# EVALUATION OF ALKALI-ACTIVATED BINDERS SUITABILITY FOR THE STABILIZATION/SOLIDIFICATION OF TUNNEL BORING MUDS

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In Europe, two major civil engineering projects, the “Grand Paris” automatic metro lines and the “Lyon-Turin” high speed railway tunnel, brought forth for the construction industry an unprecedented prerequisite within schemes of this scale: the necessity to recycle all forms of waste that comes out of the excavation process. By 2030, up to 100 million tons of muds retrieved from the boring operations, likely contaminated with sulphate and heavy metals, will have to be dealt with.

One application that would engage large volumes of these tunnel muds is the development of a stabilized subgrade layer for road construction. Common practices of the road industry dictate the stabilization of soils for subgrade layer design to be performed essentially with quicklime or Portland / Slag based cement. In addition to a proven low carbon footprint, alkali-activated slag binders could turn out to be relevant candidates for a subgrade layer application as their durability in such aggressive environments had already been demonstrated. Following this approach, we assessed the performances of four different types of binder: two alkali-activated slag binders, respectively with NaOH and sodium silicate, a Portland cement and a blended slag cement containing up to 90% of GGBS. Standard mortars were prepared with these four different binders as well as prismatic samples of stabilized mud containing about 90% of mud and 10% of binder. All samples were then cured in sealed bags at 20°C until compressive strength testing.

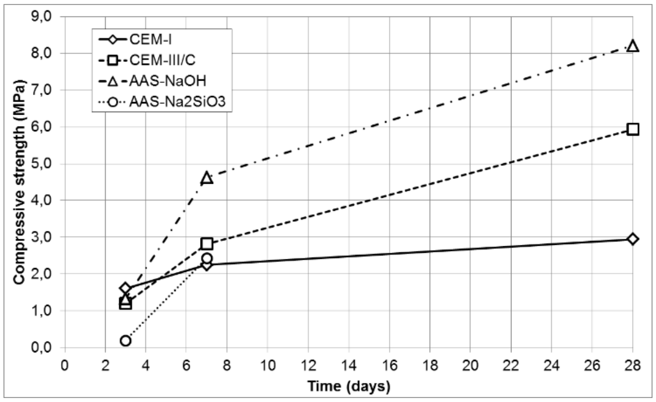

*Figure 1 - Compressive strength evolution with time of stabilized mud with 4 different binders.*

As shown in Figure 1, even though the exclusive use of Portland cement for mud stabilization provides a higher compressive strength after three days of curing (1.6 MPa), its evolution with time was rather limited after 28 days of curing. On the contrary, using either slag-rich or soda activated slag binders, the three days requirement of 1 MPa has been reached while the strength development with time was significantly higher, with values respectively of 6 and 8 MPa after 28 days. Finally, when proceeding with the sodium silicate activated slag binder, sufficient solidification does not occur after three days of curing as it could have been expected from results obtained on mortars samples.

In addition, measurement of ultrasonic pulse velocity through freshly mixed samples during seven days has enabled us to follow their macroscopic structuring and estimate quantities of significance like the setting time. Furthermore, the hydration kinetics of each binder, when mixed with a mud sieved beforehand, has been inspected by the means of isothermal calorimetry. For both methods, the results obtained are in good agreement with the compressive strengths highlighted in Figure 1, displaying the limits of a stabilization based solely on Portland cement compared to the use of a CEM-III/C or a NaOH activated GGBS.
NaOH alkali-activated GGBS was shown to be a suitable alternative solution to the traditional binders, such as Portland cement or even a CEM-III/C, for the stabilization/solidification of the studied mud within the specific set of requirements of road applications and especially in the design of sustainable subgrade layers.