Stochastic simulation and dynamic reliability analysis of earth structures

†*Yu Huang[12], Hongqiang Hu[2]

[1] Key Laboratory of Geotechnical and Underground Engineering of the Ministry of Education, Tongji University, Shanghai 200092, China
[2] Department of Geotechnical Engineering, College of Civil Engineering, Tongji University, Shanghai 200092,China.

*Presenting author: yhuang@tongji.edu.cn
†Corresponding author: yhuang@tongji.edu.cn

Abstract

In geotechnical earthquake engineering, the view that the seismic performance of earth structures is affected by various sources of uncertainty (e.g. soil properties; earthquake ground motion) is well recognized. The state-of-the-art performance-based earthquake engineering methodology developed at the Pacific Earthquake Engineering Research Center also pointed out that the explicit determination of seismic performance and explicit consideration of various uncertainties are of great significance. In present study, a novel probabilistic methodology, namely the probability density evolution method (PDEM), is proposed for the refined dynamic reliability analysis of earth structures. PDEM has ability to decouple the nonlinearity and randomness by integrating the deterministic time history analysis and stochastic analysis. Our study has conducted a stochastic simulation of earthquake randomness and assessed the effect of this randomness on the dynamic reliability of the structures. The typical stochastic seismic responses, such as mean value, standard deviation, instantaneous probability density function and dynamic reliability, are obtained in our method. The seismic performance of earth structure is assessed by the quantitative performance evaluation index from standards and existing literature. The feasibility and accuracy of our method is also verified by the commonly-used Monte Carlo simulation method. Our study can provide objective assessment of the likely seismic performance, and also act as a reference and guideline for the performance-based seismic assessment, design and reliability-based optimization of geotechnical problems.

Keywords: Seismic performance; Probabilistic method; Stochastic simulation; Dynamic reliability.