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DETOCS Newsletter

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

ENTREPRENEURSHIP TRAINING SCHOOL, ROTTERDAM, NOV 2025

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.

Happy 2026, folks! To another year working consistently towards a better and more sustainable future for everyone across the globe. A lot has happened since the last edition of this newsletter. Everox hosted an incredible training school in Rotterdam where the DETOCS Doctoral Candidates (DCs) had a dazzling introduction to the world of entrepreneurship, complete with extensive sessions and hands-on activities involving product management, pitching, and funding. The lectures by Thomas Petithuguenin, Martin Paterson, Oleg Baranov, Deborah Kuenne, and Quentin van Driel fostered an engaging and open environment for discussion and insights into the world of entrepreneurship. The week was complete with a session on the very last day where teams of DCs had the opportunity of pitching their own start-up ideas to a panel of investors!

The fourth DETOCS project meeting was also held during the same week, where supervisors and students gathered to share and discuss the progress made on the projects so far. As most of the students have passed the halfway mark on their projects, their work is now yielding exciting results that they are eager to disseminate. Various DCs attended the 5th International Conference on Calcined Clay for Sustainable Concrete in Cape Town, South Africa, and the Gordon Research Conference on The Contributions of Concrete Materials and Structures to Achieve the UN Sustainable Development Goals in Lucca, Italy, to present their work. Their experiences at these conferences have been detailed in this edition.

Enjoy this quarter's newsletter!

— Sruthi Sreeram, DC3

Contributions to the 5th International Conference on Calcined Clay for Sustainable Concrete (ICCCSC)

Cape Town, South Africa

Sandra Mujombi, DC13:

At ICCCSC conference in Cape Town, I presented two papers on the assessment of calcined clay reactivity for use as a supplementary cementitious material in low-carbon cement systems. Both studies addressed a practical limitation in this field: although calcined clays are increasingly important for reducing clinker use, a major limitation of current reactivity assessment methods is the excessive time required for testing and evaluation (1 to 28 days). The extended testing periods fall short when it comes to providing quick feedback, which is crucial for large-scale industry applications.

The first paper examined how different rapid tests can be combined to predict the 28d compressive strength in LC^3 (Limestone Calcined Clay Cement) systems. The work focused on developing an integrated framework that captures several aspects of calcined clay behaviour within a 24-hour period. The intrinsic dissolution potential of the clays was measured using the UR^2 (Ultra Rapid Reactivity) test, which quantifies dissolved aluminium and silica within minutes. Aluminate-sulfate interactions were investigated through sulfate depletion time in a clinker-free model system using isothermal calorimetry, while early pozzolanic reactivity was assessed from cumulative heat release in the R^3 (Rapid Relevant and Reliable) test over 24 hours. These methods were applied to natural clays calcined at 600 and 800 °C, and the resulting data were used in a multivariable regression model to predict 28-day compressive strength. The study showed that combining these complementary methods provides a rapid basis for estimating the performance of LC^3 blends, with potential value for rapid screening and quality control in industrial settings.

The second paper, a case study, focused on process control and the feasibility of using the UR^2 test as an at-line tool in clay calcination. A natural clay was calcined in a pilot-scale flash calciner between 825 and 925 °C under both oxidising and reducing conditions, and additional laboratory-scale calcination extended the temperature range down to 550 °C. The samples were evaluated using UR^2 and the Strength Activity Index (SAI), with a subset also tested by R^3. Across the full range of calcination conditions, the UR^2 results correlated strongly with both SAI and R^3. This relationship was maintained when laboratory and pilot-scale data were considered together, including materials with different maximum particle sizes. The results indicate that, with controlled sample preparation, the UR^2 test can serve as a robust and rapid method for monitoring calcined clay reactivity and assessing material quality before full-scale production decisions are made.

Taken together, the two presentations contribute to the development of faster, more practical approaches for the use of calcined clays in low-carbon cement production.

Thorsten Kalb, DC11:

Cement quality control is essential to reduce operational costs and ensure consistent product performance. With the growing adoption of Limestone-calcined clay cement (LC3) as a more sustainable alternative to ordinary Portland cement, new challenges arise. LC3 contains four materials with very different levels of hardness, which complicates quality control in the cement mill: soft materials risk being over-ground while hard materials risk being under-ground. On top of that, fluctuations in properties of four materials add complexity to process control, ultimately affecting the cost of production.

In February, I presented a solution to this problem at ICCCSC in Cape Town: Explainable Machine Learning for LC3. In this work, we leverage Machine Learning (ML) to predict 28-day Compressive Strength of LC3 from chemical and physical cement properties on an industrial dataset. Our ML models reduced prediction errors by 26-31% compared to a non-ML baseline; beyond performance, explainability techniques let us watch these models work. Combining forecast and explanation, cement plant operators can adjust processes earlier and maintain high product quality at lower cost. This is a use case where AI does not replace humans but supports them to take informed decisions based on data. This publication was written together with Ismael Kinoti (DC5).

I appreciate the positive feedback from an interested audience. The discussions confirmed something I find important: data scientists and cement experts need each other. Good data science starts with understanding the data, but real impact comes from informed end users who understand what ML can and cannot do. I contributed to this process in Cape Town in two ways: by attending a cement conference as a data scientist – and listening. And by introducing the general concept of Machine Learning in my presentation – simple, but accurate and without buzzwords.

Dhanush Sahasra Bejjarapu, DC8:

The work I presented at the ICCCSC was titled “Towards a testing framework to characterize chloride resistance of concrete based on cement paste-scale tests”. Replacing clinker with supplementary cementitious materials (SCMs) is one of the successful strategies available for a widespread reduction of the clinker factor, thus reducing the carbon footprint in cement. Although several studies in the past focused on the mechanical performance of clinker substitution, there are questions regarding the rapid assessment of long-term durability performance of a given cement composition. Most of the durability testing standards prescribe tests at the concrete scale, while durability of concrete is strongly dependent on the binder composition. Hence, this study aims to propose a testing framework to characterize concrete-scale chloride resistance from cement paste-scale tests, thereby reducing the number of variables to be tested and allowing for quicker adoption of novel low-carbon blends. Accelerated steady-state migration and bulk resistivity tests were conducted at paste scale on a diverse set of binders, including SCMs such as fly ash, slag, natural pozzolan, limestone, calcined clay, and recycled concrete fines. In addition, non-steady state migration coefficient at concrete scale was also characterized using Rapid Chloride Migration Test (NT Build 492). Overall, this study aims to develop a testing framework, where the chloride resistance of cement paste and concrete scales are linked together, thereby facilitating the development of low-carbon durable cement blends.

Since my project concerns durability characterization, I enjoyed some conversations with the experts of durability, and tried to sell my hypothesis to them. I realized that I need to gather more experimental evidence, especially through concrete microstructure characterization to validate my hypothesis. I personally enjoyed the keynote talks the most. These talks debunked some thoughts about calcined clays being "solved", by showing the unexplained influence of iron impurities in clays, leaving me more hope (and areas) to work as a researcher.

Wang Qun, DC2:

At the ICCCSC, I presented my work on developing a kinetic modeling study on kaolinitic clay dehydroxylation. Accurate kinetic modeling of kaolinitic clays' dehydroxylation is vital for process modeling and quality control of kaolinitic clay calcination process. However, the dehydroxylation mechanism is not fully resolved, and reported kinetic parameters are highly variable. Under this background, this study examines the dehydroxylation kinetics of two kaolinitic clays using thermogravimetric experiments at different heating rates. The resulting conversion curves were analyzed by non-linear regression with an nth-order reaction model. The results show that the nth-order model can fit and generalize the dehydroxylation behavior of kaolinitic clays under linear heating conditions below 80 °C/min. The two clays show similar pre-exponential factors and activation energies, but they differ in reaction order, suggesting different apparent rate-controlling steps of dehydroxylation. In addition, particle-size fractionation experiments show that coarser fractions dehydroxylate more slowly, confirming that particle size affects the apparent dehydroxylation kinetics. Overall, the study uncovers the complexity in kaolinitic clay dehydroxylation kinetics, providing a practical route to obtain reliable dehydroxylation kinetic models for diverse kaolinitic clays, and narrowing the gap between lab-scale experimentation and full-scale calcination process simulations.

The conference was a truly fruitful, exciting, and unforgettable experience, and I was able to listen to and be a part of many inspiring talks and discussions with leading experts and researchers in calcined clays and low carbon cements. Cape Town is a beautiful city with great weather, and an amazing trip to Table Mountain made the experience even more special. I am thankful to my supervisors and the conference organizers for creating such an excellent opportunity and platform for collaboration and knowledge sharing.

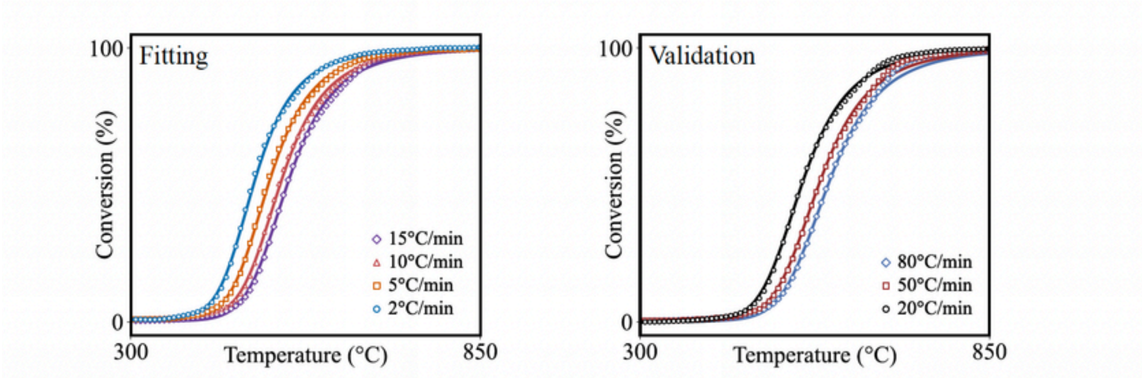

Figure 1:
A Kinetic Modeling Study on Kaolinitic Clay Dehydroxylation

Participation in the Gordon Research Conference (GRC) on The Contributions of Concrete Materials and Structures to Achieve the UN Sustainable Development Goals

Lucca, Italy

Pippa Edwards, DC15 and Sruthi Sreeram, DC3:

We are pleased to share our attendance at the recent Gordon Research Conference (GRC) for Advanced Materials for Sustainable Infrastructure Development, held in February in Lucca, Italy. The GRC was chaired by Dr. Rupert Myers (Imperial College London) and Dr. Liberato Ferrara (Polytechnic University of Milan), and brought together a diverse group of researchers and industry professionals from across cement and concrete research worldwide, providing a valuable platform for collaboration and knowledge exchange.

A highlight of the GRC format is the presentation of cutting-edge and unpublished research, prioritizing time for discussion after each talk and fostering informal interactions among scientists of all career stages beyond the formal program. The conference centred on the critical role of infrastructure in supporting human well-being, particularly in the context of global challenges such as population growth, urbanisation, and the need to renew ageing infrastructure. There were a range of insightful sessions, covering sustainable concrete materials, processing of clinker, cement and SCMs, and alternative cement and concrete technologies – all of which are key focus areas for the DETOCs program. These discussions offered fresh perspectives on emerging trends and challenges in concrete (and infrastructure) sustainability.

Beyond the formal sessions, the conference offered a wonderful opportunity to connect with colleagues in a more relaxed setting. Attendees had the chance to explore Lucca together, with additional organized excursions to encourage open conversation across research groups and career stages. The GRC's deliberate blend of structured discussion and informal exchange is what made it such a uniquely productive environment for the research community.

We look forward to applying insights from the GRC to our work in DETOCS!

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Thank you for reading!

Contact us!

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