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Effect of desert sand on the uniaxial compressive properties of mortar after elevated temperature

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ABSTRACT

In China, medium sand is widely used for engineering applications. However, over quarrying of medium sand to meet the demand for urbanization has led to the environmental issue. The arid area of Northwest China, which has high concentration of desert could provide sufficient supply of desert sand for engineering applications. In this paper, desert sand was used to replace medium sand to produce desert sand mortar (DSM). The uniaxial compression test was performed on the DSM undergoing elevated temperature treatment, and the stress-strain curves of the DSM after different temperatures were obtained. The effects of temperature and desert sand replacement rate (DSR) on the peak stress, peak strain, elastic modulus, Poisson's ratio, and mass loss rate of DSM was analysed. The test results showed that with the increase of DSR, the peak stress and elastic modulus of DSM first increased and then decreased. As the temperature increased, the Poisson's ratio of the DSM decreased first and then increased. Based on regression analysis, the relationships between peak stress, peak strain, elastic modulus, Poisson's ratio of DSM, temperature, and DSR were obtained. At the same time, a one-parameter compression constitutive equation of DSM after the elevated temperature was established. Since the equation has only one parameter, the calculation process was greatly simplified based on ensuring the calculation results. The model was in high agreement with the test results. This equation can provide a reference for further studies in the field of mechanical properties of DSM and desert sand concrete (DSC) after elevated temperatures.

1. Introduction

Article II. Sand is one of the most consumed natural resources which is essential for the preparation of concrete.

Article III. By mixing suitable amount of sand, concrete can achieve the optimal mix ratio with only small amount of cement. About 50 billion tons of fine aggregates are used every year, which is more than enough to blanket the entire UK (BBC NEWS). However, the high demand of sand due to development has cause scarcity of sand forcing some countries to import sand from other countries. In the current research trend focuses on using industrial byproduct such as copper slag (Chithra et al., 2016; Vijayaraghavan et al., 2017), blast furnace slag (Aliabdo et al., 2019; Shen et al., 2019), fly ash (Tuinukuafe et al., 2019; Singh et al., 2019) to replace sand. China has wide desert area of approximately 1.28 million square kilometers with 80% of the desert are concentrated in the arid zone of northwest China. Therefore, from the perspective of ecology and cost, it is more beneficial to use desert sand to produce concrete. Over the year, many studies have been conducted on desert sand. However, those researches only study on the effect of DSR (Zhang et al., 2019; Che et al., 2019), water to cement ration (Yan et al., 2019; Liu et al., 2017a), cement to sand ratio (Benabed et al., 2014), high strength DSC (Yang et al., 2014, 2015), dynamic mechanical properties of DSC (Liu et al., 2017b) and etc. Luo (Luo et al., 2013) and Al-Harthy (Al-Harthy et al., 2007) still discussed the effects of dune sand on the mechanical properties of concrete. Very minimum studies have been conducted on DSC from the perspective of elevated temperature.

At present, building fires have become one of the most common and easily-caused disasters. The statistics of building fires in China, as shown in Table 1.

Building fire accelerates the concrete deterioration through water-fire coupling effort which reduces the carrying capacity of a structure. In this regard, some researchers (Ren et al., 2015; Gupta et al., 2017) compared the strength of concrete with natural cooling and water cooling. Due to different cooling methods, the result indicated that the peak stress after natural cooling is better than the water cooling. Liu (Liu and Liu, 2018) conducted both microscopic analysis on specimens with

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