Elastic buckling of perfect cylinders under axial loading

Gabriel Rossetto[1], Roberta Springhetti[1], Davide Bigoni[1]
[1] *Dept. of Civil, Environmental and Mechanical Engineering, University of Trento, Trento, Italy*
E-mail:gabriel.rossetto@unitn.it,roberta.springhetti@unitn.it,davide.bigoni@unitn.it

Keywords: shell, buckling

Cylindrical shells are models used in a wide variety of applications in different fields, ranging from the aerospace, naval and construction industries. This class of structures is characterised by a high ratio between load-bearing capacity and volume. However, the resistance of a cylindrical shell can be compromised by the emergence of buckling phenomena even in the elastic region.

The literature available on the instability of thin-walled cylinders under axial compression is quite extensive, see e.g. [1,2], while the same is not true for the case of tension. Revisiting the work of Bigoni and Gei [3], where buckling under axial compression of a coated cylinder is analysed, we derive the analytical condition of instability for a hollow cylindrical shell under axial tension according to a continuum framework. We show that the buckling condition expressed by means of generalised stresses may be obtained in a more intuitive manner by means of a through-thickness integration of the incremental equilibrium conditions, without any hypothesis on the material behaviour. Assuming a hyperelastic, incompressible and transversely isotropic material about the axis of symmetry, we analyse the buckling load for neoHookean (both in its compressible and incompressible version), Mooney-Rivlin and J_2-deformation theory constitutive models. We prove that for the latter case, elastic instability under tensile load is possible.

References

[1] *Simitses, G.J., "Buckling and Postbuckling of Imperfect Cylindrical Shells: A Review", Applied Mechanics Reviews,* **39** *(10), page 1517-24 (1986).*

[2] *Teng, G.J., "Buckling of Thin Shells: Recent Advances and Trends", Applied Mechanics Reviews,* **49** *(4), page 263-74 (1996).*

[3] *Bigoni D. and Gei M., "Bifurcations of a Coated, Elastic Cylinder", International Journal of Solids and Structures,* **38** *(30-31), page 5117-48 (2001).*

Acknowledgements: Support from the ERC Advanced Grant Instabilities and non-local multi-scale modelling of materials 340561-FP7-PEOPLE-IDEAS-ERC-2013-AdG (2014-2019) is gratefully acknowledged.