A Novel Approach to Sustainable Concrete Engineering: Mechanochemical Activation of Local Waste Materials for CO2 Reduction

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As the second most used material globally, concrete is responsible for 8% of man-made CO2 emissions. The first generation pathway of emissions is from the process needed to create concrete: thermal activation which is extremely energy intensive. To combat this, mechanochemical activation (MCA) was used as a more sustainable alternative in this investigation. The second generation pathway is the breakdown of limestone into carbon dioxide. This experiment looked to use locally sourced waste materials: dredged sediments, and solid waste incineration ash as supplementary materials for traditional PLC. In addition, It was hypothesized that MCA could activate the aforementioned materials and result in increased strength and decreased CO2 production. Isothermal calorimetry revealed the reactivity of dredged sediments and incineration ashes, with heat releases of 290J compared to 258J for pure concrete. Slump flow analysis revealed that mechanochemical activation improved the consistency and workability of the concrete, with the combination of dredged sediments and incineration ashes reaching an optimal fluidity of 90%. 1, 7, and 28 day durability tests demonstrated the increased load capacity of the novel mortar of 24,000kPa in comparison to the control with 14,000kPa. The novel activated material also had increased resistivity (131.3 ohm.meter), showing their potential for increased corrosion resistance. Thermogravimetric analysis indicated the carbon sequestration potential, with activated specimens being able to uptake 15-17.5% of their weight in CO2. In accordance with these initial tests, mechanochemical activation could be used as a sustainable method to activate commonly found waste materials in Florida.

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