Aalto University
School of Engineering

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Homogenization of lightweight sandwich beams

Title of the dissertation	A nonlinear modelling approach for corrugated sandwich beams
Contents of the dissertation	The transport industry accounts for a significant share in the global energy consumption. Optimization of transport modes is hence fundamental to mitigate the effects of climate change. Performance-based mode selection is crucial, and waterborne transport is often a front-runner. Marine structures can be made yet more efficient by employing technological developments and reducing their structural weight. Recent advances in manufacturing technologies allow large-scale production of lightweight, shape-optimized structural forms. Sandwich panels excel in several fronts; in addition to their superior bending stiffness, their cores can be designed to integrate multiple, combined structural and non-structural functions. Optimized corrugated sandwich panels are composed of elements that are relatively small and detailed, what makes their structural assessment challenging. Thus, averaged, *homogenized* descriptions are favored in certain design stages. Homogenized descriptions have, however, limitations when based on conventional continuum models. Modeling with conventional continua implies clear length-scale separation, while in corrugated sandwich panels the scales are close to each other. This dissertation tackles challenges in the modeling of sandwich panels with corrugated cores. A nonlinear approach is developed and tested in different loading scenarios. The approach is founded on a non-classical beam model, whose constitutive behavior describes the behavior of a generic unit under idealized deformation modes. Scale transitions are embedded into the constitutive matrix. Effective coefficients describe progressive stiffness changes due to local buckling. The coefficients are derived based on the global strain-state and an analytical model that represents a generic face sheet. A stress localization approach is also defined, as well as a finite element. The approach is shown to be successful in predicting deflections and stresses in sandwich beams with various cores. The nonlinear approach succeeds in describing progressive nonlinear bending and buckling, also when local buckling is significant. The non-classical continuum formulation provides basis to describe size effects that are present for certain structural ratios.
Field of the dissertation	Marine Technology
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