

High-Strength Biomineralized Construction Materials and Fertilizers out of Urine

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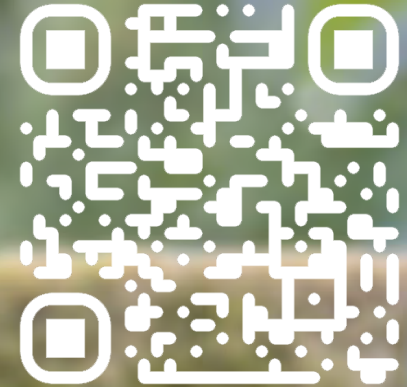
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Industry Partners:

Kuhn GmbH, Cavity GmbH, Stuttgart Airport, The Research Association for the Sand-Lime Brick Industry

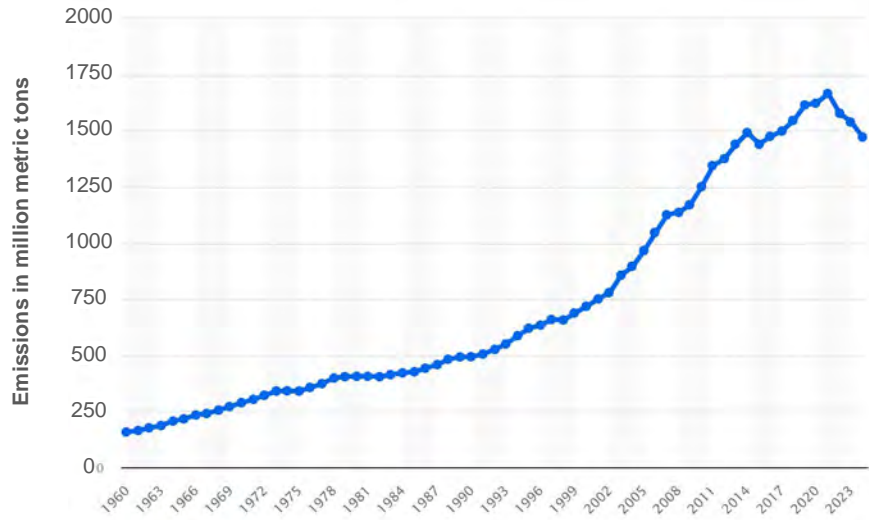


1. Introduction & motivation
2. Method
3. Findings of the project
4. Urine collection in real life setups

1. Introduction and motivation

1. Introduction & motivation

CO₂ emissions from Portland-cement production



Worldwide; Global Carbon Project; Expert(s) (Friedlingstein et al. (2023), Andrew and Peters (2023).); 1960 to 2024

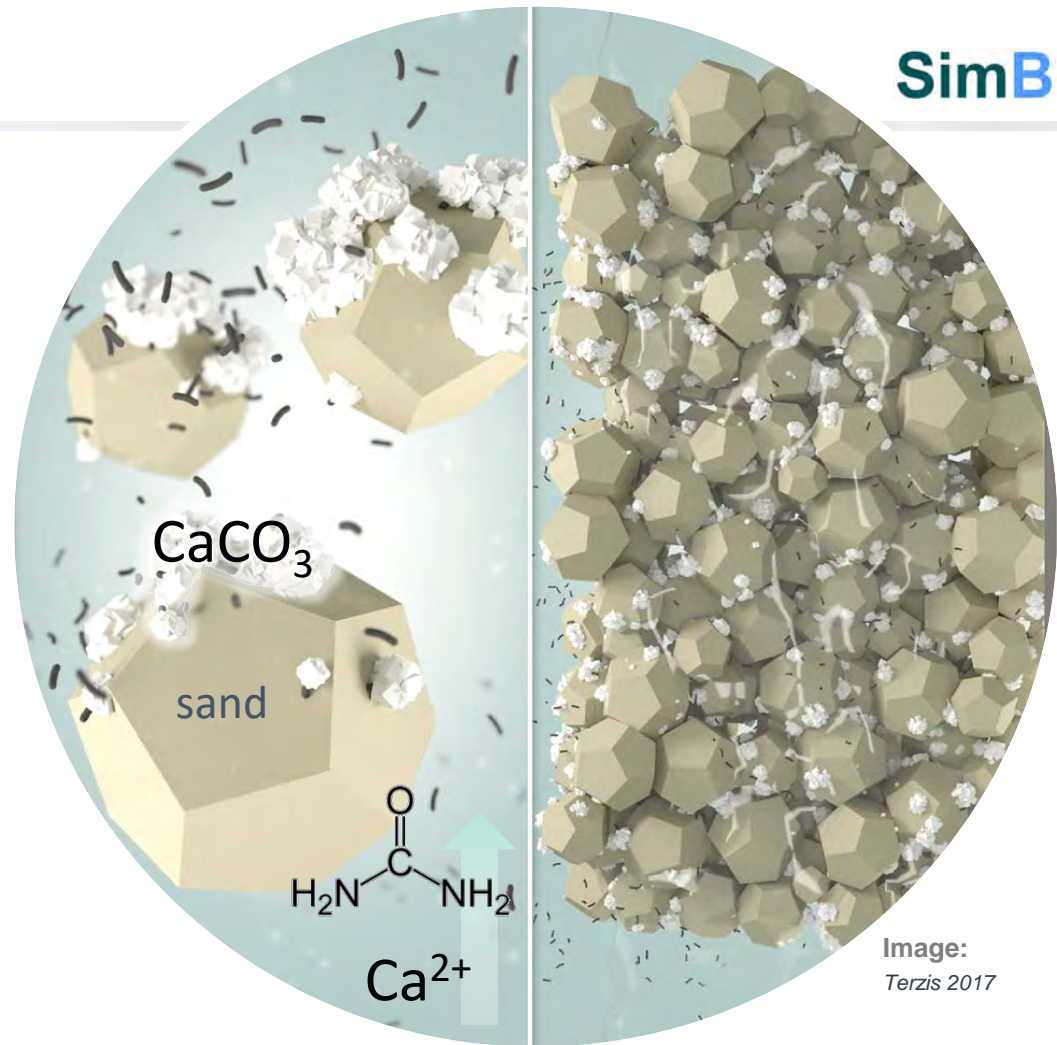
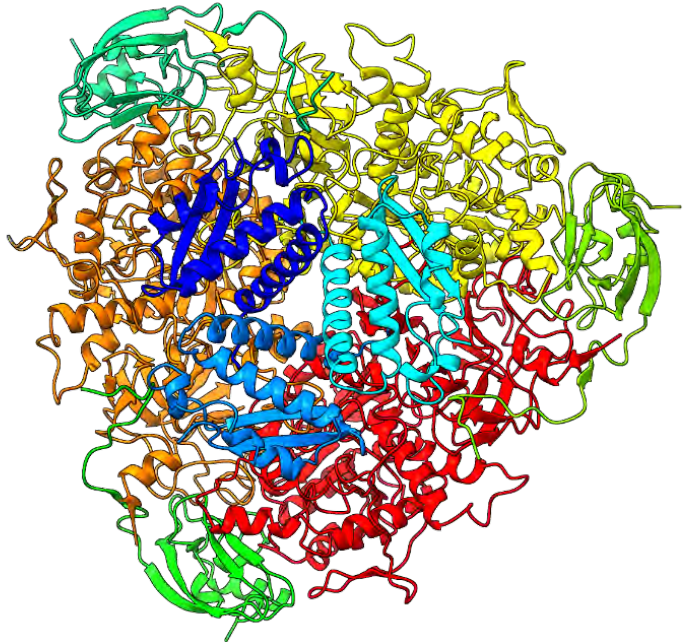


Image: <https://elemente-spezialbau.de/keyword/rohbau-beton/>

1. Introduction & motivation

Microbially induced Calcium Carbonate Precipitation (MICP)

Urease from *S. pasteurii* (PDB 6QDY)



SimBioZe

Image:
Terzis 2017

Biominingeralization using synthetic urea

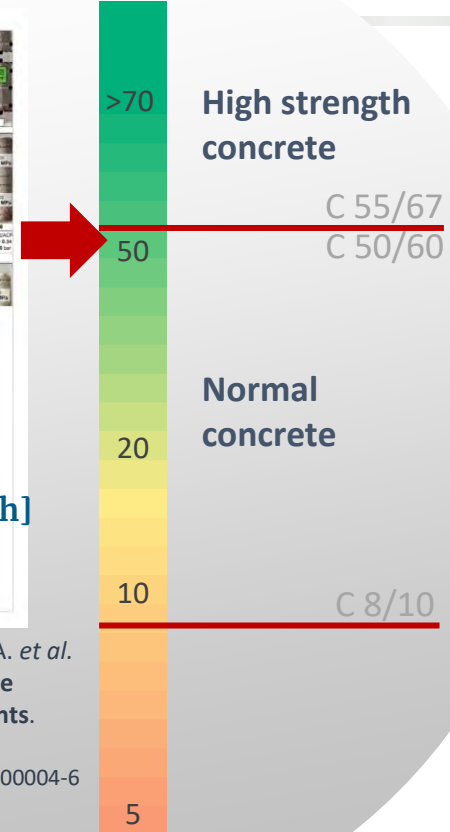


Editor **SPRINGER NATURE**
Research Communities
npj Materials Sustainability

From the Editors
Bio-Concrete
Achieves
Unprecedented... [Strength]

Daniel T Payne
Jan 05, 2024

Smirnova, M., Nething, C., Stolz, A. *et al.*
High strength bio-concrete for the production of building components.
npj Mater. Sustain. **1**, 4 (2023)
<https://doi.org/10.1038/s44296-023-00004-6>



SimBioZe project

Human urine as a source of urea for **biomineralization** and a source of nitrogen (N) and phosphorous (P) for **fertilizer production**.

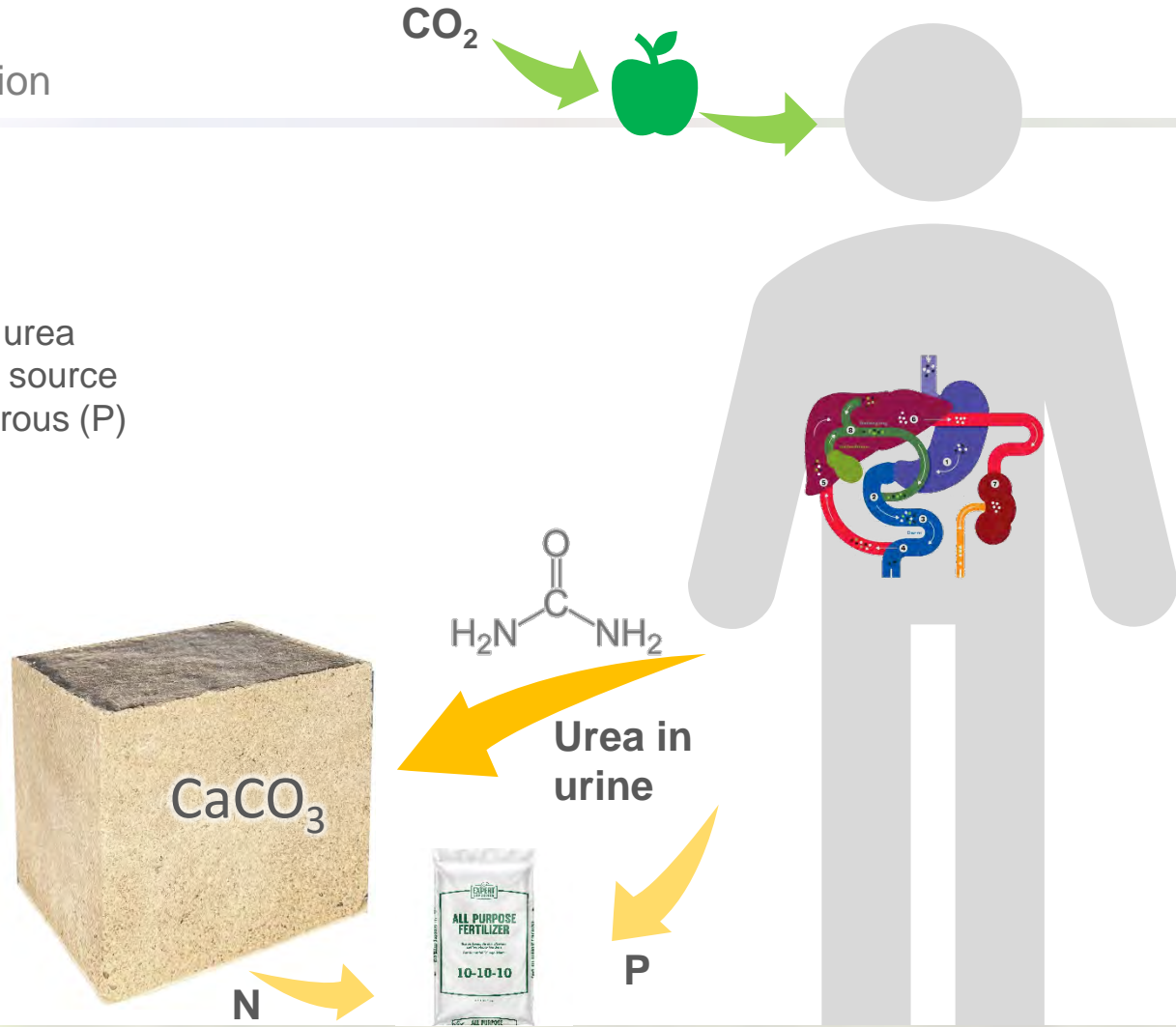
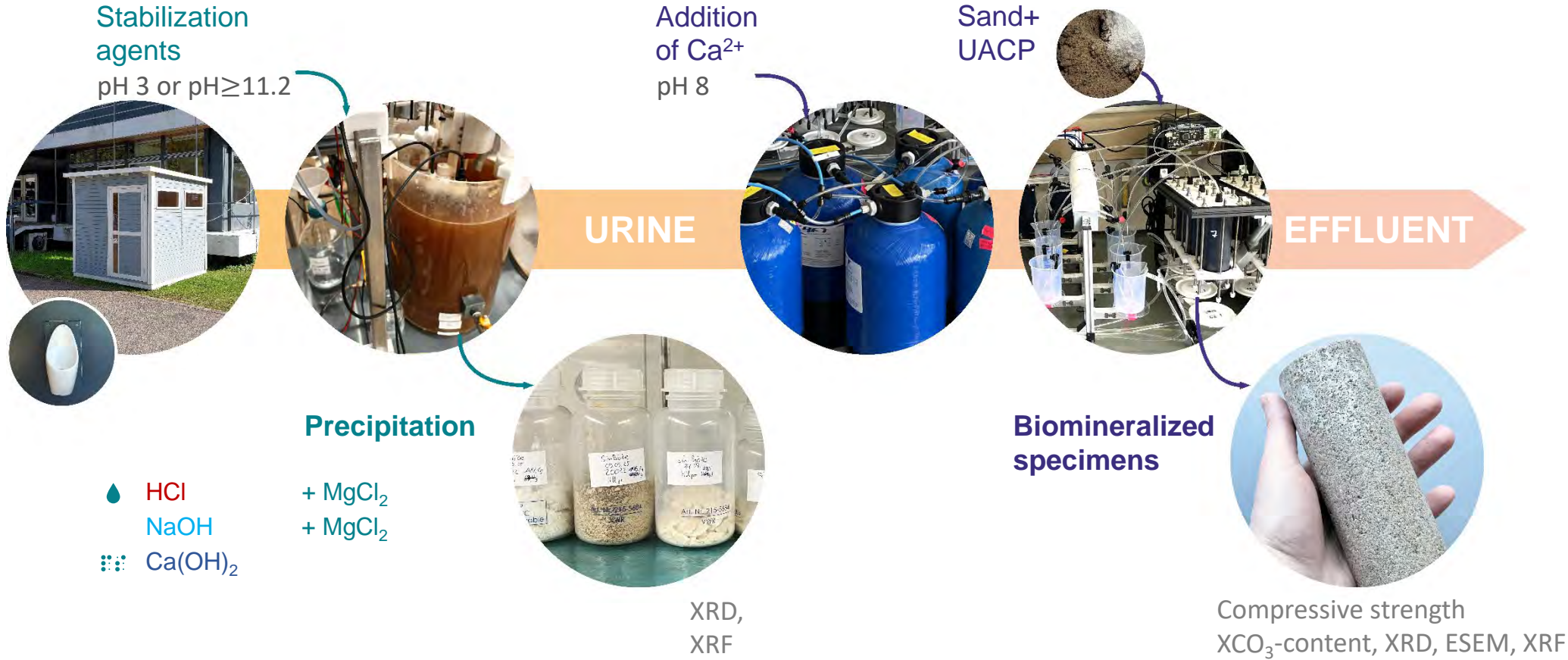


Image: <https://image.stern.de/30446016/t/mw/v3/w960/r0/-/infografik-leber-galle-niere.jpg>

2. Method



3. Findings of the project

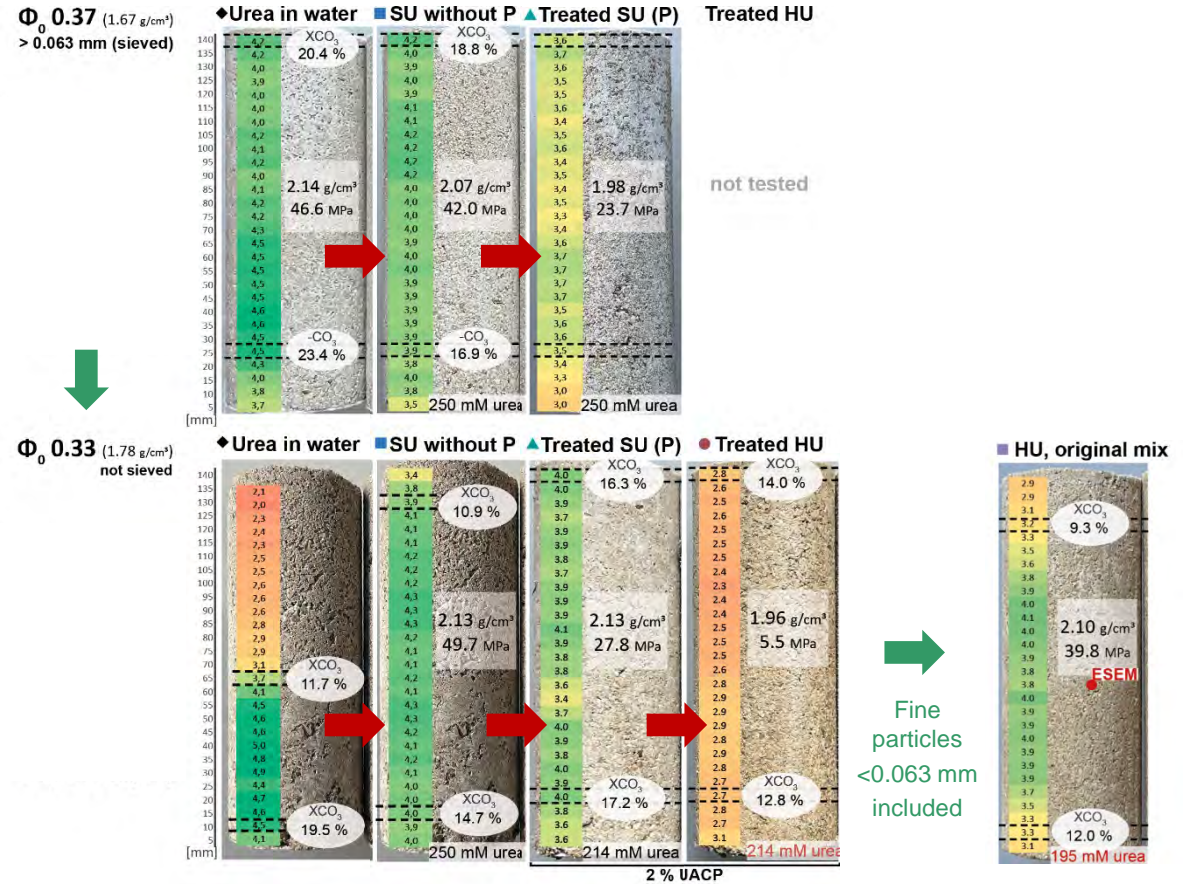
3. Findings of the project

Solution & aggregate density

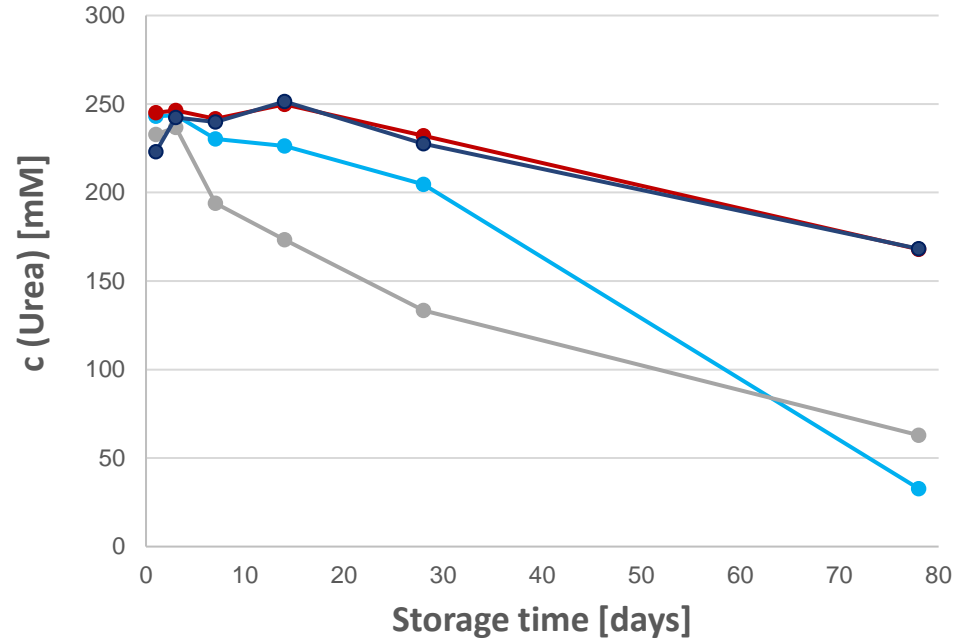
More complex solution →




less efficient biomineralization

Denser mix → strength improvement



Urine treatment method



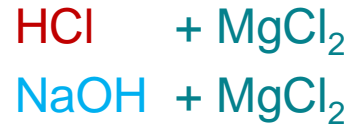
-  HCl pH=3
-  Ca(OH)₂ pH ≥ 11.2
- untreated pH=6
-  NaOH pH=11.2

3. Findings of the project

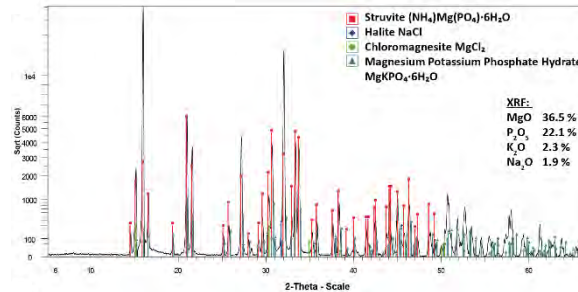
Urine treatment method



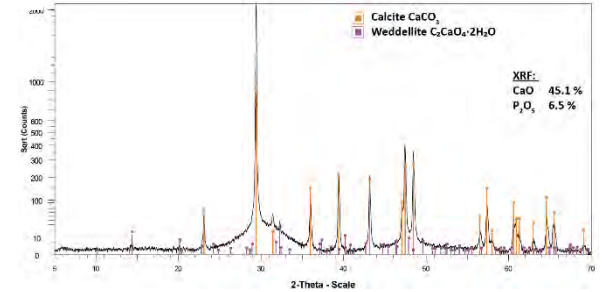
Different precipitates



Struvite

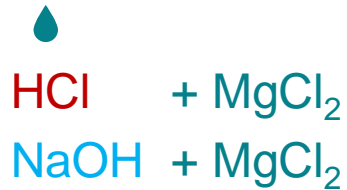


CaCO₃



Urine treatment method

pH 8



- Higher urease activity was measured at pH 8 in urine after alkaline treatment (both NaOH + MgCl₂ & Ca(OH)₂) compared to treatment with HCl + MgCl₂
- Higher compressive strength with treatment using Ca(OH)₂

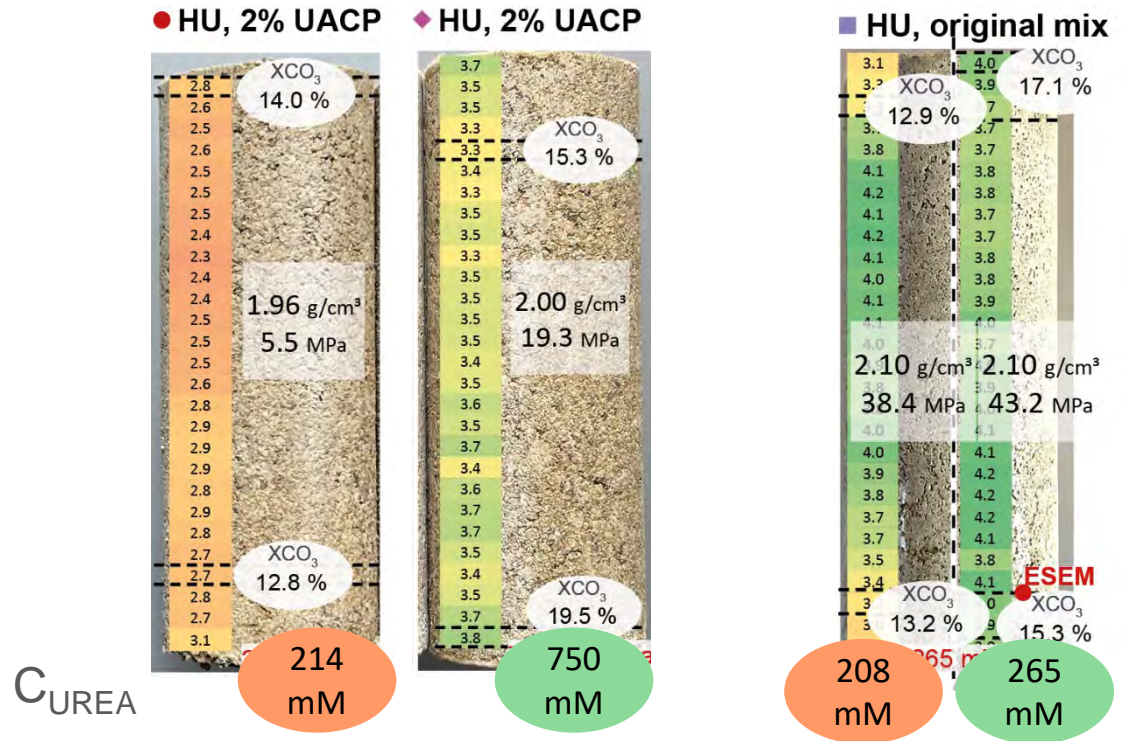
3. Findings of the project

Urea concentration

Higher urea concentration → strength improvement

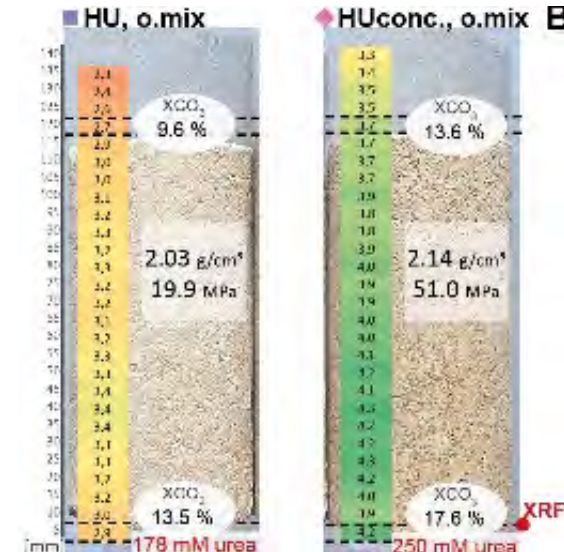
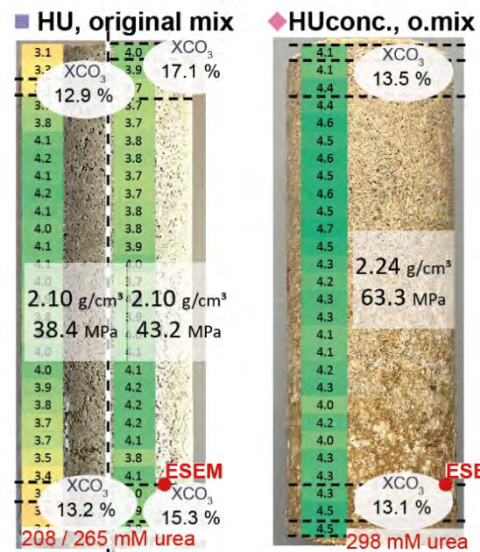
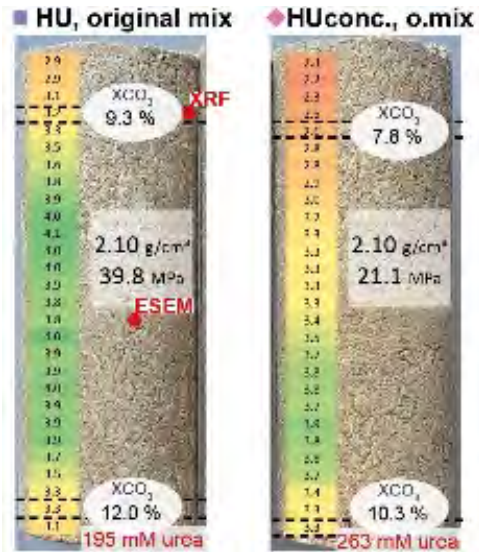
when:

- batch of urine with a naturally elevated urea concentration
- addition of synthetic urea



3. Findings of the project

Increasing urea concentration by heating at 50 °C



Comparison of different urine treatment methods



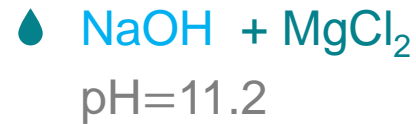
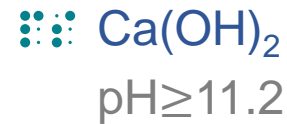
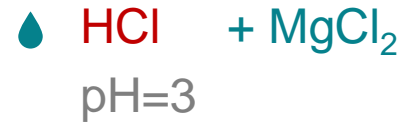
Stabilization



Precipitation



Biom mineralization



Limitations and challenges

- sustainable calcium source
- scalability
- fluctuating urea concentrations in urine



4. Urine collection in real life setups

4. Urine collection during CMT fair in Stuttgart, January 2026



4. Urine collection at the Stuttgart airport



Thank you 😊