METAKAOLIN BASED GEOPOLYMERS AS SOIL STABILIZERS

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In many kinds of engineering constructions, wind-swept soils and soft weak soils are often stabilized and strengthened with ordinary Portland cement (OPC) and lime, to increase soil strength and durability. Furthermore, such soil stabilizing can also prevent erosion and dust generation. However, OPC is known to leave an enormous environmental footprint on planet Earth as its production processes are significant energy consumers with high CO_2 emissions. Therefore, the development of a novel generation of cements with high durability and environmental sustainability is essential. One of these novel binders is the alkali-activated binder based on aluminosilicates materials as metakaolin or industrials by-products such as fly ash or slags, commonly referred to as geopolymer. It has been found that geopolymers can exhibit high compressive strength and higher chemical and thermal resistance than cement-based materials [1]. Therefore, due to their high strength, low cost, low energy consumption and CO_2 emissions, geopolymers offers a promising alternative to OPC [2]. Geopolymers also exhibit excellent adhesion to aggregates [3], therefore it is reasonable to assume that they can serve as an effective soil stabilizer.

In this study, a new composite alkali-activated material was developed and designed to serve as a soil stabilizer for wind-swept and soft soils as well as a waterproof layer, as replacement for OPC, the conventional soil stabilizer. This new developed material can also be considered as a soil cover layer for engineered barrier system (EBS) for waste disposal facilities. The composite material was designed to have extended anti-erosion/abrasion resistance, high mechanical strength and high resistance to water infiltration. The materials used in the current study include local clays and silica sandy soil, molded with metakaolin as the geopolymeric binder, activated with a solution of sodium silicate and sodium hydroxide with mass ratio of 1.3:1. Six different mixtures were studied differing in their clay/sand/metakaolin content.

The different geopolymer composites were examined for their compression properties, physical degradation, chemical and morphological characterization. Increasing the sand content in the mixtures was found to increase compressive strength and mixture workability. The best mechanical properties were obtained for the mixture with sand/metakaolin mass ratio of 1:0.3 and Solids/activator mass ratio of 1:0.33 reaching a compressive strength of 33.4 MPa, with abrasion resistance meeting the Israeli standard [4].

Two-layered samples were prepared composed of a silica-sand based upper layer designed to serve as a mechanical anti-erosion barrier and a clay based lower layer designed to serve as an infiltration barrier (see Figure 1a). The adhesion between these two layers was examined by four-point flexural test along with scanning electron microscope (SEM) observation, showing a very dense and compacted interface as clearly presented in Figure 1b.

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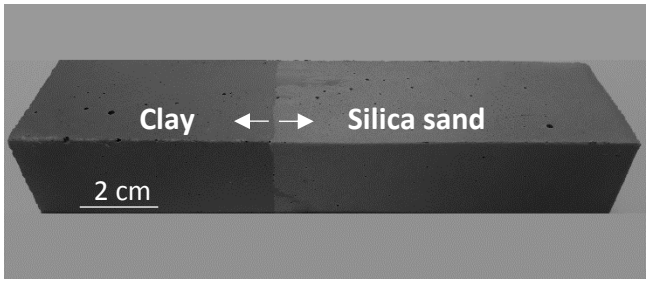
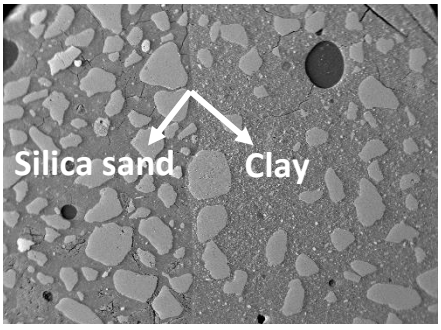


(a)



(b)

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