Repurposing Recycled Materials for Greener, Stronger Cement

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Concrete is the most widely used construction material on the planet. The production of Portland cement, concrete's major component, contributes 8% of the world's human induced carbon dioxide emissions. Another urgent environmental issue is plastics and other polymer products (that take years to biodegrade) that are disposed into landfills or as litter, which pollutes land and marine environments. The purpose of this research was to incorporate recycled polymer materials as well as fly ash, waste that results after burning coal, into cement to increase its compressive strength and create a cement that provides multiple benefits to the environment compared to 100% Portland cement. Cement mixtures, using a blend of 65% Portland cement/35% fly ash (PC/FA), were created using recycled materials, including polyethylene terephthalate (PET), rubber, polystyrene, Nylon 66, and carpet fibers. These mixtures were tested for compressive strength at three, fourteen, and twenty-one days of curing. All samples were mixed to have the same volume and density. In the initial phase of testing, none of the recycled materials performed better than the 65/35 PC/FA control. By using gamma radiation, PET and rubber were irradiated and added to the slurries. The irradiated PET (I-PET) cement mixture containing 15% I-PET provided a 33% increase in compressive strength compared to the control. Irradiation enhanced the crystalline structure of the PET allowing for increased bonds within the cement matrix. A novel cement was created that is stronger, less permeable and reduces plastic waste and carbon dioxide emissions while conserving land and water resources.

Awards Won: