Jon Bray

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Simplified procedure for estimating liquefaction-induced building settlement

Biography

Jonathan Bray is the Faculty Chair in Earthquake Engineering Excellence at the University of California, Berkeley. He earned engineering degrees from West Point, Stanford, and Berkeley. Dr. Bray is a registered professional civil engineer and has served as a consultant on several important engineering projects and peer review panels. He has authored more than 350 research publications. His expertise includes the seismic performance of earth structures, seismic site response, liquefaction and ground failure and its effects on structures, earthquake fault rupture propagation, and post-event reconnaissance. Dr. Bray was elected into the US National Academy of Engineering and is a Fellow in ASCE. He has received several other honors, including the Terzaghi Award, Ishihara Lecture, Peck Award, Joyner Lecture, Prakash Award, Huber Research Prize, Packard Foundation Fellowship, and NSF Presidential Young Investigator Award.

Abstract

Significant settlement and damage may occur due to liquefaction of soils beneath shallow-founded buildings. The primary mechanisms of liquefaction-induced building settlement are shear-induced, volumetric-induced, and ejecta-induced ground deformation. Volumetric-induced free-field ground deformation may be estimated with available empirical procedures. Although challenging to estimate, ground failure indices and experience can be used to estimate roughly ejecta-induced building settlement. Nonlinear dynamic soil-structure interaction (SSI) effective stress analyses are required to estimate shear-induced ground deformation. Results from over 1300 analyses identified earthquake, site, and building characteristics that largely control liquefaction-induced building settlement during strong shaking. A simplified procedure is developed based on the results of these analyses to estimate the shear-induced component of liquefaction building settlement. The standardized cumulative absolute velocity and 5%-damped spectral acceleration at 1 s period capture the ground shaking. The liquefaction building settlement index, which is based on the shear strain potential of the site, captures in situ ground conditions. Building contact pressure and width capture the building characteristics. Field case histories and centrifuge test results validate the proposed simplified procedure. Recommendations and an example for evaluating building performance at liquefiable sites are shared.

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