

Investigating fiber-based reinforcement networks for low-carbon concrete construction MIT Portugal seed progress report

Project awarded, August 2024 (Start date delayed until early 2025)

Project Team

MIT PI:

Caitlin Mueller, Associate Professor, Departments of Architecture and Civil and Environmental Engineering

PT PI:

Raul Figueiro, Professor, University of Minho and President of the Board, FIBRENAMICS – Institute of Innovation in Fiberbased Materials and Composites

MIT Researcher:

Adam Burke, PhD student, MIT Architecture, Building Technology

PT Researchers:

Duarte Dias, Project Manager, FIBRENAMICS - UMinho

Daniel Barros, Researcher, FIBRENAMICS

Activities Report

Spring 2025

- (MIT) Literature review on the state of the art of fiber-based reinforcement in concrete structures with an emphasis on the use of natural fibers in this context.
- (PT) Background research on natural fiber functionalization methods as a pre-treatment for improving the chemical stability and mechanical properties of natural fibers embedded in a cementitious matrix.

Summer 2025

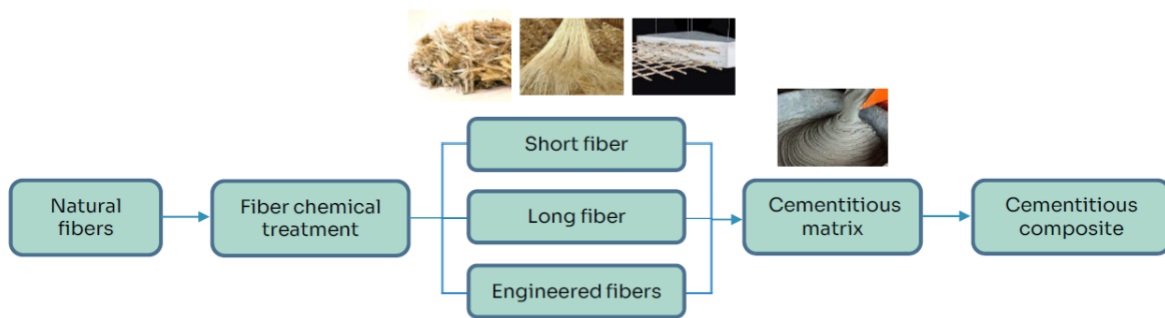
- Adam Burke visited Lisbon to attend the ICNF 2025 - 7th International Conference on Natural Fibers hosted by FIBRENAMICS to meet our Portuguese collaborators and learn about their diverse work on natural fiber composites across a variety of domains ranging from building construction to packaging.
- Monthly meetings with Duarte Dias and Daniel Barros were established for ongoing research project updates and development.
- Based on the research by the FIBRENAMICS team on appropriate functionalization methods we have developed a working plan to test the comparative behavior of natural-

fiber composites that utilize treated and untreated natural fiber woven mesh, treated and untreated natural fiber spliced rope structure, and benchmark these against short fiber samples which have more testing coverage in the literature.

- Identified functionalization methods for the natural fibers include alkaline treatments, acetylation, and silane treatments to address various concerns related to bonding between the cement matrix and the fiber as well as stability in the highly alkaline environment of concrete.
- We have also identified sisal as the natural fiber to use in our test samples based on its balance of cost and baseline strength.

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Work strategy



Cementitious composites with natural fibers: development of cementitious composites containing, natural fibers **for a more sustainable approach to increase the mechanical strength**. Study of parameters like concentration of the fillers, mechanical, microstructural and thermal properties as well as thermal performance shall be conducted.

Next Steps

- The MIT team is now proceeding on the design of experiments for a variety of initial testing samples to determine the appropriate fiber content and layout for each sample.
- The MIT team is also continuing to explore the development of methods for the fabrication of complex tensile networks and computational design methods for the placement of reinforcement in shape optimized concrete structures.
- The PT team is procuring base materials and finalizing functionalization protocols for the natural fiber reinforcement.

Planned Working Visits

In January/February Adam Burke is planning to visit FIBRENAMICS at the University of Minho to collaborate on a series of natural-fiber/concrete composite tests using a variety of treated natural fiber materials being developed by the FIBRENAMICS team over the remainder of the fall 2025.