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Pozzolanic reactions of calcined clays: study to an improved utilization

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Global warming is largely attributed to gases emissions into the atmosphere, with the main emphasis on carbon dioxide (CO_2). The cement production industry contributes about 5% of global emissions [1], with the production of approximately 0.652 tCO_2 for one ton of cement [2]. The scientific community and industry have developed research work on the property and alternative binders production process, and there are numerous publications on the subject and extensive experience in the use of some of these products with recognized benefits for the quality of concrete. They are usually of high quality products, not always the most economic, not resulting in a systematic replacement of cement, but only an addition when you want to improve concrete performance in works with high quality requirement.

The use of pozzolanic additions in the composition of Portland cement or its partial substitution in concrete manufacture is quite widespread and well known the beneficial effects of these additions on mechanical strength and durability. However, the use of metakaolin as a pozzolan is not yet widely used due to the recent developments and the difficulty to achieve the appropriate characteristics for the required performance. The European regulations and standards available, although consider the pozzolanic additions, are mostly silent as to the inclusion of metakaolin in the concrete composition. The adoption of the standard NF P 18-513 “Métakaolin, addition pozzolanic pour Betons - Definitions, specification, critères of conformité”, can improve the European level regulating for the use of the product.

In Portugal are known problems of storing the by-products of sand production in alluvial deposits or granite quarries and some of these by-products include clay minerals with high percentage of kaolin, which is thought that have potential for use as a cementitious material. There are also in the country significant deposits of clay minerals that have not attracted the interest of ceramics and paper industry due to its physical and chemical composition. It was in this context that the challenge of studying a raw material that is able to enter the concrete composition to partially replace the traditional binder, easily accessible from the point of view of production, cheaper than current commercial metakaolin with better environmental performance than cement, not only for lower energy consumption and lower production of greenhouse gases, but also because in some cases, the use of industrial by-products of reasonable quality and availability is possible.

This study aims to investigate the relationship between clay raw materials from different geographical origins in Portugal (Cervães, Coja and Catraia dos Poços, Central Region) with the quality of the resulting product and the influence of this in the concrete strength thus contributing to the knowledge of the potential for using this type of pozzolanic material in partial replacement of Portland cement. The raw material was characterized before and after calcination. The product of calcination was used in partial replacement of Portland cement in the manufacture of concrete test pieces for determination of their influence on the mechanical strength of concrete. It was concluded that although some of the product quality evaluation results do not comply with the requirements of standard NF P18-513 and the raw materials used were made up of several clay minerals with different chemical composition, particle size and temperature required for calcination, it is possible to produce pozzolanic material quality which

allows the use in partial replacement of portland cement in concrete production, maintaining or improving its mechanical strength.

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