Experimental Characterization of the Fracture Behavior of UHPFRC

GÖTZ HÜSKEN[1], STEPHAN PIRSKAWETZ[1]

[1]BAM Federal Institute for Materials Research and Testing, Berlin, Germany

Abstract

During the past 20 years, innovative developments in concrete technology have enabled the production of ultra-high performance concretes (UHPC) for the protection and preservation of concrete structures. The main characteristics of UHPC comprise a high compressive strength of up to 150 N/mm² and the development of a dense microstructure which leads to brittle material failure. However, the use of ductile fibers shows a positive influence on the deformation capacity, the crack propagation, and energy dissipation and gives these ultra-high performance fiber reinforced concretes (UHPFRCs) unique material characteristics.

However, profound knowledge on the working mechanism of the steel fibers is necessary for optimizing this material. Usually, this knowledge is obtained by means of classical measuring techniques of destructive tests. Adopting measuring techniques from non-destructive material testing helps to analyze and to identify the different stages of the fracture mechanism of high-strength and ultra-high strength fiber-reinforced concretes in detail.

The application of different non-destructive measuring techniques is shown exemplary on tensile and flexural tests conducted on an UHPFRC mix and its applicability for analyzing the fracture behavior is discussed. The main focus is on the characterization of the relevant failure modes under tensile and flexural loading by the different measuring techniques and the comparison with classical measuring techniques (e.g. extensometer, displacement transducers, etc.). The tensile and flexural tests have been analyzed by optical deformation measurements using digital image correlation (DIC), and acoustic emission analysis (AE). 3D computed tomography (CT) was used to analyze the crack formation and possible fiber pull-outs in the tested samples.