

Utilisation of Sand from Kaolin Washing for the Manufacture of Alkali-activated Artificial Sandstone

Martin Vavro (1), Leona Vavro (1), Pavel Mec (2), Kamil Soucek (1), Frantisek Pticen (3), and Pavel Reiterman (4)

(1) Institute of Geonics of CAS, Ostrava, Czech Republic (martin.vavro@ugn.cas.cz), (2) VSB - Technical University of Ostrava, Ostrava, Czech Republic (pavel.mec@vsb.cz), (3) KERAMEX Group, Karlovy Vary, Czech Republic, (4) Czech Technical University in Prague, Experimental Centre, Czech Republic (pavel.reiterman@fsv.cvut.cz)

Sandstones represent a traditional natural stones which are widely used in Czech architecture and sculpture over a long time. Thanks to their relatively easy workability, sandstones provide a wide range of stone products and also represent a popular material for architectural and sculptural purposes. In the field of restoration of artworks, they are therefore often used for manufacturing stone statue copies originally made from the same or similar type of stone. Despite a relatively common and varied occurrence of natural sandstones, the method of the artificial stone facsimiles creation in the form of various cast elements is also often applied in restoration practice. The history of application of artificial stones in civil engineering and architecture goes back to the ancient times, i.e. to Roman antiquity and possibly up to the time of ancient Egypt. The lack of appropriate natural rock, suitable in the view of colour, grain size or texture is the main reason of manufacturing copies based on synthetic mixtures. The other reason is high financial costs to create a sculpture copy from natural materials. Mixtures made from white and/or grey cements, sands, carefully selected crushed stone or well graded natural gravels, and mineral coloring pigments or mixtures with acrylate, polyester, and epoxy resins binder are the most frequently used artificial materials for cast stone manufacturing.

This paper aims to bring information about composition and properties of artificial sandstones made from alkali-activated binder mixtures based on metakaolin and granulated blast furnace slag. The filler of this artificial stone is represented by fine-grained sand generated during kaolin wet processing. Used sand is mainly formed by quartz, feldspars, micas (muscovite > biotite), residual kaolin, and to a lesser extent also by Fe oxyhydroxides ("limonite"), titanium dioxide mineral (probably anatase), and carbonate mineral unidentified in detail. Annual Czech production of this sand from kaolin-washing process is of several hundred thousand tonnes and it thus represent so far a relatively rarely used natural building material which is currently usually deposited in worked-out areas of kaolin quarries. One of the main reasons of very difficult usability of this sands in building material industry is their behavior when exposed to the weather. In only a very short time of exposure in outdoor condition they may change in colour from greyish white to yellow-brown or golden yellow. This colour change is accompanied by significant decrease of pH values of sand leachate up to pH ranging between 3.5 and 5.5, in extreme cases even up to 2.0.

Despite these extreme chemical properties of sands under study, the artificial sandstone, very similar in the physical and mechanical properties to natural ones, was successfully prepared in the laboratory. Due to the mineralogical composition of applied sands (i.e. the presence not only of quartz, but also of feldspar and muscovite), the artificial sandstone is characterized by relatively true natural appearance.