TECHNISCHE UNIVERSITÄT DARMSTADT

Master Thesis

Analysis of the local buckling and postbuckling behavior of curved stiffened shells under compression

Note: This thesis is also eligible for crediting in Aerospace Engineering.

Problem

Stiffened panels and shells are distinguished by their exceptional mechanical properties. These materials offer high stiffness and strength combined with low density. These mostly thin-walled structures are often used in the aerospace and shipbuilding industries (Figure 1). Given that thin-walled lightweight structures are frequently subjected to combined loads, their stability behavior is of central importance. For curved stiffened shells, the influence of geometric curvature must be considered from the design phase onwards.

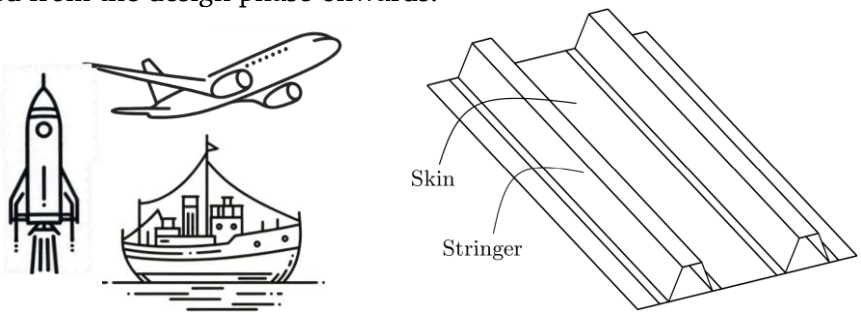

Figure 1: Applications (left), stiffened plate (right)

Tasks

This work aims to extend a computational model for omega stringer-stiffened plates to curved shell structures. The existing model describes the local buckling behavior under compressive loading, where the stringers are represented as elastic restraints along the edges (see Figure 3). Based on the Ritz method, the model is to be adapted to account for geometric curvature and applied to linear buckling as well as postbuckling analysis. The analytical results will be evaluated and validated through comparisons with results of the finite element method (FEM) as part of parameter studies.

The problem statement leads to the following subtasks, which will be addressed in this thesis:

- Introduction to relevant areas of stability theory, energy methods, and classical laminated plate theory
- Literature review on the modeling of stiffened shells using the Ritz method
- Development of a closed-form analytical model for local buckling and postbuckling
- Implementation of a suitable finite element model for result verification
- Conduction of parameter studies for a comprehensive evaluation of the derived analytical solution
- Documentation, discussion, and critical assessment of the modeling approach

Supervisor:

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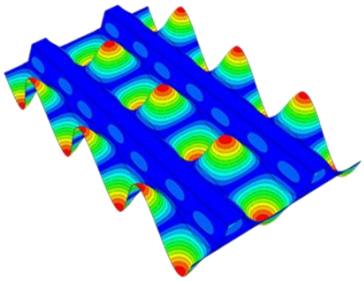

Figure 2: Buckling pattern for local stability failure

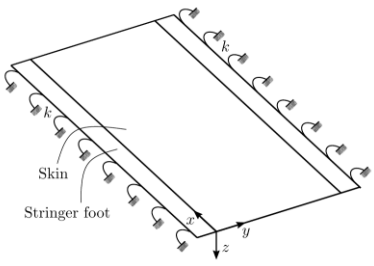

Figure 3: Reduced model with elastic restraints