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Fresh and Mechanical Properties of Zero-Cement One-Part Geopolymer Mortar and Concrete

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1 Abstract

The era of research on fly ash based Zero-Cement (ZC) containing alkali activated geopolymer mortar and concrete has already begun. By replacing 100% of cement which is the higher carbon footprint material and also by maintaining a steady level on eco-system without causing severe environmental damage or exhausting natural resources, geopolymer technology is on the way to be the most popular sustainable construction material. However, the mixing mechanism of geopolymer is very difficult using the liquid alkaline activators which are hazardous as well as difficult to handle in large construction works at sites. As a result, the development of producing one-part geopolymer or "just add water" process similar to ordinary Portland cement (OPC) construction, is necessary for the promotion of this green and sustainable construction material to the society. To this end, two different sources of Class C fly ash (FA) from Missouri State, USA are used in this study to investigate the mechanical as well as the fresh properties of ZC mortar and concrete. In this study, the dry sodium hydroxide (SH) pellets and sodium silicate (SS) powder are used as solid alkaline activators. Three different curing systems, e.g. ambient, oven and steam curing are employed in this study and corresponding strength gains are evaluated. A significant enhancement of the compressive strength was achieved by the addition of 1.9 mass% of sucrose (sugar) with respect to FA in the mix after curing at the elevated temperature.

Keywords: Geopolymer; Class C fly ash; fly ash (FA); mixing time; alkali activated; sustainability; sucrose; sugar; Zero-cement (ZC).

2 Introduction

Fly ash based alkali-activated zero-cement (ZC) geopolymers possesses superior properties compared to ordinary Portland cement (OPC), for example, enhanced resistance to acids and sulfate, improved heat resistance, lower creep and drying shrinkage, and higher compressive and tensile strength [1]. One-part or "just add water" zero-cement geopolymer mixtures are a newly initiated type of mixing process for alkali activated geopolymers, which is developed with an intend to simplify the complexity in mixing as well as handling the liquid chemical activators in the construction sites. One-part zero-cement can be prepared by mixing the dry aluminosilicate precursors (fly ash) and solid alkaline activators and use this mixture to produce geopolymer binder by just adding water like a similar process of

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