From the Editorial Board

JEFF DUNN

Inside this issue of *GEOSTRATA* themed "Earthquake Geotechnics," you'll find a cartoon that humorously reflects how many Californians react during an earthquake. Well, I'm a Californian, born and raised, and have lived more than 60 years in this land of 'quakes. And while I'm not quite so nonplussed as the Californian characterized in the cartoon, in some respects I take earthquakes in stride. I even try to predict the magnitude of the 3 to 4.5 events that I experience in the San Francisco area before checking the MyShake app on my smartphone. I've actually gotten reasonably good at it!

Notwithstanding my amateur sleuthing attempts to predict earthquake magnitudes, we all know that earthquakes are a very serious business indeed, and something not to be ignored. Geotechnical engineers practicing in many parts of the world never get away from earthquake engineering aspects. Sometimes, designers can defer to highly experienced geotechnical earthquake engineering specialists to do the complex analyses and select earthquake ground motions for a project. In other projects, it's suitable to use simplified analyses techniques to evaluate, for example, liquefaction susceptibility and resulting settlements based on what we've learned from robust empirical studies of past earthquake events.

Regardless of the approach taken, however, it's essential to understand the fundamentals of earthquake engineering. This issue includes articles on some of those fundamentals, but also discusses techniques that continue to advance, at a seemingly ever-increasing pace, our understanding of seismicity and earthquake engineering. It also touches on the importance of more effectively communicating to society about earthquake risk, and building and infrastructure response to seismic events.

What's Inside?

This issue begins with Michel Bruneau's dramatically titled commentary, "We're All in This Together — The Blessings of Disaster." But how can disasters be blessings? Of course they grab the public's attention, but they also provide focus and help drive action toward a more robust and resilient society. Isn't this concept, after all, the observational approach first promoted in our profession by Terzaghi and Peck? We readers of *GEOSTRATA* are devoted to enhancing the world's safety through risk reduction. We think about hazards and have knowledge of how to achieve resilience. Unfortunately, while the general public seems to expect resilience in their buildings and infrastructure, they aren't generally giving the topic much thought, and therefore aren't usually very knowledgeable about it. Bruneau's commentary challenges us to help with reaching out to the general public and getting them interested and educated on the topic, as we truly are all in this together.

Developing reliable earthquake ground motions is key to preparing earthquake-resistant designs and the analyses on which they're based. However, characterization of earthquake ground motion varies from place to place, and the impacts of this variability aren't always easily discerned. Some

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areas of the world have robust ground motion data sets due to frequent earthquakes and dense ground motion monitoring networks and are developing and applying regional ground motion models, but this hasn't happened in other areas of the world, where large earthquakes occur less frequently and/or monitoring networks are sparse. The way that uncertainty is captured in some current models varies. In "Reducing Uncertainty in Ground Motion Models," Domniki Asimaki and Grigorios (Greg) Lavrentiadis outline how the ergodic approach has been used for more than five decades and only relatively recently has begun to morph into the use of nonergodic techniques. The authors discuss separating uncertainty from randomness and describe the components of uncertainty inherent in earthquake hazard and risk applications. They also discuss how, with rich data sets available for many analyses, we can now allow stakeholders to make better decisions, either by accepting current levels of uncertainty or working to reduce the range of uncertainty through additional data collection and simulation efforts.

The general public, of course, doesn't think much about seismic-design codes and what performance level those codes are intended to achieve. In discussions I've had with nontechnical and technical people, the vast majority seem quite surprised, and occasionally shocked, to learn that buildings and some infrastructure systems are, for the most part, designed to provide life-safety performance during a large earthquake, but could be so heavily damaged that repair is not economically feasible. Christine (Zee) Beyzaei, Katherine (Jo) Johnson, and Sissy Nikolaou, in their article "The Future of Seismic Codes," cover how a paradigm shift in seismic design code provisions is becoming a new and exciting engineering frontier where geotechnical engineering will play a key role. They describe a new post-earthquake performance state that moves beyond life-safety to functional recovery. This change in how codes should be modified was deemed important enough that in 2018 the U.S. Congress tasked the National Earthquake Hazards Reduction Program with developing a report that would provide options for improving post-earthquake performance of buildings and lifeline infrastructure. Issued in 2021, the report provides key recommendations for developing functional recovery performance. The authors emphasize that geoprofessionals are uniquely positioned to provide leadership and guidance to help drive this shift to enhanced levels of seismic performance.

As we learn more about climate change, more of us begin to believe the consequent impacts like air-quality issues hundreds of miles away from wildfires, or increased and repetitive flooding in some places. In the past, we've tended to separate the impacts of a large storm, such as a 100-year event, by assuming it wouldn't happen concurrently with a major earthquake because the probability of that dual occurrence was considered low enough to separate the impacts of those two events. In "A Shifting Landscape," Tugce Baser, Ozgun Alp Numanoglu, and Sissy Nikolaou describe how this assumption isn't correct in some cases. Major earthquakes have driven complex multihazard cascading occurrences such as landslides that were also triggered by weather events. The authors present details of an already slow-moving landslide driven by climate-induced weather events, which was then accelerated in response to a number of large and small seismic events. A recent workshop on cascading hazards is the first step of a larger effort with the goal of building resilient communities and environment.

In "Scaling the Challenges Posed by Earthquakes," Ramin Motamed, Mourad Zeghal, Daniel W. Wilson, Srikanth S. C. Madabhushi, and Ahmed Elgamal note that predicting the dynamic response of soil during an earthquake and the resulting impacts on infrastructure remains challenging because of complex material behavior. With that premise, they show how physical modeling and the level of control that can be applied to physical model tests can be key to elucidating critical fundamental mechanisms of dynamic soil behavior. This article describes how 1g shake table testing, which tends to be more costly, can

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be used in conjunction with advanced centrifuge testing that incorporates dynamic loading to systematically study ranges of soil parameters and their relationship to dynamic properties. They also emphasize that synergy between field observations and physical modeling will continue to play its essential role to allow continued refinement of analysis techniques and design for suitable earthquake-induced performance, and continued interaction with industry to transfer insights to actual applications.

Advances in exploration, testing, and numerical modeling, coupled with learning from full-scale field testing of soil-improvement techniques, are being integrated to build a seismically resilient platform to redevelop a 400-acre island constructed in the 1930s by hydraulic filling in the highly seismic environment of the San Francisco Bay. In “Treasure Island,” Pedro Espinosa, Uri Eliahu, Stefanos Papadopulos, and Christopher Stouffer describe how the island’s creation and evolution was a factor in their evaluation to optimize the soil improvement needed to enhance the seismic resilience of the area for planned future redevelopment. They say it’s important to avoid using overly simplified methods of seismic analysis, which can often lead to over-conservatism. Instead, they believe clients are better served when geotechnical engineers educate them up front about the need for additional expenditures and time for more detailed geotechnical investigations and more robust and detailed analyses that can improve resilience and represent significant savings.

This issue’s GeoLegend and the next Terzaghi Lecturer is Andrew J. Whittle. Interviewed by Jack Lawrence, Carina Tanissa, Travis Shoemaker, and Maksymilian Jasiak, we learn that after Whittle completed his doctorate at MIT, he joined the MIT faculty, where today he’s recognized as an international expert in numerical analysis methods and soil constitutive modeling to predict the performance of foundations and underground construction. The interview delves into Whittle’s other interests in civil engineering, his bias toward engineering problem-solving, his reflections on how geotechs might augment ongoing efforts to mitigate climate change, and his views on what defines a GeoLegend. All in all, a most interesting interview.

Our resident GeoPoet, Mary Nodine, closes this issue on a special area of geotechnics with an interesting literary take on seismicity in her aptly titled poem, “Earthquake.” She succinctly captures the process earthquake engineers and scientists have taken to study, learn, and adapt to help prepare more effectively for the next one.

We hope you enjoy this issue. Feel free to send feedback to Jim Withiam, editor-in-chief, at *jlwithiam@gmail.com*. GS

This message was prepared by *GEOSTRATA* editor **JEFF DUNN, Ph.D., P.E., G.E., BC.GE, M.ASCE**. He can be reached at *rjeffdunn@gmail.com*.

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