

ENHANCEMENT OF THE STRUCTURAL BEHAVIOUR OF FLAT SLABS UNDER CYCLIC AND SEISMIC ACTIONS THROUGH THE RATIONAL USE OF HIGH PERFORMANCE FIBRE REINFORCED CONCRETE

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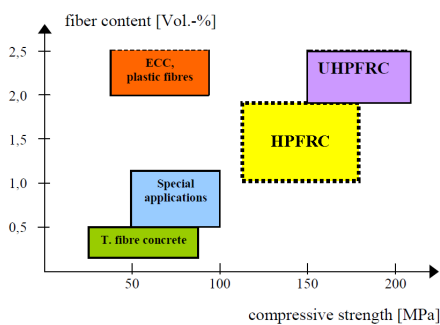
Abstract: The research proposed in this project aims to increase the knowledge on the behaviour of flat slabs structures with the rational use of High Performance Fibre Reinforced Concrete (HPFRC) and Ultra-High Performance Fibre Reinforced Concrete (UHPC). These high performance materials give the opportunity to design slender, lighter, elegant and efficient structures. Another innovative aspect of the use of these materials, associated with slenderer structures, is the use of less amounts of raw materials in its manufacture, with less environment impact. Another objective is to propose design recommendations for safer structures, particularly under seismic actions. The research is strong-minded in the safety of people and in the economy of the construction industry. These objectives will be reached with experimental and numerical research.

Methodology:

Development of the HPFRC and UHPFRC

This task deals with the selection, formulation and optimization of concrete mixtures while satisfying the performance requirements.

For a given set of constituent materials, in a 1st phase an experimental plan will be carried out to develop a HPC. The mixes will be adjusted to obtain a flowable concrete with the target compressive strength (90-120 MPa), before addition of fibres. Then, in a 2nd phase, the influence of the fibres addition in HPC matrixes will be assessed, in both the fresh and hardened states. Concerning UHPFRC, a commercial premix (Ductal) will be used to facilitate the industrial production of UHPFRC. Nevertheless, the water content, superplasticizer dosage and fibres content have to be adjusted in the current project.



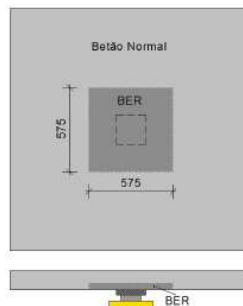
Mechanical characterization of the HPFRC and UHPFRC

This task includes a complete mechanical characterization of the HPFRC and UHPFRC mixtures selected for the large-scale tests. Steel fibre reinforced concrete is traditionally being tested in bending using various techniques for testing and evaluation of results.

Nevertheless, the flexural toughness could never be regarded as material property and the results are affected by such factors as: specimen size and geometry, loading conditions and evaluation techniques etc. Due to this fact it is necessary to use standardised methods to obtain the flexural toughness, such as three-point bending test according to EN 14651. In addition, compressive strength, elasticity modulus and uniaxial tension tests (in the case of UHPFRC) will be carried out.

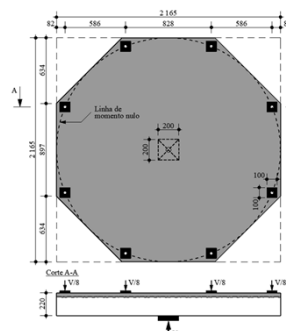
Monotonic Punching Tests - HPFRC at FCT-NOVA

The main objective of this task is providing experimental evidence on the punching shear behaviour of flat slabs using HPFRC. The HPFRC is going to be used only in localized regions of the slab-column connection, being the remaining part of the slab cast with a NSC, in order to determine the efficiency of the proposed solution. Different solutions with different geometries of the HPFRC zone will be studied. It is planned to carry out 5 large-scale tests of an interior column-slab connection subjected to monotonic loading.



Monotonic Punching Tests - UHPFRC at FEUP

The main objective of this task is providing experimental evidence on the punching shear behaviour of composite RC-UHPFRC slabs. This is the typical governing design situation occurring in flat slabs, for which the strengthening technique based on the application of UHPFRC overlays has a huge potential.



Cyclic Punching Tests

The main objective of this task is providing experimental evidence on the punching shear behaviour of flat slabs using HPFRC and UHPFRC under combined gravity and reversed cyclic lateral loading.



Numerical and Parametric Analysis

The objective of this task is to complement the experimental campaign of the research team by performing numerical simulations on punching shear behaviour of flat slab/column connections under monotonic, cyclic and seismic loading conditions, using non-linear finite element analysis codes. The outcomes of this task will enable to obtain representative data allowing to provide more consistent and complete design provisions for the use of HPFRC/UHPFRC in slab/column connections, both for monotonic and cyclic loading. Moreover, it will allow to evaluate the effect of changing different parameters, such as: flexural reinforcement ratio, shear reinforcement ratio, mechanical concrete properties and geometry of the models and of the HPFRC/UHPFRC zone.

Expected Results:

- Improved structural solutions for flat slabs in new buildings, based on the localized and rational use of HPFRC at the slab-column connection
- New solutions for strengthening flat slabs in existing buildings, based on the application of UHPFRC overlays
- Increase database of experimental results on punching behaviour of flat slabs, using HPFRC/UHPFRC
- Improved knowledge on the behaviour of flat slabs under seismic actions
- Important contribution to the preparation of design recommendations

Acknowledgements:

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