Robust knockdown factors for the design of axially loaded cylindrical and conical composite shells - Development and validation

H.N.R. Wagner, C. Hühne, S. Niemann

PII: S0263-8223(16)32427-8
DOI: http://dx.doi.org/10.1016/j.compstruct.2017.02.031
Reference: COST 8252

To appear in: *Composite Structures*

Received Date: 4 November 2016
Revised Date: 1 February 2017
Accepted Date: 7 February 2017

Please cite this article as: Wagner, H.N.R., Hühne, C., Niemann, S., Robust knockdown factors for the design of axially loaded cylindrical and conical composite shells - Development and validation, *Composite Structures* (2017), doi: http://dx.doi.org/10.1016/j.compstruct.2017.02.031

ROBUST KNOCKDOWN FACTORS FOR THE DESIGN OF AXIALLY LOADED CYLINDRICAL AND CONICAL COMPOSITE SHELLS - DEVELOPMENT AND VALIDATION

H.N.R. Wagner, C. Hühne and S. Niemann

Institute for Composite Structures and Adaptive Systems, German Aerospace Center (DLR), Lilienthalplatz 7, 38108 Braunschweig, Germany
ronald.wagner@dlr.de

Keywords: Buckling, composite shells, robust design, knockdown factor, high-fidelity design, imperfection, single perturbation load approach, cylinder, truncated cone

Abstract

The stability failure of the axially loaded cylindrical shell is considered as the last unresolved classical stability problem, although it has been investigated for over 100 years. Therefore designers rely on the application of empirical knockdown factors from the 1960s like the NASA SP-8007 for cylindrical shells and the NASA SP-8019 for truncated conical shells which are very conservative for modern shell structures.
At the German aerospace center (DLR) perturbation approaches for the design of cylindrical and conical shells were developed which deliver knockdown factors for a physical based estimation of the lower-bound buckling load. Perturbation approaches are suitable for research and industrial applications as they are independent from imperfection measurements and easy to implement. The corresponding numerical models are validated by means of high-fidelity buckling experiments and it shows that empirical buckling loads can be calculated very precisely in contrast to the previous methodology. New robust knockdown factors are presented for preliminary shell designs which are based on curve fitting of numerical knockdown factors of the perturbation approaches.
Thus, it is possible to utilize the load bearing capability of launch-vehicle primary structures up to 40 % more effectively, resulting in considerable weight saving potentials for composite shell structures.