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Replacing Pulversized Fly Ash in cement with natural and anthropogenic geomaterials identifying the corresponding physico-chemical properties used for the encapsulation of Low-Level Waste

Andrea Kozlowski, Joanna Renshaw, and Katherine Dobson
University of Strathclyde, Civil and Environmental Engineering, United Kingdom of Great Britain – England, Scotland, Wales (andrea.kozlowski@strath.ac.uk)

Clinker substitutes are frequently used in the cement and concrete industries to reduce CO_2 emissions associated with production, improve physico-chemical properties and performance, and reduce costs. Pulversized Fly Ash (PFA), a fine waste residue produced in coal-fired power stations, is the commonly used partial clinker substitute in Ordinary Portland cement (OPC) for cements for the immobilisation of low-level nuclear waste (LLW). Because of the global trend to shut-down coal-fired power stations, the production of PFA is decreasing and will eventually cease. Alternative sustainable clinker substitutes can be used must meet strict performance standards for the safe enclosure of LLW for the final disposal. These include physical, chemical, and mechanical properties; performance and suitability for use.

This study investigates the suitability of different materials (natural and anthropologic) as a substitute of PFA in OPC in LLW immobilisation, and compares the behaviour of these substituted cements to those of the current standard. The focus of the study is on the cementing and physico-chemical properties of the cement, and the interaction between groundwater, the cement, and the stored waste.

Here we present the characterisation the standard PFA+OPC (samples provided by Low-Level Waste Repository Ltd.) using X-ray computed tomography (XCT), and the latest data from the ongoing analysis elemental composition of the alternative materials and the leaching tests. Over the leaching period the samples undergo repeated XCT analysis to link structural changes to the chemical evolution. Future work will include studying the long-term leaching effects and the interaction of the LLW (usage mock waste formulation) with concrete.

These studies will allow us to identify changes to the cement microstructure and physico-chemical properties arising from the PFA substitutes, and the chemical and physical interaction of the cements, especially with groundwater Such understanding is critical for the adoption of clinker alternatives in LLW encapsulation.