BIND-AMOR: flash-calcined dredging sediments of the AMORAS mechanical dewatering plant (*) as cement substitute

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Introduction: The AMORAS mechanical dewatering plant treats about 450.000 tonnes (dry matter) of maintenance dredging sediment from the port of Antwerp each year. The produced dewatered filter cakes are currently landfilled in an adjacent site. Given the constant composition and continuous supply, the dewatered dredging sediments may be a suitable raw material for large volume applications such as construction materials.

This contribution presents the outcomes of the BIND-AMOR project that investigates the application of flash-calcined dredging sediments as cement substitute for concrete. Concrete is the most-widely used man-made material (30 Gt/y). One of the reasons of its success is that it is very robust in application and that it can incorporate large amounts of secondary raw materials such as blast furnace slags or fly ashes from coal combustion as part of the cement binder. When properly calcined, also clay-rich materials obtain cementitious properties in combination with Portland cement; i.e. they contribute to the development of the strength of the concrete by engaging in a chemical pozzolanic reaction with the $Ca(OH)_2$ formed during the hardening of the cement. The observation that also dredging sediments obtained pozzolanic activity when calcined formed the outset of the project.

Materials and methods: A representative batch of dewatered dredging sediments (filter cakes from the AMORAS mechanical dewatering plant) was flash-calcined in a pilot plant at 800-900 °C. During flash-calcination the dried and ground material passes through the heated for a very short period (0.5-1 s) and immediately cooled, resulting in a quenching process. The flash calcination process decomposed clay minerals (mainly illite and smectite) by dehydroxylation. The clay minerals were transformed into a pozzolanically reactive amorphous material. Partial melting phenomena occurred as observable by the formation of spherical particles (Fig. 1). Finely dispersed calcium carbonates were decomposed and bound into the activated clays. Chlorine levels were low (0.1 wt.%) and enable application in reinforced concrete. Organic components were largely thermally destructed. Pyrite contained in the sediments was oxidized and reacted with lime to anhydrite. [1].

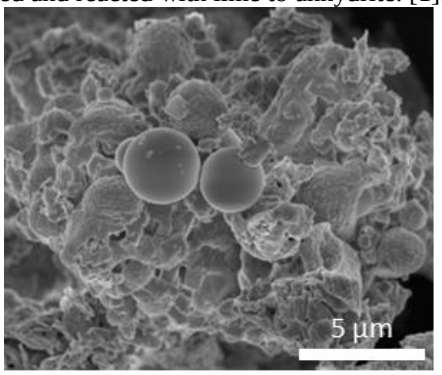

Fig. 1: Flash-calcined dredging sediments of the AMORAS mechanical dewatering plant.

Results: The flash calcined material was used as cement substitute. The results were compared to two commercial cements: one pure Portland cement (CEM I) and one substituted with 20-30% coal combustion fly ash (CEM II). The conclusions are summarized below:

- At 30 wt.% substitution of cement by calcined dredging sediment, early strengths were lower than the CEM I but higher than the CEM II references. At 3 months similar strength as the CEM I was reached. The higher the replacement of cement by calcined dredging sediments, the lower the early strength development.
- The environmental quality was compliant to the Flemish limit values of heavy metal leaching and organic pollutant content and permit the use of the calcined dredging sediments as concrete component.

Conclusions: Flash-calcined dredging sediments of the AMORAS mechanical dewatering plant can be considered as suitable cement substitute for concrete. Proper concrete strength development, workability and environmental quality were obtained.

References: [1] Snellings et al. (2016) *Appl Clay Sci* **129**:35-39

(*) AMORAS = Antwerp Mechanical Dewatering, Recycling and Application of sediments: see Sednet-event 6-9April 2011