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论文

用变分渐近法进行复合材料层合板仿真及三维场重构

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摘要：

为有效模拟和准确重构复合材料层合板三维应力/应变/变形场， 基于变分渐近方法构建单斜对称的复合材料层合板渐近修正理论和重构关系。主要内容包括： 基于旋转张量分解概念用一维广义应变和翘曲表示板的三维应变场， 以考虑包括板翘曲变形在内的所有变形; 基于变分渐近法将原三维问题分析严格拆分为非线性二维板分析（等效单层板模型）和沿法线方向的一维线性分析; 通过层合板厚跨比和二维应变量阶数2个较小参数将应变能渐近修正到第二阶, 并转换为Reissner形式以便于实际应用; 利用生成的二维板变形和翘曲函数精确重构三维场。通过一具有20层复合层合板的柱形弯曲算例表明： 基于该理论和重构过程开发的渐近变分程序VAPAS重构生成的三维应力场精确性较一阶剪切变形理论和古典层合理论更好, 与三维有限元精确解相一致。

关键词： 变分渐近法 复合材料层合板 应力重构 Reissner模型

Simulation and 3D field recovery of composite laminated plates by use of variational asymptotic method

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Abstract:

Abstract： To effectively simulate and accurately recover the three-dimensional stress/strain/deformation field of composite laminated plates, an asymptotic revise theory and the recovery relationship were established based on the variational asymptotic method (VAM). The original 3D stress field was expressed by one-dimensional generalized stress and warping function based on decomposition of rotation tensor (DRT) to consider all the deformations, and VAM was used to strictly split the three-dimensional problem into a two-dimensional non-linear analysis of deformation plate (equivalent single-layer plate model) and a one-dimensional linear analysis along the transverse normal direction. Then, the strain energy was asymptotic corrected to second order by taking advantage of the ratio of height to span and the order of two-dimensional strain, and the energy was converted to the form of Reissner formula for practical applications. Based on this theory, a variational asymptotic plate and shell analysis program (VAPAS) was developed. The cylindrical bending example of a 20-layer composite plate shows that the three-dimensional field recovered by this theory agrees better with the exact results than that by the first-order shear deformation theory (FOSDT) and classic laminated theory (CLT).

Keywords: variational asymptotic method composite laminated plates stress field recovery Reissner model

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