A Greener Shade of Grey: The Effects of a Novel Water-Reducing Geopolymer on SO3 in Non-Standard Coal Combustion Residues

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Concrete is the most used construction material in the world. Unfortunately, Portland cement, a major ingredient in concrete, has a massive carbon footprint. Coal combustion residues, or CCRs, have very similar chemical compositions compared to Portland cement. Fly ashes, a kind of CCR, have already been used to partially replace Portland cement in concrete. Other CCRs, especially bed ash, have too high a sulfite (SO3) content to be used. Normally, the hydration reaction of concrete produces ettringite, a hexicalcium aluminate trisulfite hydrate, which quickly decomposes into calcium aluminate monosulfite, but a higher than 5% sulfite content inhibits this decomposition reaction. The ettringite reaction also produces a great deal of water, which causes the concrete to swell and become brittle. The researchers sought to control the volume of concrete made with high sulfite bed ash-based concrete in this year's research. They treated concrete made with Nisco and Rodemacher bed ash with an experimental geopolymer functioning as a water-reducing admixture. The control mixtures were concrete made with traditional Portland cement and class F and class C fly ash. Samples cured in either 50% or 100% humidity. Compressive strength was measured at 7 and 28 days and volume was measured at 7, 14, 21, 28, 35, 42, 56, and 90 days. Although the compressive strengths of the experimental mixtures were less than that of the control, the volumes of the experimental mixtures were very similar. The researchers suggest using a water-reducing admixture to control the volume of concrete made with high-sulfite CCRs.