DEVELOPMENT OF ALKALI ACTIVATED ADHESIVE APPLICABLE FOR ALKALI ACTIVATED PANELS

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The overall goal of InnoWEE project (Innovative pre-fabricated components including different waste construction materials reducing building energy and minimising environmental impacts), is the development of optimized reuse of construction and demolition waste - CDW (concrete, bricks, mortars, glass, and wood) into prefabricated alkali-activated panels to be used in energy-efficient buildings. Moreover, one of the tasks is the development of an alkali-activated adhesive that would bond together different types of alkali-activated panels (high-density panel - HDG and low density, wood-based alkali-activated panels - WGD).
The following parameters are important for the efficiency of the adhesive:

- chemical bonding between the AAM layer and the adhesive;
- matching between shrinkage and expansion, and
- mechanical interlocking (improved by a roughsurface).

For alkali-activated adhesives it is known that the adherence of alkali-activated mortars to the cement-based substrate is poor (Vanconcelos et al., 2011). It was assumed that if the sand-to-binder ratio was low, then high shrinkage caused micro cracks on the contact surface, which decreased the bond strength. Zhang (Zhang et al., 2010) has also proposed a mechanism of chemical bonding where the dissolution of hydrated cement takes place and a new alkali-activated gel containing calcium is formed so that good adherence is achieved.
Within the present study, the precursors selected for the adhesive preparation were slag and fly ash. KOH and K-silicate were applied as alkali activators. Samples were mixed using the standard procedure for ceramic tile adhesives and then evaluated for shrinkage and compressive strength. Other parameters important for its application in real conditions are consistency and open time, were also determined.
As expected, it was found that shrinkage mainly depends on the water in the mixture, but also on the amount of added fly ash, and it amounted to 1.8 and 1.4% for the two mixtures that were selected for application on different substrates. Both mixtures have the same ratio of slag to fly ash; i.e. 1:2,but in the first mixture (No. 28) the activator is only K-silicate, and in the second one (No. 42) the activator is a mixture of KOH and K-silicate. The compressive strengths were 21.5 and 54.1 MPa, respectively.
These two mixtures (No.28and No. 42) were then applied on different substrates (ceramic tiles, concrete plates, alkali-activated plates), and after 3 days the pull-off strength was determined.
The bonding strength depends very much on the substrates; results are presented in Table 1.

Table 1: Pull-off strength of the selected adhesives on different substrates

Mixture	Ceramic tiles/concrete tile (MPa)	Concrete tile/concrete tile (MPa)	Concrete tile/alkali-activated panel – HDG (MPa)	HDG/WGD panels (MPa)
28SL FA KS (SL:FA 1:2)	1.1	1.8	0.1	0.5
42SL FA KS KOH (SL:FA 1:2)	≈ 0.01	1.8	0.2	≥0.4*

*failure in sub-layer

For comparison, the bond strength for repair mortar (EN 1504-3) should be min. 0.5 MPa; for ETICs, the requirements for the bond between the adhesive and the wall min. 0.25 MPa; between the external layer (mortar) and the insulation min. 0.08 MPa.

References:

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