Incorporating industrial side streams in sustainable cement

(Proposer: Prof. Luca Valentini)

Currently, the yearly rate of raw materials extraction amounts to approximately 100 billion tonnes, 40% of which being constituted by industrial minerals. Mining and quarrying activities have a tremendous impact on the environment, moreover the significant amount of waste generated during the processing of raw materials exerts a strong pressure on landfill facilities. To mitigate such impacts, it is necessary to significantly reduce primary extraction, by increasing the amount of reutilization of materials classified as waste or by-products. Building materials play a central role in this scenario, since: a) the large majority of sourced industrial minerals are incorporated in the construction industry; b) construction and demolition waste accounts for more than a third of all waste generated in the EU. On the other hand, construction materials represent an ideal sink for the upcycling of different side streams.

This PhD project will address such issues by implementing strategies aimed at utilizing waste obtained by processes such such as construction and demolition, and municipal solid waste incineration, in alternative cementitious binders. This approach can potentially both reduce the amount of virgin raw materials sourced for cement production, and mitigate the environmental footprint associated with the production of conventional cement.

The specific aims of this project include:

- thorough characterization of the adopted waste materials;
- formulation of binders comprising reduced amounts or zero Portland cement, based on statistical methods;
- kinetic and thermodynamic study of the reactions associated with cement hydration and degradation;
- quantification of the reduced environmental impact, based on Life Cycle Assessment (LCA).

The results of this project can have significant impact towards a more rational use of mineral resources and the mitigation of CO_2 emissions associated with the cement industry.

Possible collaborations: University of Ferrara; Holcim; Østfold University College; NOAH

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