

21st GERALD A. LEONARDS LECTURE

Professor Giulia MB Viggiani
Cambridge University

Engineering Frozen Ground: Understanding the behaviour of soil on freezing and thawing.

April 11, 2025 - 5:00 p.m.

Krannert Auditorium, 403 Mitch Daniels Blvd, West Lafayette, IN (free, open to the public).

The Lecture will be followed by a Reception and Dinner at 6:30 p.m. (registration required), Atrium of the Neil Armstrong Hall of Engineering, 701 West Stadium Ave, West Lafayette

The use of artificial ground freezing to form earth support systems has had applications worldwide. These cover a variety of construction problems, including the formation of frozen earth walls to support deep excavations, structural underpinning for foundation improvement, and temporary control of ground water in construction processes. At the same time, climate change driven seasonal freezing and thawing of soils in the northern hemisphere can have very detrimental impact on infrastructure. Freezing and thawing of a moist soil is a process coupling heat and mass transfer, which involve complex thermal, hydraulic and mechanical processes with significant mutual interactions. The lecture will describe an extensive and successful application of artificial ground freezing during excavation of some of the stations of Line 1 of Napoli Underground through loose granular soils and a fractured soft rock. Construction was accompanied by an intense programme of monitoring designed to measure and control the effects on adjacent structures, which, for its extension and completeness, represented a unique opportunity to collect field data on the performance of AGF. The lecture will describe the main phenomena that were observed during construction, and some of the analyses that were carried out to interpret different aspects of the process. Experimental observations on frost heave susceptibility carried out using innovative equipment will also be discussed.



Giulia Viggiani is Professor of Infrastructure Geotechnics in the Department of Engineering of the University of Cambridge, where she is the Head of Civil Engineering, Academic Lead of the UKCRIC National Research Facility for Infrastructure Sensing, and a Co-Investigator and member of the Executive Committee of the Cambridge Centre for Smart Infrastructure and Construction. Before this, she was Full Professor of Geotechnical Engineering at Università di Roma Tor Vergata.

She has a *Laurea* in Civil Engineering from Università di Napoli Federico II and a PhD in Geotechnical Engineering from the City University in London. She has been Scientific Visitor at the Max Planck Institute for Mathematics in the Sciences in Leipzig, MTS Visiting Professor of Geomechanics at the University of Minnesota, Distinguished Visiting Scholar at the University of Macau, and Academic Visitor at Imperial College, working on the JLE-Link Project.

Her role as a recognised expert in the field of geotechnical engineering for infrastructures has been acknowledged both at national and international levels. She has been invited to deliver General Reports and Keynote Lectures at several international conferences. She is an Italian chartered Civil Engineer and member of the ISSMGE, AGI and BGS. She currently chairs ISSMGE TC204 – Underground Construction in Soft Ground.

She has been involved in many infrastructural projects in Italy and the UK, including, *e.g.*, monitoring building response to construction of the Jubilee Line Extension in London, the design and construction of Lines 1 and 6 of Napoli underground and of Line C of Roma underground, and the design of the foundations, anchor blocks and terminal structures of the Strait of Messina Bridge.

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The Leonards Lecture was established in 2003 in honor of Professor Gerald A. Leonards, one of the giants of the geotechnical engineering profession.



Professor Gerald A. Leonards was born on April, 29, 1921 in Montreal, Quebec, Canada. He obtained his BSCE at McGill University in 1943 and received both MSCE and PhD from Purdue in 1948 and 1952, respectively. He was a full-time faculty member at Purdue from 1952 to 1991, when he was named Professor Emeritus.

Professor Leonards' research interests were very wide and he made pioneering contributions to knowledge on strength and compressibility of compacted clay soils, strength and consolidation of natural deposits, cracking of earth dams, frost action, analysis of buried conduits, pile foundations, stability of slopes and embankments on soft clays, stress-deformation and liquefaction of sand, and methodologies for investigating failures. He published extensively nationally and internationally. His 1962 book on "Foundation Engineering" quickly became a standard reference worldwide.

Throughout his career, Dr. Leonards' insight and expertise was sought on earthwork and foundation projects all over the world, a number of which involved the investigation of failures. He was appointed as the only non-European to sit on an official government commission in Italy to investigate ways to stabilize the Tower of Pisa.

Over his career Dr. Leonards received numerous awards from professional societies. In 1980 he was honored by the American Society of Civil Engineers by being asked to present the Terzaghi Lecture and also received the Terzaghi Award in 1989. In 1988 he was elected to the National Academy of Engineering.

From the students' perspective, "GAL" was a dedicated professor and researcher, who never missed an opportunity to learn more about his chosen field and to share his views on new developments. His influence continues to be felt through the lasting influence he had on his students and colleagues.

Adapted from text by V.P. Drnevich

Previous G.A. Leonards Lecturers

Milton Harr (2003), Victor Milligan (2004), Robert Holtz (2005), Michele Jamiolkowski (2006), Suzanne Lacasse (2007), Jean-Lou Chameau (2008), Bernard Amadei (2009), Richard D. Woods (2010), Herbert Einstein (2011), Carlos Santamarina (2012), Craig Benson (2013), Lyesse Laloui (2014), Richard Goodman (2015), David Frost (2016), Patricia Culligan (2017), Eduardo Alonso (2018), Steve Kramer (2019), Rick Deschamps (2022), Krishna Reddy (2023), Jonathan Bray (2024).

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2025 - Purdue Geotechnical Society Program and Leonards Lecture Committee

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The PGS was founded in May 2003 to enhance the strong bond and working relationship among alumni, faculty, students, and staff of the Geotechnical Engineering group at Purdue University for the benefit of all.
<https://engineering.purdue.edu/PGS>