

Pozzolanic Properties of Synthetic Zeolites as Materials Used for the Production of Building Materials

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Abstract : Currently, cement production reaches 3-6 Gt per year. The production of one ton of cement is associated with the emission of 0.5 to 1 ton of carbon dioxide into the atmosphere, which means that this process is responsible for 5% of global CO₂ emissions. Simply improving the cement manufacturing process is not enough. An effective solution is the use of pozzolanic materials, which can partly replace clinker and thus reduce energy consumption, and emission of pollutants and give mortars the desired characteristics, shaping their microstructure. Pozzolanic additives modify the phase composition of cement, reducing the amount of portlandite and changing the CaO/SiO₂ ratio in the C-S-H phase. Zeolites are a pozzolanic additive that is not commonly used. Three types of zeolites were synthesized in work: Na-A, sodalite and ZSM-5 (these zeolites come from three different structural groups). Zeolites were obtained by hydrothermal synthesis of fly ash in an aqueous NaOH solution. Then, the pozzolanicity of the obtained materials was assessed. The pozzolanic activity of the zeolites synthesized for testing was tested by chemical methods in accordance with the ASTM C 379-65 standard. The method consisted in determining the percentage content of active ingredients (soluble silicon oxide and aluminum) in alkaline solutions, i.e. those that are potentially reactive towards calcium hydroxide. The highest amount of active silica was found in zeolite ZSM-5 - 88.15%. The amount of active Al₂O₃ was small - 1%. The smallest pozzolanic activity was found in the Na-A zeolite (active SiO₂ - 4.4%, and active Al₂O₃ - 2.52). The tests carried out using the XRD, SEM, XRF and textural tests showed that the obtained zeolites are characterized by high porosity, which makes them a valuable addition to mortars.

Keywords : pozzolanic properties, hydration, zeolite, alite

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