Simulation using the Karhunen-Loeve expansion – some computational aspects

Kok-Kwang Phoon (National University of Singapore)

Abstract

For time dependent reliability assessment using simulation, one of the main challenges is to develop efficient computer algorithms that can generate realistic sample functions on a modest computing platform. This task is much more difficult than the simulation of random variables because the realisations must fit the prescribed covariance function besides producing the target marginal distribution. To ensure sufficient generality for practical applications, the simulation procedure should be capable of handling: (a) stationary or non-stationary covariance functions, (b) Gaussian or non-Gaussian marginal distributions, and (c) short or long processes. Aside from theoretical consistency and generality, computational efficiency is a key practical concern because the typical practicing engineers will not have access to computational resources beyond a desktop PC.

This presentation explores the possibility of exploiting the well-known Karhunen-Loeve (K-L) expansion for simulation of realistic sample functions in a theoretically consistent and computationally efficient way. Stationary and non-stationary Gaussian processes over any finite interval can be simulated relatively easily once the basis eigenfunctions are determined. A simple wavelet-Galerkin numerical scheme could be used to compute these K-L basis functions (eigensolutions of the prescribed covariance function). Non-Gaussian processes (even highly skewed ones) can be produced by an iterative algorithm.

The Speaker

Email: cvepkk@nus.edu.sg
Homepage: http://www.eng.nus.edu.sg/civil/aboutus/facultystaff/cvepkk/pkk.html

Dr KK Phoon is an Associate Professor of the Geotechnical Engineering Group in the Department of Civil Engineering, National University of Singapore. He is presently a Visiting Professor at the Centre for Ships and Ocean Structures. His current research interests include reliability-based foundation design, simulation of random processes, preconditioners for Krylov subspace solution of large 3D soil-structure problems, and land reclamation. Dr KK Phoon is the chair of the ASCE Geo-Institute technical committee on Risk Assessment and Management, member of the Board of Directors in Civil Engineering Risk and Reliability Association (CERRA), editorial board member of the ASCE Journal of Geotechnical and Geoenvironmental Engineering and International Journal of Geoengineering Case Histories, and a core-member of ISSMGE TC23 on Limit State Design in Geotechnical Engineering Practice. He has served on numerous conference advisory and scientific committees and is the author of more than 80 technical papers (including co-editor of 5 proceedings)