Elaboration of a lightweigth concrete with high energetic performances (LC-HEP): Study of the impregnation rate together with the mechanical properties

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Abstract

The purpose of this study is to combine lightness and architectural aesthetics with the thermal and energetic qualities of concrete walls. Concretely, it is a question of reducing the thickness and the weight of the concrete walls, while both preserving intact their capacity of heat storage and limiting the effects on their mechanical properties. Lightweigth concrete with high thermal energy storage capacity (LC-HEP) was manufactured by mixing a composite phase change material (PCM), namely coconut oil (GV23-26), with silica gel (SG), sepiolite (S), or bentonite (B) in an ordinary Portland cement concrete (O-PCC). Corresponding mixtures are noticed E-PCMs: E-PCM-SG, S, B.

The impregnation rate of GV23-26 into the various matrixes (SG, S and B), and the effects of the addition of the E-PCM into the cement mortar on the compressive and flexion strengths, were investigated. Two techniques were retained for impregnations, in ordinary conditions and under vacuum. Then, the obtained E-PCMs were added to the LC-HEP according to three separate scenarios: the ordinary addition, and the addition by substituting aggregates or sand respectively. Finally, the chemical stability of E-PCMs was examined by using Fourier Transform Infrared Spectroscopy (FT-IR).

The LC-HEPs are made with E-PCMs in proportions ranging from 50/50 to 100/0, corresponding to weight ratios of GV23-26 over the total weight ranging from 1 to 12%. It was found that the matrix that has the best absorption potential gives the lowest mechanical strength. In fact, significant loss in mechanical strength was observed in LC-HEP. The impregnation rate of the silica gel (SG) can reach up to 126%$_m$ under vacuum at 60°C, with a very limited mechanical strength whereas, under the same conditions, the sepiolite reaches only 57%m but with a permissible mechanical strength (with regards to the buildings reglementations). The addition by sand substitution is the most performant technique in terms of combining between mechanical strength and the integrating ratio of E-PCM. FT-IR analysis of the composites showed that the totality of E-PCMs is chemically stable.

Keywords: Portland cement concrete, building envelope, impregnated phase change materials, impregnation rate, mechanical strength, chemical stability.