

Use of biomass fly ash for mitigation of alkali-silica reaction of cement mortars

T.C. Esteves ^a, R. Rajamma ^b, D. Soares ^c, A.S. Silva ^c, V.M. Ferreira ^b, J.A. Labrincha ^a

^a University of Aveiro, Department of Ceramics and Glass Engineering/CICECO, 3810-193 Aveiro, Portugal

^b University of Aveiro, Department of Civil Engineering/CICECO, 3810-193 Aveiro, Portugal

^c National Laboratory for Civil Engineering (LNEC), Materials Department, 1700-066 Lisbon, Portugal

ABSTRACT

The degradation of large concrete structures over time is well known. One of the main reasons is the reaction that occurs between the cement paste and some reactive siliceous aggregates, which causes a significant expansion that depends on the employed materials and exposure conditions of the structure. This process is known as alkali-silica reaction (ASR) and affects several structures worldwide, including major dams and bridges in long time run. In this work the effect of fly ashes from biomass combustion in the mitigation of the ASR was investigated. The fly ashes were collected from two industrial plants located in the central area of Portugal: (i) a thermal power plant (BFA1), (ii) co-generation process of a pulp and paper industry (BFA2). The fly ashes were characterized by different techniques to determine the following properties: particle size distribution (laser interference), loss on ignition and thermal behaviour (TG/DTA), chemical (XRF) and phases (XRD) composition and pozzolanic activity (EN 196-5:2005). These biomass fly ashes were irregular in shape and fine in size. The chemical characterization revealed significant differences in CaO and SiO₂ contents, but both fly ashes can be considered as class C fly ashes if compared with those generated from the coal combustion.

Accelerated mortar-bar tests were conducted according to ASTM C1260/ASTM C1567 to evaluate the behaviour of the biomass fly ash in the ASR inhibition mechanism. The expansive behaviour was studied on mortars where the cement was partially replaced (20–30 wt%) by the biomass fly ashes. This substitution tends to reduce the expansion upon accelerated curing conditions, and BFA2 is more effective than BFA1. But the incorporation of biomass fly ash in the blend along with metakaolin (MK), 20% BFA + 10% MK did a significant improvement in the expansion results, indicating the effective use of biomass fly ash along with metakaolin in mitigating the ASR.

Keywords: Alkali-silica reaction, Mitigation, Biomass fly ash, Metakaolin, Mortars