EPOLLS: An Empirical Method for Predicting Surface Displacements Due to Liquefaction-Induced Lateral Spreading in Earthquakes

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Abstract

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In historical, large-magnitude earthquakes, lateral spreading has been a very damaging type of ground failure. When a subsurface soil deposit liquefies, intact blocks of surficial soil can move downslope, or toward a vertical free face, even when the ground surface is nearly level. A lateral spread is defined as the mostly horizontal movement of gently sloping ground (less than 5% surface slope) due to elevated pore pressures or liquefaction in underlying, saturated soils. Here, lateral spreading is defined specifically to exclude liquefaction failures of steeper embankments and retaining walls, which can also produce lateral surface deformations. Lateral spreads commonly occur at waterfront sites underlain by saturated, recent sediments and are particularly threatening to buried utilities and transportation networks. While the occurrence of soil liquefaction and lateral spreading can be predicted at a given site, methods are needed to estimate the magnitude of the resulting deformations.

In this research effort, an empirical model was developed for predicting horizontal and vertical surface displacements due to liquefaction-induced lateral spreading. The resulting model is called "EPOLLS" for *Empirical Prediction Of Liquefaction-induced Lateral Spreading*. Multiple linear regression analyses were used to develop model equations from a compiled database of historical lateral spreads. The complete EPOLLS model is comprised of four components: (1) *Regional-EPOLLS* for predicting horizontal displacements based on the seismic source and local severity of shaking, (2) *Site-EPOLLS* for improved predictions with the addition of data on the site topography, (3) *Geotechnical-EPOLLS* using additional data from soil borings at the site, and (4) *Vertical-EPOLLS* for predicting vertical displacements. The EPOLLS model is useful in phased liquefaction risk studies: starting with regional risk assessments and minimal site information, more precise predictions of displacements can be made with the addition of detailed site- specific data. In each component of the EPOLLS model, equations are given for predicting the average and standard deviation of displacements. Maximum displacements can be estimated using probabilities and the gamma distribution for horizontal displacements or the normal distribution for vertical displacements.

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Dedicated to

the courage of my sister
Doris A. Rauch

the strength of my father
Paul H. Rauch

the lasting memory of my mother
Dorothy L. Rauch

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