International Conference 2025
27th – 28th December 2025

Innovative Ultra High Performance Concrete with Improved Early-Age Behaviour

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Abstract:

Cement-based materials are the most widely used construction materials because they offer outstanding economic efficiency compared to other construction materials, as well as remarkable mechanical performances and durability. However, cement-based materials also involve some problems, such as low strength (especially in bending) compared to their weight, and brittleness. Recently, research for the development and practical use of FRCCs, and especially UHPCs, has been actively carried out to solve such problems. The addition of expansive agent on plain concrete (without fibre reinforcement) proved to be able to increase compressive strength a little, to leave the same flexural strength, and above all to produce initial expansion with consequent reduced final shrinkage at long ages.

Aim of this experimental work was to characterize the early-age behavior of several Fiber-Reinforced Cement-based Composites (FRCCs) containing CaO-based expansive agent. The influence of different amounts of fibers (namely 2.0%, 1.75% and 1.5% by volume of FRCC) on the mechanical performance of FRCCs was investigated. The attention was focused on the strength development at early ages, with tests carried out at 0.25 (i.e. 6 hours, corresponding to time of demolding), 1, 2, 7 up to 28 days of curing. FRCCs were characterized at both fresh and hardened state, by measuring fresh consistency as well as compressive and flexural strength up to 28 days on prismatic specimens.

The addition of different amounts of fibers has not influence on compressive strength; at least 50 MPa resistance was reached in every case after 24 hours of curing, while the 28-day compressive strength was in the range of 115-120 MPa, independently of the fibers amount. At very early ages the different dosage of fibers did not influence flexural strengths, while after 7 days of curing a range of 3 MPa between the mixtures with minimum (1.5%) and maximum dosage (2%) of fibers was observed. However, at least 13 MPa of 24-hour flexural strength was always reached, as well 28-day flexural strength of 20 MPa. Residual flexural strength at 3.5 mm of displacement seems to be independent of the amount of fibers up to 7 days of curing, then the highest dosage (2%) seems to guarantee better post-cracking behaviour.

Keywords:

Advanced Materials, Fiber Reinforced Concrete, High Performance Concrete, UHPC.