

## **Performance-Based Design for Soil Liquefaction**

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Many advances have been made over the 50-some years in which geotechnical engineers have actively been involved in the practice of earthquake engineering. Most recently, advances have come through the development of performance-based earthquake engineering, which seeks to predict the seismic performance of structures and facilities in ways that are useful to a wide variety of stakeholders. This presentation reviews the evolution of performance-based earthquake engineering and its application to liquefaction problems. Inconsistencies in current procedures for liquefaction hazard evaluation are identified and techniques for correcting them described, including an approach under development that will allow the benefits of the performance-based approach to be realized without additional effort on the part of the practicing geotechnical engineer. The paper gives examples of different manners in which performance-based earthquake engineering can be implemented, and illustrates the most advanced implementation with an example of a bridge founded in liquefiable soils. Finally, a series of challenges and opportunities presented by performance-based earthquake engineering for geotechnical engineering practitioners are identified and discussed.



**Steve Kramer** received his BS, M.Eng., and PhD degrees from the University of California, Berkeley in 1977, 1979, and 1985, respectively. Kramer joined the geotechnical group in the University of Washington Department of Civil Engineering in 1984. He has taught a wide range of undergraduate and graduate courses in geotechnical engineering, and advised numerous graduate students on Masters and Ph.D. research projects. His primary research interests include soil liquefaction, site response analysis, seismic slope stability, and hazard analysis. Much of his current research work is in the area of performance-based earthquake engineering, specifically the integration of probabilistic response analyses with probabilistic seismic hazard analyses.

Kramer is the author of the book *Geotechnical Earthquake Engineering* and of numerous technical papers and reports. He has been the recipient of the Presidential Young Investigator Award from the National Science Foundation, the Arthur Casagrande Professional Development Award from ASCE, a Walter Huber Research Prize from ASCE, and the 2009 Norman Medal from ASCE. Kramer was a Senior Research Scientist in the International Centre for Geohazards at the Norwegian Geotechnical Institute (NGI) in 2003, and is also a member of the faculty of the European School for Advanced Studies in the Reduction of Seismic Risk (the ROSE School) at the University of Pavia in Italy.

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