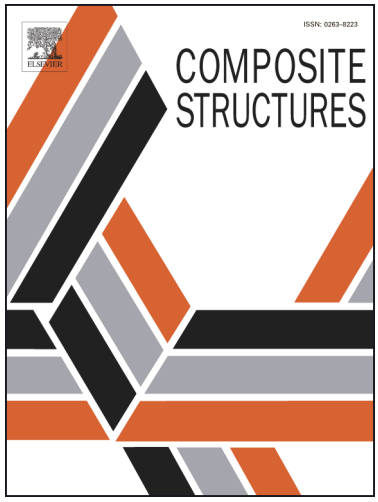

Failure of FRP-strengthened SFRC beams through an effective mechanism-based regularized XFEM framework

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Failure of FRP-strengthened SFRC beams through an effective mechanism-based regularized XFEM framework

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Abstract

Failure of beams made of Steel Fiber Reinforced Concrete (SFRC) and strengthened with plates of Fiber Reinforced Polymer (FRP) typically occurs after the detachment of the FRP plate, and depends on the content of steel fibers. Relevant finite element simulations are few, and, usually, neglect the modeling of the detachment process. On the contrary, the proposed regularized eXtended Finite Element Model (XFEM) focuses on the detachment process. In particular, the present approach takes into account the fiber-bridging effect exerted by the steel fibers at the detachment zone, while modeling the detachment through a mechanism-based procedure. The obtained results are fully consistent with the experimental data.

Keywords: SFRC,FRP, XFEM, detachment, mixed-mode, three-point-bending test

1. Introduction

Steel-Fiber-Reinforced-Concrete (SFRC) has been intensively used in civil engineering applications, such as tunnel linings, risers, pipes, covers, railways sleepers, repair of highway and airfield pavements, and several others [1]. The addition of steel fibers increases concrete toughness and ductility, and improves durability. Steel fibers induce a crack-bridging effect [19] that delays crack formation, spreads the cracks over a larger process zone while reducing the crack size [4, 29, 28, 1]. Externally-bonded FRP plates increase the strength of SFRC beams. To simulate SFRC beams strengthened with Fiber Reinforced Polymer (FRP) plates, reliable Finite Element (FE) models should take into account the steel fiber content, and follow the entire structural path. The few pertinent FE analyses focus on the cracking of the concrete by means of smeared-crack approaches [1, 42], while neglecting the detachment of the FRP plate. The present study proposes a regularized eXtended FE Model able to simulate crack pattern and detachment consistent with experiments.