IMPACT AND FAILURE PERFORMANCE OF THIN-WALLED LATTICE STRUCTURES

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ABSTRACT

Thin-walled two-dimensional structures having macroscopic (repetitive) lattice topologies may exhibit a significantly more favorable structural, thermal, buckling and post-buckling performance per unit weight than traditional monocoque shells and plates. In addition, their properties may be easily customized, and – in combination with actuators – they have the potential of being used as flexible, actively controlled shape-changing structures. In suitable applications they are therefore multifunctional, versatile and highly attractive alternatives to conventional types of lightweight construction, especially in areas where drastically increased demands on weight- and fuel-efficiency, safety and environmental compatibility are key design drivers, such as e.g. the energy, aerospace, automotive and other transport industries.

The aim of the proposed presentation is to explore the extent to which lattice topologies may influence the mechanical properties (stiffness, compliance, strength) and failure behavior of weight-efficient structural components subjected to quasi-static, impact and thermal loads. A variety of lattices (of e.g. the orthogonal, honeycomb, isogrid, kagome and auxetic type) will be considered, and the load-carrying and failure properties of structural configurations such as flat plates, curved panels and hollow tubes will be compared to those of equivalent components consisting of solid sheets of uniform wall thickness.

REFERENCES

[1] M.F. Ashby, A. Evans, N.A. Fleck, L.J. Gibson, J.W. Hutchinson, H.N.G. Wadley, 2003. Metal Foams: A Design Guide. Butterworth-Heinemann.

[2] A.G. Evans, J.W. Hutchinson, N.A. Fleck, M.F. Ashby, H.N.G. Wadley, 2001. The topological design of multifunctional cellular materials. Prog. Mater. Sci. 43 (3-4), 309-327.
[3] L.J. Gibson, M.F, Ashby, 1997. Cellular Solids: Structures and Properties. Cambridge University Press.
[4] R. Hutchinson, N. Wicks, A. Evans, N. Fleck, J. Hutchinson, 2003. Kagome plate structures for actuation. Int. J. Solids Struct. 40, 6969-6980.
[5] H. Obrecht, P. Fuchs, U. Reinicke, B. Rosenthal, M. Walkowiak, 2007. Influence of wall constructions on the load-carrying capability of thin-walled structures. Int. J. Solids Struct. (in press).
[6] C.A. Steeves, S.L. dos Santos e Lucato, M. He., E. Antonucci, J.W. Hutchinson, A.G. Evans, 2007. Concepts for structurally robust materials that combine low thermal expansion with high stiffness. J. Mech. Phys. Solids (to be published).
[7] N. Wicks, S. Guest, 2004. Single member actuation in large repetitive truss structures. Int. J. Solids Struct. 41, 965-978.

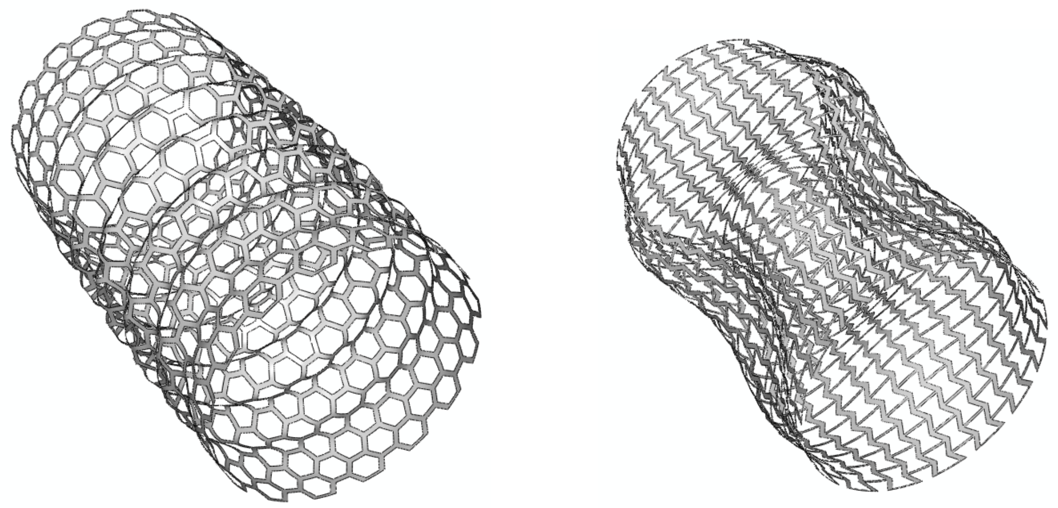

Fig. 1 Buckling modes of an axially compressed lattice cylinder having a regular hexagonal (left) and a standard auxetic topology (right).