

Development of High Fly Ash Content Cements for Use in Concrete Construction

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ABSTRACT

Recent developments in cement manufacture have seen the use of various fluxes and mineralisers to facilitate clinkering/formation of cement minerals at reduced temperatures. Potential advantages associated with the production of these include, reduced fuel consumption, lower Nox emissions and longer kiln life. It has been possible following this approach and mineralising with a combination of fluorine and sulfate to produce high early strength clinkers (HESC).

These materials, because of their enhanced hydraulic activity, could be used in combination with by-product materials, including fly ash, to match normal Portland cement (NPC) concrete performance. Indeed, with the fast reacting properties of these HESCs, there may be potential for combining them with relatively high levels of low lime fly ash, beyond the 30%, which is commonly used in the UK. This typical NPC/fly ash combination, for structural concrete, has grown up around difficulties in achieving early strengths at higher fly ash levels, which in extending periods that formwork is required to support recently cast concrete, can have significant cost implications.

The paper will describe the work of a study carried out to develop HESC/fly ash cements for use in concrete construction. The initial phase of the study physically and chemically characterised several HESCs and fly ashes and examined their reactivity in pastes, when combined at different levels. Tests were carried out with the materials in mortar, to the European cement testing standard, BS EN 196, to establish suitable HESC/fly ash combinations to fit within the cement strength classes of BS EN 197. Preliminary tests were also made to examine the impact of these combinations on the early strength of concrete, compared to that containing NPC.

Thereafter, having identified suitable HESC/fly ash combinations, the study progressed to examine the impact of these materials (with up to 45% fly ash) on the full range of fresh, engineering, permeation and durability properties of concrete, compared to NPC and other rapid hardening Portland cement/fly ash combination concretes. Issues including the importance of curing of concrete on performance were also considered. The practical implications of the work will be explored and it will be demonstrated that with the high fly ash levels that may be used in combination with HESC, performance enhancements and environmental and economic benefits are achievable.