

Production of Cement-Free Construction Materials via Fly Ash Carbonation

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Abstract : The production of ordinary Portland cement (OPC) is a CO₂ intensive process. Specifically, cement clinkering reactions require not only substantial energy in the form of heat, but also result in the release of CO₂, from limestone decarbonation and the combustion of fuel. To overcome this CO₂ intensive process, clinkering-free cementation is demonstrated by the carbonation of fly ash; i.e., a by-product of coal combustion. It is shown that in moist environments and at sub-boiling temperatures, calcium-rich fly ashes readily react with gas-phase CO₂ to provide cementation. After seven days of CO₂ exposure at 75°C, such formulations achieve a compressive strength on the order of 35 MPa and take-up 9% CO₂ (by mass of the solid). On the other hand, calcium-deficient fly ashes, due to their lack of alkalinity (i.e., abundance of mobile Ca or Mg), show little if any potential for CO₂ uptake and strength gain. The role of the CO₂ concentration and processing temperature are discussed and linked to the progress of reactions, and the development of microstructure. The outcomes demonstrate a means for enabling clinkering-free cementation while enabling beneficial utilization of CO₂ and fly ash; i.e., two abundant but underutilized industrial by-products.

Keywords : fly ash, carbonation, concrete, strength

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