An a posteriori error estimator for laminated Kirchhoff plates

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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:

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