Automated Ritz method for the analysis of bi-directional functionally graded deep beams

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Abstract

The paper investigates the structural performance of bi-directional functionally graded beams (BDFB), The beam is made of an elastic material with varying properties in both the longitudinal and transverse directions. The beam's material composition gradually changes from one surface to the other, as well as across its depth, following a specific grading law, such as the power-law distribution. This research focuses on analyzing the mechanical response of BDFBs under various loading and boundary conditions. The beam is modeled as a plane stress problem and the analytical solution in terms of polynomials is obtained using Ritz method. In order to reach accurate solutions, the equations resulted from the principle of minimum potential energy is cast in a matrix form. This task is achieved using indicial notations. The integration of various elements of the obtained matrix is performed using Mathematica. For that purpose, an automated integration scheme is implemented in the Mathematica code. The proposed integration scheme enables the inclusion of as many polynomial terms as required for the convergence of the solution. The accuracy of the solution is verified by Finite element analysis.

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