Properties of Structural-Grade Foamed Concrete Using Low-Lime Fly Ash as a Cement and Filler

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ABSTRACT

Foamed concrete has a number of advantageous properties, ie., very low density (800 to 1600kg/m ^{3} /50 to 100lb/ft ^{3}), high workability, and excellent thermal insulation, which make it an attractive material for construction. However, the key problem inhibiting its use in structural applications is the difficultly of designing mixes to achieve the minimum grade requirement of around 25 MPa (3600psi). It will be shown that by partially substituting Portland cement (Type I) with fine (<7.2% ret 45:m) low-lime fly ash and replacing 50 to 100% of the fine aggregate with coarse (26.0% ret 45:m) low-lime fly ash, structural grade foamed concrete is readily achievable at densities of around 1200kg/m ^{3} (75lb/ft ^{3}).

This paper will describe the main rheological characteristics (yield stress and plastic viscosity), key engineering properties(E-value and drying shrinkage) and durability performance (permeation, frost attack and carbonation). It will be demonstrated that large core/surface temperature differentials could be developed in foamed concrete structural sections. This is due to its highly insulating nature, which retains thermal energy created by heat of hydration and high internal temperatures over a considerable period after casting. There are obvious risks of thermal cracking and delayed ettringite formation. The adoption of fly ash technology will be shown to be an effective method to ameliorate this problem. The effect of density on thermal conductivity (8) and the consonant advantages of using fly ash will be established.

The results of full-scale pilot tests on reinforced, foamed fly ash concrete beams, tested in flexure to the full elasto-plastic limits, will also be described. In addition, a simple mix constituent proportioning method for foamed fly ash concrete will be provided.