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Automation of stochastic finite element method by symbolic-numeric approach

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ABSTRACT

Nowadays, the use of advanced software technologies, especially symbolic and algebraic systems, problem solving environments and automatic differentiation tools, can influence directly on how the mechanical problem and corresponding numerical model are postulated and solved, leading to automation of the finite element method. The paper presents an approach to automation of the stochastic finite element method (SFEM, Ghanem and Spanos 1991) by means of hybrid symbolic-numeric approach (Korelc 2002, sell also www.fgg.uni-lj.si/symech/). The SFEM method has been proposed and developed as an alternative to the Monte Carlo simulation that, when it is combined with the FEM, requires a large number of randomly generated samples.

The symbolic generation of characteristic matrices $N_{ij} = \int_\Omega N_j(\mathbf{x})\, N_i(\mathbf{x})\, d\mathbf{x}$ and $C_{ij} = \int_\Omega C(\mathbf{x}_1, \mathbf{x}_2) N_j(\mathbf{x}_1)\, N_i(\mathbf{x}_2)\, d\mathbf{x}_1 d\mathbf{x}_2$ used within the Karhunen-Loeve (KL) decomposition of the random system characteristics will be presented. Emphasis will be given on Galerkin approach and integration of C_{ij} in the case when structure involved is composed of several components with random system characteristics (e.g. single-storey steel building composed of welded steel plates).

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