INFLUENCE OF PRECURSOR COMPOSITION AND MIX-DESIGN PARAMETERS ON THE COMPRESSIVE STRENGTH OF AMBIENT-CURED GEOPOLYMER CONCRETE: A DATA-DRIVEN ANALYSIS

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ABSTRACT

The compressive strength of ambient-cured geopolymer concrete is influenced by interacting precursor, activator and mixture-design characteristics, making it difficult to generalise optimum conditions from individual experimental studies. This study employed a data-driven statistical approach to examine these relationships using 251 geopolymer concrete mixtures tested at 28 days under ambient curing. The database comprised fly ash-only, fly ash–ground-granulated blast-furnace slag (GGBS) blended and GGBS-only systems. Descriptive statistics, non-parametric comparisons, effect-size analysis and multivariable regression were used to evaluate relationships between mixture characteristics and compressive strength. Compressive strength increased progressively from fly ash-only through FA–GGBS blended to GGBS-only systems, while higher-strength mixtures were increasingly characterised by greater GGBS contribution. Differences among precursor systems remained significant after adjustment for selected activator and aggregate characteristics. Individual activator parameters did not consistently distinguish the high-strength group; however, NaOH molarity, sodium silicate-to-NaOH ratio and water-to-solids ratio showed significant associations with strength after multivariable adjustment. These findings indicate that precursor composition is a major discriminator of ambient-cured compressive strength, while activator effects depend on the broader mixture context. The results provide a basis for identifying promising mixture-design regions for subsequent experimental optimisation.

Keywords: Alkaline activator; ambient curing; compressive strength; data-driven analysis; fly ash; GGBS; geopolymer concrete; mix design.