GROUP-THEORETIC APPROACH FOR NONLINEAR PROBLEMS IN ARCHITECTED MATERIALS AVOIDS USE OF IMPERFECTIONS

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Abstract

Many interesting problems in nonlinear mechanics, from classical to more recent, pertain to applications with high initial symmetry: from the buckling of thin walled structures to the morphing in architected materials – the list is long! A common feature of these problems, in addition to their importance for engineering applications, is their great theoretical interest due to the complex bifurcation mechanisms leading to their failure. Unlike the classical Euler column buckling with the widely separated bifurcation points where the post-bifurcation equilibrium paths can be easily found using imperfections in the shape of the different eigenmodes, using imperfections in these highly symmetric structures with complex bifurcation diagrams is confusing and can often lead to erroneous results. The method proposed here is based on the perfect structure and uses the properties of its initial symmetry group to identify and follow the bifurcated equilibrium paths: primary, secondary, tertiary and so on, and for the case of elastic systems, to study their stability. Two different applications will be presented here: the development of folds and creases in an axially compressed elastic half-space, the pattern formation in biaxially compressed circular honeycomb. Time-permitting some additional applications for the thermo-mechanical martensitic transformations in NiTi crystals might be presented.

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