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Discussion

# A discussion of the paper "Influence of natural pozzolan, colemanite ore waste, bottom ash, and fly ash on the properties of Portland cement" by Ş. Targan, A. Olgun, Y. Erdogan, and V. Sevinc☆

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The authors have studied the effects of natural pozzolan, colemanite ore waste, bottom ash, and fly ash on the properties of Portland cement (PC). It is a very informative paper. I think, the chemical effects of pozzolanic materials on crystal formation and developing during the hydration should be clarified by the authors.

For the characterization of a cementitious/pozzolanic material as a binding agent for concrete, it is not sufficient to determine the bending and compressive strengths, setting time, and soundness. It is the physical properties, such as specific gravity, specific surface, grain size distribution, aggregate to cementitious/pozzolanic material ratio, fineness, water demand, and moisture content, that should be available. Moreover, for the introduction of a new material, it is advisable to inform its origin, microstructure by SEM analysis, and chemical and phase composition. The total heat evolved by the hydration of cement mix, and its pozzolanic activity, should be investigated.

Concrete setting is influenced by a number of variables such as source, properties, type, and amount of cement and cementitious/pozzolanic powder additives; water-to-cementitious materials ratio; temperature of the mixture; soluble alkalies; liquid admixtures; etc. Borogypsum (BG) in colemanite ore waste retards cement setting primarily because of the orthoboric acid impurity present, but setting time is not clearly related to the $B_2O_3$ content in BG.

The alkali contents of pozzolanic materials, especially in colemanite ore waste and natural pozzolan, are considerably higher than that of PC clinker (Table 1). Alkalies in PC clinker occur as sulfates and, depending on the amount of $SO_3$ available, may also be present in calcium silicate and aluminate phases. The introduction of alkalies into clinker mineral modifies their crystal structure, which, in turn, can change their hydraulic reactivity. Alkalies affect the clinkering process by modifying the physicochemical properties of the melt formed in the kiln and may have an adverse effect on the phase composition of clinker [1].

The addition of pozzolanic blending agents, each different in composition, introduces a great diversity into cement systems. The addition of pozzolan results in the transformation of large pores into fine pores, thereby causing pore refinement. It is most likely that the pore refinement occurs due to the conversion of the calcium hydroxide by the pozzolanic silica into calcium silicate hydrate (C-S-H) phase [2,3].

Any pozzolanic substance that interferes with crystal formation and interbonding is bound to influence the overall cohesive strength of the cement. Mechanical interlocking plays a significant role in chemical forces during crystal formation and developing [4].

Table 1
Physical and chemical characteristics of used materials

| Chemical analysis (wt.%) | Clinker | Natural zeolite | Fly ash |
|---|---|---|---|
| $SiO_2$ | 19.43 | 62.17 | 42.81 |
| $Al_2O_3$ | 5.78 | 9.76 | 23.03 |
| $Fe_2O_3$ | 3.69 | 2.02 | 5.33 |
| CaO | 63.34 | 1.43 | 21.60 |
| MgO | 0.66 | 0.75 | 1.81 |
| $SO_3$ | 0.74 | 0.07 | 3.39 |
| KK | 0.20 | 14.06 | 1.28 |
| $Na_2O$ | 0.29 | 0.46 | 0.34 |
| $K_2O$ | 0.68 | 3.72 | 1.38 |
| Free CaO | 1.44 | – | 3.17 |

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