

# Efflorescence and Alkali Leaching in Slag-Based Geopolymer Tiles for Wet Environments

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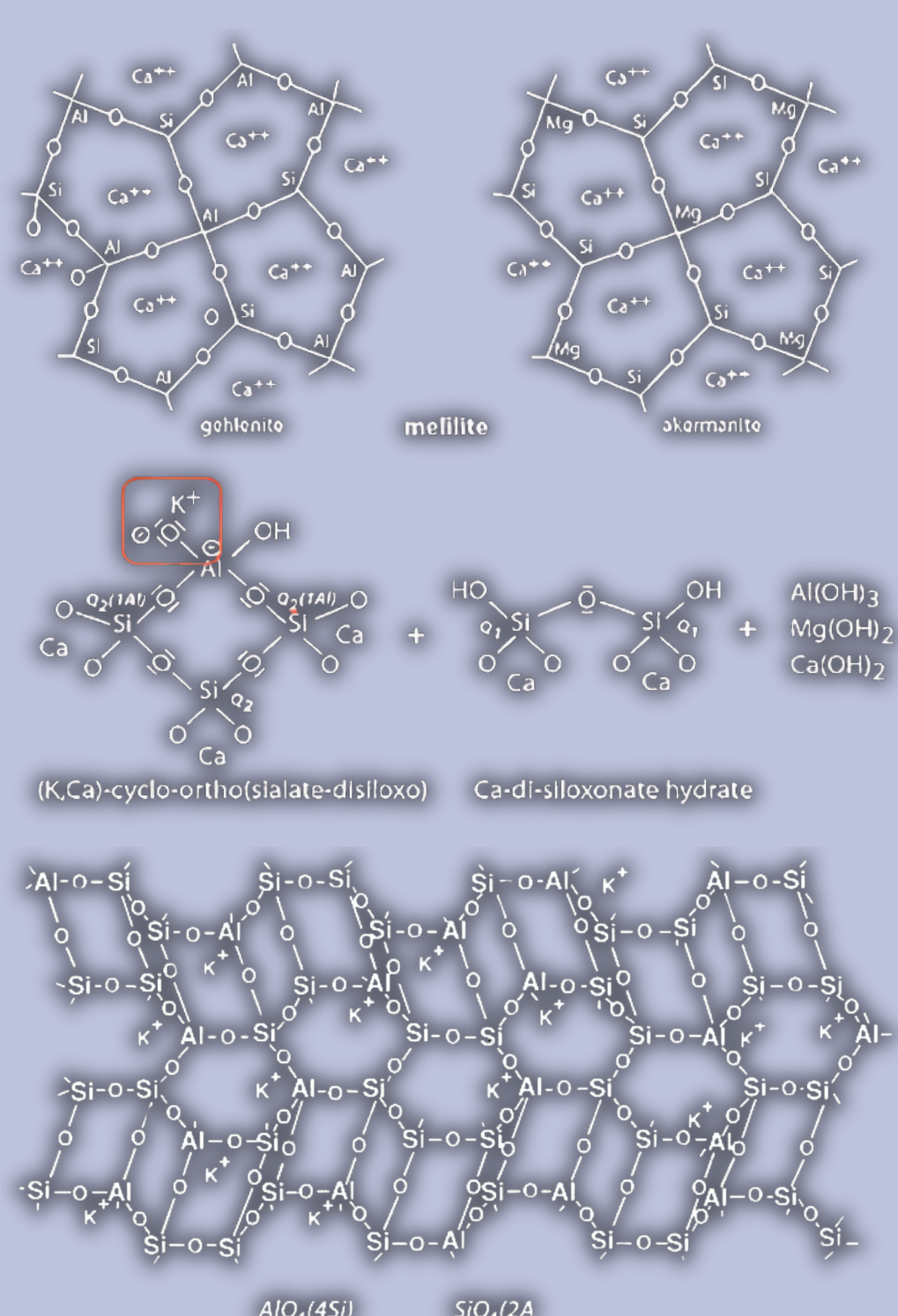
## The Wet Cell:

The Wet Cell project focuses on developing water-resistant paneling solutions for wet environments such as bathrooms and showers, using sustainable and biobased materials. The project addresses the significant environmental impact of conventional concrete by investigating alternative binders, including geopolymers produced from industrial by-products such as blast furnace slag.

## Research Objectives

- ✓ Verify geopolymeric nature of samples
- ✓ Compare dried leachate results with Škvára model
- ✓ Characterize the Efflorescence and Leachate

## Geopolymeric Process



## Efflorescence

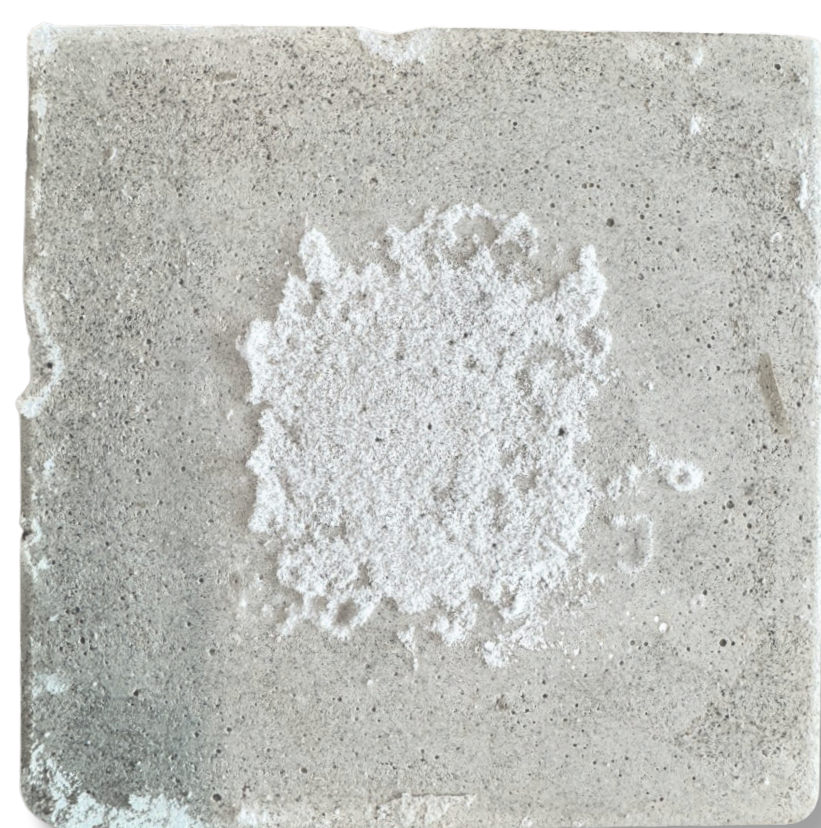


Figure 2. Efflorescence on top of sample

- Efflorescence is the phenomenon of salt formation by the migration and crystallization of soluble alkali

## Background & Results

### Bad Water Resistance

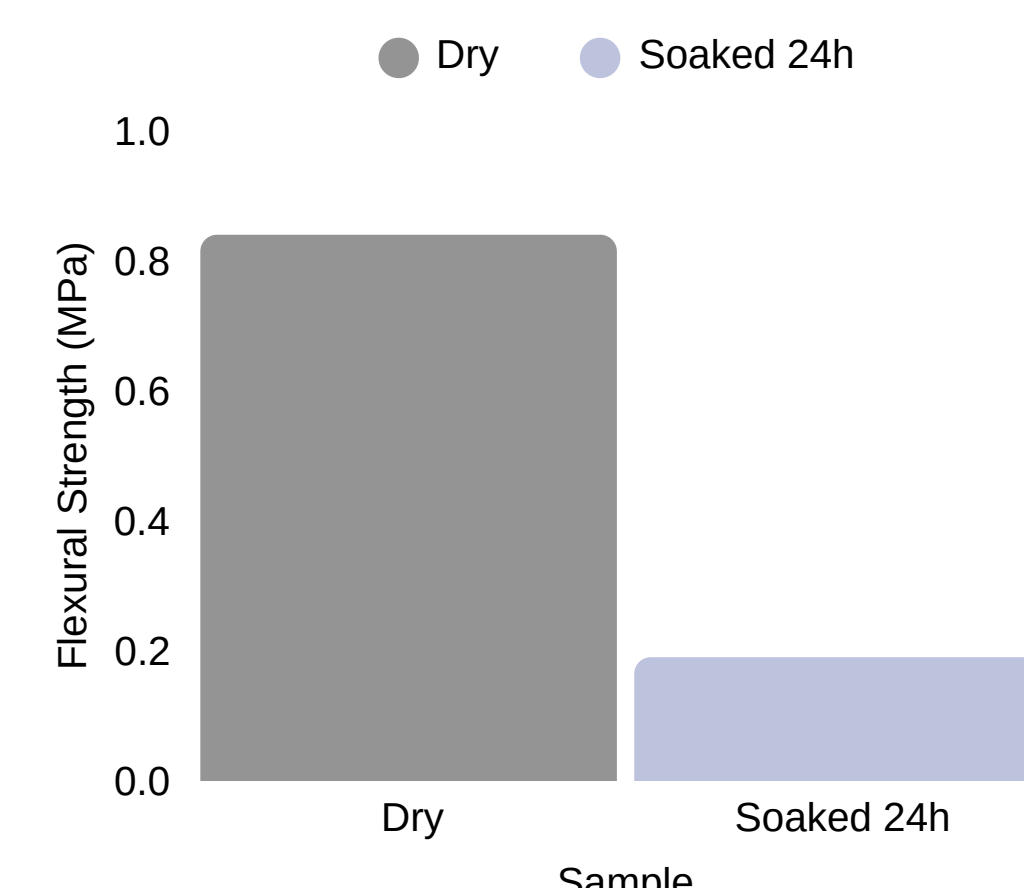


Figure 3. Flexural strength before and after 24h water

- Our tile samples lose the majority of their strength when exposed to water

### Leachate Identification and Prediction Model

- What is being leached out of the samples?
- Does it compare to Škvára model for leachates?

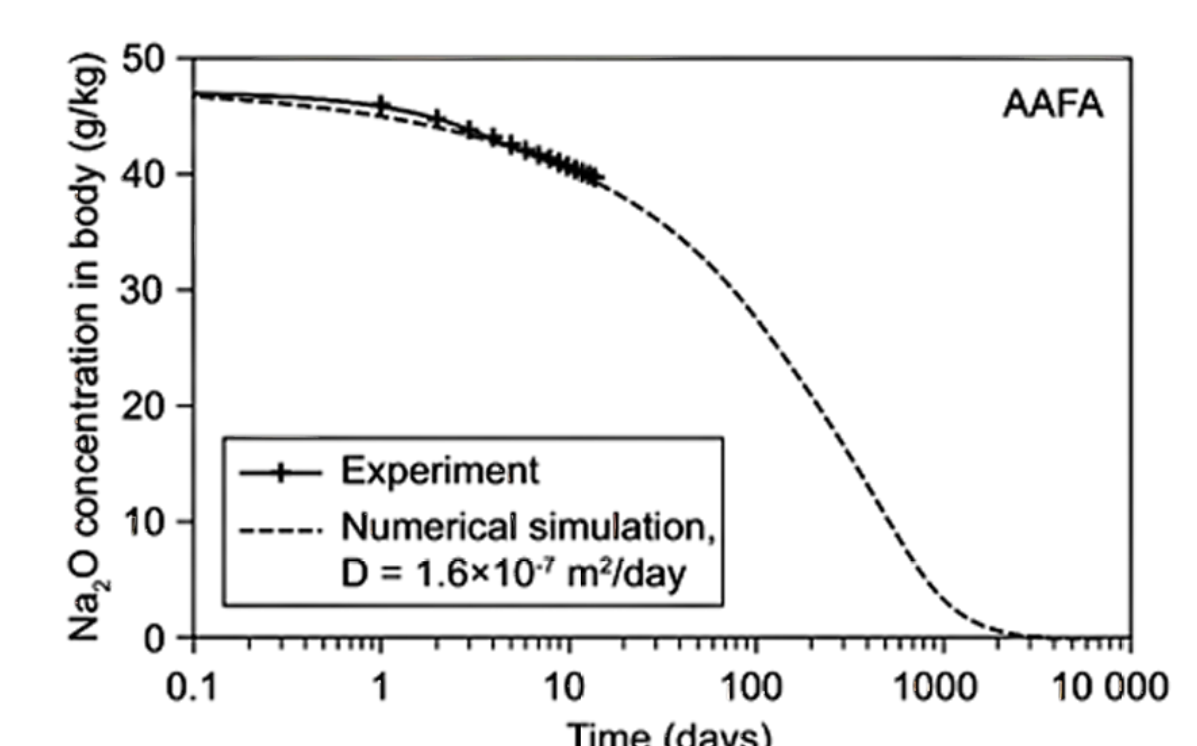


Figure 4. Predictive Leachate Model (Škvára, et al., 2012).

## Methods

### Efflorescence characterization

- Crude method via Flame test - yellow indicating Na
- Effervescence in contact with Acetic acid indicate carbonate presence

### Leachates

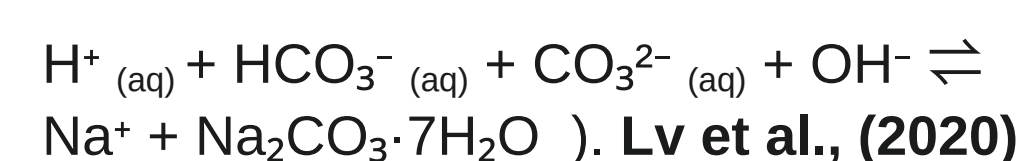
- Over a period of 2+ week, material samples were fully submerged in water
- The Leached water was then separated and completely evaporated then measured
- Similarly, Acetic acid was applied and effects for Effervescence were observed

### Efflorescence Results

- 3g of Efflorescence was collected
- Effervesce in presence of Acetic acid



Figure 5. Efflorescence in Contact with Acetic acid indicating the presence of carbonates



### Dried Leachate Results

- Average : 5.08g
- Only partially Effervesced in Acetic acid
- This may indicate Na-silicate being leached out of the sample



Figure 6. Dried Leachate in Contact with Acetic acid

## Conclusions

- ✓ Geopolymeric nature of samples is unlikely
- ✓ Efflorescence is likely to be  $\text{Na}_2\text{CO}_3$
- ✓ Silicates are likely leached from samples
- ✓ Using dried mass of leachate is not feasible for determining compatability with Škvára model

## Discussion

Due to the Bicarbonate Buffer reaction:  $\text{CO}_2 + \text{CO}_3^{2-} + \text{H}_2\text{O} \rightarrow 2\text{HCO}_3^-$  the mass of the final leachate is affected. Alternative methods like Optical Emission Spectroscopy will better record compatibility with the Škvára model.

Geopolymerization within samples is unlikely given the behaviour of the material. The material produced is more akin to a class of Alkali Activated Materials with hydrate chemistry similar to that of cement. For geopolymerization, needed is the addition of aluminosilicates (identified by  $^{27}\text{Al}$  NMR resonances between 20 and 50 ppm)

## References:

- Davidovits, J. (2018). Why alkali activated materials (AAM) are not geopolymers (Technical Paper No. 25). Geopolymer Institute Library. [https://www.geopolymer.org/fichiers\\_pdf/techpaper25.pdf](https://www.geopolymer.org/fichiers_pdf/techpaper25.pdf)
- Škvára, F., Šmilauer, V., Hlaváček, P., Kopecký, L., & Cílová, Z. (2012). A weak alkali bond in (N, K)-A-S-H gels: Evidence from leaching and modeling. *Ceramics – Silikáty*, 56(4), 374–382. [https://www.ceramics-silikaty.cz/2012/pdf/2012\\_04\\_374.pdf](https://www.ceramics-silikaty.cz/2012/pdf/2012_04_374.pdf)
- Lv, X., Qin, Y., Lin, Z., Tian, Z., & Cui, X. (2020). Inhibition of efflorescence in Na-based geopolymer inorganic coating. *Construction and Building Materials*, 260, 119876. <https://doi.org/10.1016/j.conbuildmat.2020.119876>