Leaching environmental assessment framework for the potential reuse of dredged sediments in concrete

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Introduction: Due to their environmental characteristics (trace element and organics concentrations), sediments dredged from seaport have to be managed onshore. In France, dredged sediments are considered as wastes and their reuse as secondary aggregates is allowed if there is no risk for environment. In this context, a French Industrial Research Chair on the circular economy of sediments was launched in 2014 to established environmental, technical, and economics criteria for sediment reusing [1]. In this research, the studied scenario consists of substituting a percentage of marine sand by seaport sediments in the preparation of concrete intended in bicycle path construction [2]. The aims of this research are to characterize toxic substances released by sediment-based concrete and to enhance the relevance of a medium-scale experiment. To increase the concrete technical performances, the selected sand replacement rate is about 50%, and two adjuvant rates are tested (0.5% and 3%).

Methods: The experimental methodology follows guidelines published by SEDIMATERIAUX (French national program) [3]. In a first step, the dredged sediment used was characterized, and then it was used in substitution of sand to produce concrete that was cured for up to 90 days. Then, a sample of concrete was transformed as granular materials (three aliquots with particle sizes ranging from 0 to 0,125 mm, 1 mm and 4 mm) and other cutting in 4 cm in a side cubes. Batch and dynamic monolithic leaching tests were carried out on granular and cubic monolithic samples, respectively. Batch leaching tests were conducted according to the NF EN 12457-2 [4] protocol and whereas dynamic monolithic leaching tests were tested according to the NF EN 15863 [5] standard. Medium-scale experiments were carried out during 6 months on large concrete samples (foundation layer block: 65 cm x 30 cm x 43 cm; road surface block: 65 cm x 15 cm x 43 cm). Experiments were designed to allow to simulating water immersion for foundation layer blocks and the water runoff for road surface blocks (Fig. 1).

Results and discussion: Based on national technical guidelines published by SETRA [6], the control concrete (C0) and sediment-based concrete samples (50% sand replace by sediment and 0.5% of adjuvant (C50-1) and 3% of adjuvant (C50-2)) are considered as inert materials. Although chlorides and sulfates levels found in elutriate samples exceed the national thresholds, the compliance with the soluble fraction parameter allows the materials to be consider as inert.

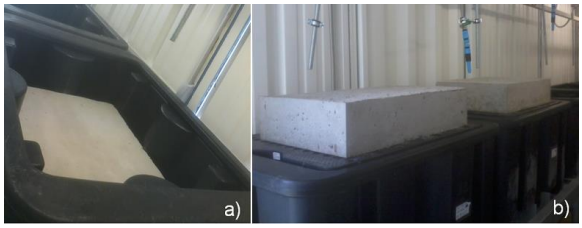

Fig. 1: Photograph of experimental set up allowing simulating a) water immersion for foundation layer blocks b) water runoff for road surface blocks

Dynamic monolithic leaching tests and medium-scale experiments allowed checking the low leaching rates of pollutants in the water and identifying diffusion phenomena as the main leaching mechanism.

To complete this study, it will be necessary to study the effects of pH variation according to Leaching Environmental Assessment Framework Test Methods [7] and to complete the modelling approach.

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