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Strength optimization and key factors correlation of one-part fly ash/ladle furnace slag (FA/LFS) geopolymer using statistical approach

Abstract

The utilization of ladle furnace slag (LFS) in one-part geopolymer technology has not been reported. The study of the cause-and-effect relationship between the mixing ratio is therefore important. The present work optimized one-part fly ash (FA)/LFS geopolymer with 33 full factorial design using variance analysis (ANOVA) to predict the key engineering properties of the one-part geopolymer with satisfactory precision. Three factors, which are alkali activator to aluminosilicate sources (AA/AS), sodium metasilicate to sodium hydroxide, Na2SiO3 to NaOH (SM/SH) and water to binder (W/B) ratios, were considered. The AA/AS, W/B and interrelationship between AA/AS and W/B ratios were the most significant factors influencing the key engineering properties. The one-part geopolymer with AA/AS, SM/SH and W/B ratios of 0.20, 5.0 and 0.25 were concluded as an optimal response to achieve a good compressive strength of 38.8 MPa after 28 days. The microstructural and phase analysis indicated that the LFS participated moderately in geopolymerization reaction with the formation of calcium silicate hydrate (C–S–H) and sodium aluminate silicate hydrate (N-A-S-H). The optimized one-part FA/LFS geopolymer met the minimum requirement of ASTM C1157 (>28.0 MPa) for a functional construction binder. The outcome of the paper offers a guideline to the construction industry to maximize the use of LFS to prepare green construction binder.

Keywords

Factorial design; Fly ash; Ladle furnace slag; One-part geopolymer; Optimization