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Slag of Greek provenance uses in materials science and geophysics: implications for a highly potential material in the service of the development of Greek economy

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Ground granulated blast-furnace slag (GGBS) is a secondary raw material that can be used as an alternative low energy binder. Hydraulic properties can be occurred through its alkali activation. GGBS is characterized by the glassy to crystalline ratio and by its chemical and mineralogical composition. Acidic slag cannot easily get crystallized in oppose to the basic one. Crystalline phases show very low reactivity with Ca(OH)2, while amorphous phases can easily react in the presence of basic substances. The aim of the present study was to study the evolution of new advanced silicate materials presenting high durability at high temperature environments.

Specimens were produced using two types of slag of Greek origin. The first type was a ferrous slag, while the second one was calcareous. Their maximum particle size was 4 mm and 0.07 mm respectively. Specimens were prepared using the above slag types and siliceous sand as an aggregate. Sand was divided according to European Standard EN 196-1 in three fractions: PG1 (1<d<2 mm), PG2 (0.5<d<1 mm) and PG3 (0.08<d<0.5 mm). Sodium silicate (Portil-A) was used in order to produce a waterglass solution, which played the role of the slag's alkali activator solution. The specimens produced were left in the moulds for 24 h, then cured in water for 27 days at laboratory temperature (25±2degC) and finally dried at 110degC. After the 28-day initial curing, some specimens were subjected to intensive heating for 2 h and then they were left to get cool, while the rest used as reference specimens. Heating temperatures ranged between 200degC and 1200degC.

Basic mechanical, thermal and physical parameters of the above specimens were studied. Young's modulus of elasticity (E), Poisson ratio (σ), shear modulus (μ) and volume modulus (k) were calculated using pulse velocity method. In order to measure density, matrix density and open pores size, vacuum water saturation method was used. The determination of the water-vapor transportation parameters was done at steady state isothermal conditions using a set-up of dimensional water-vapor diffusion. Thermal conductivity and heat capacity were also specified.

Specimens showed very good behavior under heating. Thermal properties were not significantly affected during the heating procedure leading to the conclusion that such materials can be used as protective layers against fire. Covering concrete structures is an effective way of protection against high temperatures. The above study shows that the slag of Greek origin is a material with a significant potential to be used in the field of building constructions protection against high temperatures. Though, it is an extremely promising material of highly potential value which can turn it into to the accessory part of the steam engine for sustainable development of the Greek economy.