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Stochastic finite element analysis of structures in the presence of multiple imprecise random field parameters

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Abstract

The research work presents the study on non-deterministic problems in the presence of the multiple imprecise-random-field uncertainties by extending the spectral stochastic finite element framework. The standard random field is expanded to characterize the behaviour of physical model with imprecise randomness more appropriately for real engineering problems based on available sources of uncertainty. The Young's modulus and body force of structures are considered as imprecise random fields with bounded statistical moments. Mathematical expressions and solution procedure are developed to produce the uncertain-but-bounded statistical characteristics of responses, namely interval mean value, interval standard deviation and bounding distribution functions. The bounding probability density and cumulative distribution of the imprecise random response are then effectively visualised by means of Polynomial Chaos Expansion. The feasibility and effectiveness of the presented method are illustrated by three numerical examples.

Keywords: spectral stochastic finite element method; imprecise random fields; multiple random fields; interval random response; interval statistical moments.

1. Introduction

Appropriate representations and simulations of complex structures to effectively reflect their underlying nature under inevitable features of uncertainty have substantially drawn attentions and interests of investigation into computational stochastic mechanics for engineering problems [1-5]. The modelling processing of stochastic framework aims at appropriately characterizing the variability of phenomena consistently with the underlying real-world information, consequently constructing the behaviour of physical models more realistically.

A popular systematic approach in computational stochastic mechanics showing proficient stochastic modelling is the spectral stochastic finite element method (SSFEM) proposed by Ghanem and Spanos [6]. This method has been receiving substantial attentions by many studies and been continually improving to achieve more accurate results [7-17]. SSFEM

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