Enhancing Concrete Microstructure: A Comparative Study of Biological and Synthetic Hydrogel Additives

Tophoj, Michael (School: Ogallala High School)

Concrete has historically been an integral part of human infrastructure, but the methods and recipes for making this material are varied. One family of materials proposed for concrete synthesis is hydrogels. This study aims to investigate the effect of select biological and synthetic hydrogels on the formation of concrete. The hypothesis is that a mixture of biological and synthetic hydrogels will have the greatest effect. Nine different mixtures, incorporating chitosan, chia powder, polyethylene glycol (PEG), and sodium polyacrylate (PAC), were prepared, each combined with concrete in a fixed ratio. After curing, the resulting samples were broken, dyed, and analyzed for formation using a zoomed camera to measure relative pore count. Additionally, the hydration process was analyzed by monitoring the weight of the samples over a 7-day period to assess water retention. Preliminary studies suggest that hydrogels, particularly the biological types, influence the size and morphology of cementitious structures, with larger crystals forming preferentially around the biological hydrogel domains. These results support the hypothesis that hydrogels can enhance concrete's curing process by improving hydration and modifying the porosity, potentially leading to more durable concrete. The combination of biological and synthetic hydrogels appears to have superior performance compared to single-hydrogel treatments. This research contributes to the growing field of improving building materials with sustainable additives, which could offer a pathway towards more durable and environmentally friendly infrastructure solutions.

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