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Effectiveness of fly ash in reducing the hydration heat release of mass concrete

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Abstract

The use of fly ash for temperature reduction in mass concrete has been widely reported over the past decades for low strength concretes. However, based on the literature reports, there seems to be a temperature limit above which fly ash reactivity is significantly increased, and it is no longer efficient in reducing the heat release of mass concrete. The current work investigated the effectiveness of fly ash in reducing the adiabatic temperature rise of concretes produced with a wide range of binder contents (from less than 200 to over 600 kg per m³ of concrete) and cement replacement levels by fly ash (from 0 to 45%). The temperature of the concretes was monitored by adiabatic calorimetry for 72 hours. Furthermore, the compressive strength of specimens cured both in standard regime (23°C) and in adiabatic condition were determined at 28 days. The results showed that the increase in FA content progressively decreased the temperature rise for concretes with binder contents up to 250 kg/m³ and temperature peaks up to 56°C. In contrast, for concretes with higher binder contents, which reached temperature peaks over 60°C, the temperature rise/kg of binder ratios were similar, regardless the strength class and FA content. Furthermore, the specimens cured in the adiabatic regime showed 28-day compressive strength about 10% lower than those cured under standard condition. Finally, a thermal efficiency index was proposed, given by the ratio between the temperature rise of the concrete and its adiabatic compressive strength (°C/MPa). The FA content that led to the best °C/MPa index reduced as the concrete strength increased, from 45% for 20 MPa to 15% for 35-55 MPa.

Keywords: Mass concrete; adiabatic calorimetry; temperature rise; fly ash.

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