Uncertainty analysis of varied meshes of a finite element model using Monte Carlo simulation

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Abstract

Purpose – Advanced computational methods help to solve complex engineering problems via finite-element simulation. However, uncertainties during the process occurred due to the nature of geometry, material properties, loading, and boundary conditions. These inaccuracies affect the accuracy of results obtained from the analysis. This paper aims to analyse the uncertainty parameters of a finite element model in Excel-Visual Basic Application (VBA) by applying a random simulation method.

Design/methodology/approach – This study focuses on a finite element model with a different mesh. Young's Modulus, E, Poisson's ratio, and load, L are the uncertainty input parameters considered random variables.

Findings – Results obtained proved that the finite element model with the most nodes and elements has better solution convergence.

Originality/value – Random simulation method is a tool to perform uncertainty analysis of a finite element model.

Keywords Uncertainty, Monte Carlo simulation, Mesh convergence, Finite element method, Numerical simulation

Paper type Research paper

Introduction

Modern technologies have helped humans build top-notch structures. Humans constructed skyscrapers, bridges, elevated highways and even down to compact size mini-USB drives, micro-sized computer processors and hard drives to ease hassle daily life routine. However, the safety and longevity of these structures are questionable as uncertainties exist. According to Farkas *et al.* (2010) and Stritih *et al.* (2019), uncertainties are due to a lack of information and ambiguities during manufacturing and process modeling.

Fuzziness represents a lack of information of a human's perspective on uncertain quantities. Aleatory and epistemic uncertainty are two types of uncertainties (Bulleit, 2008; Li *et al.*, 2018). Aleatory is related to the law of nature, while epistemic uncertainty is dependent on human thinking capacity. Furthermore, the material properties applied and the variability in the manufacturing process are also the leading cause for uncertainties (Hu and Mahadevan, 2017; Liu *et al.*, 2019). Due to the limitation of human knowledge capacity in the manufacturing process, there are uncertainties in material properties,

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