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Engineering Properties of Omani Natural Pozzolana

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Abstract

The use of natural and artificial cementitious and pozzolanic materials has become a common practice in today`s cement-based materials. Cementitious and Pozzolanic materials are known to provide an added value to concrete/mortar or paste not only in terms of mechanical and durability performances but also to enhance their sustainability by reducing the environmental impacts of construction industry. For centuries, *Sarooj*, a local artificial cementitious/pozzolanic material has been used in Oman and other neighboring countries in various engineering structures and traditional buildings but its use is now limited to plastering and some restoration of historical buildings. Although the Sultanate of Oman is rich with natural mineral resources, the engineered production of natural and artificial pozzolanas is lacking even non-existing except the traditionally produced pozzolana called *Sarooj*.

The aim of the present research project was first to develop and then assess the physico-mechanical and durability properties of local natural pozzolana produced from soils extracted from two different locations within the Sultanate named Nizwa (NZS) and Fanja (FNJ) soils. The ground soil was subjected to calcination at various selected temperatures based on the test results of thermogravimetric and differential thermal analysis. The burnt soil was subjected to series of materials characterization including the main physical, chemical, microstructural and crystal structure properties. The results indicate a high potential of a reactive material that could be used as a cementitious and/or pozzolanic material in cement mortar and concrete industry. The two powdered materials were incorporated in mortar, at various contents ranging from 0% to 50%, as a partial replacement of Portland cement.

The blended mortar was assessed in terms of fresh mortar flow, compressive strength, durability performances including porosity, resistance to sulphate and acid attacks, chloride permeability, as well as insulation properties.

The results showed a reduction in the flow diameter when adding various contents of these two natural pozzolanas. Compressive strength of the blended mortar was slightly reduced at early age while the long term strength was generally enhanced. Exposure of mortar cubes to sulfuric acid and sulphate-chloride solutions for a period of 12 weeks did not significantly affect the strength compared to around 50% drop in the compressive strength of the control mortar. Both pozzolanas, especially the FNJ one have significantly reduced the chloride permeability and resulted in mortars with moderate to low/very low permeability. Furthermore, the thermal conductivity of mortar was not affected by the inclusion of various amounts of NZS or FNJ pozzolanas. Overall, by using these two locally produced natural cementitious/pozzolanic materials in a partial replacement of Portland cement, the sustainability of mortar/concrete or even plaster can further be enhanced.

Keywords: Acid attack, natural pozzolana, mechanical properties, durability, porosity, sulphate and chloride attacks, sustainable mortar, thermal conductivity water absorption.