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predavanje

A Mixed Shell Formulation Accounting for Thickness Strains and Finite Strain 3D Material Models

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Theory and Numerical Models of Unidirectional Stiffened Composite Materials: 3D Finite-Element-Analysis of Fiber-Matrix Micro-Instabilities

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01/04/08		Fakultet strojarstva i brodogradnje, I. Lučića 5		

predavači

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A mixed shell formulation accounting for thickness strains and finite strain 3d-material models

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Abstract

A nonlinear quadrilateral shell element for the analysis of thin structures is presented. Within the Reissner-Mindlin theory a three-field variational formulation with independent displacements, stress resultants and shell strains is developed. The introduction of independent thickness strains allows incorporation of arbitrary nonlinear three-dimensional constitutive equations without further modifications. The essential feature of the new element is the robustness in the equilibrium iterations. It allows very large load steps in comparison to other element formulations. We present results for finite strain elasticity, inelasticity, delaminations of thin films on rigid subtrates, bifurcation and post-buckling problems.

Theory and Numerical Models of Unidirectional Stiffened Composite Materials: 3D Finite-Element-Analysis of Fiber-Matrix Micro-Instabilities

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Abstract

Fiber reinforced composite materials, which are compressed parallel to the fibers illustrate different failure mechanisms. One of these is the buckling of a single or several fibers at the micro-level, which also is called micro-buckling. At first the micro-buckling of a fiber in a matrix is reduced to the stability behavior of an infinite beam on an elastic foundation. In the following a 3D-analytical description of the stability behavior of a single fiber in a matrix is presented and finally a geometrically non-linear finite element analysis on a defined characteristic cell is employed. Here, some alternative finite element discretizations are compared in order to model the characteristic cell in a proper way. Transverse-isotropic material behavior is taken into account with respect to some anisotropic fibers. The near fiber parallel free surface of the matrix has an effect on the micro-buckling, which has been studied. For the case of a periodical fiber arrangement appropriate boundary conditions are introduced. The results of the 1D-beam model, the fully 3D-analytical model and the 3D-numerical investigations are compared qualitatively and quantitatively as well as with experiments.

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Education:
Diploma (FH) in civil engineering at FH Bielefeld in 1976,
Diploma in civil engineering at the University of Hannover in 1984,
Dr. degree with Professor E. Stein at the Institute of Structural Mechanics and Numerical Mechanics in Hannover 1987,
Title of the thesis: Theory and numerics of thin elastic shells with finite rotations,
Habilitation at the University of Hannover in 1995 on Theory and finite element formulations for fibre reinforced composite structures.

Labour Relations:
Structural engineer in a construction company for glue laminated timber structures 1977-1979,
Military service 1978,
Research assistant at the University of Hannover from 1984-1989 and 1990-1995,
Visiting Scholar at the University of California in Berkeley 1989-1990,
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Professor for Structural Analysis in the Civil Engineering Department of the Technical University of Darmstadt since 1998.

Research interests:
Beam and shell structures, mechanics of fibre reinforced polymers, numerics of inelastic deformations, finite element methods.

Publications:
About 100 scientific papers in proceedings and international journals like:
ZAMM, Archive of Applied Mechanics, International Journal for Numerical Methods in Engineering, Computer Methods in Applied Mechanics and Engineering, Finite Elements in Analysis and Design, Computational Mechanics, Engineering Computations, Composite Structures, European Journal of Finite Elements.

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Curriculum Vitae Prof. Dr.-Ing. habil. Werner Wagner

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1973-1980	Studies in Civil Engineering, University of Hannover
1980-1985	Research assistent and lecturer at Institut for Baumechanik and Numerische Mechanik, University of Hannover
1985	PhD.thesis on Geometrical Nonlinear Shear-Elastic Shell Formulations with Application to Finite-Element-Calculations of Snap-Through and Contact-Problems
1985-1990	Senior lecturer at Institut for Baumechanik and Numerische Mechanik, University of Hannover
1990	Habilitation thesis on Stability Problems in the Theory of Elasticity with Application to the Finite-Element-Method
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since 1994	Professor for Structural Mechanics and Head of the Institut for Structural Analysis at University of Karlsruhe (TH)
Member of	the executive council of GACM (German Association for Computational Mechanics)
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Publications	About 200 scientific papers in proceedings and international journals