UTILIZATION OF ACTIVATED LOCAL KAOLIN INDUSTRIAL BY-PRODUCTS IN BUILDING INDUSTRY

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ABSTRACT

Recent years have seen changes in the environment legislation relating to the disposal of the industrial waste materials. These changes have created growing interest for the use of waste by-products materials. Clean environment is the major benefit gained from this process.

The present work aims to investigate the suitability of replacing Portland cement by a waste obtained from alum production factories through the extraction of aluminum from calcined kaolin, the dealuminated kaolin (DK). The study shall be conducted on the as received waste as well as after treating with lime solution. The chemical and mineralogical compositions of the samples are determined, also their pozzolanic reactivity and the surface areas. The products obtained from hydrating Portland cement pastes with the solid wastes are characterized by means of Thermo-Gravimetric (TG) and Differential Thermal Analysis (DTA), also by X-ray diffraction (XRD) and scanning electron microscopy (SEM) technique. The total and capillary porosity and the pore size distribution are investigated using Mercury Intrusion Porosimetry (MIP) and de-sorption measurements.

The effect of up to 20% by mass replacement of the OPC by the solid wastes on the setting time, the flowability, the rate of flowability loss and the rheology using were studied by means of the mortar flow table apparatus. The flowability of the mixes are measured as a function of the applied stress and at elapsed periods up to 120 minutes. The compressive and tensile strength and mass transport properties as a function of the sorptivity and water absorption were investigated for mortar specimens. The effects of the dealuminated kaolin on compressive of concrete, the splitting, flexural, modulus of elasticity, stress strain behavior, drying shrinkage, sorptivity and initial surface absorption were also investigated. Hence, the optimum content of the waste to be used in concrete was determined. The morphology and microstructure of aggregate-paste interfacial transition zone as well as the bulk paste was examined using SEM technique.

The durability of the OPC mortars made with up to 10% dealuminated kaolin was finally studied in sulfate environments for age up to 32 weeks. The rate of strength loss, expansion,

and weight gain were determined. The degradation of OPC/DK reinforced mortar specimens exposed to chloride environments was also investigated by monitoring the corrosion activity of the embedded reinforcement in terms of the corrosion potential and corrosion current density using half-cell and zero resistance ammeter apparatus respectively..

The main findings of this investigation can be summarized as follows:

1- The as received dealuminated kaolin and that treated with lime possess higher pozzolanic reactivity and show larger surface areas than silica fumes.
2- The inclusion of either untreated dealuminated kaolin (DKut) or treated dealuminated kaolin (DKt) in OPC matrix can modify the microstructure related characteristics. An increase in the amount of CSH and a reduction in the amount of CH were observed together with the presence of some poor ettringite crystals produced in the aggregate-paste interfacial transition zone and bulk zone.
3- The incorporation of the as received dealuminated kaolin (DKut) in OPC paste accelerates the setting time; while the lime-treated dealuminated kaolin (DKt) lead to retardation. The flowability of the OPC mortar is little affected by the as received DK samples and is strongly reduced by DKt and silica fume. The rate of flowability loss of OPC mix is notably affected when dealuminated kaolin is utilized.
4- Adoption of dealuminated kaolin as a cement replacement material in OPC mixes could improve the mechanical, fluid transport properties and the resistance to cracking under loads. The optimum content of dealuminated kaolin was found to be around 10 % of OPC mass.
5- The incorporation of untreated dealuminated kaolin in OPC concrete leads to a notable reduction in their drying shrinkage. The amount of reduction increased with increasing DK content.
6- The inclusion of untreated dealuminated kaolin is more significantly effective from the structural and economical point of view than the treated one.
7- The minimum degradation of the reinforced OPC mortar containing DK when exposed to aggressive environments of sulfate or chloride ions was achieved by 5%DKut inclusion. The inclusion of SF to OPC/DKut mortar mixes has remarkable improvements in their compressive strength, % expansion, weight gain, and reinforcement corrosion resistance.

Key Words: By-product, Cement replacement materials, Dealuminated Kaolin, Pozzolanic activity, Microstructure, Fresh properties, Mechanical properties, Mass transport properties, Durability.