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Stress and strain recovery for functionally graded free-form and doubly-curved sandwich shells using higher-order equivalent single layer theory

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Abstract

We investigate recovery of through-the-thickness transverse normal and shear strains and stresses in statically deformed functionally graded (FG) doubly-curved sandwich shell structures and shells of revolution using the generalized zigzag displacement field and the Carrera Unified Formulation (CUF). Three different through-the-thickness distributions of the volume fractions of constituents and two different homogenization techniques are employed to deduce the effective moduli of linear elastic isotropic materials. The system of partial differential equations for different Higher-order Shear Deformation Theories (HSDTs) is numerically solved by using the Generalized

Differential Quadrature (GDQ) method. Either the face sheets or the core is assumed to be made of a FGM. The through-the-thickness stress profiles are recovered by integrating along the thickness direction the 3-dimensional (3-D) equilibrium equations written in terms of stresses. The stresses are used to find the strains by using Hookeâ€™s law. The computed displacements and the recovered through-the-thickness stresses and strains are found to compare well with those obtained by analyzing the corresponding 3-D problems with the finite element method and a commercial code. The stresses for the FG structures are found to be in-between those for the homogeneous structures made of the two constituents of the FGM.

Keywords

Functionally Graded Materials; Stress and strain recovery; Higher-order Shear Deformation Theory; BÃ©zier curve; Generalized Differential Quadrature method

1 http://software.dicam.unibo.it/diqumaspab-project

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