When Geotechnical Earthquake Engineering Meets Artificial Intelligence: The ReStructure 2.0 Project

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Geotechnical Meetings @PoliTo

Friday, 21st April 2023
16:00

Albenga Room,
DISEG, Entry 1

civilengineering_polito

Politecnico di Torino

DISEG

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Abstract

Standard seismic design of retaining structures in Europe is based on a century-old theory, that does not account for the actual physical behavior of soil-structure systems. Methods based on this theory, commonly referred as Mononobe-Okabe methods, often lead to conservative design of retaining structures that causes an unsustainable consumption of resources without any benefits on the performance and safety of the construction. Such design approach is against the principles of the European Green Deal that identified the need of cleaner constructions in the Building and Renovation policy area. The main goal of *ReStructure 2.0* is to develop a novel physics-based framework based on soil-structure interaction principles, recognizing the relative displacement between wall and retained soil as the driving factor in the seismic response of wall-soil system. This novel approach is based on the combination of computational simulations, experimental and field data, relational databases, and artificial intelligence techniques. This more adequate design approach can lead to a significant reduction of the resources used during the construction, making the process more sustainable, affordable, and green.

This presentation illustrates two important parts of *ReStructure 2.0*: *(i)* a simplified solution for the evaluation of the seismic increment of the earth pressure acting on a retaining structure, and *(ii)* some preliminary results of the AI methods applied on the results of an extensive parametric analysis carried out in OpenSees. The simplified solution presented here has been recently adopted in the US National Earthquake Hazards Reduction Program (NEHRP) Recommended Seismic Provisions for New Buildings and Other Structures.

Biosketch

Maria Giovanna Durante graduated cum laude in Civil Engineering at the University of Sannio. In 2015 she obtained her PhD from the University of Naples "Federico II." During her PhD she worked on a collaborative EU-funded project that allowed her to work at the shaking table facility of the University of Bristol in the UK. In 2016 she joined the University of California, Los Angeles (UCLA) as a postdoctoral scholar. During this period, she developed an innovative method to evaluate the seismic performance of retaining structures that has been adopted in the recent 2020 National Earthquake Hazards Reduction Program (NEHRP) recommendations. Dr. Durante then moved to the University of Texas at Austin where she held a postdoctoral fellow appointment between 2018 and 2020, working at the Texas Advanced Computing Center (TACC). During her period at TACC she worked on the fastest academic supercomputer in the world, developing tools for the natural hazard community, and developing AI skills. Her paper on the application of AI techniques in the field of geotechnical earthquake engineering was featured on the cover and as the Editor's Choice in the prestigious international journal Earthquake Spectra (Volume 37, Number 4). She is the recipient of various awards including the 2018 Earthquake Spectra Outstanding Paper Award by the Earthquake Engineering Research Institute. In 2021 she was awarded the prestigious Marie Sklodowska-Curie Fellowship for a project entitled: *"ReStructure 2.0 - A novel physics-based methodology for the seismic analysis of retaining structures leveraging machine learning techniques"*. Her current research interests focus on seismic soil-structure interaction using physical experiments and numerical simulations, and big data analytics and artificial intelligence applications in geotechnical earthquake engineering problems.

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