

Moving Towards Low-Clinker Limestone Calcined Clay Cement (LC³)- Insights on Carbonation Performance

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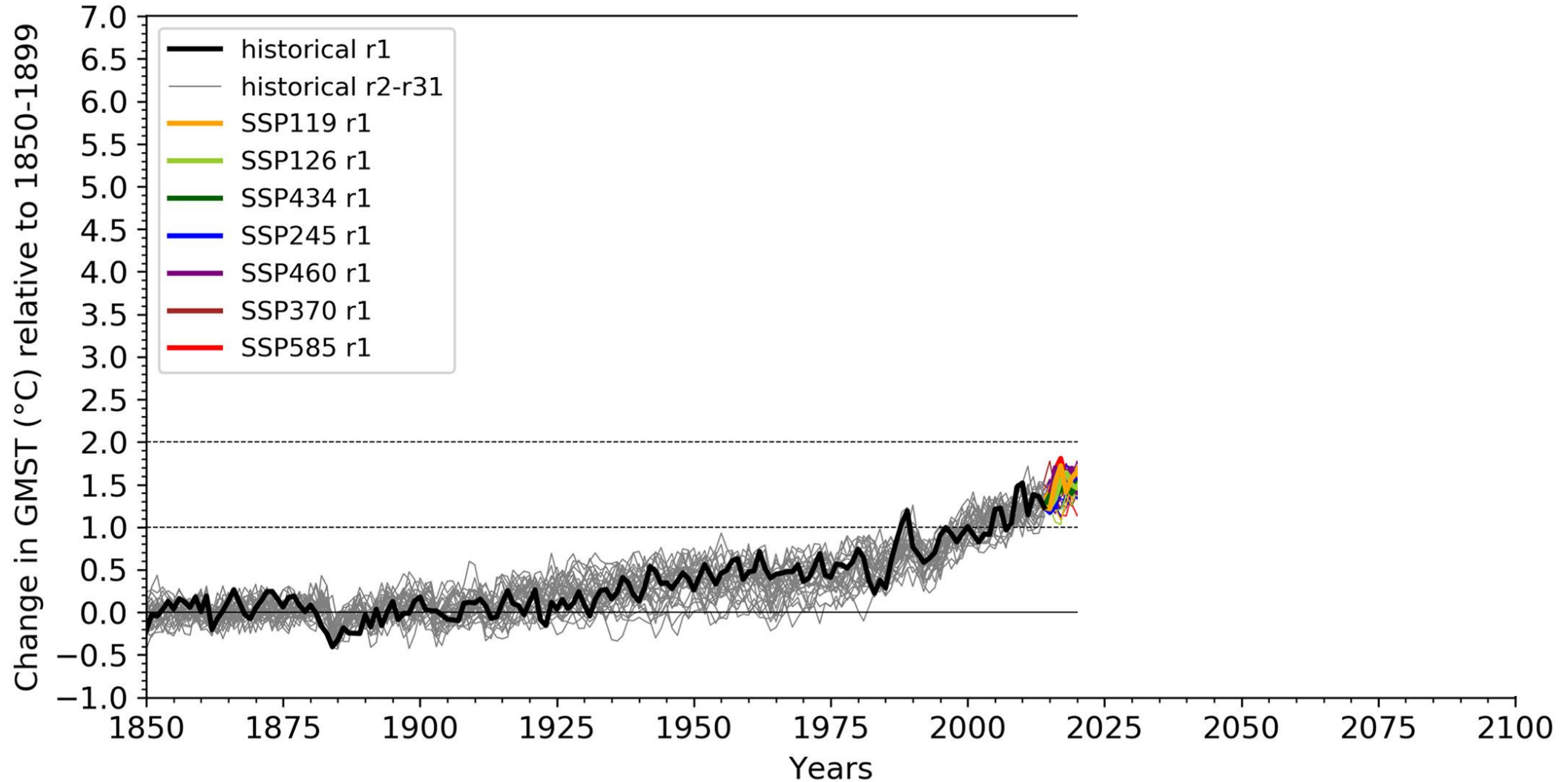
Civil & Environmental Engineering

University of Illinois at Urbana-Champaign

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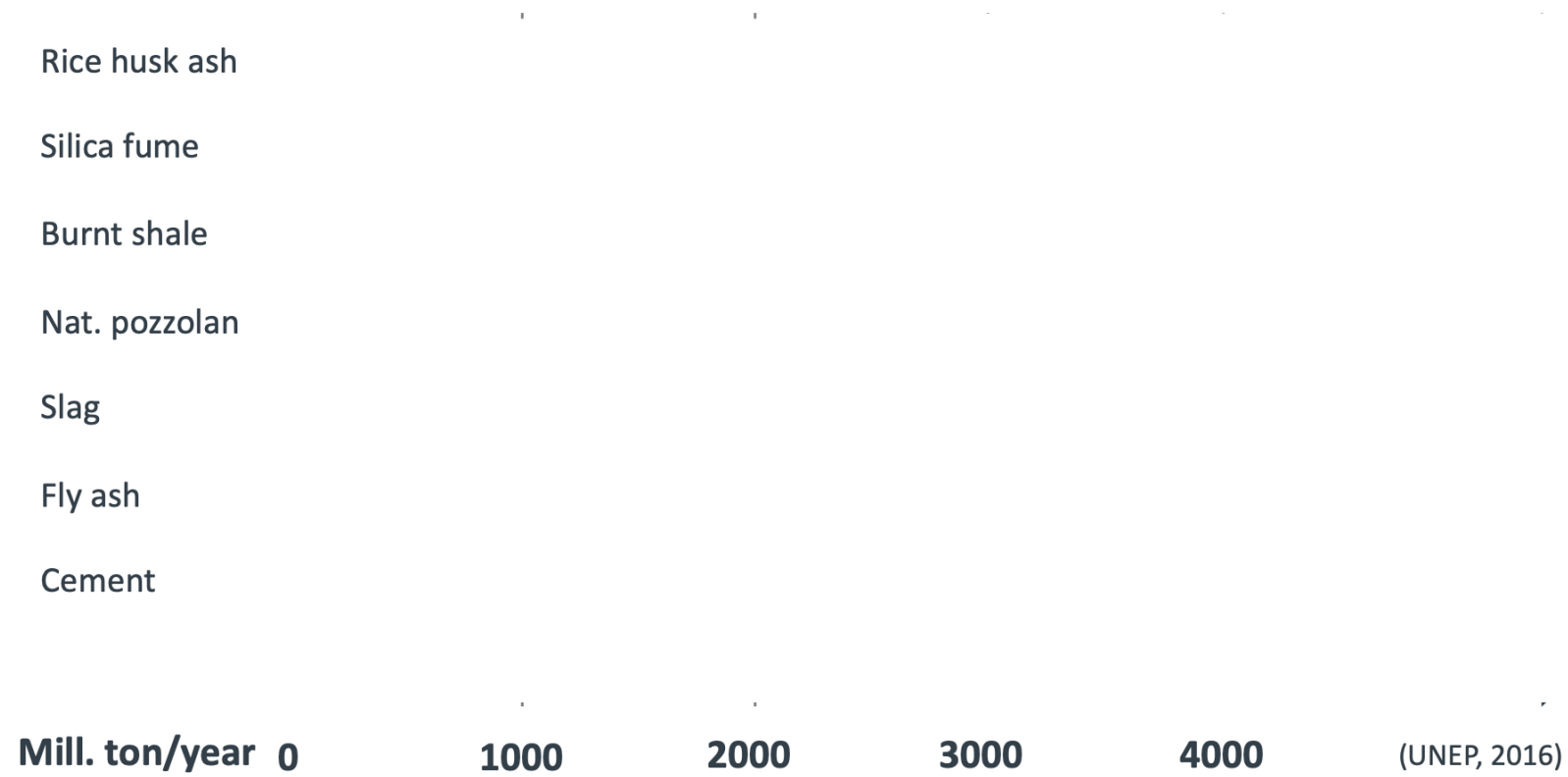


Climate change is a fact, we need to act fast!



Boucher et al., *J. Adv. Model. Earth Syst.* **2020**

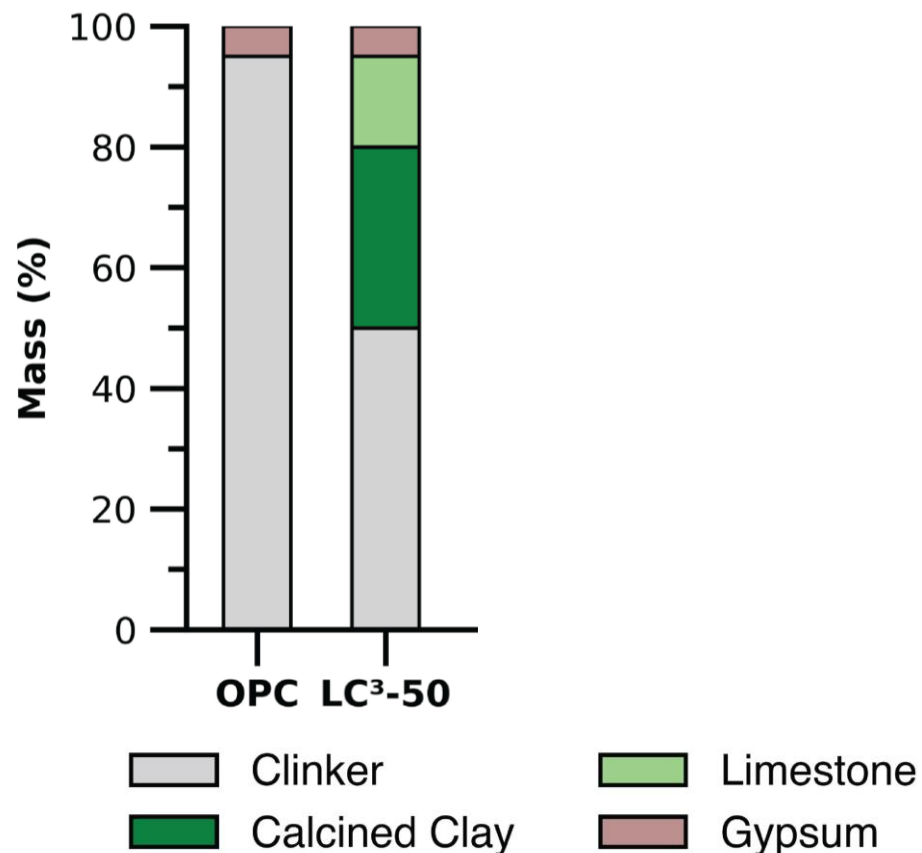
A decline in the availability and quality of conventional SCMs necessitates newer, alternate materials.



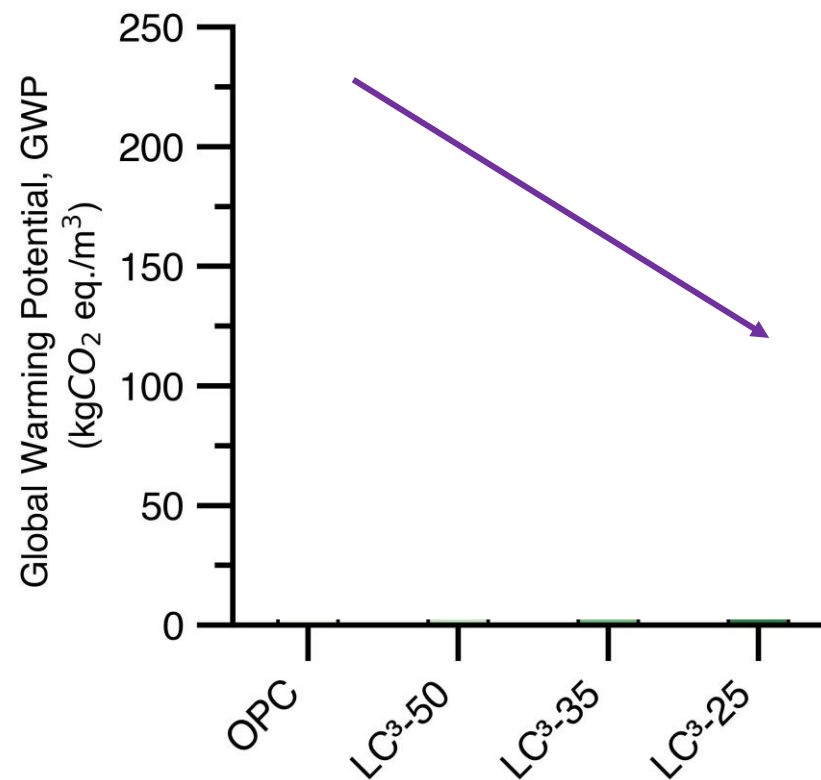
Availability of SCMs suitable for construction

Limestone Calcined Clay Cement is a practical, high-performance alternate to Ordinary Portland Cement (OPC)

LC³-50: 50% replacement of cement

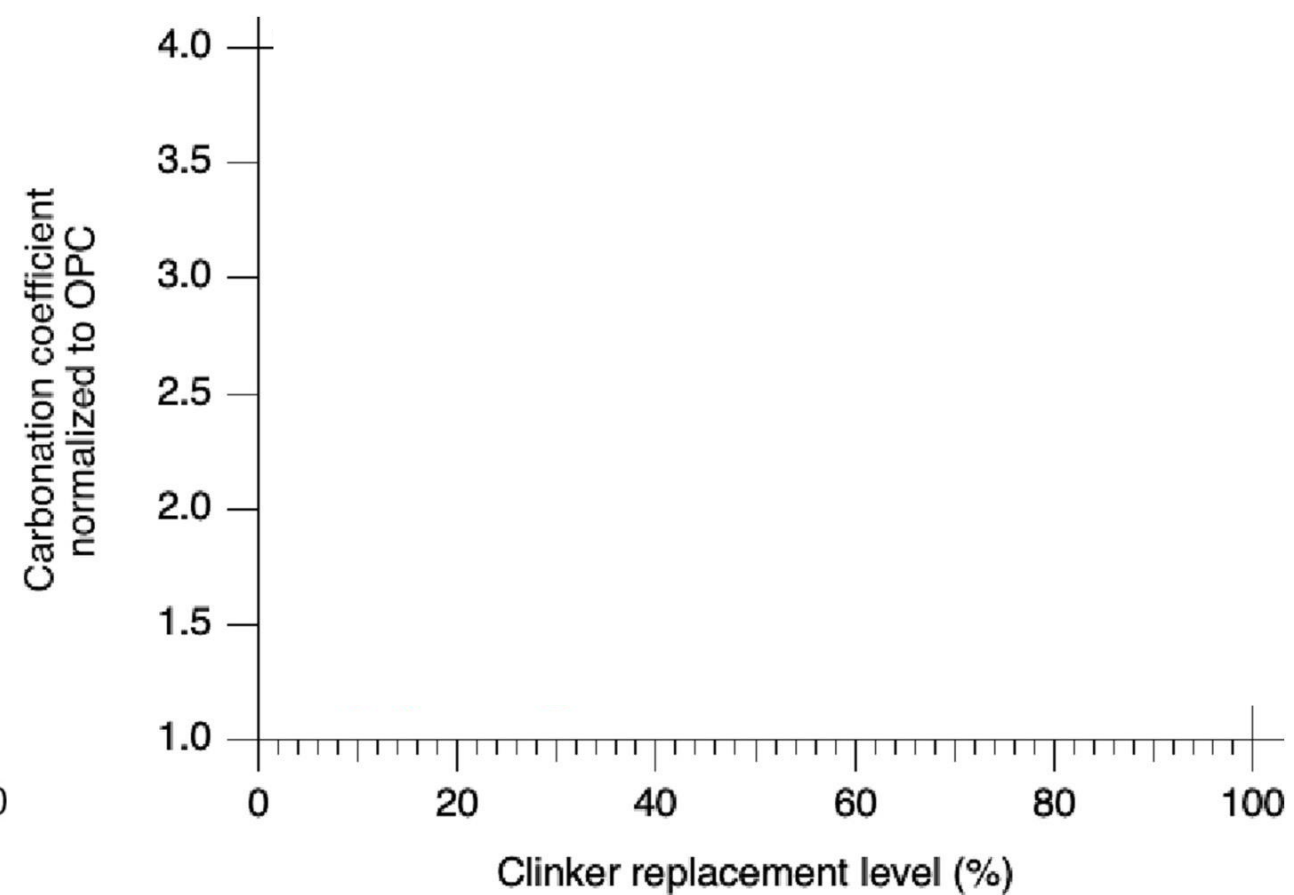
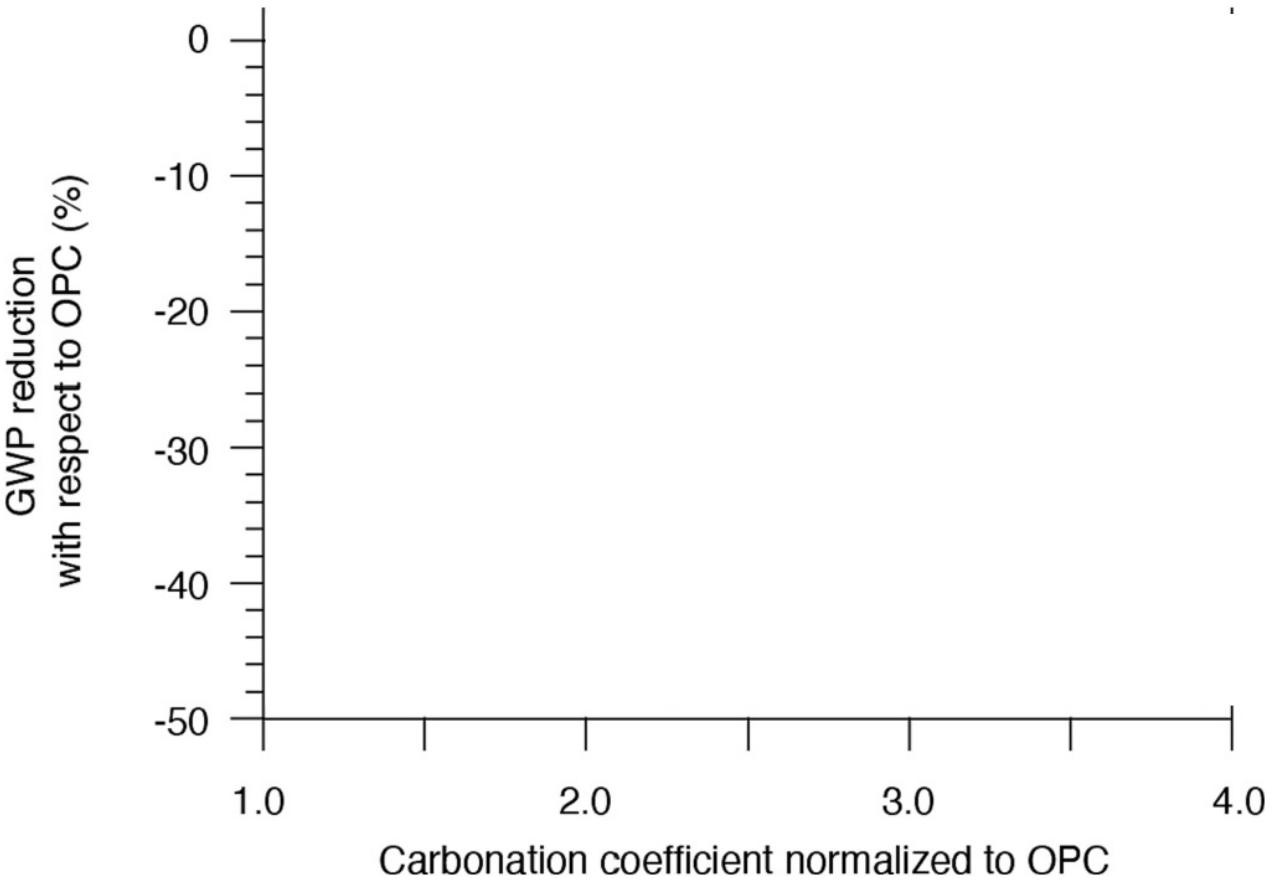


Can we go to lower clinker contents?

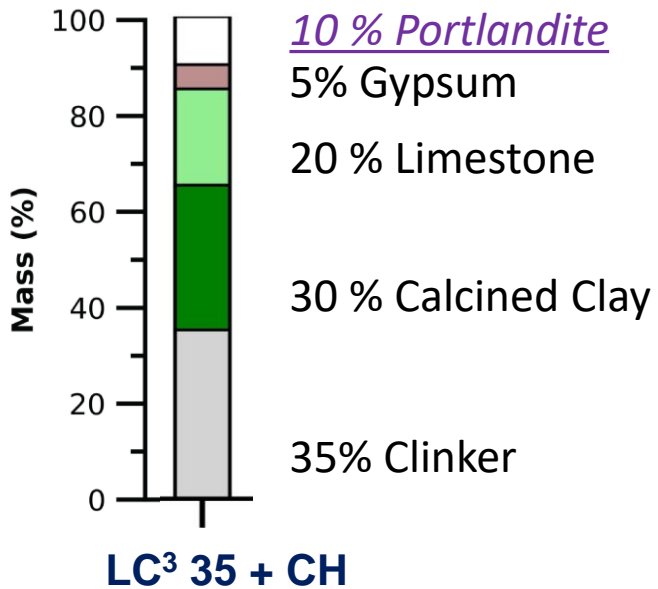
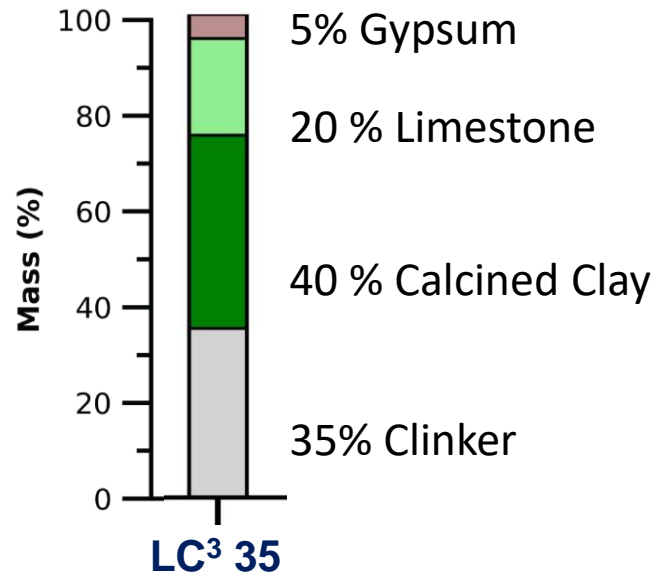


What are the potential challenges of low-clinker blends?

Carbonation resistance and low-clinker systems: A 'double-edged sword'

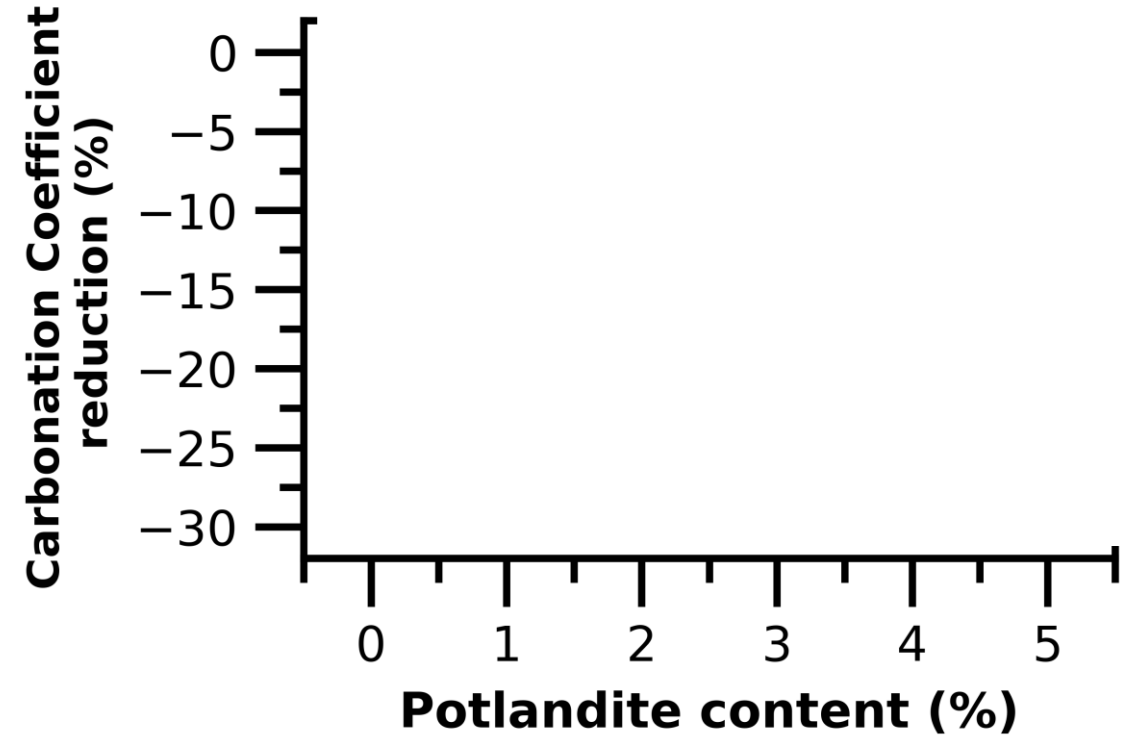
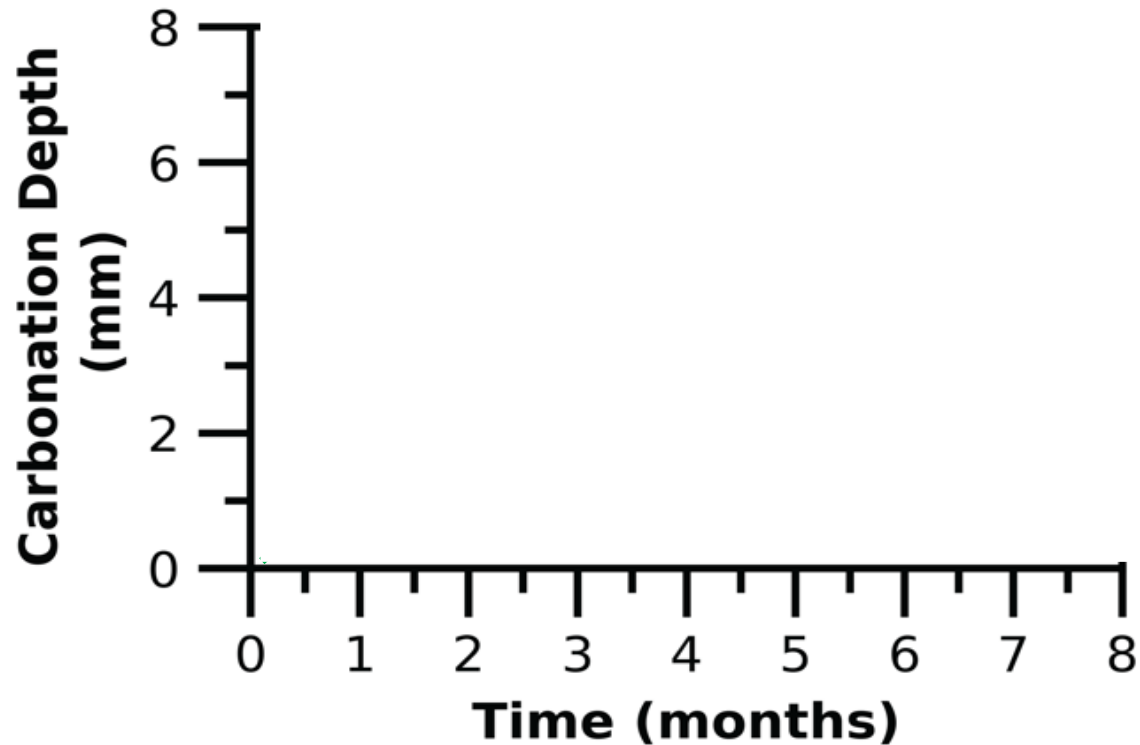


Our solution: Portlandite addition for enhanced buffer capacity



Strätlingite
content ↑

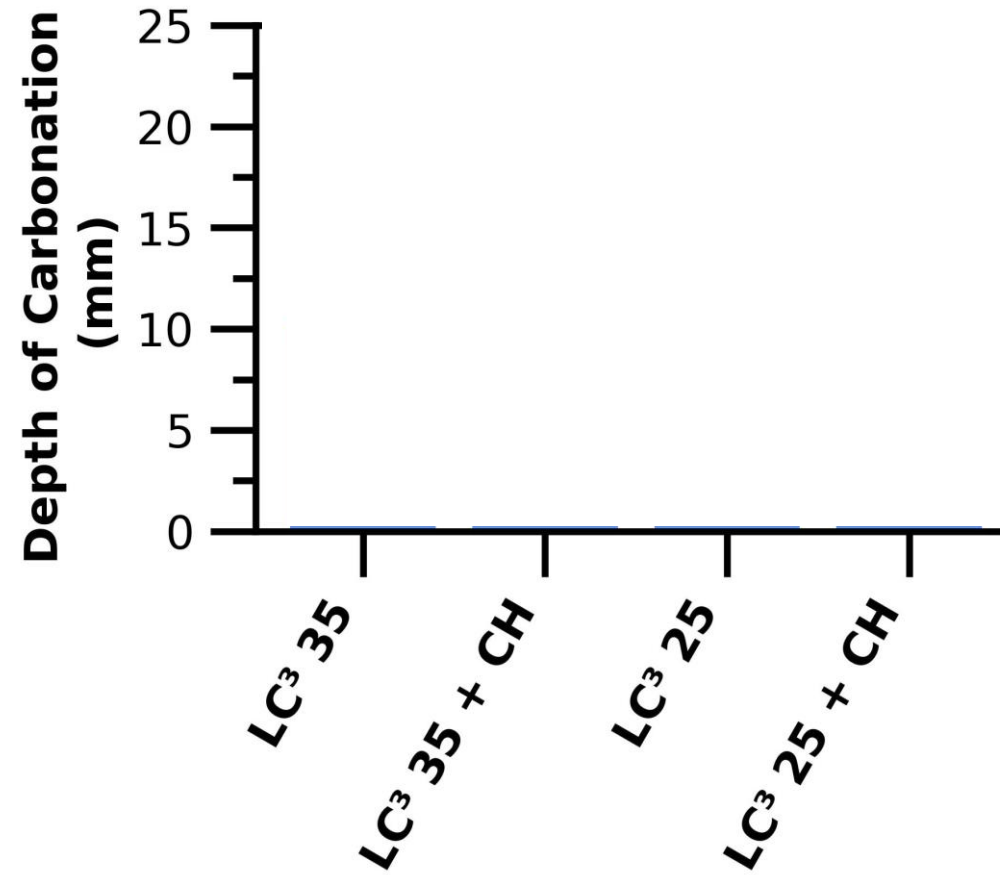
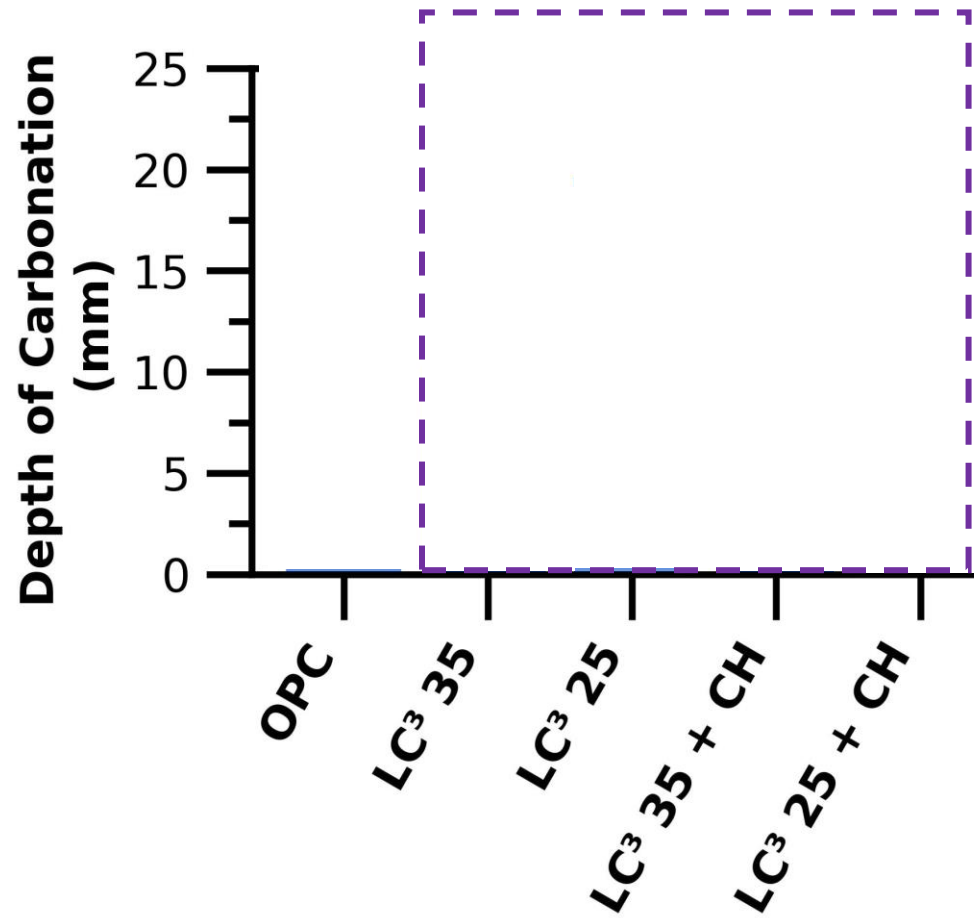
Decrease in the carbonation depth with a small amount of portlandite addition: Improved buffer capacity and microstructural refinement.



- Decreased carbonation depth with additional $\text{Ca}(\text{OH})_2$.
- Rate plateaus due to microstructural refinement, caused by the added $\text{Ca}(\text{OH})_2$.

Rathnakumar et al., *In Preparation*. 2024

Small amount of portlandite reduces the carbonation depth by almost half in low-clinker LC³ blends after 3 years of natural CO₂ exposure.



Conclusions and Outlook

- Low-clinker LC³ has the potential to move past 50% clinker content. Concerns about their increased carbonation rate still remain.
- We observe that doping a small amount of portlandite in low-clinker LC³ enhances its carbonation resistance by boosting the buffer capacity against CO₂ ingress.
- Realistic carbonation exposure of low-clinker LC³ with portlandite indicates pore refinement and reduced carbonation depth, encouraging low-clinker LC³ to be used in reinforced concrete applications.

Acknowledgements



Team

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