EFFECT OF ALKALI CONTENT ON COMPRESSIVE STRENGTH AND EFFLORESCENCE OF NaOH ACTIVATED COPPER SLAG MORTAR

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ABSTRACT

The effect of different alkali contents i.e. 4%, 6%, 8% and 10% by weight of copper slag on the compressive strength and efflorescence of Alkali Activated Copper Slag Mortar (AACSM) was investigated. The compressive strength of AACSM was increased with increase in alkali content and heat cured specimens showed better compressive strength than ambient cured. The specimens with alkali contents of 8% and 10% showed significant efflorescence, however the efflorescence in specimens with 4% and 6% alkali content was negligible.

INTRODUCTION

Alkali-activated materials (AAMs) are hardened product of a chemical reaction of aluminosilicate materials and alkali-activators.[1] To develop the low-cost AAMs in any specific region, locally available sources of aluminosilicate have to be identified and also specified the correct activator for the activation of these aluminosilicate.[2] Copper slag (CS) is a by-product of smelting process of copper and in India around 15 million tonnes CS is generated annually.[3] Intense research has been carried out on the utilization of CS as replacement of Portland cement in concrete.[4] However, very few studies are available regarding the use of CS for the development of AAMs.[5,6] The presents study was conducted to synthesize AAMs using copper slag as aluminosilicate and NaOH as alkali-activator.

METHODS AND MATERIALS

Granulated CS was first ground in laboratory ball mill and its major constitutes was Si_2O (37.6%), Al_2O_3 (11.5%), Fe_2O_3 (42.4%), CaO (3.80%) and Na_2O (0.74%). The specific gravity and surface area of CS was 3.92 and 405 m^2/g respectively. Sodium hydroxide solution of 12M was used as alkali-activator. Standard sand to CS ratio of 3 and water to solid ratio of 0.3 was fixed for all mixes. Two different curing regimes were selected; ambient curing (25±3^{0}C) and heat curing (80^{0}C for 24h). The compressive strength of AACSM was determined after 7 and 28 days. Efflorescence formation on the top surface of 28 days ambient cured AACSM specimens was visually compared.

RESULTS

The 7 days and 28 days compressive strength of AACSM was increased with increase in alkali content due to the formation of aluminosilicate gel (Figure 1). Heat cured specimens show better compressive strength than ambient cured specimens and remarkable gain in compressive strength for heat cured specimens was observed at 7 days of curing. However the development in compressive strength for ambient cured specimens was less at the curing age of 7 days.

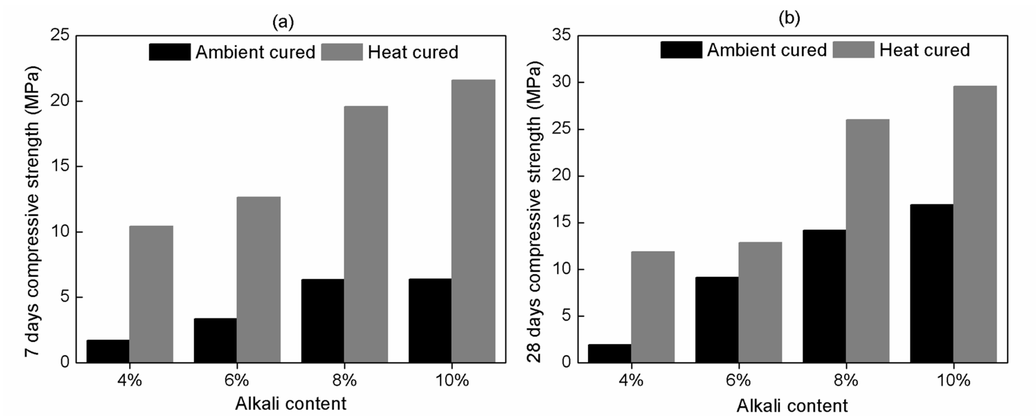

Figure 1: Effect of alkali content and curing regime on (a) 7 days compressive strength (b) 28 days compressive strength

The AACSM mixes with 4% and 6% alkali content demonstrates the negligible efflorescence in Figure 2(a) and 2(b), however for 8% alkali content few white crystals were seen on top surface in Figure 2(c). The significantly amount of efflorescence formation was observed in Figure 2(d) for mix contains 10% alkali content. The pH value of leaching liquid of AACSM mixes with alkali content of 4%, 6%, 8% and 10% was 10.35, 10.61, 11.53 and 12.65 respectively. It reflects that with the increase in alkali content, soluble alkalis were leach out from the AACSM mixes.

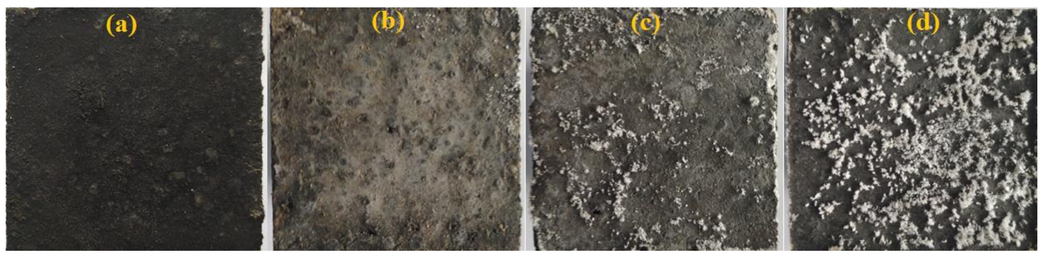

Figure 2: Effect of different alkali contents (a) 4%, (b) 6%, (c) 8% and (d) 10% on efflorescence formation on top surface of AACSM mixes

CONCLUSIONS

✓The compressive strength of AACSM was increased with increase in alkali content and heat cured specimens showed better compressive strength than ambient cured.

✓Maximum efflorescence was observed for 10% alkali content.

✓Optimum alkali content of 8% is recommended for alkali-activation of CS.

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