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Numerical Modeling of Functionally Graded Plates

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Summary

Functionally graded materials (FGMs) are special composites with material properties varying continuously in some spatial directions. Because no distinct interfaces exist in FGMs, failures from interfacial stress concentrations developed in conventional structure components can be avoided. In designing components involving FGMs, it is important to study the response of FGM structures to mechanical and other loadings. However, most of the classical beam, plate and shell theories are not appropriate for functionally graded structures. Therefore, it is necessary to establish new theoretical or numerical models for the analysis of functionally graded structures.

In the analysis of FGM structures, partial differential equations with variable coefficients are presented and generally, they are difficult to be solved analytically. Only for some specific cases, analytical solutions can be obtained. As for more general problems, numerical methods are needed.

In the present paper, a functionally graded rectangular plate with arbitrary distributions of material properties is studied using a simply and effective method based on Haar wavelet. To solve the state equations of FGMs plate obtained from three dimensional elasticity theory, double trigonometric series are taken to satisfy the edge boundary conditions, while Haar wavelet series is adopted to expand the variable in thickness direction, and then Haar wavelet coefficients are solved to obtain the Haar series solutions of the displacement and stress components. Numerical results are provided to show the influence of the different functionally graded models and plate configurations on the stress and displacement fields.

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