DOCTORAL COURSE TEACHING FOR THE ACADEMIC YEAR 2024/25.

# Functional Concrete for Sustainable Constructions

*Carbon neutrality is a global goal, but cement production causes 8% of $CO_2$ emissions. Making concrete more efficient and sustainable is essential. This course explores this issue under the guidance of exceptional professors.*


## Program

10 hours

17-19.03.2025

At 2.30 pm

English course

Professor Dr. Tomoya Nishiwaki and internarl professors Alessandro P. Fantilli & Paola Antonaci will guide the doctoral students' classes.

**Who can participate?**
PhD programs of interest in Civil and Environmental Engineering, Materials, Sustainable Processes and Systems for the Energy Transition, and Materials Science and Technology.

## Who is leading the course?

**Dr. Tomoya Nishiwaki** is an Associate Professor at the Department of Architecture and Building Science, Tohoku University, Japan, since 2010. He was previously an Associate Professor and Lecturer at Yamagata University and a visiting researcher at Delft University of Technology (2014–2015).His research focuses on functional concrete, including self-healing concrete, 3D printing, and fiber-reinforced concrete. He has published over 60 peer-reviewed papers indexed in Scopus, with 1140 citations and an h-index of 13 (as of February 2025). Notable works cover engineered geopolymer composites, non-destructive testing, and hybrid fiber-reinforcement in ultra-high-performance mortar.Dr. Nishiwaki has received multiple awards, including an Education Award from Tohoku University, and has secured research grants from Japan's Ministry of Education and international collaborations with China and the Netherlands. His funded projects include 3D printed high-strength composites, resilient infrastructure, and novel functional concrete materials. He has been a speaker at major international conferences such as SMiRT27 and the International Conference on Self-Healing Materials. At Tohoku and Yamagata Universities, he has taught courses like "Life Cycle Engineering," "Building Materials," and "Sustainable Engineering."

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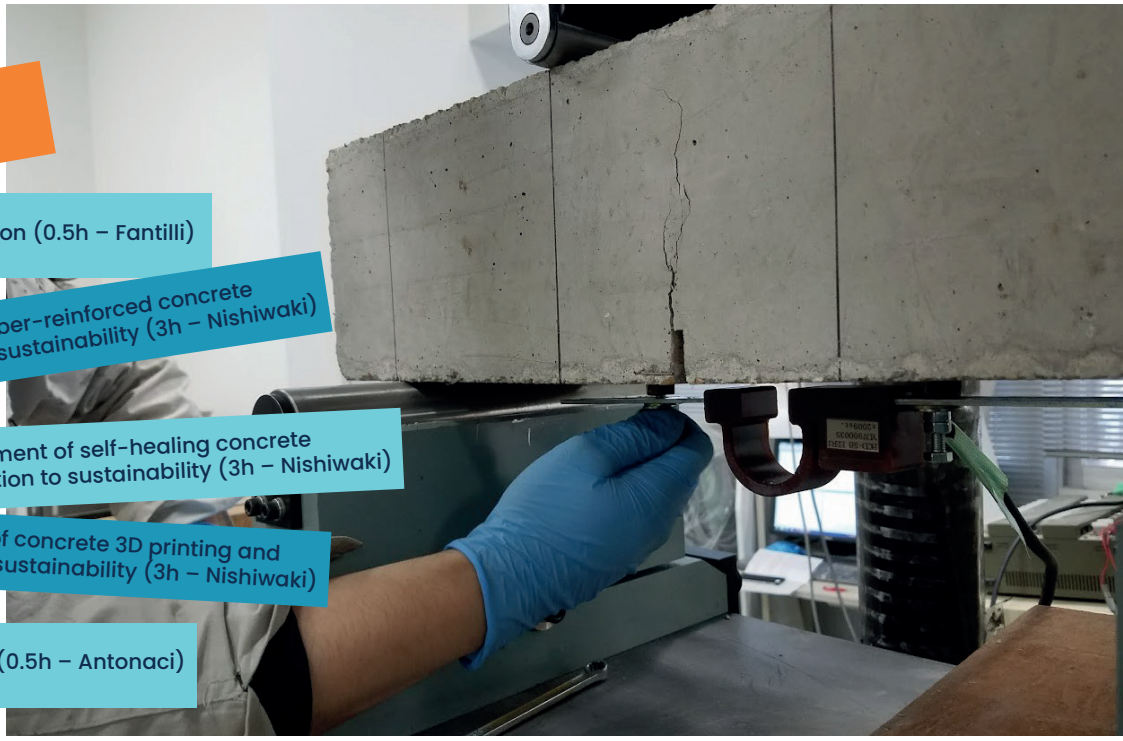
# Functional Concrete for Sustainable Constructions

*Detailed information*

## Syllabus

- Introduction (0.5h – Fantilli)
- Development of fiber-reinforced concrete and its contribution to sustainability (3h – Nishiwaki)
- Development of self-healing concrete and its contribution to sustainability (3h – Nishiwaki)
- Development of concrete 3D printing and its contribution to sustainability (3h – Nishiwaki)
- Conclusions (0.5h – Antonaci)



Achieving carbon neutrality is a global priority. Concrete, the second most consumed material after water, contributes up to 8% of global CO2 emissions due to cement production, emphasizing the need for more sustainable solutions.

This lecture explores innovative functional concretes that enhance sustainability, focusing on: (1) fiber-reinforced concrete, (2) self-healing concrete, and (3) 3D-printed concrete. Fiber-reinforced concrete addresses low tensile strength and brittleness, potentially eliminating the need for steel reinforcement and improving durability. Self-healing concrete autonomously repairs cracks, reducing maintenance needs—particularly valuable for aging populations like in Italy and Japan. Concrete 3D printing offers material and labor efficiency but requires advancements in reinforcement technologies for broader application.

**This lecture covers functional concrete advancements and carbon reduction via supplementary cementitious materials (SCMs).**

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