Loss of ellipticity in a continuum is associated with localization of deformation patterns, because it allows for macroscopically discontinuous equilibrium solutions in nonlinear solids. This was first pointed out by Ericksen using a simple bar under uniaxial loading and subsequently elaborated in two- and three-dimensional solids with non-convex energy densities that exhibit solutions with discontinuous deformation gradients, often in the form of fine microstructures. Subsequent developments in various types of microstructured solids have also shown that a loss of ellipticity in their macroscopic (homogenized) properties leads to equilibrium solutions with highly localized deformation fields, as in the case of kinkbands in axially compressed, fiber-reinforced composites or cellular-type structures (honeycomb). Consequently a macroscopic loss of ellipticity is widely considered as a precursor of localization of deformation in solids.

However, a localized deformation pattern does not necessarily occur when a solid looses ellipticity “on the average” i.e. in its macroscopic (homogenized) response. The key to understanding the connection between a macroscopic loss of ellipticity and a localization of the solid’s deformation pattern lies in the post-bifurcation behavior of the solid under investigation. The connection is elucidated for the case of media with periodic microstructures through an investigation of the post-bifurcation behavior of finitely strained, nonlinear layered solids. It is shown that depending on constitutive properties and microgeometry, solids that lose macroscopic ellipticity at certain loads can sustain higher macroscopic loads, thus avoiding localization of deformation. An asymptotic post-bifurcation analysis for these composites investigates under what conditions a loss of macroscopic ellipticity implies or avoids localization of deformation and gives examples for each case.