

Optimization of Silica Fume, Fly Ash and Cement Mixes for High Performance Concrete

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KEYWORDS: equilibrium mineral assemblage, fly ash, lever rule, silica fume, ternary mix

ABSTRACT

High performance concrete often consists of ternary mixes of silica fume, fly ash or other pozzolans, and Portland cement. However, the specification of the proportions of these components remains uncertain. One objective could be to add just enough of the pozzolans to consume all the excess calcium hydroxide produced during the hydration of the Portland cement. In terms of the cement chemistry ternary phase diagram, this means finding the intersection between the tie line connecting the cement composition and the fly ash composition and the boundary line of the calcium hydroxide stability field. The boundary line can be found by assuming that the final equilibrium mineral assemblage is a mixture of C-S-H gel and calcium aluminate hydrates. In order to determine the tie line it is necessary to know the composition of the fly ash and also of the Portland cement. Since not all of the fly ash is reactive, and the kinetics of the reactions proceed at a finite rate, it may be necessary to adjust the length of the lever arm based on a detailed analysis of the fly ash composition and measurement of its pozzolanicity. This approach to mix optimization can also include the water/cement ratio, in which case the phase diagram becomes a tetrahedron with the additional constraint of a plane defining the self-desiccation limit.

Submitted for consideration in the 2005 World of Coal Ash, April 11-15, 2005, Lexington, Kentucky, USA.