DESCRIPTION FOR THE GENERAL PUBLIC (IN ENGLISH)

In the European Union, 76% of all greenhouse gas emissions originate from fossil fuels combustion and from industrial processes. More than 5% of all CO_2 emissions comes from the Portland cement production process. Familiar with the above data, scientists investigate alternative binders characterized by a low carbon footprint. One possible path of development of sustainable construction materials are alkali-activated binders - geopolymers.

Geopolymers are a new group of ecologic binders with a nonorganic, amorphous structure formed by silica and aluminum chemical compounds. The analysis and research on their properties has its beginnings in the late 1970'. Their concept was firstly introduced by J. Davidovits. Geopolymer composites are formed by mixing pozzolanic material with alkaline activator and certain curing conditions. Obtained binders are characterized by properties similar to cement binders and additionally high chemical and thermal resistance.

One of the most common pozzolanic materials used for production of geopolymer binders is a fly ash obtained i.e. from a combustion in electrical plants. Poland is currently one of the biggest manufacturers of combustion byproducts in European Union. Poland generates close to 15 m. tones of fly ash and slag every year. Their reuse reaches only 57% of total. Most of it is used in the civil engineering, transport and cement production. Given the new European Union regulations on CO_2 emissions, many polish coal-based power plants are switching to the co-combustion of coal and biomass, or even to pure biomass combustion. The fly ash obtained this way differ in their chemical composition and has different properties. For its use in geopolymerization process it is required to conduct a research including, among others, a chemical compound analysis with regard to oxides, that in fly ashes from regular combustion of coal doesn't occur in significant amount, like phosphorus oxide (P_2O_5).

The main aim of the project is to perform a fundamental study on the influence of phosphorus oxide, present in the chemical composition of byproducts of coal and biomass combustion, on the microstructure and binding of geopolymers, alkali-activated binders, and consequently also on their mechanical properties. To date, no such studies concerning the effects of phosphorus oxide have been conducted, and the content of P_2O_5, depending on the combustion byproduct used, ranges from 0.1 to approx. 41%.

In order to analyse the influence of phosphorus oxide on binding process a time of setting of the designed mortars will be performed. The results will be examined in relation to the temperature change and amount of heat release in the geopolymerization process in a function of time (isothermal calorimetry). In order to study the microstructure and products of binding, a series of tests enabling the analysis of phosphorus addition influence on the structure and phase classification of geopolymer mortars will be performed. It will include an image analysis, use of a scanning electron microscope (SEM) with an EDS attachment, Fourier transfer infra-red (FTIR), and X-ray diffraction (XRD).

The results of the proposed fundamental study will assist in drawing conclusions concerning the relations between geopolymerization products and the content of phosphorus compounds in alkali-activated waste material, and therefore will facilitate conducting studies of materials with different percentage contents of phosphorus oxide thanks to the opportunity to parameterize the relation. Understanding the effects of phosphorus compounds on geopolymerization may result in excluding certain byproducts of coal and biomass combustion from use as precursors for the geopolymerization binders due to its excessive content.