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Durability of ultra-high performance concrete in tension under cold weather conditions

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Abstract

Freezing and thawing resistance is a key characteristic for concrete materials in cold weather conditions. In this study, the tensile properties and elastic modulus of ultra-high performance concrete (UHPC) under accelerated freeze-thaw cycles are characterized. Six series of UHPC specimens are experimentally tested with a well-designed direct tension test (DTT) method to capture complete tensile stress-strain responses. Both the dynamic and wave moduli of elasticity of UHPC are measured at specific cycles using the standard impact test and self-designed "smart aggregate" technology, respectively. Long term freezing and thawing cyclic conditioning of UHPC samples results in reductions of elastic modulus, tensile strength, strain capacity, and energy absorption capacity. The tensile stress-strain curves of UHPC demonstrate distinct descending with increasing freeze-thaw cycles, particularly in the strain softening region. The energy-based approach is found to be more sensitive and effective than the elastic modulus-based approach when evaluating material deterioration over time and capturing accumulative material degradation subjected to rapidly-repeated freezing and thawing actions. As from the test results, UHPC is characterized as a very durable cementitious material, but it is not inherently unconquerable. Extended freezing and thawing actions can still lead to deterioration of the material, with respect to its elastic modulus, tensile strength, energy absorption capacity, etc. As

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