EFFECTS OF LIMESTONE POWDER ON THE PROPERTIES OF CEMENT-BASED MATERIALS

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Question:
“Does the limestone powder act as just a filler in concrete or does it transform itself and also act as a chemical additive?”

Answer:
Limestone powder acts as a filler as well as a chemical additive in concrete.

Use of a type of blended cement, known as Portland L limestone cement, in Europe has been reported. This cement contains up to 35 % limestone powder, the rest being portland cement. As limestone powder is in effect a type of filler, the limestone cement can be said to have a filler content of up to 35 % [1].

“The performance of limestone filler addition to portland cement has been widely studied in pastes, mortars, and concretes [2]. In general, limestone filler improves the hydration rate of cement compounds and consequently increases the strength at early ages [3]. From a chemical point of view, limestone filler does not have pozzolanic properties, but it reacts with the alumina phases of cement to form an Afm phase (calcium monocarboaluminate hydrate) with no significant changes on the strength of blended cement” [4].
Hornain et al. [5] studied the diffusion of chloride ions in mortars as influenced by the use of limestone powder as a filler. All mixtures were prepared at a fixed water to cement (w/c) ratio of 0.55. Test results showed that the diffusion coefficient of chloride ions was reduced with the use of limestone filler [5].

Sawicz et al. [6] reported the influence of powdered limestone and water-cement ratio (w/c) on the durability of concrete immersed in a sulphate solution (5 % Na$_2$SO$_4$). Sulphate durability was estimated by means of a length change of concrete and X-ray diffraction analysis of pastes made with and without limestone powder. A beneficial influence of powdered limestone on the sulphate resistance of concrete was observed for w/c < 0.60. For w/c > 60, the powdered limestone showed almost no effect on sulphate resistance of concrete. Due to the addition of limestone powder, transformation of ettringite to monosulphate and hemi-sulphate was prevented. Instead, ettringite transformed to monocarbonate and hemicarbonate [6].

“The phase composition and pore structure of cement paste in concrete may be changed by use of aggregate. The presence of CO$_2$ in the pastes prevents the reaction of ettringite, formed in the course of the hydration stages, with C$_3$A to monosulfate at the end of the induction period. Instead the concentration of ettringite remains almost unchanged and the crystallisation of hemicarbonate, monocarbonate or both is observed. The limestone aggregates affect not only the permeability of concrete, but also the chemical structure of pastes in concrete [7]”. This is an important factor for the deterioration of concrete under sulphate attack [8].
References


