ALKALI-ACTIVATED MINERAL WOOLS

Juho Yliniemi, University of Oulu, University of Sheffield
juho.yliniemi@oulu.fi
Paivo Kinnunen, University of Oulu
Brant Walkley, University of Sheffield
John Provis, University of Sheffield
Mirja Illikainen, University of Oulu

Key Words: Mineral wool, stone wool, glass wool, man-made mineral fibers, alkali-activated cement, geopolymer

Mineral wools –a general term for stone wool and glass wool– are the most common building insulation materials in the world. The amount of mineral wool waste generated in Europe totaled 2.3 Mt in 2010 – including wastes from mineral wool production and from construction and demolition industry. Unfortunately, mineral wools are often unrecyclable due to their fibrous nature (Figure 1) and low density. Thus, the utilization of mineral wool waste in post-consumer products remains low.

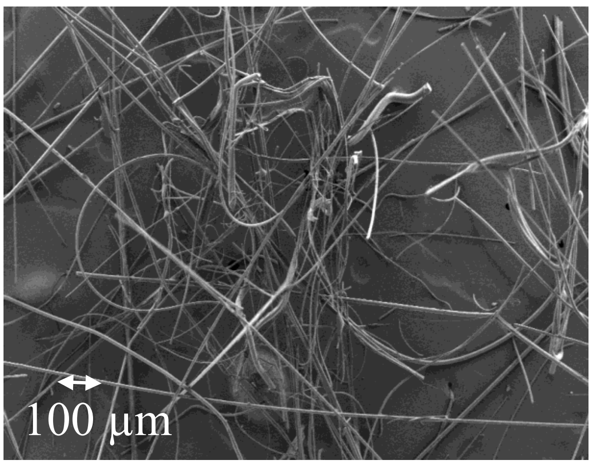
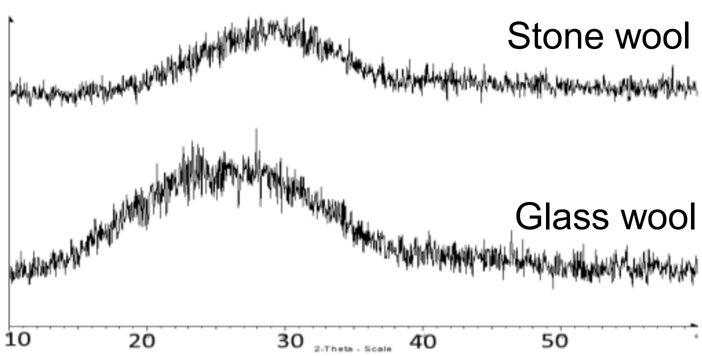


Figure 1 – Mineral wool fibers before milling.

Interestingly, as mineral wools are synthetic glasses designed to dissolve in lungs, they have favorable chemical and mineralogical composition also for alkali activation (Figure 2). However, in order to successfully mix mineral wools with alkali activators they must be processed to destroy the fiber structure.
Here, we show that with careful processing of mineral wools and reaction mix formulation, mineral wools may be alkali-activated to form sustainable cements with excellent mechanical properties.
The results show that mineral wools are highly soluble in alkaline conditions (up to 60% solubility in 24h) which promotes the formation of strong binders (>100 MPa compressive strength and flexural strength up to 20 MPa). Depending on the mix design different types of amorphous, NASH, CSH and hydrotalcite phases are formed. Finally, we discuss some problematic issues regarding the overall process and our suggestions to overcome them.
Mineral wool could turn out to be very valuable raw material for AAMs as itself or as co-binder as they have very constant chemical and physical properties compared to many other AAM precursors. Alkali-activation of mineral wools therefore offer an attractive route for waste valorisation and production of low-CO_2 cements with excellent mechanical properties.



	Stone wool	Glass wool
CaO, [%]	18	8
SiO_2, [%]	40	56
Al_2O_3, [%]	16	2
Fe_2O_3, [%]	9	1
Na_2O, [%]	1	15
K_2O, [%]	1	1
MgO, [%]	11	2

Figure 2 – X-ray diffractogram showing the amorphous nature of the mineral wools. On the right typical chemical compositions of stone wool and glass wool are presented.