



Physico-chemical, mechanical, microstructure and durability characteristics of alkali activated Egyptian slag



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HIGHLIGHTS

- Alkali activator contents affected the location and intensities of the conductivity maximum.
- Mix S5 shows the higher values of compressive strength at all curing ages up to 90 days.
- Mix S1 shows higher values of strength in 5% MgSO₄ or MgCl₂ solution upto 180 days.
- Alkali activated GBFS improves the durability and the resistance to chemical attack.
- The total chloride and total sulphate contents decrease with alkali activated GBFS.

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ABSTRACT

The aim of the present work is to study the characteristics of alkali activated Egyptian slag (GBFS) mixed with different contents of Na₂O and SiO₂. The rate of the kinetic of activation of GBFS has been studied by electrical conductivity, FTIR, DTA/TGA, XRD and SEM techniques. Electrical conductivity of alkali activated slag systems depends mainly on the binder composition, the activator type and its concentration. The increase in alkali activator contents affected the location and intensities of the conductivity maximum. As the hydration time increases the amount of hydration products increase, hence the chemically combined water and combined slag contents increase. SEM images showed the presence of (N,C)ASH gel with low porosity. With the increase of the content of Na₂O leads to form a denser closed microstructure, leading to higher compressive strength values. The activated GBFS showed good durability in 5% MgSO₄ or 5% MgCl₂ solution, i.e., the compressive strength increased gradually with immersing time up to 180 days. The total chloride and total sulphate contents decrease with alkali activated GBFS due to the forming hydrated products that fill some available open pores, thereby inhibiting Cl⁻ or SO₄²⁻ ions penetration; this effect leads to a decreased accessibility of Cl⁻ or SO₄²⁻ ions towards the more dense with low capillary pore structure. It can be concluded that alkali activated GBFS are more durable in 5% MgSO₄ or 5% MgCl₂ than OPC pastes.

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1. Introduction

The role of alkali activated cements protect the environment through the utilization of by-product materials in their manufacture and end applications in waste management. The production of alkali-activated concretes is associated with low energy consumption and low CO₂ emission, along with the potential to reach high mechanical strength at early ages of curing, resistance

to chemical attack and resistance to high thermally treated temperatures. These properties have made concretes based on alkali-activated binders a very interesting [1–3]. Portland cement (OPC) production increases global greenhouse gas emissions such as dioxin, NO_x, SO₂, and particulates, through the calcination of clinker in hydrocarbon heated furnaces. The high CO₂ emissions arising (7% of all CO₂ generated) from OPC manufacture have been attributed to calcination of limestone, which leads to formation and release of CO₂ and high energy consumption during manufacturing at temperatures up to 1550 °C [4]. Reduction in cement consumption has been attained by the use of industrial by products such as blast-furnace slag (GBFS), fly ash (FA), silica fume (SF) and cement kiln dust (CKD), as partial cement replacement materials [5,6].

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