Assessment of methods for the numerical solution of the Fredholm integral eigenvalue problem

Abstract:

The computational efficiency of random field representations with the Karhunen-Loève expansion relies on the numerical solution of a Fredholm integral eigenvalue problem. In this contribution, different methods for this task are compared. These include the finite element method (FEM), the finite cell method (FCM) and the Nyström method. For the FEM with linear basis functions, two different approaches to treating the covariance function in the integral eigenvalue problem are investigated: L2-projection and linear interpolation of the covariance function between the nodes of the finite element mesh. The FCM is a novel approach, originally presented by Parvizian et al. (Comput. Mech., 41: 121-133, 2007) for the solution of elliptic boundary value problems. This method is based on an extension to the FEM but avoids mesh generation on domains of complex geometric shape. In the Nyström method, a numerical integration rule is applied to transform the integral eigenvalue problem to a matrix eigenvalue problem. It is shown that the expansion optimal linear estimation (EOLE) method proposed in Li & Der Kiureghian, J Eng Mech-ASCE, 119(6): 1136-1154, 1993) constitutes a special case of the...
Nyström method. The behavior of all methods is investigated with respect to a two-dimensional example of a plate with a hole.