Mode I fracture energy of fly ash-based geopolymer concrete

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Geopolymer concrete uses inorganic binding materials such as fly ash or blast-furnace slag in contrast to conventional concrete, which relies on cement. Utilisation of geopolymer concrete reduces the carbon-footprint by decreasing the production of cement, which is one of the highest CO_2 emitting industries, and by reusing the (geopolymer) industrial waste. The mechanical properties of geopolymer concrete and the factors influencing them are well established, however, detailed studies on its fracture energy are limited. In the current study, the mode I fracture energy of fly ash-based geopolymer concrete was investigated using the wedge-splitting test (WST) method. Research was conducted to identify the effects of several factors on the fracture energy of geopolymer concrete, including the curing temperature, maximum aggregate size, sodium hydroxide concentration, addition of water, and superplasticiser. Increase in the curing temperature to 60°C had the maximum influence indicating approximately 300% increase in fracture energy. For the ambient-temperature cured geopolymer concrete, an increase in fracture energy was observed when the maximum aggregate size or the molarity of the sodium hydroxide solution were increased. Addition of water in the geopolymer concrete mix improved the workability of the mix, however, compromised the fracture energy, whereas the addition of polycarboxylate-based superplasticiser showed a negligible influence on the workability or fracture energy. Overall, the fracture energy of ambient-temperature cured geopolymer concrete was approximately 300% lower, and was comparable in the case of elevated-temperature cured geopolymer concrete, when compared to that of conventional concrete.