

Biobased Recycled and Engineered Concrete Aggregates

Study on the development of Biobased Recycled and Engineered Concrete Aggregates (BRECA) using combined microbial-induced calcium carbonate precipitation and layered nano-silica deposition

Background

The construction sector can help address environmental challenges by reducing material extraction and waste, especially through recycling concrete from construction demolition waste (CDW). However, recycled concrete aggregates (RCA) have reduced strength and durability due to cracks and pores in the adhered cement mortar, limiting their use as a substitute for natural coarse aggregates (NCA). Removing the old mortar is costly and environmentally unfriendly. While eco-friendly methods, such as microorganism-based processes, show some improvement, significant challenges remain to make RCA a viable alternative for widespread use.

The Idea and Approach

This research aims to study on the development of an innovative technology called Biobased Recycled and Engineered Concrete Aggregates (BRECA), designed to transform RCA into an environmentally friendly and sustainable construction material. The proposed approach integrates nano-silica and bacteria-based processes to effectively fill the pores and cracks on the RCA surface with denser forms of calcium carbonate (CaCO_3). To achieve the goal of developing BRECA, the research will address the limitations of current state-of-the-art methods for improving RCA's mechanical and durability properties. An in-depth understanding of the underlying mechanisms at the micrometer-scale is essential; therefore, precise imaging techniques and data analysis will be employed to trace and quantify the products of bacterial activity at such a small length scale. This will guide the optimization of the process parameters for developing BRECA. The effectiveness of BRECA in improving the mechanical characteristics and durability of concrete will be evaluated and compared with natural coarse aggregates (NCA) based on mechanical properties.

Research Impact and Knowledge Sharing

If successful, BRECA technology could transform the construction industry, waste management, and support a circular economy. Positive outcomes may lead to a life cycle assessment, large-scale global use, and reduction in mining, with potential for other CDW materials like recycled brick aggregates. Results will be shared through Open Science journals and international conferences.

Timeline, Location, and Key Personnel

The project, funded by COWIfonden (reference no. A-167.11), is scheduled to begin in December 2025 and run until February 2027. It will be led by Dr. Noushad Bin Jamal, in collaboration with Assoc. Prof. Alexander Michel from the Technical University of Denmark's (DTU) Environmental and Resource Engineering Department.