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Research on basic mechanical properties of different modulus alkaline excited ECC

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ABSTRACT

The effect of the alkali activator modulus on the mechanical properties and microstructure of two types of fiber-reinforced engineering cementitious composites (alkali-excited ECC) with desert sand as fine aggregate was studied. The alkali activator was prepared by a certain proportion of NaOH and sodium silicate mixture, and the mechanical performance indexes were used for analysis, including compressive/tensile/flexural strength, Poisson's ratio and elastic modulus, flexural toughness ratio and energy performance index (*PSH*). The results showed that the appropriate alkali activator modulus was conducive to improving ECC mechanical performance. The indexes of the high water-to-binder ratio alkali-excited ECC and the low water-to-binder ratio alkali-excited ECC were the best when the alkali activator modulus of 1.5 and 2, respectively. Under the same modulus of alkali-activator, the compressive and flexural strengths of two types of alkali-excited ECC specimens increased with age, and *PSH* of low water-to-binder ratio alkali-excited ECC specimens increased with age. SEM results showed that after the action of alkali activator, the substrate surface of alkali-excited ECC was attached with colloidal substances. Combined with EDS and XRD hydration analysis, the hydration products were mainly C–S–H, C-A-H and Ettringite.

1. Introduction

Alkali-activated cementitious material is a new type of inorganic non-metallic cementitious material prepared by exciting raw materials such as fly ash and slag with an activator (Pangdaeng et al., 2014; Provis and Bernal, 2014; Sanchindapong et al., 2020). At present, alkali-activated cementitious materials have generally been considered as ecological materials for reuse of waste materials. By replacing cement with fly ash, solid waste can be used to conserve resources and reduce carbon emissions compared to conventional concrete (Ng et al., 2018; Yuan et al., 2020). In recent years, fly ash has been widely used to generate geopolymers because of its ease of use, low cost, and participation in the formation of aluminosilicates (Nath et al., 2017; Kan et al., 2020). Also, alkali-activated cementitious materials are considered to replace ordinary Portland cement-made concrete (Wang et al., 2017; Mohamed, 2019). Therefore, the study of alkali-activated cementitious materials is conducive to reducing carbon emissions, and is conducive to the rational utilization of industrial waste fly ash in Ningxia, which has certain economic and social benefits.

Alkali-excited ECC is a new type of composite material prepared by adding an alkali activator to ECC. The alkali activator is usually configured with NaOH and sodium silicate in a certain proportion (Yehualaw et al., 2021; Bocullo et al., 2019). At present, more and more scholars have started to study alkali-excited ECC (Koenig et al., 2019; Shah et al., 2020; Kan et al., 2020; Zhang et al., 2021). In recent years, the shortage of river sand resources, the state's restrictions on river sand development, and the increase in transportation costs have limited the wide application of river sand. The use of desert sand instead of river sand to prepare ECC is in line with the concept of green and sustainable development, and this method can lay the foundation for the application of ECC. At present, the global desert area has accounted for 20% of the total land area. The global deserts are mainly concentrated in 13 regions, and the northwest region of China is the concentrated area of deserts. There are Tengger Desert, Ulan Buh Desert and Mu Us Desert around Ningxia, which can make full use of the local desert sand, which is of great significance to reduce costs, reduce carbon emissions and slow down desertification. Therefore, our group studied ECC with desert sand as fine aggregate (Che et al., 2019; An et al., 2020; Yang et al., 2021).

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