An a posteriori error estimator for laminated Kirchhoff plates

Michael Weise\textsuperscript{1} Arnd Meyer\textsuperscript{2}

Lightweight construction plays an important role in modern engineering. Fibre reinforced polymers (FRP) are in common use in this field. Strong fibres (e.g. glass fibres, carbon fibres) are combined with a weaker polymer which holds the fibres in place. This gives a composite material which features high stiffness and strength in fibre direction while having a relatively low specific weight. The material can be described as a continuum featuring transversely isotropic material behaviour, a special case of anisotropy, see [1].

FRP structures are often constructed as a thin shell, e.g. parts of the bodies of planes or cars. Since the material is only strong in fibre direction, multiple layers with different fibre directions are combined into a laminate to account for different load cases. Our goal is to simulate such structures. As a simplification we restrict ourselves to plates, that means we only consider structures with a flat mid-surface.

Using the Kirchhoff plate model and assuming constant materials over the thickness one gets a plate equation decoupled from the in-plane deformation of the mid-surface. In the given problem this only holds true for a symmetric laminate sequence over the thickness but not in the general asymmetric case. Here in-plane deformations can cause out-of-plane deformations and vice versa.

A precise simulation of FRP components is the basis for efficient design of lightweight structures. A fast as well as highly accurate computation can be achieved using the adaptive finite element method with its solution-dependent automatic mesh refinement, based on local error estimation.

In our talk we present an a posteriori error estimator for the specified problem. It considers element residuals and edge jump terms of the arising plate, membrane and couple parts of the equation.

References:


\textsuperscript{1} Chemnitz University of Technology, Mathematics, 09107 Chemnitz, Germany, michael.weise@mathematik.tu-chemnitz.de

\textsuperscript{2} Chemnitz University of Technology, Mathematics, 09107 Chemnitz, Germany, arnd.meyer@mathematik.tu-chemnitz.de