CERIS Civil Engineering Research and Innovation for Sustainability

Recycled steel fiber reinforced concrete for structural elements subjected to chloride attack: mechanical and durability performance

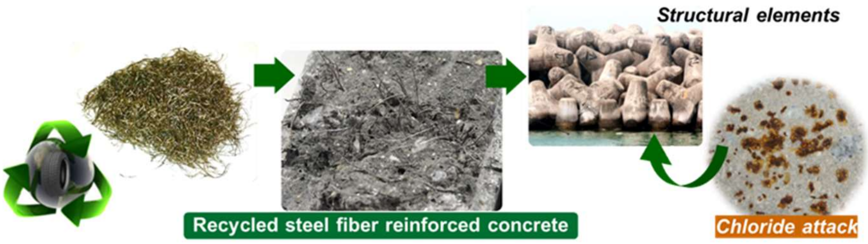
Summary

Recycled Steel Fibers (RSF) derived from the tire recycling industry have been successfully used in concrete to improve its post-cracking load bearing capacity and energy absorption performance. For structural elements exposed to chloride environments, an important aspect of Recycled Steel Fiber Reinforced Concrete (RSFRC) durability is the corrosion resistance. However, research on the durability of RSFRC is almost inexistent, namely concerning the effects of chloride attack, which may limit the mobilization of the full potential of RSFRC. The present thesis aims to assess the mechanical behavior and durability performance of RSFRC under chloride attack involving both experimental and analytical/numerical research, which knowledge may contribute for future design guidelines and design tools for RSFRC structures. The research activities carried out covered two main fields, the technology of RSFRC manufacturing and the investigation on the corrosion susceptibility of RSFRC. In the first field, an experimental program was carried out to characterize the RSF in terms of geometry, chemical composition, mechanical properties and microstructure. The influence of rubber particles attached to RSF surface was assessed in the performance of RSF as concrete reinforcement and in its corrosion resistance. A sustainable mix composition of RSFRC was attained and their mechanical properties were evaluated by three-point notched beam bending tests and compressive tests.

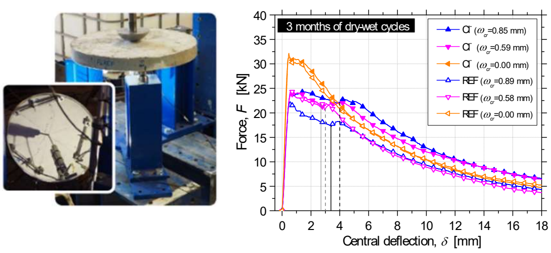
The second research field involved an experimental program to characterize the RSF corrosion and to investigate the corrosion effects of RSF on the fiber reinforcement mechanisms developed during the fiber pull-out from cracked concrete previously exposed to corrosive environment. Additionally, the post-cracking behavior of RSFRC under chloride attack was characterized from double edge wedge splitting tests and round panel tests. In these tests, the influence of the crack width, chloride exposure period and fiber distribution/orientation profile was considered. The experimental results were used to perform numerical simulations by inverse analysis, aiming to derive the post-cracking constitutive laws of RSFRC. A simplified prediction of the critical chloride content corresponding to the beginning of fiber corrosion and of the long-term performance of a RSFRC structural element exposed to a specific dry-wet aggressive maritime environment was performed. In addition, the technical, environmental and economic benefits of using the developed RSFRC for application to structural elements were assessed at material level and compared to Industrial Steel Fiber Reinforced Concrete.

Keywords

Recycled Steel Fiber Reinforced Concrete (RSFRC), chloride attack, mechanical and durability performance, experimental research, numerical simulations.



Motivation of the PhD Research.



Experimental results of pre-cracked and uncracked RSFRC round panels.

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Period

2015-2019

Funding

FCT scholarship (PD/BD/113638/2015)