Influence of Hot Water Curing on the Mechanical Properties of Ultra-High-Performance Concrete (UHPC) Incorporating Alumina Powder

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Abstract

Ultra-high-performance concrete (UHPC) is increasingly valued for its superior mechanical performance and fine aggregate composition, making it ideal for modern infrastructure applications where strength and durability are paramount. However, achieving high early strength in UHPC remains a significant challenge, limiting its broader application. This study examines the effects of adding alumina powder and using hot water curing on the mechanical characteristics of UHPC. The study investigates the effects of incorporating 14% alumina micron powder with a specific curing regime. After casting, the specimens are cured at room temperature for 24 h, and subjected to hot water curing at 60 and 90 °C for 3 days before transitioning to conventional curing. The results indicate substantial improvements in the uniformity, compressive, and bending strength as

compared to traditional UHPC. The consistency test demonstrated that the mixture with the incorporation of alumina became more condensed, as indicated by a decrease in Vicat needle penetration. The compressive strength tests demonstrated that the alumina-enhanced UHPC, which was cured at a temperature of 90 °C for 3 days, had the maximum initial strength. Specifically, it reached a value of 176.78 MPa after 7 days and 155.45 MPa after 28 days. The flexural strength of UHPC was also enhanced, with the highest values seen in UHPC cured at 90 °C after 7 and 28 days. The scanning electron microscopy (SEM) study revealed that the alumina-enhanced ultra-high-performance concrete (UHPC) exhibited a more compact microstructure with a reduced number of pores, especially when subjected to higher curing temperatures. The results indicate that the utilisation of alumina powder and hot water curing greatly enhances the performance and durability of UHPC, making it a highly viable solution for critical infrastructure applications.

Author keywords

Alumina; Compressive strength; Concrete; Early strength; Flexural strength; Hot water curing; Microparticles; UHPC

Indexed keywords

Engineering controlled terms

Aluminum oxide; Concrete aggregates; Critical infrastructures; Curing; Durability; Powders; Public works; Scanning electron microscopy; Sustainable development; Ultra-high performance concrete; Water

Engineering uncontrolled terms

Alumina powder; Early strength; High-performance concrete; Hot water; Hot water curing; Infrastructure applications; Mechanical; Micro particles; Property; Ultra high performance

Engineering main heading

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