One-part alkaline activated cements manufactured by the activation of brick dust and biomass bottom ash using a potential sustainable activator from spent diatomaceous earth

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Alkaline-activated cements or geopolymers are cements produced by alkaline activation of an aluminosilicate-rich precursor, which can be of natural origin (metakaolin) or industrial wastes and by-products. The most commonly used alkaline activator is sodium hydroxide (NaOH) and sodium silicate (Na_2SiO_3). However, both NaOH and especially Na_2SiO_3, which are commercially synthesized, contribute significantly to greenhouse gas (GHG) emissions, by requiring energy-intensive industrial processes for their manufacture. In addition, these alkaline activators are toxic and caustic, which can lead to serious health hazards. For these reasons, research on alternative waste-derived activators or more sustainable sources has intensified to mitigate the environmental impact and reduce the cost of geopolymers. Therefore, the use of alternative waste-derived activators needs to be explored.

The objective of this study is the activation of alkaline activated cements from brick dust and biomass bottom ash (BBA), by optimizing the percentage of Na_2O in the alternative activator, obtained through the thermochemical treatment of spent diatomaceous earth residue with NaOH. In addition, it is sought to determine the optimum combination of brick dust and BBA. As a control, binders have also been manufactured using only the chamotte powder precursor or only the BBA residue.

The physical properties (bulk density, apparent porosity and water absorption), mechanical properties (flexural and compressive strength) and thermal conductivity of the synthesized binders were determined. The results show that both the percentage of Na_2O in the activator and the weight percentage of incorporated BBA have significant influence on the properties of alkali-activated cements. The best compressive strength results (30 MPa) were obtained for cements containing 75 wt% t of fired bricks and 25 wt % of BBA, activated with an alternative activator containing 30 wt % of Na_2O per 100 g of precursor.

The results demonstrate that it is possible to substitute commercial activators with alternative activators derived from diatomaceous earths used in the production of alkaline activated cements based on chamotte and BBA.