Property closure of double-arrowhead mesostructure

Another example of a double-arrowhead mesostructure is presented to demonstrate the property closure and its dependence on the geometric parameters of the considered unit cell. The analytical approach proposed by Berinskii [1] is employed to establish the interdependence among C_{11}, C_{22}, and C_{12}, while Huber's method [2] is utilized to derive the relation with the shear modulus (C_{66}). Owing to geometric feature constraints, an appropriate parameter range is selected to analyze the property space of the double-arrowhead structure. The geometric variables are constrained as $a/b = [0.4, 0.6]$, $\theta = [70°, 80°]$, and $\rho = [0.1, 0.5]$. When these parameters are held constant, their representative values are taken as $a/b = 0.5$, $\theta = 75°$, and $\rho = 0.30$; the corresponding unit cell configuration is illustrated in Fig. 1 (a). The individual single-variable property spaces and the combined three-variable property space are shown in Fig. 1 (b) and (c), respectively. The observation on shape of the closure remains consistent with the previously discussed cases.

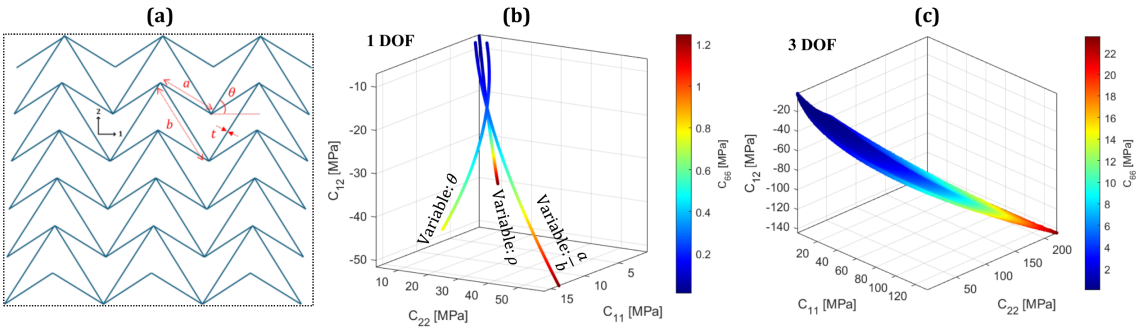

Figure 1: (a) In-plane view of the double-arrowhead structure with unit cell features, (b) three-dimensional property curve for single-variable (1 DOF) consideration, (c) three-dimensional solid property domain for all three variables (3 DOF) consideration.

References

[1] I. E. Berinskii, In-plane elastic properties of auxetic multilattices, Smart Materials and Structures 27 (7) (2018) 075012.

[2] W. Sun, C. Rasmussen, R. Vetter, J. Paulose, Geometric mapping from rectilinear material orthotropy to isotropy: Insights into plates and shells, Physical Review E 108 (6) (2023) 065003.