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Axial Decay of Time Harmonic End Perturbation in Prestretched Hyperelastic Plates

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A detailed spectral analysis is presented for dynamic eigenfields generated by time harmonic end perturbations applied to a semi-infinite prestrained plate. Formulation is exact within continuum elasticity theory and frequency maps are provided over a range of prestretch, material (hyperelastic) properties, boundary constraints and frequency of applied disturbance. We concentrate on axially decaying eigenmodes and show that at each frequency there is a finite limited number of propagating modes. It is suggested that the infinite number of axially decaying modes defines a restricted validity of Saint-Venant's principle in finite elastodynamics. The influence of field parameters on frequency maps and axial decay rates is numerically exposed and supported by asymptotic expansions. Among the main findings are the sensitivities of dynamic response near points of instability, the effect of finite strain compressibility and importance of boundary data. All illustrations are for laboratory tested hyperelastic solids, with possible application to laminated composite structures.

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