Characterization of Alkali-Activated Mine Tailings

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I) INTRODUCTION

In mining, tailings are the materials left over after the process of separating the valuable fraction from the ores. Mine tailing disposal creates a severe environmental impact.

II) RESEARCH OBJECTIVE

The primary objective was to study the potential effects of alkali activation of mine tailings. Identifying the applications of mine tailings as potential secondary raw materials would help develop better waste-management techniques.

III) EXPERMIENTAL PROGRAM:

a) Mine Tailings

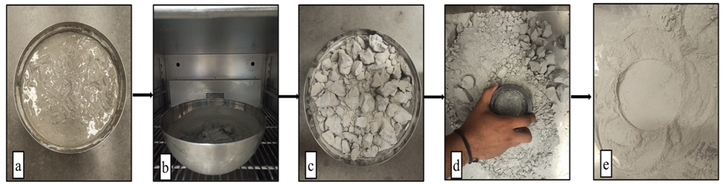

Figure 1: Mine Tailing (a) received in wet condition, (b) kept in oven for drying, (c) oven-dried, (d) manual crushing of lumps formed after oven-drying, and (e) final dry powder form

- Mine tailings: received as slurry
- Oven dried at 80^{0}C for 48 hours
- Crushed to fine powder before use

b) Alkali Activating Agents

- ***Activating agents:***

(I) Sodium silicate solution:
SiO_2-to-Na_2O ratio (M_s) = 3.26
Solid content (%) = 36.60
(II) Sodium hydroxide:
To reduce the M_s to desired range

- ***Activation Procedure:***

(I) Sodium hydroxide solution was prepared and allowed to cool down to ambient temperature
(II) Sodium silicate solution was added to arrive at the desired M_s value

- ***Parameters used in the study:***

(I) M_s desired = 1.15
(II) Na_2O-to-powder mass ratio (n): 0.10

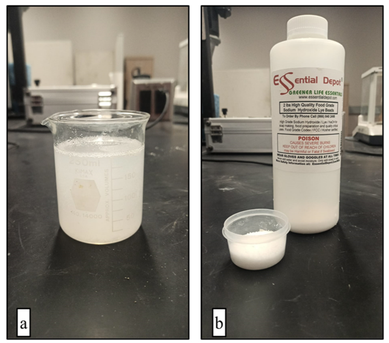

Figure 2: (a) Sodium silicate solution, (b) sodium hydroxide powder

c) Mix Proportions

- *Binder material:* Mine tailings
- *Replacement materials:* Cement and slag used as replacement for mine tailings
- *Replacement levels:* 10 and 30% (by mass)
- *Liquid-to-binder (l/b) ratio:* 0.40

Note: l/b of 0.6 was used when 30% mine tailings were replaced by cement (to attain workable mix)

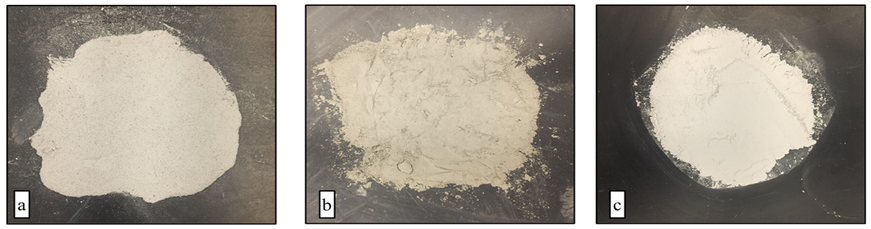

Figure 3: Binders used in the study: (a) mine tailings, (b) cement, and (c) slag

IV) RESULTS

- Table 1 presents the results of laboratory tests conducted
- Viscosity shear test was done 10 minutes after mixing (shear rate sweep with vane geometry)

Table 1: Viscosity shear test after mixing

Mix Designation	Binder Composition (by mass)	l/b ratio	Vicat's Initial Setting time (mins)	Mini Slump Cone Diamter (cm)	Ultimate compressive strength (UCS) -3days (MPa)		Viscosity (Pa.s)
					Oven curing	Wet Curing	
A	70% Powder, 30% cement	0.60	8.00	-	1.86	6.67	16806
B	90% Powder, 10% cement	0.40	75.00	8.20	-	1.07	6.41
C	70% Powder, 30% slag	0.40	71.00	12.50	6.75	13.71	4.18
D	90% Powder, 10% slag	0.40	83.00	10.65	3.76	3.13	21.98

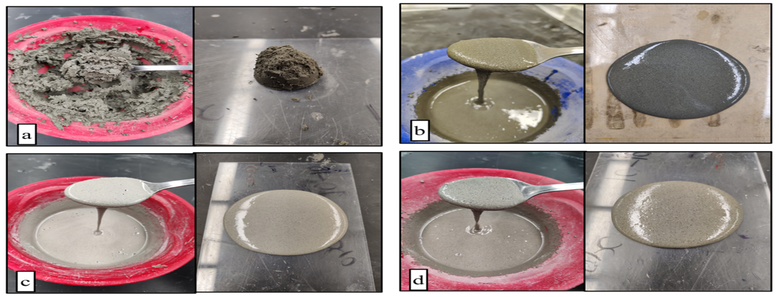

Figure 4: Mixture after mixing and mini slump cone diameter for - (a) A – 70% mine tailings, 30% cement (b) B – 90% mine tailings, 10% cement (c) C – 70% mine tailings, 30% slag (d) D – 90% mine tailings, 10% slag

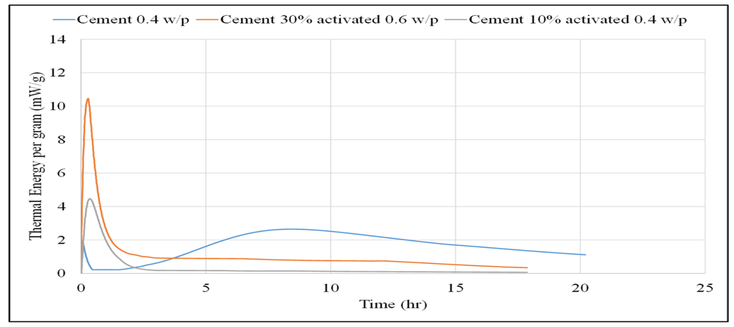

Figure 5: 20 hours calorimetry results: cement

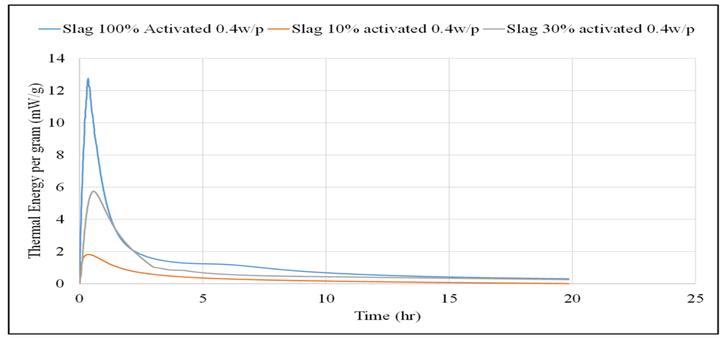

Figure 6: 20 hours calorimetry results: slag

V) POTENTIAL APPLICATION: COATING

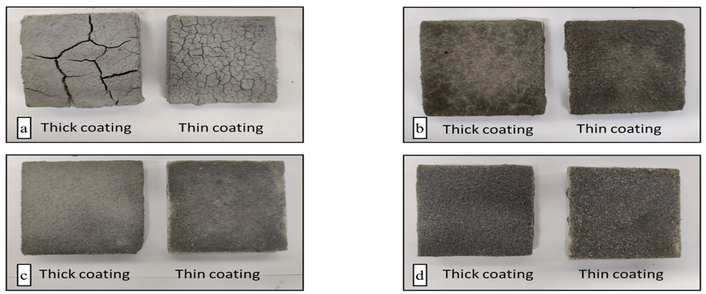

Figure 7: Coating for (a) A – 70% mine tailings, 30% cement; (b) B – 90% mine tailings, 10% cement; (c) C – 70% mine tailings, 30% slag; and (d) D – 90% mine tailings, 10% slag

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