

Development of Green Cement, Based on Partial Replacement of Clinker with Limestone Powder

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Abstract : Over the past few years there has been a growing interest in the development of Portland Composite Cement, by partial replacement of the clinker with mineral additives. The motivations to reduce the clinker content are threefold: (1) Ecological - due to lower emission of CO₂ to the atmosphere; (2) Economical - due to cost reduction; and (3) Scientific\Technology - improvement of performances. Among the mineral additives being used and investigated, limestone is one of the most attractive, as it is considered natural, available, and with low cost. The goal of the research is to develop green cement, by partial replacement of the clinker with limestone powder while improving the performances of the cement paste. This work studied blended cements with three limestone powder particle diameters: smaller than, larger than, and similarly sized to the clinker particle. Blended cement with limestone consisting of one particle size distribution and limestone consisting of a combination of several particle sizes were studied and compared in terms of hydration rate, hydration degree, and water demand to achieve normal consistency. The performances of these systems were also compared with that of the original cement (without added limestone). It was found that the ability to replace an active material with an inert additive, while achieving improved performances, can be obtained by increasing the packing density of the cement-based particles. This may be achieved by replacing the clinker with limestone powders having a combination of several different particle size distributions. Mathematical and physical models were developed to simulate the setting history from initial to final setting time and to predict the packing density of blended cement with limestone having different sizes and various contents. Besides the effect of limestone, as inert additive, on the packing density of the blended cement, the influence of the limestone particle size on three different chemical reactions were studied; hydration of the cement, carbonation of the calcium hydroxide and the reactivity of the limestone with the hydration reaction products. The main results and developments will be presented.

Keywords : packing density, hydration degree, limestone, blended cement

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