

Abstract

Ultra High performance concrete (UHPC) is commonly used for repair and rehabilitation projects where high early strength is needed, such as bridge deck maintenance and emergency pavement repairs. One challenge of conventional UHPC made with ordinary Portland cement (OPC) is its slow early age strength development caused by the high water-to-binder ratio. This research studied the use of Calcium Sulfoaluminate (CSA) cement as a partial replacement for OPC at 25% and 50% to improve early performance. Complete replacement was not applied to avoid problems related to shrinkage, long term stability, and compatibility with silica fume. All mixes used the same water-to-binder ratio of 0.23 together with a polycarboxylate superplasticizer, synthetic C-S-H accelerator, and sodium gluconate retarder. Workability and setting behavior were evaluated using slump flow and setting time tests, while compressive strength was measured at 3 hours. The results showed that adding CSA reduced slump flow, but all mixtures still met the SF1 classification. At the same time, CSA significantly accelerated the setting process. The control mix required about 2 hours for initial setting, while mixes with 25% and 50% CSA set much faster. Early compressive strength also increased considerably. The OPC control mixture reached only 1.3 MPa after 3 hours, while the 25% and 50% CSA mixtures achieved 16.6 MPa and 23.2 MPa, respectively. The 25% CSA mixture showed the most balanced performance because it provided high early strength while still allowing enough working time during placement. Overall, the study indicates that CSA-blended UHPC can be a promising material for rapid repair and rehabilitation projects.

Keywords: UHPC; CSA cement; early strength; structural repair; ettringite; setting time.