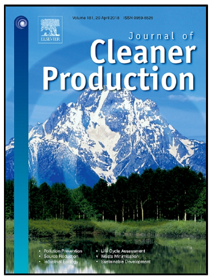

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One-Part Geopolymer Cement from Slag and Pretreated Paper Sludge

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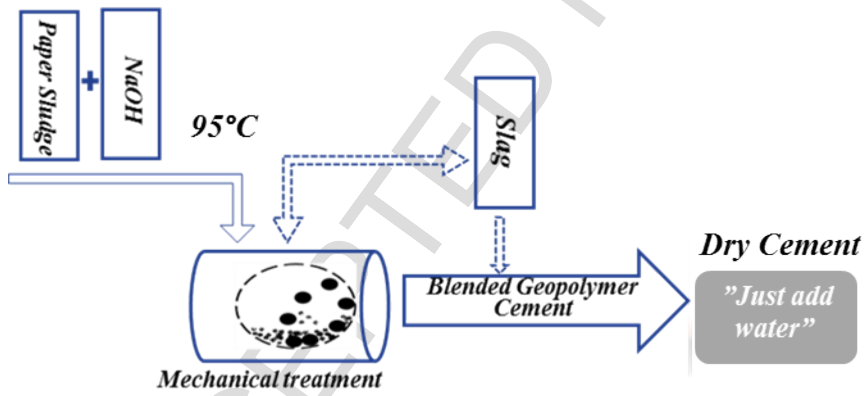
Abstract
The aim of this study was the valorization of paper sludge waste from paper industry in designing one-part geopolymer cement using ground granulated blast furnace slag as main precursor. The effects of increasing the amount of paper sludge pretreated with a constant amount of sodium hydroxide (2% of slag) on mechanical strength, heat evolution, setting time and durability were analyzed. The reaction products were characterized using X-ray diffraction and thermogravimetric analysis. The findings showed that paper sludge can successfully be used as a secondary source of calcium carbonate in the one-part ("just add water") geopolymer. The compressive strength of the cured geopolymer increased with increasing the amount of paper sludge, and the non-reacted sludge acted as a filler. The maximum strength (42 MPa, 28 d) was reached at 18 wt-% paper sludge addition. The main reaction products were calcium aluminate silicate hydrate and hydrotalcite-like cementitious gels. From the perspective of its blast-furnace slag content, strength properties, water absorption and setting time, the one-part geopolymer cement could be classified as a CEM IIIC and Type 32.5N class cement under the European standard EN-197.

Graphical Abstract



Keywords: One-part geopolymer· Durability· Paper sludge· Geopolymer· Alkali activation·

1. Introduction

The increasing demand for environmentally friendly and sustainable construction materials has necessitated finding alternatives or substitutes for ordinary Portland cement (OPC). Environmental impacts and emissions of greenhouse gases from OPC production has been widely documented, and with the increasing infrastructure development worldwide, the demand and production of OPC cement as binder in concretes structures will continue to increase [1–5]. Different alternatives for OPC in construction materials, measures to reduce the reliance on its use and curbing the detrimental environmental impacts have been suggested by several authors. Partial substitution of OPC with different supplementary cementitious materials has been suggested and is already the norm in many countries [6–10]. In addition to this, the design and development of alternative