TECHNISCHE UNIVERSITÄT DARMSTADT
Institut für Werkstoffe im Bauwesen

Proposal for Thesis in Bachelor/Master

Can we infinitely recycle lime-based mortars? An experimental approach for sustainable design

Lime is one of the earliest industrial commodities known to man and fundamental in many industrial value chains, environmental applications, agriculture and, particularly, in the construction industry, representing about 18% of the entire market.

Considering that constructions make possible the economic growth and development of our society as we know it, there is a continuous need for improvements on building materials. Among these materials, lime-based mortars have been used in the masonry construction as joint in between bricks and blocks. As enabling material, when compared with cement, some of the benefits of using lime-based mortars include low water penetration, increased breathability and moisture control, increased bond strength, reduced cracking due to dissolution-precipitation of $CaCO_3$ and a lower carbon footprint.

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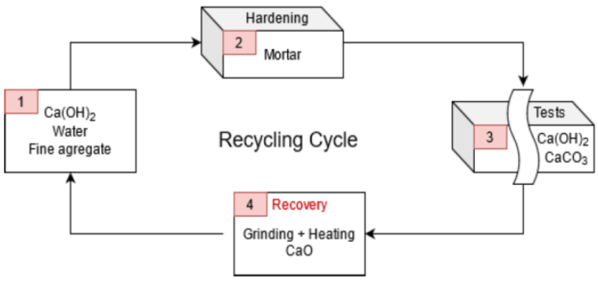
A couple of decades ago, the main focus of any research in the area was on the design properties of the material (e.g. physic-chemical and mechanical behaviour). However, the current environmental crisis has tightened the boundaries for the new generation of building materials. Nowadays, it is no longer enough to fulfil technical characteristics but also economic and environmental criteria are key to ensure the feasibility and acceptance of the **sustainable design** of any material. Within this framework, the "lime cycle" opens up a door to consider that, theoretically, lime mortars could be infinitely recycled once they have fulfilled their service life.



There is also room for improvement of these materials by replacing part of the hydrated lime by other residues/by-products such as waste glass or calcined clays, that due to its pozzolanic behaviour in a highly alkaline environment can improve the properties of the final product. However, **the practical feasibility of this solution as well as the physic-chemical quality of the "renewed" mortar at the end of the recycling cycle must be experimentally addressed**. To achieve this, the following activities are considered

1. Literature research covering the topics: lime cycle, hardening process & chemical reactions of lime-based materials, lime-cement mortars, natural and artificial pozzolans, availability of residues compatible with lime.
2. Chemical and physical characterization of the raw materials selected for the study (chemical composition, mineralogical phases, proportion of amorphous phases, density, morphology, particle size distribution, etc.).
3. Mix design of the mortars including two references (lime, cement-lime) and recycled materials compatible with the studied system.
4. Studies over pastes and mortars at accelerated carbonation conditions: early age behaviour (isothermal calorimetry), analysis of the reaction products (XRD, FTIR, DTA/TGA, SEM) and the mechanical behaviour of the mortars (compressive strength) at each step of the recycling cycle.
5. Critical assessment of the change on the properties of the studied mortars while increasing the number of recycling cycles.