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Author: Ms. Ines Uriol Balbin
Delft University of Technology (TU Delft), The Netherlands, i.uriolbalbin@tudelft.nl

USE OF NONDIMENSIONAL BUCKLING EQUATIONS FOR LAUNCH VEHICLE STRUCTURES DESIGN

Abstract

For cylindrical shells in space applications, such as launch-vehicle shell structures, interest in the use of sandwich composite with laminated facesheets and shear deformable core is increasing. This is due to the high structural efficiency that the use of sandwich composites can provide. Moreover, designers can tailor the structures to reduce structural weight and increase strength and stiffness, by selecting the optimal combination of laminate stacking sequence and orientation, core material and thickness, and geometry of the cylindrical shell.

These launch-vehicle structures are often cylindrical shells, where stability phenomena such as buckling are to be prevented. Therefore, the critical axial buckling load is a driving design constraint and thus the buckling behavior must be well understood. However this phenomenon is initially difficult to predict and consequently designers recur to, for the most cases, to conservative estimations and the verification and validation process is long and expensive.

The proposed nondimensional equations can be used to characterize the buckling behavior of different shell configurations. The nondimensional parameters identified in the equations are employed to detect changes that present a high influence in the shell buckling response. Designers can use a small number of nondimensional parameters to navigate a broad design space with multiple variables. Nondimensional parameters can also provide insight into the scaling technology used to reduce the cost of experimental validation and certifications of large-scale structures.

This work focuses on the influence of the nondimensional transverse shear parameters in the buckling behavior of sandwich cylindrical shells made of anisotropic facings with a bonded orthotropic core. The nondimensional equations are applied to several cylindrical shells with different core and facing materials, highlighting when the transverse shear becomes relevant. These cases are verified by finite element analyses using the commercial code Abaqus.