

# Static and free vibration analysis of laminated composite plates by the scaled boundary finite-element method

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## Abstract

This study presents the static bending and free vibration analysis of laminated composite plates using a three-dimensional consistent approach based on the scaled boundary finite element method. The stiffness matrix for each layer is constructed from three-dimensional governing equations. The in-plane dimensions are modeled by two-dimensional higher order spectral elements. Padé expansion is used to express the through thickness solution analytically. In the present technique, a layer-wise approach is proposed to construct the stiffness matrix of the laminated composite. For the mass matrix, the displacement fields are approximated as a sum of two functions, respectively, of the transverse coordinate  $z$  and the in-plane coordinates  $x, y$ . The Lobatto quadrature is applied to the integration along the transverse direction, and this leads to a diagonal mass matrix. The displacement fields of the derived stiffness and mass matrices are consistent with those in conventional three-dimensional finite element method. It allows the proposed technique to accurately describe both discrete layer transverse shear effects and discrete layer transverse normal effects. No ill conditioning occurs when the thickness of the plate becomes thin. Two numerical examples are presented to show the accuracy and convergence rate of proposed technique. Good agreement with three-dimensional analytic solutions is obtained.

**Keywords:** Laminated composite structure; Scaled boundary finite-element method; Spectral element; Static bending analysis; Modal analysis