GEO-INSTITUTE

8th ANNUAL LIVE STREAMING WEB CONFERENCE

December 4-8, 2023

The Geo-Institute Earthquake Engineering and Soil Dynamics Technical Committee will live-stream the session "Emerging modeling techniques in geotechnical earthquake engineering: Research to practice" on Wednesday, December 6, at 2 PM EST. The topics include:

"Data Science in Geotechnical Earthquake Engineering: Seismic Site Response of Sedimentary Basins,"
Chukwuebuka Nweke, Ph.D., EIT, M. ASCE

Data science, from the context of engineering, is concerned with the collection, processing, analysis, and visualization of data in hopes to make predictions. Geotechnical civil engineers primarily focus on the characterization of hazard. The overall goal is to establish frameworks/build models that can extract insights from data. Whether through laboratory experiments on soils, field experiments at sites, or observations of geologic features, geotechnical engineers have always gathered information to quantify the extent of potential damage to infrastructure from natural hazards. At the onset, the available data was limited due to equipment capabilities and the lack of comprehension of existing uncertainties (inherent subsurface and above-ground processes and its interface with anthropogenic structures and development). Currently, the exponential explosion of available data due to advancements in technology and the accumulation of knowledge over time has provided a platform for improved hazard characterization. Examples include the availability of Light Detection and Radar (lidar) data, Interferometric Synthetic Aperture Radar (InSAR), or Structure-from-Motion (SfM) for visualizing site conditions over local and regional scales. Other examples include the growing network of sensors for earthquake recordings and early-warning, as well as infrastructure health monitoring. We also have the capability to perform physics-based simulations of earthquakes, extreme weather events, and more. In the context of earthquake site effects in sedimentary basins, there is a wealth of information available that can be used to characterize the complex amplification effects that have been observed from recent events. Efforts are currently focused on parameterizing features and validating protocols for use in hazard estimation.

"Numerical modeling to understand limitations of CPT-based liquefaction hazard assessment,"
Kaleigh Yost, Ph.D., EIT, M.ASCE

Earthquake-induced soil liquefaction can cause excessive damage to the built environment, including cracking of foundations, severe and irregular building settlements, and breaking of utility lines, among many other adverse consequences. Current procedures used to assess liquefaction hazard struggle to accurately predict liquefaction in soil profiles containing zones of thin, highly stratified sands and silts/clays layers. One contributing factor to this inaccuracy is that cone penetration tests (CPTs), one of the most commonly used in-situ testing techniques to characterize soils for liquefaction assessment, do not adequately characterize individual layer stiffness and thickness in complex stratigraphy. In this presentation, the mechanisms (i.e., multiple thin-layer effects) causing and controlling this behavior will be demonstrated with results from numerical simulations of cone penetration using the Material Point Method (MPM). Furthermore, it will demonstrate how MPM results can be used to develop procedures to correct CPT data for these effects, with the goal of improving the accuracy of liquefaction hazard assessments.

"Approaches to numerical modeling and data-driven methods in geotechnical earthquake engineering practice," **Katerina Ziotopoulou**, Ph.D., PE, M.ASCE

Earthquake-induced soil liquefaction remains a leading cause of earthquake damage worldwide. Geotechnical systems are complex and hard to sample, and the devastating impact of rare and stochastic earthquakes presents a constant challenge for geotechnical infrastructure. Our liquefaction engineering toolbox consists of empirical and semiempirical models all the way to advanced numerical models. The former may not be applicable to complex geosystems and cannot typically identify failure mechanisms, while the latter can be challenging to interpret and require significant engineering effort to develop, calibrate, and validate. Over the last decades, the intensive recording and curation of case history and experimental data is increasingly enabling the development and validation of numerical modeling protocols and methods. In parallel, the emerging field of data science provides exciting opportunities for interacting with data while honoring geotechnical domain knowledge. This presentation will discuss recent developments in the numerical modeling for geotechnical earthquake engineering applications and implications of emerging data science-based methods for practice.