Sep 17th, 12:00 AM - Sep 19th, 12:00 AM

Topologically Interlocked Material Systems: From a Material Design Concept to Properties

Thomas Siegmund
Purdue University, siegmund@purdue.edu

IUTAM Symposium Architectured Material Mechanics,
T. Siegmund, F. Barthelat, eds
September 17-19, 2018, Chicago, IL, USA, , Chicago, IL, USA

Topologically Interlocked Material Systems: From a material design concept to properties

Thomas Siegmund[1],
(1) Purdue University, West Lafayette, Indiana, siegmund@purdue.edu

KEYWORDS:
Topological Interlocked Materials, Mechanical Behavior, Scaling, Impact, Tensegrity, Sandwich, Origami

Topologically interlocked stereotomic material systems are load-carrying assemblies of unit elements interacting by contact and friction [1,2]. This contribution summarizes research on such material systems in a variety of configurations based on tessellation geometry and percolation, and it considers external rigid confined, external flexible confined, internal flexible confined, as well as considers the unit elements as solids (elastic and elastic-brittle) or shells (elastic), and under consideration of a range of assembly geometries. Both quasistatic and dynamic loading is considered. We show that for external confinement the dual tessellations structure introduces the load transfer path in the assembly, and that internal Mises truss systems can be used to describe the mechanical response. Yet for internal confinement the load transfer is rather different and can best be described based on Caladine's model for tensegrity. We extend the passive mechanical response to considerations of active systems and demonstrate that active control is a viable path to more complex material response with variable stiffness, energy absorption and shape.

Acknowledgments

This work is supported by NSF award #1662177.

References

[1] Dyskin, A.V., Estrin, Y., Kanel-Belov, A.J. and Pasternak, E., 2001. A new concept in design of materials and structures: Assemblies of interlocked tetrahedron-shaped elements. *Scripta Materialia*, *44*(12), pp.2689-2694.
[2] Siegmund, T., Barthelat, F., Cipra, R., Habtour, E. and Riddick, J., 2016. Manufacture and Mechanics of Topologically Interlocked Material Assemblies. *Applied Mechanics Reviews*, 68(4), p.040803.
[3] Calladine, C.R., 1978. Buckminster Fuller's "tensegrity" structures and Clerk Maxwell's rules for the construction of stiff frames. *International Journal of Solids and Structures*, *14*(2), pp.161-172.