Fresh and Mechanical Properties of One-Part Alkali-Activated Self-Consolidating Concrete

Problem Statement and Objectives

Recently, a rapidly growing effort was opened by the production of innovative cement-free flowable concrete towards decreasing the emissions of GHG to the atmosphere. Alkali-activated materials would replace cement-based concrete completely and would meet the sustainability criteria directly. The development of AASCC from an increasingly diverse range of waste-based precursors and activators has restricted its popularity, standardization, and production. The present study aimed to design and conduct an experimental program to examine the potential production of one-part AASCCs. Also, exploring the effect of the nature, concentration, and combination of various source materials and dry-powder activators on AASCC fresh and hardened properties cured under ambient curing conditions.

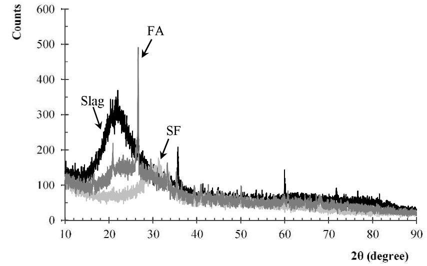

Fig. 1–XRD patterns of source materials (a) Slag (b) SF and (c) FA

Experimental Program

The main precursor material used to produce single, binary, and ternary AASCC precursor blends was ground granulated blast furnace slag (GGBFS). Fly ash (Class-F FA) and silica fumes (SF) with different weight percentages were also used in this study to replace GGBFS. For all AASCC mixtures, a combination of two dry-powder activators was used to activate the source materials, namely, anhydrous sodium metasilicate (Na_2SiO_3) and Sodium carbonate (Na_2CO_3).

Experimental Methodology

After examining the potential of producing AASCC mortar mixtures, 3 activator levels i.e. 16, 20, and 25% were chosen based on trial-and-error tests. In phase II, the effect of using multi precursor (i.e. single, binary, and ternary) and activators on the fresh and hardened concrete properties was studied. For fresh concrete, slump flow, L-box and segregation resistance tests while for hardened concrete, compressive strength development, UPV, electrical resistivity, sorptivity and permeable pores were measured.

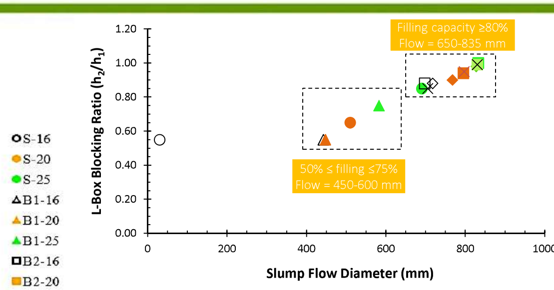

Fig. 2–Relation between slump and L-Box blocking ratio

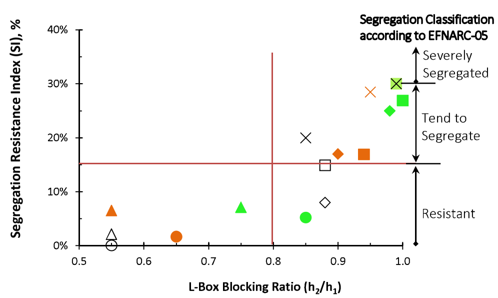

Fig. 3–Relation between L-Box blocking ratio and segregation resistance

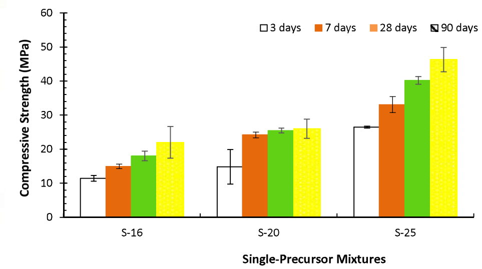

Fig. 4–Compressive strength results for the AASCC single-precursor mixtures

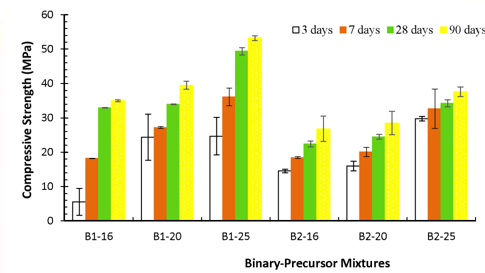

Fig. 5–Compressive strength results for the AASCC binary-precursor mixtures

Study Conclusions

The study's findings highlighted the high potential to produce green, easy-to-handle, one-part AASCC with fresh and hardened performance. Fresh concrete properties showed that the proper selection of precursor blend improved its workability in the absence of effective chemical admixtures. Hardened concrete tests indicated that combinations of Na_2CO_3 and $MetaNa_2SiO_3$ have accelerated the hardening and strength development of mixtures without elevated heat curing. The combination of up to 25% activator dosage is considered the optimum to achieve the highest workability and strength values.

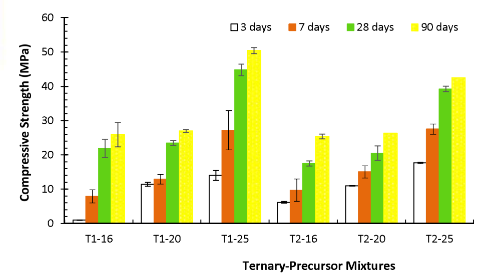

Fig. 6–Compressive strength results for the AASCC ternary-precursor mixtures

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