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Flexural behavior of geopolymer composites reinforced with steel and polypropylene macro fibers

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Abstract: Like ordinary Portland cement concrete, the matrix brittleness in geopolymer composites can be reduced by introducing appropriate fiber reinforcement. Several studies on fiber reinforced geopolymer composites are available, however there is still a gap to understand and optimize their performance. This paper presents the flexural behavior of fly ash-based geopolymer composites reinforced with different types of macro steel and polypropylene fibers with higher aspect ratio. Three types (length-deformed, end-deformed and straight) of steel fibers and another type of length-deformed polypropylene fiber with optimum fiber volume fraction of 0.5% are studied. The effects of different geometries of the fibers, curing regimes (ambient cured and heat cured at 60° C for 24h) and concentration of NaOH activator (10M and 12M) on the first peak strength, modulus of rupture and toughness of the geopolymer composites are investigated. The quantitative effect of fiber geometry on geopolymer composite performance was also analyzed through a fiber deformation ratio. The compressive strength, splitting tensile strength and flexural toughness are significantly improved with macro fibers reinforcement and heat curing. The results also show that heat curing increases the first peak load of all fiber-reinforced geopolymers composites. End-deformed steel fibers exhibit the most ductile flexural response compared to other steel fibers in both heat and ambient-cured fiber reinforced geopolymer composites.

Keywords: *Fly ash-fiber reinforced geopolymer composite; macro fiber; alkaline solution concentration; curing; flexural behavior.*

1 INTRODUCTION

Geopolymers have been studied as alternative matrices to ordinary Portland cement (OPC) for structural applications; the former may present several advantages in terms of low carbon emissions [1-2], early strength development [3], superior chemical resistance [4-6], and thermal durability [7-8] among others. The inherent brittleness of the matrix, however, presents shortcomings very similar to that of OPC matrices, i.e. both require fiber reinforcement to improve deformation, toughness and crack growth when subjected to flexion and tension stresses.

There has been an increasing interest in the development of fiber-reinforced geopolymers, with the employment of a great variety of fibers. Carbon fibers have been used in the development of matrices with increased