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Development of an Ecological Binder by Geopolymerization of Untreated Dredged Sediments

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Abstract : Theevolution of the global environmental context incites companies to reduce their impact by reusing local materials and promoting circular economy. Dredged sediments represent a potential source of materials due to their large volume. Indeed, the dredging operations carried out in Gironde alone generated an annual volume of sediment of approximately 9 million m^3. Moreover, on the eve of the evolution of laws concerning dredging practices, the recovery of sediments is necessary to create a viable economy for their management. This thesis work is oriented towards the development of an ecological binder from the fine fraction of untreated dredged sediments. In fact, their physico-chemical properties make them favorable for the synthesis of geopolymer, current competitor of cement, thanks to its lower carbon footprint and environmental impact. However, several obstacles must be overcome before implementing this new family of materials: the use of sediments without thermal or chemical treatment, the absence of a formulation approach, ignorance of the reactions produced, etc. During the first year of the thesis, a physico-chemical characterization of the sediments made it possible to validate their use as precursors forgeopolymerization according to three criteria: their fineness, their mineralogical composition, and the percentage of amorphous phase. Following these results, several formulations have been defined, taking into account the environmental impact. The sediments were activated with an alkaline solution of sodium hydroxide and sodium silicate. Two other formulations with cement and blast furnace slag have been defined for comparison. The results highlighted the possibility of forming geopolymers from untreated and still wet dredged sediments. The development of structural bonds through the formation of hydrated sodium aluminosilicate thus leads to higher strengths at 90 days (4.78 MPa) than a mixture with cement (0.75 MPa). A 30% gain in CO_2 emissions has also been obtained compared to cement. In order to reduce the uncertainties linked to the absence of a formulation approach, to optimize the number of experiments to be carried out in the laboratory, and to obtain an optimal formulation, an analysis by mixing plan was conducted in order to frame the responses according to the proportions of the constituents. Following the obtaining of an optimal binder, the work will focus on the study of the durability and the interspecific variability of the sediments on the mechanical properties by testing the binder developed with different sediments dredged from the Bordeaux estuary. , the Grand Port Maritime of Bayonne, La Rochelle, and the Bassinsd'Arcachon.

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