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Effects of graphene oxide aggregates on hydration degree, sorptivity, and tensile splitting strength of cement paste

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Abstract

It has recently been found the graphene oxide (GO) aggregates form in cement paste due to the chemical cross-linking of calcium cations. Therefore, the effects of GO addition on the properties of cement based materials should be dependent on the properties of GO aggregates rather than GO nanosheets. In this study, GO aggregates were first characterized by particle size measurement. Then, the effects of GO aggregates on the degree of hydration, sorptivity, and tensile strength of cement paste were investigated. The aspect ratio of GO aggregates is much larger than that of the original GO nanosheets. Compared to plain cement paste, the increase of non-evaporable water content of the cement paste was found to be very limited, around 1.17% and 3.90% for cement pastes containing 0.02% and 0.04% by weight GO, respectively. The sorptivity of cement paste, especially the secondary sorptivity, was notably reduced for GO incorporated cement paste. The tensile strength was significantly improved by GO aggregates. Incorporation of 0.04% by weight GO increased the tensile strength by 67% compared to that of plain cement paste.

Keywords: Graphene oxide, Aggregates, Cement paste, Hydration, Sorptivity, Tensile strength

1. Introduction

GO nanosheet is an atomically thin layer of graphite with the hydroxyl and epoxide groups mainly on the basal planes, and carboxylic acid groups at the edges [1]. Due to the presence of the hydrophilic functional groups, GO nanosheets can form stable suspension in water, which is favorable for GO to be incorporated in cement based materials. In addition, GO has much better mechanical properties compared to cementitious materials. The tensile strength and elastic modulus of multiple-layer GO are around 130 MPa and 32 GPa, depending on water content and thickness of the samples [2]. However, monolayer GO was found to have an effective Young's modulus of 207.6±23.4 GPa [3], which is much higher than that of multiple-layer GO. Theoretically, an elastic modulus of ~670 GPa and tensile strength of 63 GPa were obtained by using Monte Carlo method [4]. Most importantly, large-scale synthetic production of GO is feasible by