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Impact of Portland Cement Content on Alkali Activated Bottom Ash

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1 Introduction

Bottom ash (BA) represents 40% of ashes from the coal-fired thermoelectric power plants (Cheriaf *et al.*, 1999), it is estimated 4.5 million tons of BA per year in Brazil (IEA, 2016). Unlike fly ash, the disposal of bottom ashes goes to settling basin. Studies have shown the use of bottom ashes as an alternative aluminosilicate source for alkali activations (Topçu *et al.*, 2014, Tambara Júnior *et al.*, 2018). However, its performance is worse than fly ash activated. This is due to bottom ash, it presents less amorphous content, higher unburned coal and low reactive SiO_2 and Al_2O_3.

Blended or hybrid cements are systems containing large amount of silicoaluminate mineral and small content of Portland cement (Garcia-Lodeiro *et al.*, 2016). A variety of low-reactivity waste materials can be used to develop hybrid cements. In this article was investigate the influence of ordinary Portland cement (OPC) on the mechanical strength (28-d and 60-d), kinetic of water absorption at 1-d and 28-d and pore structure at 28 days of activation of blended alkali activation mortar of BA/OPC. The reaction was monitored with isothermal conduction calorimetry to evaluate the heat flow variations in the pastes in the early time of reaction. The OPC was blended from 0% to 30%.

A combination of sodium hydroxide (NaOH) pellets, water distilled and sodium silicate solution (Na_2SiO_3) was used as an alkaline activator. A superplasticizer additive based on polycarboxylate ether was used to adjust the workability (flow value > 250 mm) required for self-leveling mortars.

Two different behaviors were observed according to the OPC content on the hybrid cements. Results are classified as *low OPC content* (OPC2.5 and OPC5) and *moderate OPC content* (OPC10 and OPC30), according to distinct behaviors. For all OPC additions, increasing OPC content accelerates the activation reaction.

To isothermal calorimetry it was observed a faster reaction at 80ºC, due to this it was not possible to detect the first peak associated aluminosilicate dissolution. For the alkali activation only with BA (OPC0) it is seen the lowest heat release and total heat. This occurs due its insufficient dissolution phases that start the formation of N-A-S-H gel.

To *low OPC content* it is noticed the formation of a single peak in heat evolution. The increment of OPC content resulted in a higher heat release and total heat, this indicates an increase of reaction degree. To *moderate OPC content* it is verified a quick first peak formation may be associated with an accelerated Si and Al dissolution and N-A-S-H formation. Also, a secondary peak starts after 15 minutes of activation. After the first gel formation the pH of pore solution decreases by which the calcium provided from OPC begins to react and form a (N,C)-A-S-H gel type (Garcia-Lodeiro *et al.*, 2016).

At 28 d was observed to all samples a reduction of water absorption, greater to moderate OPC content. It was observed that OPC10 showed the lowest water absorption to 28 days. The authors associate this behavior to the pore filling due best compatibility of last formation of (N,C)-A-S-H gels observed through microscopy analysis (Tambara Júnior *et al.*, 2018).

To mortars at low OPC content there is observed higher pore formation and unreacted bottom ash. As calorimetry analysis shows, the improve of OPC content results in a higher energy release. This fact can be associated with the reduction of porous sizes, where improves the silicon dissolution, resulting in a denser N-A-S-H/C-A-S-H gels.

This study evaluated the OPC content on the blended mortars of bottom ash and Portland cement. The main conclusion obtained in this work it is that even with low Portland cement content (2.5%) there is possible to manufacture hybrid mortars made with bottom ash. The OPC replacement contribute to increase the reactivity of the bottom ash.

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References

Cheriaf, M., Cavalcante Rocha, J. and Péra, J. (1999). Pozzolanic properties of pulverized coal combustion bottom ash, *Cem. Concr. Res.* 29 1387–1391. doi:0008-8846/99/$.

Garcia-Lodeiro, I., Donatello, S., Fernández-Jiménez, A. and Palomo, A. (2016). Hydration of hybrid alkaline cement containing a very large proportion of fly ash: A descriptive model, *Materials*. 9 doi:10.3390/MA9070605.

IEA, International Energy Agency Coal Information 2015 with 2015 data. (2016). Energy Technol. Perspect, https://www.oecd-ilibrary.org/energy/coal-information-2016_coal-2016-en, Accessed date: 14 October 2019

Tambara Júnior, L.U.D., Cheriaf, M. and Rocha, J.C. (2018). Development of Alkaline-Activated Self-Leveling Hybrid Mortar Ash-Based Composites. *Materials.* 11, 1829.