Project CO2REDCEM

"Recycling of gravel wash mud for manufacturing CO_2-reduced cement"

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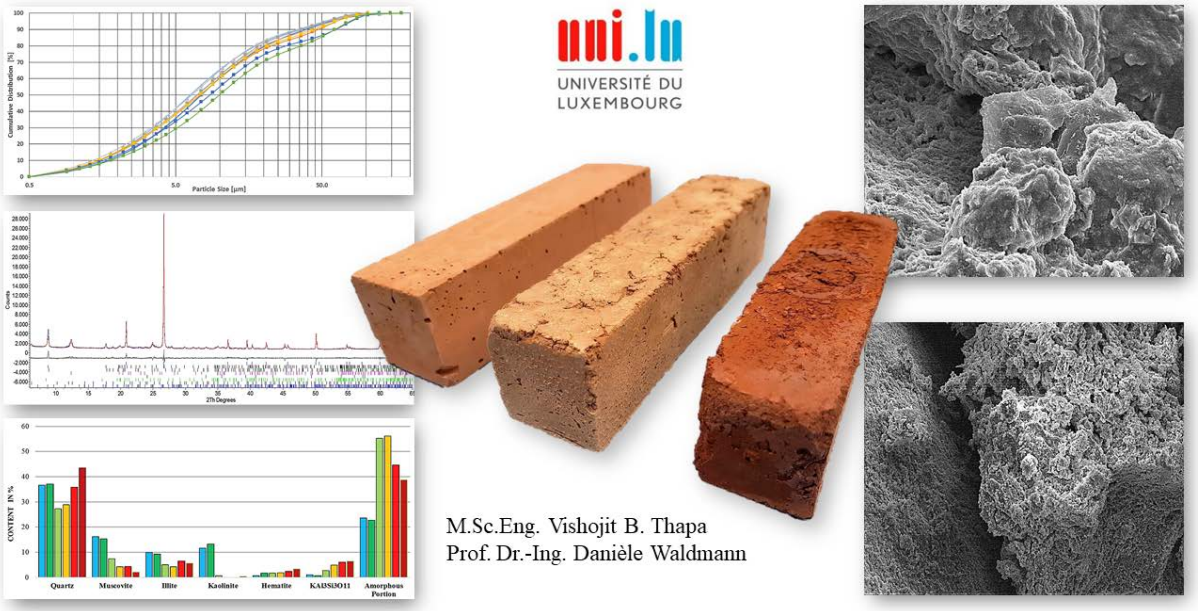
Concrete figures among the most widely used construction material in the world and statistics point out that up to 8 % of the annual CO_2 emissions worldwide result from cement industries. Currently, the suitability of alternative raw materials and concepts as potential cement clinker replacements is highly discussed. The demand for such a cement substitute or replacement has enormously risen as the production of Ordinary Portland Cement (OPC) clinker involves high thermal activation of clay and limestone by sintering at temperatures above 1400ºC.

Considering these circumstances, this research project carried out at the University of Luxembourg, in collaboration with different industrial partners, aims at reducing the generation of CO_2 emissions during cement production by minimisation of the use of cement clinker or complete replacement by new binder compositions and concepts. In this project, the raw material used is gravel wash mud (GWM), which occurs as a waste product from gravel mining. This clayey mud is collected from a sludge reservoir, located in the North West of Luxembourg. At present, this waste product is landfilled without any further use. However, this prime material offers very promising properties, which require thorough characterisation before its revalorisation for the substitution of cement.



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Reusing or recycling of waste elements into goods has been among the greatest ambitions of our and earlier generations and it will take a more important role in future economy. One primary goal of this project is to replace the “end-of-life” concept of gravel wash mud by reusing it as a new raw material. This endeavour will bring double benefit to environment as the waste is prevented from landfilling and it is revalorised as a prime resource in another system. Currently, three different binder concepts are examined to assess the performance of the prime material within these binder reaction mechanisms:

- **Alkali-activated binder:** A cementless binder is synthesized by alkaline activation of processed and calcined GWM powders. The reduction of CO_2 emissions is achieved by the calcination process of clayey gravel wash mud, which requires less thermal treatment and thus lower energy consumption than normal cement production.

- **Substitution of OPC by calcined GWM powders:** Concrete mixtures based on partial replacement of Portland cement by calcined GWM powders. This study includes the investigation of the reaction mechanisms and an optimisation of the mixtures regarding the rheological properties of the fresh cement paste.

- **Cementless concrete mixtures containing GWM:** Concrete mixtures without cement are developed using GWM and other constituents, classified as industrial by-products. This research includes the mineralogical and microstructural characterisation of the constituents, the understanding of the reaction mechanism, the optimisation of the mixtures to enhance the

performance of the novel concrete and an understanding of the short-term and long-term concrete properties.

One important objective of this project consists in the development of a sustainable concrete formulation with optimal mechanical and thermal properties. Finally, further steps of this project comprise in large-scale tests, analysis of long-term concrete behaviour and a life-cycle assessment to confirm the development of a new, ecologically friendly and high-quality building product.

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