Double Edge Wedge Splitting Test to Characterize the Design Postcracking Parameters of Fiber-Reinforced Concrete Subjected to High Temperatures

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Abstract: The determination of the postcrack tensile properties of steel fiber–reinforced concrete (SFRC) after exposure to elevated temperatures is a current methodological challenge. The objective of this research is to evaluate the applicability of the double edge wedge splitting (DEWS) test to characterize the postcrack tensile properties of SFRC after exposure to elevated temperatures. Results show that the DEWS test has reduced scatter and facilitates the interpretation of results with diminished frictional interaction between the apparatus and the specimen. The results in terms of coefficient of mechanical degradation were comparable to those obtained by bending tests in literature, which highlights the suitability of the DEWS test to be adopted in future researches and guidelines. The postcrack tensile properties were not significantly affected up to ~300°C and a linear reduction ratio was verified with the increase in temperature. Additionally, the constitutive model proposed may reproduce the effect of temperature on the tensile stress-strain behavior of the SFRC and is a valuable input for hygro-thermo-mechanical numerical models oriented to simulate the mechanical behavior of structures made with SFRC. **DOI: 10.1061/(ASCE)MT.1943-5533.0003701.** *© 2021 American Society of Civil Engineers.*

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Introduction

Steel fiber–reinforced concrete (SFRC) is a composite material that has been used to replace steel rebars either partially or totally in reinforced concrete (de la Fuente et al. 2011; di Prisco et al. 2009; di Prisco and Toniolo 2000). Due to this reason, the postcrack tensile properties of SFRC when exposed to elevated temperatures are of paramount importance for buildings and tunnels, in which fire must be considered as an accidental load. In these cases, SFRC may undergo dehydration of hydrated phases, extensive cracking, and coarsening of the pore structure, resulting in a deteriorated matrix and reduction of the tensile strength (Alonso and Fernandez 2004; Taylor 1997; Vydra et al. 2001). These factors are detrimental for the proper characterization of the tensile properties of the SFRC by means of mechanical tests.

In this sense, Rambo et al. (2018) evaluated the applicability of the double punch test (DPT) for the determination of the tensile properties of SFRC after exposure to elevated temperatures. Results showed an increased frictional interaction between the steel punch and the deteriorated specimen, which led to an incorrect interpretation of the results. This highlighted that an inaccurate test methodology may significantly affect the postcrack tensile strength results and lead to unsafe design assumptions.

The determination of the design-oriented constitutive equations for SFRC subjected to high temperatures is well established when bending tests are performed [ASTM C1609 (ASTM 2012); EN 14651 (CEN 2007)]. In bending tests, the friction between the supports and the specimen when the matrix is deteriorated by the high temperature may be altered, raising doubts about the effect of this condition on the postcrack response of the composite. Because bending tests require prismatic specimens, their execution is more complex and the results present a higher scatter than DPT (Galeote et al. 2017). In addition, the bending response of the composite may be significantly different from its tensile behavior, requiring the use of conversion factors for structural design that might be unrepresentative for some load levels (Bernard 2019) and induce incorrect assumptions during the design stages (Borges et al. 2019; di Prisco et al. 2010).

In this sense, the double edge wedge splitting (DEWS) test may be a proper procedure to evaluate SFRC exposed to elevated temperatures (di Prisco et al. 2013). A Fracture Mode I is induced in the specimen, minimizing the occurrence of compressive stresses that could alter results and their interpretation. Furthermore, this test requires small cubic specimens, which may be easily extracted from the structure affected by fire for the evaluation of the tensile properties. The DEWS test provides a simpler yet more reliable test

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