding the reduction of dead load and with regard to the aesthetics by using filigree trusses, for example for pedestrian bridges or roof systems. However, to fully utilise the advantages of UHPFRC, new conceptions of the structures as well as methods for the dimensioning are necessary.

For this reason, the behaviour of UHPFRC tension chords reinforced with conventional as well as with high-strength steel has been examined in an experimental study with the focus on the cracking and deformation behaviour. Subsequently, an analytical model was developed to enable the calculation of UHPFRC elements in tension. On the basis of a numerical study, the behaviour of reinforced UHPFRC tension chords was investigated for different combinations of UHPFRC and reinforcing steel with respect to steel properties and reinforcement ratios. The results demonstrate that strength and ductility characteristics of the reinforcing steel influence the overall behaviour, and that common design regulations, for instance minimum reinforcement requirements, have to be reconsidered.

https://doi.org/10.2749/222137810796024105