A NEW FORMULATION FOR THE DESIGN OF EXTREME MATERIALS USING TOPOLOGY OPTIMIZATION

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In [1,2], Sigmund introduced a topology optimization-based computational method for the design of periodic materials with extreme material properties (e.g., Poisson's ratio=1). In this approach, the weight of a unit cell of the periodic structure is minimized, subject to constraints on the cell's effective properties. The effective properties are obtained via standard finite element-based homogenization schemes. While Sigmund reported considerable success with the use of truss elements in this method, the use of continuum elements – e.g., four-noded or nine-noded quadrilateral elements – proved more troublesome, particularly in the design of materials with negative Poisson's ratios.

We consider an alternate formulation for this problem that is based on minimizing the difference between a unit cell's actual properties and the desired extreme properties. A constraint is imposed on the weight of the unit cell. A sample microstructure with $\nu = -0.95$ is shown in Figure 1. An analysis of the formulation, and numerical results comparing the current formulation to the Sigmund formulation will be discussed.

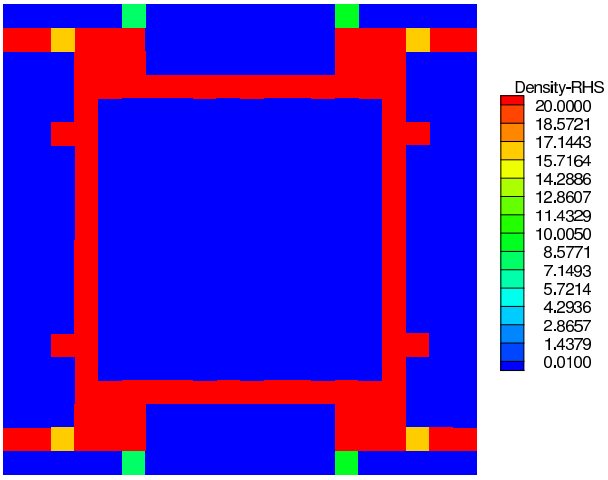

Figure 1: A unit cell with an effective Poisson's ratio of -0.95 obtained using the proposed formulation.

References

[1] O. Sigmund, "Materials with Prescribed Constitutive Parameters: An Inverse Homogenization Problem," *International Journal of Structures and Solids*, v. 31, p. 2313–2329, 1994.

[2] O. Sigmund, "Tailoring materials with prescribed elastic properties," *Mechanics of Materials*, v. 20, p. 351–368, 1995.