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Use of oyster shell (*Crassostrea gigas*) as aggregate replacement for producing environmentally-friendly concrete

Context and Objectives:

Due to the depletion of resources, by-products claims the attention to be reused or reincorporated in other materials. Cementitious materials are on the top of the list of the most consumed materials leading to high demand for raw materials. Oyster shell farming activity generates a high amount of waste (shells) from the process of maintenance and cleaning of farming areas. In addition, the shells represent over 70% of oyster weight leading to over 700 kilograms of waste per tonne of production. One of the problems of using crushed oyster shell as aggregate in cementitious materials is due to the flaky and elongated particle shape that can be tricky on the granular arrangement. To tackle the particle shape problem, it is necessary to optimise the granular skeleton in order to promote a better particle packing for the OS. Therefore, the first task of this thesis was to optimise the oyster shell granular skeleton in order to decrease the percentage of voids of the aggregate mxiture. In sequence, a 100% oyster shell and conventional concrete were developed and their mechanical and durability properties were studied. Performantial approach can be made used to compare these two concrete performances. To provide an environmental assessment, the Life Cycle Assessment methodoloy will be used to evaluate the potential environmental impacts of both concretes.

Results and Discussion:

The first part of the thesis was focused on the study of the granular skeleton arrangement. Mixture design was used to combine particle classes into ternary mixtures in order to decrease the percentage of voids. Particle classes were mixed from the largers classes towards the smalers ones. The results allowed to decrease the percentage of voids at every and each round of optimisation. In the sequence, the concrete formulation was studied and two concrete formulations were tested: 1) Reference concrete with sand and gravel and, 2) Oyster shell concrete with 100% of coarse and fine aggregate replacement. The second part of the thesis is dedicated to the analyse of the performances of these concretes in terms of mechanical properties and durability. This analyse will be carry out based on the performantial approach guidelines.

The third and final part of the thesis will concentrate under the analysis of the potential environmental impacts due to the production of $1m^3$ of oyster shell and reference concrete in a concrete plant based in Arcachon, France. The Life Cycle Assessment (LCA) is the chosen methodology and will allows to identify potential improvements in the process of these concretes production in order to decrease the environmental impacts due to transportation and resources extraction.