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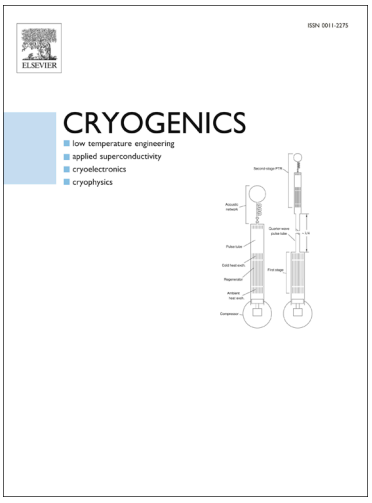

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Effect of cryogenic temperature on the flexural and cracking behaviors of ultra-high-performance fiber-reinforced concrete

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ABSTRACT

This study investigates the flexural and cracking behaviors of ultra-high-performance fiber-reinforced concrete (UHPFRC) before and after exposure to cryogenic temperatures for liquefied natural gas (LNG) storage tank applications. Normal concrete (NC), which has been used to make LNG storage tanks in Korea, was also considered for comparison. In order to evaluate the cracking resistance of NC and UHPFRC, several edge-type slabs were fabricated and tested by restraining their thermal deformation. Four-point bending tests were also performed to estimate the flexural performance before and after cryogenic cooling. Test results indicate that UHPFRC exhibited higher resistance to microcrack formation under these conditions. UHPFRC also showed substantially better flexural performance, both before and after exposure to cryogenic cooling, compared to NC. In addition, the microcracks in UHPFRC that were induced by the pre-cracking load were suddenly and effectively filled with calcium carbonate ($CaCO_3$), which was formed by a chemical reaction between melting water and calcium ions. This was verified by energy dispersive X-ray spectroscopy analysis. $CaCO_3$ formation resulted in enhanced flexural performance, including higher strength, deflection capacity, and energy absorption capacity, as compared to the virgin UHPFRC specimens without any cracks.

Keywords: *Ultra-high-performance fiber-reinforced concrete; Cryogenic cooling; Flexural performance; Crack resistance; Self-healing*

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1. Introduction

Concrete has been used widely as a construction material around the world. In order to improve the