

Structural Behaviour of UHPC with Micro-Reinforcement

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Abstract

With intent to provide a ductile failure and to use Ultra High Performance Concrete (UHPC) to full capacity usually steel fibres are added during the mixing process. The impaired workability as well as random orientation and spreading of the fibres, the increased environmental pollution and the cost factor are beside the spots of corrosion resulting from near-surface fibres the main disadvantages in the use of micro steel fibres. Earlier studies primarily dealt with the replacement of the fibers concerning ductility, load bearing behaviour and durability by the application of a micro-reinforcement. Within this paper the development of a design concept for micro-reinforced UHPC is presented. Based on experimental investigations, main findings are transformed into analytical expressions, idealized and afterwards implemented into a design concept.

Keywords: UHPC, Micro-Reinforcement, Cracking, Design Concept, ULS.

1 Introduction

As the essential innovation in concrete construction, Ultra High Performance Concrete (UHPC) affords new opportunities for future structures due to its extremely high compressive strength and excellent durability properties. Numerous applications in different fields, for example new cast-in-place UHPC constructions, prefabricated components, repair and maintenance of existing concrete structures or steel-concrete-composites, have already been realized [e.g. 1, 2, 3]. To handle the brittleness, micro steel fibers are mixed in the fresh concrete and thus a basic element of UHPC so far. Beside impaired workability and their random orientation and spreading, the production of micro steel fibers (\emptyset 0.15 - 0.20 mm) causes alongside cement the

major environmental impact of global warming potential, ozone depletion potential, acidification potential and nutrification potential in the production of UHPC [4]. Additionally, the largest cost block in production of UHPC represents the micro steel fibers with 70 % of the overall cost [5].

A micro-reinforcement (\emptyset 1.0 mm, spacing of wires, or rather mesh-size, 10 mm) can provide an alternative to ensure ductility of UHPC without the mentioned disadvantages of micro steel fibers. The spot welded wires require substantially less energy in production because of their tenfold diameter compared to micro steel fibres and therefore less costs. Furthermore, the accurately defined orientation and distribution of the wires during the casting process leads to an efficient application without strength reduction factors. Additionally, the mat structure allows, in