Characterising the transformative shear response of cellular lattices when subject to topological reconfiguration

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Demand for lightweight, adaptive and re-configurable structures is increasing in many fields such as space and robotics, encouraging designers to develop morphing lattice structures [1]. Changes in topology of lattice-like structures alters their effective mechanical properties by altering load paths through the making and breaking of connections between the members [2, 3]. Here we consider a planar sinusoidal lattice structure (fig. 1) that undergoes a topology transformation into a kagome-like system by forming new connections upon contact of adjacent unit cells under compressive loading. [4]. The topology change is associated with a step-change in the effective compressive and shear modulus of the lattice. Unlike traditional morphing systems that typically seek to transform structural geometry, the topology changes allow for large changes in elastic response thus increasing the design envelope for stiffness tailoring. To demonstrate this behaviour, we characterise the shear response of the sinusoidal lattice through the use of finite element analysis and proof-of-concept 3D printed demonstrators.

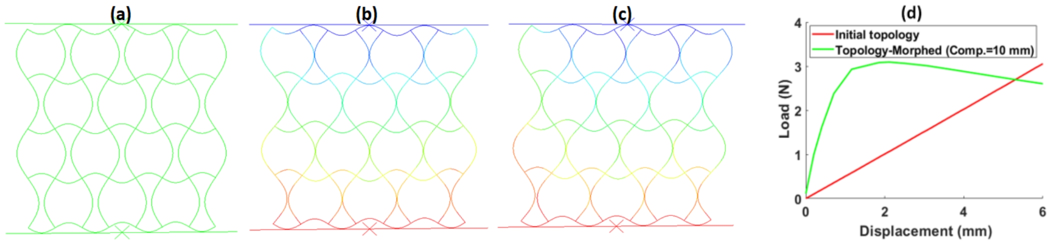

Fig. 1: Schematic of the sinusoidal lattice (a) initial topology, (b) topology-morphed (under compression), (c) shear loaded (topology-morphed) and (d) plot of load-displacement curve under shear

References

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