Effect of discarded steel fibers on impact resistance, flexural toughness and fracture energy of high-strength self-compacting concrete exposed to elevated temperatures

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Abstract

This paper presents a systematic experimental investigation to explore the effect of incorporating discarded hybrid steel fibers (DSF) on the rheological, mechanical, and hardened properties of high strength self compacting concrete (HSCC). This study also covers the effect of elevated temperatures (300 ◦C, 500 ◦C, and 700 ◦C) in the furnace with a heating time of 2 h on residual mechanical and hardened properties of produced concrete. The results revealed that adding DSF to the HSCC slightly reduced its filling ability and passing ability, while increasing its resistance to segregation. Although residual strength was decreased by exposure to elevated temperatures over 300 ◦C, residual mechanical properties of fiber-reinforced high strength self-compacting concrete (FRHSCC) was significantly higher than HSCC. There was a significant increase in the impact resis tance, fracture energy, and toughness index of FRHSCC compared to HSCC, where the increase was about 130%, 500%, and 1300%, respectively. After exposure to 700 ◦C, it was found that concrete becomes more brittle, loses its strength, density, and changes color alongside the appearance of fine cracks on its surface at 500 ◦C. The results also indicated that elevated temperatures had a greater influence on impact resistance, toughness, and fracture energy compared to compressive strength. DSF almost doubled the impact resistance and tensile strength of HSCC, and the highest effect was on the toughness and fracture energy at both ambient and elevated tem peratures. The ultra-pulse velocity test has also been shown to be a suitable technique to infer loss of strength and deterioration of fire-exposed concrete structures. Finally, this study confirms that DSF can be successfully used as a steel fiber in producing FRHSCC to be structurally used as well as improving residual hardened properties and resistance to heating effects.