**Docket #:** S19-518

# High quality, low carbon cement

Stanford researchers have developed a high-quality cement with a 70% reduction in CO2 emissions with no upcycling. Cement is the second most consumed resource in the world, accounts for 8% of the world's CO2 emissions, is tough to recycle, and has a lifetime of about 50-100 years or less. In response, the Rocks and Geomaterials Laboratory at Stanford has engineered a low to near-to-zero carbon footprint cement clinker through a cement-processing technique that replaces limestone with carbon-free volcanic rocks and mimics how fibrous microstructures effectively reinforce rocks. The new process significantly slashes carbon dioxide emissions during manufacturing allowing for reductions of 70% of CO2 emissions, and can potentially increase durability.

**Stage of Research**

Researchers are in the prototype phase and testing the properties.

**Related Dockets**
24-282

## Applications

- Hydraulic **cement** construction particularly suited to **harsh environments**:
    - Areas that experience **seismic ground shaking**
    - Wellbore casings subject to injection of $CO_2$, **acid fluids**, or re-injection of wastewater fracking
    - Planetary shelters and habitats of tomorrow

## Advantages

- **70% reduction in $CO_2$ emissions** without relying on carbon upcycling:

    - Pyroprocessing of this alternative raw material leads to no carbon footprint
    - No need to build new cement plants for carbon capture and sequestration
- **Exceptional physico-chemical properties** making it suited to harsh environments:
    - High compressive strength
    - Expanded durability - naturally reinforced, binds well, and absorbs strain energy (seismic shaking)
    - High thermal stability
    - High chemical resilience and resistant to acid fluids - minimal alkali-silica reaction (ASR) expected due of the lack of silica in the clinker

## Publications

- Stanford Office of Technology Licensing Annual Report, Fiscal Year 2022: Low Carbon, Resilient Cement
- Vanorio T., and W. Kanitpanyacharoen, (2015). Rock Physics of Fibrous Rocks Akin to Roman Concrete Explains Uplifts at Campi Flegrei Caldera. *SCIENCE*, vol. 349 no. 6248 pp. 617-621. Paper featured on the cover of SCIENCE.
- Vanorio T., J. Chung, and S. Siman Tov, A. Nur, (2023). Hydrothermal Formation of Fibrous Mineral Structures: The Role on Strength and Mode of Failure. *Frontiers Earth Sci., Sec. Earth and Planetary Materials.*

## Patents

- Published Application: WO2021113737
- Published Application: 20230013411

## Innovators

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