Graphene nanoplatelet-fly ash based geopolymer composites

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1. Introduction

Geopolymers are currently being considered as a replacement of ordinary Portland cement and have drawn considerable attention for their cost efficiency, chemical stability, corrosion resistance, high strength gain, low rate of shrinkage and freeze and thaw resistance [1–3]. However, because of their ceramic-like characteristics, geopolymers show a quasi-brittle behavior similar to OPC; therefore, low flexural strengths and catastrophic failure during service usually affect the extensive microstructure and mechanical properties of a fly ash based geopolymer. The GNPs are relatively homogeneously distributed in the matrix of all composites. However, overlapping and agglomerate formation of GNPs was detected by FESEM. The results showed that the compressive strength of the geopolymer improved by 1.44 and 2.16 times, respectively, when adding 1% GNPs. The introduction of a GNP filler, even at low filler weight fractions, increased the toughness, stress and strain at the first crack and rigidity. Moreover, the wetting efficiency and entanglement because of the increased thickness of up to approximately 100 nm [19]. By contrast to graphene oxide (GO), graphene nanoplatelets (GNPs) have emerged as a competitive, alternative material for graphene because thermal annealing or chemical treatment can eliminate functional groups on GO to produce GNPs [19,20]. Furthermore, in comparison with carbon nanotubes (CNTs) for which only one side of the atomic lattice contacts the matrix and the other side of the lattice faces into the center of the tube, both faces of graphene contact the matrix. Consequently, graphene provides a stronger contact with binders [21]. Because of the

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ABSTRACT

Geopolymers show high quasi-brittle behavior because of their ceramic-like characteristics. Recent findings have indicated that graphene can be used as an additive to improve the mechanical properties of composites. In this study, we report the effect of the addition of graphene nanoplatelets (GNPs) on the microstructure and mechanical properties of a fly ash based geopolymer. The GNPs are relatively homogeneously distributed in the matrix of all composites. However, overlapping and agglomerate formation of GNPs was detected by FESEM. The results showed that the compressive and flexural strength of the geopolymer improved by 1.44 and 2.16 times, respectively, when adding 1% GNPs. The introduction of a GNP filler, even at low filler weight fractions, increased the toughness, stress and strain at the first crack and rigidity. Moreover, the wetting efficiency decreased with an increase in GNP content.