







Abstract

Reclaimed Asphalt and Alkali-Activated Slag Systems: The Effect of Metakaolin [†]

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1. Introduction

The demolition of old flexible pavements layers generates large quantities of reclaimed asphalt pavement (RAP). This material can be milled and reused for new pavement sections as aggregates. Alkali-activated materials (AAM) are alternative cementitious binders with high strength and chemical resistance [1]. The main problem associated with RAP in cementitious materials is the strength loss due to the porous interface [2–5]. The use of metakaolin (MK) can improve slag based AAM's properties [6,7]. The objective of this study is to investigate if the properties of RAP-AAM produced with low alkali concentration (4% Na₂O and Ms = 0 and 1) can be improved with 5% MK replacement. This investigation compared isothermal calorimetry, compressive and flexural strength results for RAP-AAM produced with and without MK replacement.

2. Materials

The RAP-AAM was produced mixing a powdered precursor with an alkali solution. The precursors used were ground granulated blast furnace slag (GGBFS) supplied by Ecocem and MK (Caltra). The alkali solution was prepared using sodium hydroxide sodium silicate solution form VWR. Fine RAP aggregate was obtained by removing the fine fraction (<4 mm) of a locally milled flexible pavement supplied by Willemen Infra Recycling. Table 1 shows the compositions studied.

Table 1. Compositions (Ms = silica modulus, w = water, p = precursor, a = fine RAP aggregate).

	Precursor		Alkali-Solution			a/p
	GGBFS	MK	Na ₂ O	Ms	w/p	
R4-0	100.0 g	0 g	4%	0	0.5	1.5
5MK4-0	95.0 g	4.5 g	4%	0	0.5	1.5
R4-1	100.0 g	0 g	4%	1	0.5	1.5
5MK4-1	95.0 g	4.5 g	4%	1	0.5	1.5

Mortar mixing details and experimental procedures can be found elsewhere [5].



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3. Results and Discussion

Figure 1 presents the calorimetry results for the different RAP-AAM samples studied. The sharp peak at the start of the experiment was only partially captured. The second and main peak is related to the precipitation of the reaction products [8,9]. Samples with sodium silicate (R4-1 and 5MK4-1) have a delayed second peak due to the workability retention and the reduced availability of OH⁻ [10,11]. Replacing 5% of GGBFS with MK decreased the intensity and delayed the second peak. It also reduced the cumulative heat of the samples. The retarding effect of MK in the formation of reaction products was also observed in another research [12].

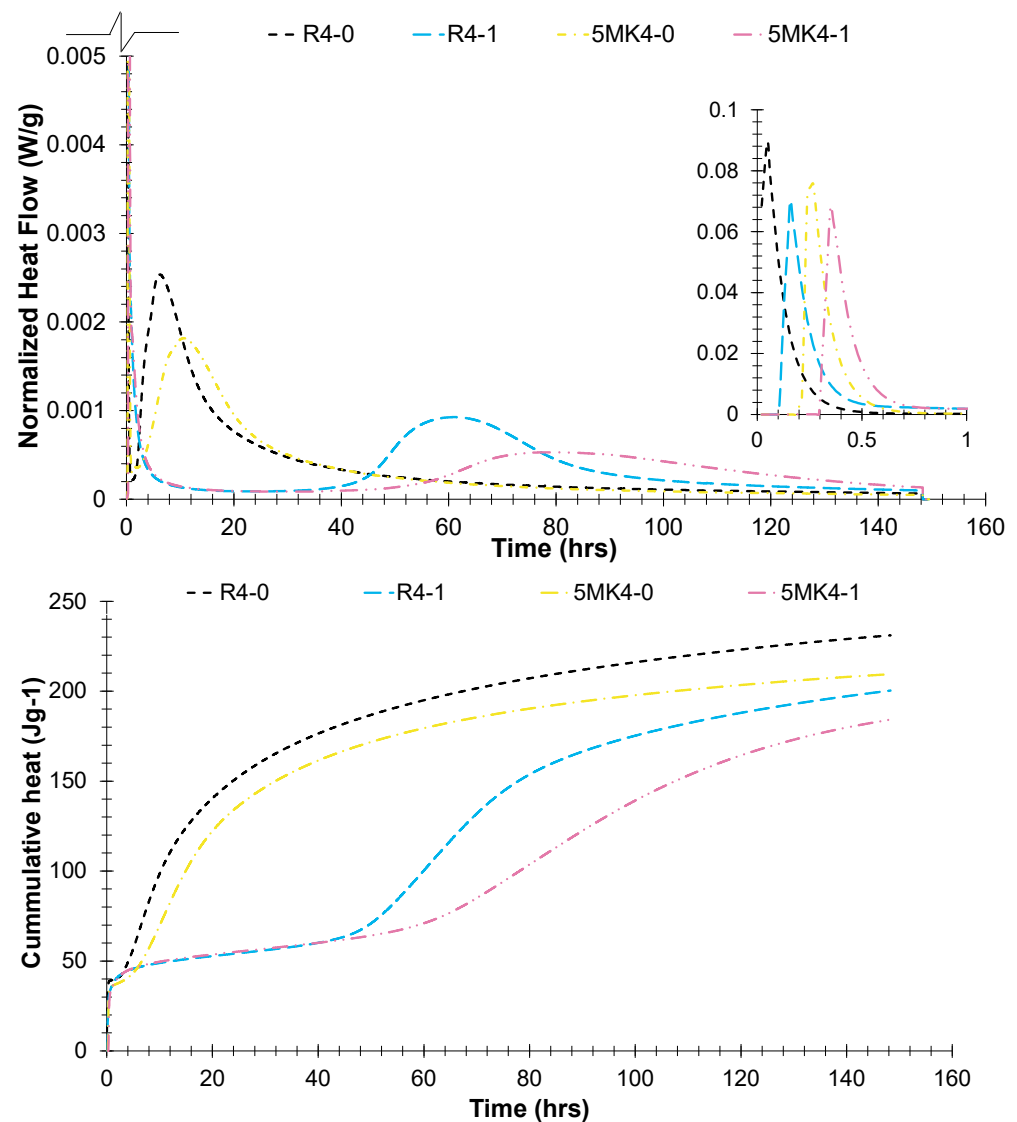


Figure 1. Calorimetry results of RAP-AAM.

The compressive and flexural strength of the samples is presented in Figure 2. The use of MK reduced the early strength of the samples (both compressive and flexural). At later ages, however, the use of MK caused some slight improvements in strength. This result differs from other studies [7,13] that reported a reduction in compressive strength and gains in flexural strength for sodium hydroxide alkali-activated pastes and mortars.

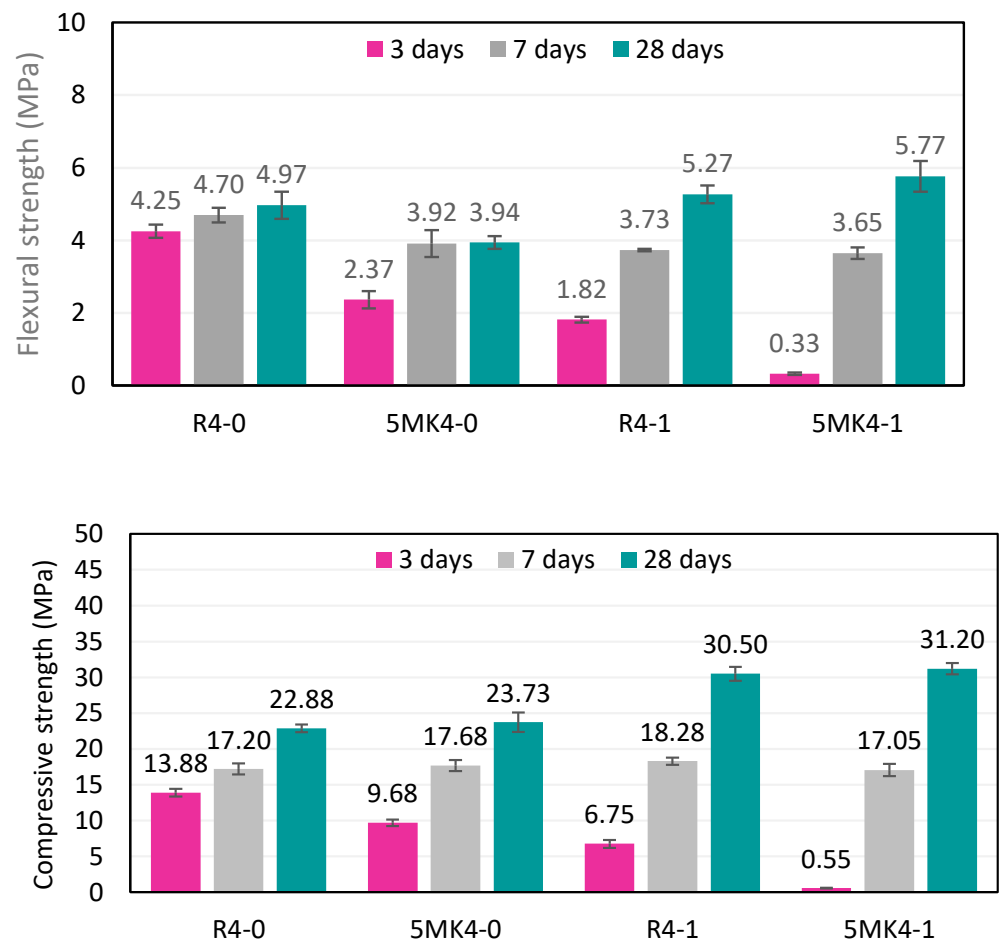


Figure 2. Compressive and flexural strength results for RAP-AAM.

4. Conclusions

The use of MK delayed the formation of main reaction products, which significantly impacted the early strength of the studied mixes. The filler effect of MK may have helped anchor RAP particles to the matrix and caused slight improvements in compressive strength observed at 28 days. This study did not see significant improvement in flexural strength as observed elsewhere [7], most likely due to the low alkali concentration used. Further studies of the benefit of MK for RAP-AAM at higher concentration of alkalis is needed.

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