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Mechanical properties of ambient cured high strength hybrid steel and synthetic fibers reinforced geopolymer composites

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Abstract

Ambient cured geopolymer offers significant promise to the construction world as a possible alternative to ordinary Portland cement (OPC). However, as a member of the ceramic family, geopolymers exhibit extremely brittle behaviour. The inclusion of short discrete fibers is an effective way to enhance their ductility. In this research, a series of fiber combinations and volume fractions between steel fibers with end-hooked or spiraled and synthetic fibers (made of high strength polyethylene (HSPE)) were incorporated in a high strength ambient cured geopolymer matrix. The performance of synthesized geopolymer composites was compared in terms of fresh and hardened state properties, such as workability, uniaxial compressive strength, modulus of elasticity, Poisson's ratio, flexural tensile strength, energy absorption capacity and post-peak residual strength etc. The interfacial bond between the spiral steel fiber and the geopolymer matrix as well as fiber distribution in the composites were assessed through individual fiber-pull out tests and physical examination of the cast samples, respectively. The test results show that the addition of fibers significantly improved the load carrying capacity of the composites under flexure load, i.e. increased from 3.89 MPa to 11.30 MPa together with an improved behaviour in compression. In general, all fiber reinforced composites displayed a stable deflection hardening response and multiple-cracking failure mode. Moreover, among composites with different fiber volume fractions, the composite having 1.60% steel+0.40% HSPE showed the highest ultimate flexure strength, correspondingly the highest energy absorption capacity. The individual fiber pull-out test curves ascertained a strong bonding between the geopolymer mortar and spiral-steel fiber.

Keywords: Geopolymer, Spiral-steel fiber, Hooked-end steel fiber, Synthetic fiber, Compressive strength, Flexure strength

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