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Enhancement of ductility characteristics of fiber-reinforced ternary geopolymer mortar

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ABSTRACT

There is a need for ambient-cured geopolymer as a potential replacement for conventional ordinary Portland cement (OPC) based concrete. But geopolymers, that belong to the ceramic family, behave in a brittle manner and hence this research focusses on the enhancement of ductility using fibers. Thus, this experimental work was conducted to investigate the performance of polypropylene (PP) and micro steel fiber (MS) of fiber-reinforced geopolymer mortar (FRGM) on the hardened properties. The volume fractions of fiber used were 0%, 0.5%, 1%, and 1.5%. The ternary blended geopolymer mortar consisted of fly ash (FA), ground granular blast furnace slag (GGBS), and palm oil fuel ash (POFA). The hardened properties investigated are compressive strength, splitting tensile strength, modulus of elasticity (MoE), and ultrasonic pulse velocity (UPV). Furthermore, the load-deflection response was investigated in terms of deflection, load, flexural, and toughening mechanisms. The morphology of matrix mortar with the bonding of the fibers was examined through field emission scanning electron microscope (FESEM). The results revealed that the splitting tensile strength was enhanced with the inclusion of 0.5% of PP fibers and up to 1.5% of MS fibers by 27% and 177%, respectively. The enhancements in the ultimate flexural strength with 1.5% fiber were found 173% and 33% higher for MS and PP fibers, respectively compared to the control mixes. The inclusion of both MS and PP fibers showed a significant enhancement in the post-cracking flexural and toughness energy measured at L/150 mm. Furthermore, the addition of fiber volume of 0.5–1.5% enhanced the toughness by 33% (T_{600}), 62% (T_{150}), and 28% (T_{600}), 46% (T_{150}) for MS and PP mixes, respectively.

1. Introduction

Globally, the demand for conventional building materials is growing due to the increasing population worldwide. Among the most essential constituent materials necessary in the development of concrete is the main binding material, which is conventional ordinary Portland cement (OPC) or blended cements. In 2015, the global cement production reached an all-time high of 4300 million tons [1]. Due to the rapid development of many infrastructures throughout the world, the global production of cement is likely to rise to 6100

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