The applicability of river sediment for the production of clay bricks

Vilma Ducman[1], Ana Frankovič[1], Mojca Božič[2], Boštjan Gregorc[2]

[1]Slovenian National Building and Civil Engineering Institute, Dimičeva 12, 1000 Ljubljana, Slovenia

[2]Dravske elektrarne Maribor, Obrežna ulica 170, 2000 Maribor, Slovenia

Phone: +386 1 2804 438

E-mail: vilma.ducman@zag.si

Introduction: Each year approximately 30,000 m^3 of sediment accumulates in the Lake Ptuj from the hydro power plant. This sediment is currently being handled by conventional solutions of management, which entails either disposing the sludge in landfills or reintegrating the sediment into rivers or water-ecosystems. Due to a lack of space for sludge deposition in the valley of the Drava River, in addition to new imposed regulations, there is an urgent need to find new solutions for sediment management. The beneficial uses of river sediment are becoming increasingly interesting in terms of environmental protection and sustainable development. As a major construction and building material, bricks are in great demand. Due to limitations in natural clay resources, however, it is also necessary to find alternative raw materials for the production of bricks. Considering the composition of river sediment, and its continuous availability, the potential use of dredged sediments for brick production is highly promising. A number of research studies have confirmed the feasibility of various (river, harbor, reservoir) sediments to be used in the brick sector [1-4]. In the present research investigation sediment from the River Drava (Lake Ptuj) was evaluated for its potential use in the clay brick sector. Furthermore, the extent to which it would be possible to replace virgin clay with sediment was determined.

Methods: Representative sediments were taken from Lake Ptuj. Sediments were first analysed to determine their chemical (by XRF) and mineralogical (by XRD) compositions. The sedimention method was used to determine particle size distribution.

Mixtures composed of varying amounts of brick-making clay and sediment (up to a maximum of 50%) were then prepared on a laboratory vacuum extruder. The following properties were determined for clay and each clay/ sediment mixture: (i) plasticity, (ii) shrinkage during drying, (iii) shrinkage after firing, (iv) density after firing, (v) and mechanical properties after firing.

Results: The chemical (Table 1) and mineralogical compositions confirmed that sediment is of a suitable composition to be used in the clay-based sector, and that it contains at least 50% clay content. Furthermore, the particle size of the sediment was below 500 μm. It is therefore expected that a reasonably high amount of brick-making clay could be replaced by such sediment. The addition of sediment to clay slightly increases shrinkage on drying, but reduces shrinkage on firing.

Table1: Chemical compositions of sediment and clay (main components)

	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	Na_2O + K_2O
Sed.	45,4	13,8	6,1	7,9	4,9	3,8
Clay	61,6	16,4	6,7	0,5	0,9	2,8

Furthermore, density after firing decreases while water absorption increases (Fig. 1). Only when 50% of sediment is added are the mechanical properties notably lowered; the compressive strength of brick-making clay was 33 MPa, compared to 32 MPa when 30% of sediment was added, decreasing to 25 MPa when the mixture contained 50% sediment.

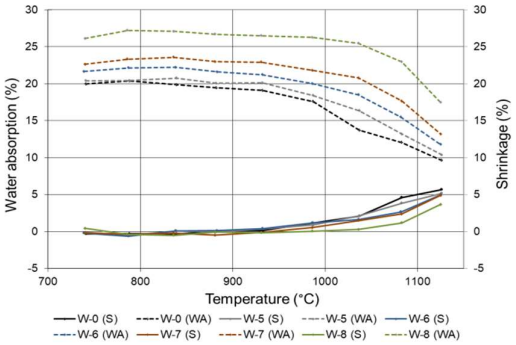

Fig. 1: Water absorption and shrinkage with respect to firing temperature for the reference sample (brick making clay; W-0), and for samples with 10, 20, 30 and 50 % sediment added (W-5, W-6, W-7, and W-8, respectively).

Discussion: Laboratory results confirmed the potential of sediment to be directly used in the clay brick sector. These findings will enable further planning of the upscaling process and evaluation of results from a technological point of view.

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References: [1] Samara et al. (2009) *J. Hazard. Mater*. 163, 701–710. [2] Mymrin et al. (2017*) J. Clean. Prod.* 142, 4041–4049. [3] Hamer et al. (2002) *Waste Manag.* 22, 521–530. [4] Chiang et al., (2008) *J. Hazard. Mater.* 159, 499–504 (2008).