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Study on freeze-thaw resistance with NaCl of desert sand engineering cement composites

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Highlights

- High performance engineered cementitious composite using desert sand (DSECC) is developed.
- Two desert sands were collected from the Tengger Desert and Mu Us Desert in China.
- 3% NaCl solution on the top surface was tested by one-sided freeze-thaw cycles.
- The salt-freezing resistance performance of DSECC using T has slightly better than that using M.

Abstract

To test the salt-freezing resistance performance of desert sand engineering cement composite (DSECC) prepared by different types of desert sand, the specimens with 3% NaCl solution on the top surface after 56 days of curing were tested by one-sided freeze-thaw cycles (FTC) and compression test after freezing and thawing. Two desert sands were collected

Tengger Desert and Mu Us Desert in China, denoted T and M. The appearance, water absorption rate, mass loss rate, relative dynamic elastic modulus and longitudinal ultrasonic speed of the DSECC were tested after 0, 4, 8, 12, 16, 20, 24 and 28 cycles of freeze-thaw. Compressive strength was tasted after 8, 16, 24, and 32 cycles of freeze-thaw. Results show that FTC can accelerate the damage of the appearance. Meanwhile, the water absorption rate increases, the relative dynamic elastic modulus, the longitudinal ultrasonic wave speed, and the compressive strength decreases. Under the same FTC, the salt-freezing resistance performance of DSECC using T has slightly better than that using M.

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Keywords

Desert sand; Engineering cement composites; Freeze-thaw resistance; NaCl

1. Introduction

Engineering cement composite (ECC) is a high-performance concrete with high durability, high sustainability, typical moderate tensile strength and a higher ductility are 4–6 MPa and 3–5% (300–500 times that of concrete) (Li, 2003; Ma et al., 2015). Examples of applications of ECC in transportation, building, and water infrastructures can be found in reference (Li, 2003, 2019; Li et al., 1993; Zhang et al., 2017). ECC is a mixture that contains of cement, water, fly ash, fine sand, randomly distributed ultrafine microfiber and chemical additive. The type, size and amount of fiber and matrix ingredients, along with interface characteristics are tailored for multiple cracking and controlled crack width (Li and Leung, 1992). Through the micro-mechanism analysis of ECC, we found that the performance of ECC material is more severely affected by the content and size of the fine aggregate, and that the high-content and large-size of fine aggregate can increase the fracture toughness of the matrix while reducing the interface friction (Sahmaran et al., 2009; Li et al., 1995). Therefore, fine aggregate type and grain size seriously affect the achievement of target ductility. To achieve the target ductility, most of the reported that expensive microsilica sand which have the feature of maximum particle size of 200 μm have used in polyvinyl alcohol engineered cementitious composite (PVA-ECC) (Li et al., 2001).

In order to reduce the cost of ECC, the method of replacing microsilica sand with coarser river sand is considered by some scholars (Sahmaran et al., 2009; Deng et al., 2018; Guan et al., 2019). Due to the shortage of river sand resources and the long distance transportation to increase the project cost, people in recent years had to turn their attention more to desert sand. Desert sand has a small particle size and a smooth round surface. It is distributed throughout the world, such as Arabia and Australia. And it is also widely distributed in northwest China, such as Ningxia Hui Autonomous Region, Xinjiang Uygur A