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DETOCS Newsletter

Data **E**nabling **T**ransformation and **O**ptimization towards **C**oncrete **S**ustainability

DETOCS

Here's what has happened in the last quarter and what's to come!

Welcome to the quarterly DETOCS newsletter! We are excited to share the latest project milestones, details of training events, and give our doctoral candidates the opportunity to shed some light on their ongoing research.

A project meeting was held in August to discuss the progression of the individual projects with all of the project partners and collaborators. The last quarter has seen DCs shift their focus drafting publications and wrapping up their theses. One of the journal was recently published in Journal of Industrial Ecology, titled **"Toward process-based inventory data for Portland clinker substitutes"**, authored by DC15 (Pippa Edwards) and her collaborators.

The DCs have also continued attending conferences, including the 22nd International Conference on Building Materials (IBAUSIL) in Weimar, Germany and the 2nd International Conference on Mineral Carbonation of Cement and Concrete in Tokyo, Japan. This issue also contains accounts of the DCs' experiences at these conferences, as well as a description of the work that they presented there.

Enjoy this quarter's newsletter!

— Sruthi Sreeram, DC3

In this newsletter you will be briefed on:

Toward process-based inventory data for Portland clinker substitutes (*P. Edwards, DC15*)

22nd International Conference on Building Materials (*M. Cipriano, DC4*)

2nd International Conference on Mineral Carbonation of Cement and Concrete (*S. Sreeram, DC3*)

Toward process-based inventory data for Portland clinker substitutes

Pippa Edwards, DC15

We are pleased to share our new article, published in the Journal of Industrial Ecology, which tackles a critical bottleneck in the drive to decarbonize the cement industry. Clinker substitution is one of the most cost-effective levers for decarbonising cement, and a wide range of substitute materials and processes are under investigation to increase substitute supply. However, the life cycle assessment (LCA) community has lacked consistent, high-quality, process-level data on how these substitute materials are produced.

Our study addresses this gap directly. We reviewed 188 articles and compiled 36 sets of inventory data covering eleven of the most frequently investigated substitute materials. Inventory data were disaggregated into 57 unit-process datasets such covering processes such as calcination, drying, milling, crushing, and quarrying, with the intent that these datasets can be used flexibly as proxy data for new materials and process arrangements. Using a pedigree-matrix quality assessment, we found that many existing datasets are outdated (over half exceed 15 years old) or incomplete, and that verified operational data for newer materials like calcined clay is still missing entirely, despite 14 facilities now operating worldwide.

Applying this new inventory to life cycle calculations, we found that all clinker substitute production processes had lower carbon footprint than conventional clinker production, by at least ~50%. Thermal processes like calcination carry by far the highest carbon footprint, while mechanical processes are comparatively low-impact. However, the overall degree of clinker substitution in a cement blend matters far more for reducing its carbon footprint than which particular substitute material is used or how intensively that material is processed. This means that even higher-footprint substitutes, such as calcined clay, can still yield lower-carbon cements overall when they enable a lower clinker content. We hope this open dataset will improve the transparency of future LCA studies, support verification of commercial environmental claims, and help guide technology investment across the concrete value chain.

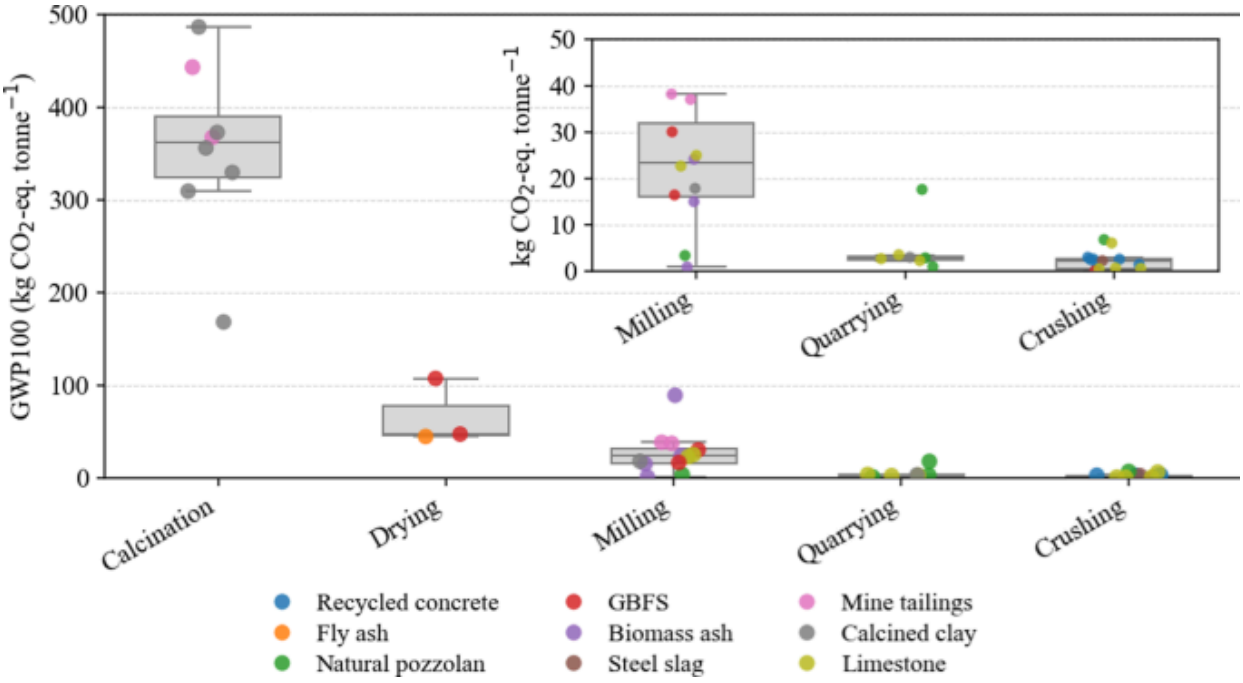


Figure: Gate-to-gate carbon footprint of frequently occurring unit processes (calcination, drying, milling, quarrying and crushing) for processing clinker substitutes with respect to European production conditions. Inset used to improve visualisation of processes with median GWP100 <50 kg CO_2-eq. tonne. The horizontal line inside the boxes indicates median values. The lower box border indicates the lower quartile (25th percentile), and the upper box border indicates upper quartile (75th percentile). Error bars extend to 1.5 times the interquartile range. Dot points represent individual unit process datasets, coloured by material per the legend. (Source: https://doi.org/10.1007/s44498-026-00186-x)

22nd International Conference on Building Materials: A Summary

Marcelly Pires de Sousa Ramos Cipriano, DC4

The 22nd International Conference on Building Materials (ibausil) took place in September 2026 in Weimar, Germany. During the conference, I had the opportunity to present our paper entitled “Energy-based evaluation of a mechanically activated kaolinite-rich clay” developed in collaboration with researchers from RWTH Aachen University, TU Braunschweig, and Fuller Technologies as part of the DETOCS project.

My research focuses on mechano-chemical activation (MCA) of clays as a potential route to produce reactive supplementary cementitious materials (SCMs) for low-carbon cement systems. While high-energy milling can significantly enhance clay reactivity, understanding how mechanical energy translates into structural disorder and pozzolanic activity remains a key challenge. Addressing this knowledge gap was the main motivation behind this work.

In this study, we investigated a kaolinite-rich clay activated under different planetary milling conditions. A kinematic model was used to estimate milling energy and correlate it with structural changes and pozzolanic reactivity, assessed using the R^3 test. The results showed that while increasing milling energy progressively promoted amorphization, reactivity followed a non-linear trend, approaching a plateau at higher energy levels. This highlights that the extent of amorphization alone cannot fully explain clay reactivity, suggesting that the nature of the structural defects generated during milling also plays an important role. These findings provide a basis for optimizing MCA processes, where increasing energy input does not necessarily lead to proportional reactivity gains, an important consideration for industrial applications.

This was my first presentation at an international scientific conference, so the experience was particularly meaningful to me. I was honoured to share my research with the scientific community! The interest shown by the audience reinforced the relevance of my work. Besides, attending other sessions allowed me to recognize how our findings connect with ongoing research in the field while offering a distinct contribution, which gave me more confidence in the direction of my doctoral research.

Finally, I would like to thank my co-authors, Elsa Qoku, Wilson Ricardo Leal da Silva, and Thomas Matschei, for all their support throughout this work.



Energy-based evaluation of a mechanically activated kaolinite-rich clay - Cipriano - 2026 - ce/papers - Wiley Online Library

2nd International Conference on Mineral Carbonation for Cement and Concrete

Sruthi Sreeram, DC3

From the 27th to the 30th of September, I had the joy of attending the MC3 conference in Tokyo, Japan. For the three months before that, I was inundated with curious enquiries on how excited I was to go to Tokyo. I barely answered any of those questions. Have you ever done rheological experimentation with finicky and variable industrial by-products and wastes? *Excited* does not begin to capture the feeling of lifting a cone and getting the exact flow spread you were aiming for. (It's almost like the frustration of every failed trial before that just evaporates from your memory. *Almost*.)

Giving one of two presentations that addressed the topic of rheology during this conference, I joked to my colleague that rheology is like the middle child of carbonated materials: often forgotten despite its indispensibility. My presentation described a study we conducted comparing uncarbonated and carbonated SCMs, specifically whether they suffered an initial loss of fluidity or flow loss over time, and how they differed in terms of superplasticizer demand. The two classes of materials under consideration were recycled concrete pastes (RCPs) and basic oxygen furnace (BOF) slags. Increases in initial yield stress that held steady over the studied time period were indicated across the board, with the yield stress increases showing a close correlation with the carbonation uptake. It was water demand at fault, not flow loss over time. However, when considering the superplasticizer it took to reduce the yield stress down to a chosen value, a curious result emerged: that the RCPs didn't actually see a practically significant change in superplasticizer demand, while the demand more than doubled for the carbonated BOF slags. Most of the time, we love to point our finger at the increase in specific surface area when we encounter an increase in water demand, but that was not a sufficient first-order explanation this time due to a lack of correlation. What could potentially be blamed instead was the water absorption by the SCM itself. While the water absoprtion of the RCPs didn't change much after carbonation, there was a sharp increase with the BOF slags, in line with the trend of the required PCE dosage. It offers a simple first-order explanation to some of our rheological problems, but still requires further investigation.

The conference was an enriching time, with its niche topic and enthusiastic researchers with an array of opinions of which carbonation technologies will be most impactful towards cement decarbonanization. The best part about working with a younger technology is sifting through the many questions of scientific curiosity to get down to what matters: increasing compressive strength. (Jokes aside, I was really grateful for the opportunity to get to attend this wonderful conference. Thank you Tim, Isabel and Wilson!)





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Thank you for reading!

Contact us!



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