Proposta de Projeto de Doutoramento a Desenvolver no Âmbito do 1º Concurso para Atribuição de Bolsas de Investigação na Área de Engenharia Civil

1. Título do projeto

Título: High-performance geopolymer mortars made with local by-products

Palavras-chave: Geopolymeric mortars; Alkali-activated material; Environmental impact; Wastes

Referência: CEE_EC_FCTNOVA3

2. Instituições envolvidas

Instituição onde o doutoramento será realizado: FCTNOVA

Outras instituições participantes no projeto de investigação: Collaboration with other institutions will be established when the project starts. This project intends to make possible to broaden the knowledge of the scholarship holder, as well as his network of academic relationships (partnerships), being in contact with other researchers from the Department of Civil Engineering at FCT NOVA.

3. Equipa de Orientação

Orientador: Prof. Doutor Luís Gonçalo Correia Baltazar

4. Descrição do Projeto

In recent decades the increase of cement consumption in Portuguese-Speaking African Countries (PALOP) is notable, representing a great environmental problem. The production of Ordinary Portland Cement (OPC) needs a large energy consumption and releases a lot of greenhouse gases into the atmosphere during the extraction of OPC raw materials, production (calcination and production of clinker) and during the transport of the final product (Pacheco-Torgal et al., 2012). In addition, most PALOP import the clinker to produce OPC, which increases the cost and environmental impact of the final products. OPC is the most consumed raw material in the production of concrete structures, being the second most consumed material, behind only water that is a fundamental component for life (Provis et al, 2014; Bernal et al., 2016). Researches about new binder classes of materials have been made in order to produce a material able to replace the OPC in civil industry. Geopolymers (GP) or alkali-activated materials are a new class of binder materials able to resist several environments, like acid or freeze-thaw without losing its mechanical strength (Provis et al., 2009). This type of binder can be made using industrial materials like metakaolin or industrial wastes like blast furnace slag and fly ash (Temuujin et al., 2011; Baltazar et al., 2019). Another example of raw materials used to produce the geopolymeric binder are bottom ash (Gastaldini et al., 2007; Komnitsas et al., 2015), rejects from agriculture (rice ash and sugar cane bagasse) and municipal wastes and ceramic production waste (Puertas et al., 2008; Zheng et al., 2010). When the production the GP is made using industrial by-products of local origin, the final cost of the binder is lower, increasing its market acceptance.

The focus of this project is to compare and assess the potential of different local materials (by-products/wastes) rich in silica and alumina in the production of geopolymeric mortars. The alkaline solution concentration will be altered in order to observe how these different by-products form a geopolymeric structure in high and low concentrations (in different weight percentages) of alkali activators. The mechanical strength of these specimens will help to formulate an optimized composition of the mixture to obtain a material able to replace OPC in the

construction industry. The results will provide information on how the different starting materials and alkali concentrations produces matrixes with different properties. Different characterizations techniques to obtain information about the geopolymeric reactions and increase of mechanical strength of the mortars will be used:

- The main objective is to produce different samples of the geopolymer binder (mortars) using local by-products or wastes as raw material. Producing geopolymers mortars by alkaline activation using solutions with different Na_2O concentrations. This change of the sodium oxide will promote an alkaline environment that will increase or decrease the rate of geopolymer mortar production.
- Analyze the structure of the raw materials and the geopolymers using spectroscopic methods (FTIV) and X-ray diffraction (XRD). These analyses are very important to observe the geopolymerization progress.
- Study the influence of the Na_2O concentration on the mechanical strength and the morphological modification of different mortars produced. Evaluate the influence of curing time on the mechanical strength (increase or decrease).
- Make correlations between mechanical strength, microstructure and morphological changes with curing temperature in the first hours of cure. Study of water absorption, density and pore volume of the specimens of different based geopolymers mortars produced.

The coordinator of this project currently develops research in the field of geopolymer materials for the consolidation of old masonries and was the supervisor of several master's theses in the conservation of the built heritage, which falls within the subject of this project. By capitalizing the previous achievements and experience of the advisor, this project will contribute to the production of materials that have properties superior to those found in OPC, without the release of large amounts of CO_2 and the consumption of virgin raw materials as observed in the production of OPC.

5. Referências Bibliográficas

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