Particle Enhancements for Greener Stronger Cement

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Concrete, a major construction material, is the second most “consumed” substance (behind water) in the world. The manufacturing of Portland cement, concrete’s key ingredient, produces 7% of global carbon dioxide emissions. In order to gain a more environmentally friendly and potentially cheaper cement, the researcher sought to replace large quantities of Portland cement with fly ash, a byproduct of burning coal, in order to create an equally strong, but more environmentally friendly cement blend. Using ratios to maintain the same volume and density, four mixtures were created (50/50, 65/35, 85/15 and 100/0) using different proportions of cement to fly ash. After a certain number of days of curing, compressive strength tests were performed. The 100% Portland cement yielded the highest compressive strength, but all the fly ash slurries were more environmentally friendly due to the decreased amounts of Portland cement. Next, admixtures (selected from various materials with varying particle sizes) were added to the fly ash blends to enhance the cement’s compressive strength and lower its permeability. In determining an optimal mixture that increased strength while using more industrial byproduct, fly ash, admixtures were mixed with the 65/35 blend which was chosen because a large amount of Portland cement was displaced by the fly ash. One admixture tested produced a geopolymer bond with superior compressive strength, demonstrating a 20% strength increase over 100% Portland cement. This admixture also demonstrated a significant reduction in water needed to create the slurry. As a result of these tests, a novel formulation of an ideal cement blend that is stronger, more environmentally friendly, longer lasting, uses less water, and uses industrial byproduct was discovered.

Awards Won: