MECHANICAL CHARACTERIZATION OF CEMENT AND GYPSUM BASED MORTARS WITH NANO AND MICRO SILICA PARTICLES FOR PASSIVE FIRE PROTECTION OF STEEL STRUCTURES

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Steel structures are used in several types of civil engineering solutions on a global scale due to their wide range of benefits [1]. However, in fire situations, the steel's mechanical properties are reduced as the temperature increases [2]. The main objective of this study was the development and the mechanical characterization of six types of passive fire protection mortars based on gypsum or cement with the addition of nano and micro silica particles (NMS). Based on an experimental campaign [3], it was selected a group of mortars with the best thermal behaviour. Different contents of gypsum, cement, polypropylene fibre, expanded perlite and vermiculite and NMS were used in the compositions. Before the determination of their Young's modulus of elasticity (E), shear strength (G) and Poisson's ratio (μ), through non-destructive tests, and their flexural and compressive strengths, through destructive tests, a complementary work was performed to physically characterize each mortar: microstructure analysis by SEM; density measurement; porosity measurement by mercury penetration; the mortar with the best thermal behavior (gypsum + expanded perlite + NMS) [3] was submitted in a comparative analysis with the commercial composition (composition of reference) by TGA and XRD tests as the mass loss as a function of temperature was determined by TGA and the identification of crystalline phases of materials by XRD. The linear regression coefficients (R) correlating the flexural strength with average E and G, and compressive strength with average E and G were 0.9628, 0.9571, 0.9122, and 0.9085, respectively. At the end of this work, it was possible to conclude that: 1) the better thermal performance of GP.NMS, when compared to C, is due to the fact that it loses less mass with the increase of temperature (consequently, less cracking) and due to the existence of an amorphous material (EP) in its composition; 2) from the analysis of non-destructive tests, the mortars developed have uniform and homogeneous matrices since the values of velocities/frequencies are in accordance with the range of values in the literature reviewed and 3) the higher the dosage of binder and the lower the dosage of aggregate, the higher the velocities/frequencies obtained and, consequently, higher values of mechanical strength; 4) only GV and GV.NMS showed mechanical properties higher or similar to C; 5) adding 1% in volume of NMS in gypsum-based mortars caused a decrease in their mechanical and physical properties, however, in the cementitious ones, the opposite occurred and 6) the studied mechanical properties (flexural and compressive strengths) seem to be well correlated with the physical properties (E and G), according to the validation coefficients.

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