CERIS Civil Engineering Research and Innovation for Sustainability

Fire behaviour of concrete structures reinforced with GFRP bars

PhD student
Inês Cruz Mina Rosa

PhD program
Civil Engineering (IST, University of Lisbon)

Supervisor
João Pedro Firmo (CERIS, IST, University of Lisbon)

Co-supervisors
João Ramôa Correia (CERIS, IST, University of Lisbon) and Mário Arruda (CERIS, IST, University of Lisbon)

Period
2017-2022

Funding
FCT scholarship (SFRH/BD/129681/2017)

Summary

The main objectives are (i) the comprehensive assessment and understanding of the fire behaviour of concrete structures reinforced with fibre reinforced polymer (FRP) bars for two different applications - new more durable constructions and rehabilitation of degraded steel-RC members - and (ii) the development of fire design recommendations. This study will imply coupling an experimental research programme with the development of supporting numerical modelling tools. From the experimental campaign to be developed, the following results are expected: (i) characterization of the physical-mechanical properties of FRP rebars at elevated temperature; (ii) in-depth understanding of the adherence between concrete and FRP rebars at elevated temperature, in terms of strain distributions, strength, failure modes, critical temperatures, including the effects of the rebar's surface finishing and geometry (diameter and bends); (iii) in-depth understanding of the fire behaviour of FRP-reinforced concrete (RC) slabs, in particular regarding the thermal and structural responses, including the effects of rebar's surface finishing and geometry, lap splices, types of end anchors, reinforcement ration and load level.

Alongside the experiments, numerical investigations will be performed using a commercial finite element package, from which the following output is expected: development of numerical models incorporating the constitutive relations as a function of temperature of both FRP bars and interface (experimentally determined) to simulate the thermomechanical fire responses of various RC structural members (beams and slabs) reinforced with FRP bars with varying concrete cover, diameter, surface finishing and detailing.

Apart from providing the scientific community with very relevant results, this study aims at proposing design recommendations and construction details that will enable extending the safe use of FRP rebars in new construction and rehabilitation. The research to be developed is grounded within the FCT-funded project FireComposite.

Keywords

Reinforced concrete, glass fibre reinforced polymer (GFRP) bars, bond behaviour, fire performance, experimental tests, numerical modelling.

Pull-out tests setup.

Fire resistance tests setup.