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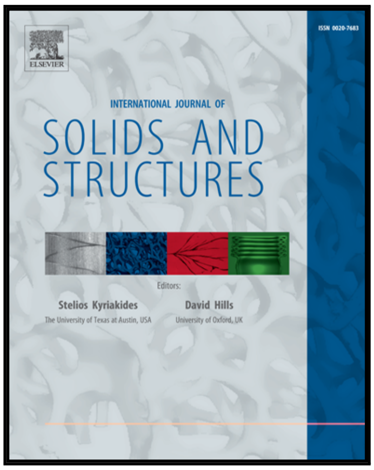

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Lower-order symmetric mechanism modes and bifurcation behavior of deployable bar structures with cyclic symmetry

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Abstract

Kinematic bifurcation is generally unavoidable for deployable structures. Stating at one critical point along the compatibility path, a deployable structure could exhibit unexpected motions. It can either keep transforming along the primary path, or get into one of the bifurcation paths. In this study, a group-theoretic approach, which is applicable for bifurcation analyses on symmetric deployable bar structures, is developed with the aid of symmetry groups and their irreducible representations. The key issue is to decompose the compatibility matrix of a deployable structure into block matrices in the symmetry-adapted coordinate system, and then extract new mechanism modes with lower-order symmetries. These symmetric mechanisms are associated with independent bifurcation paths, and can identify the feasibility of the paths. Further, using the prediction-correction algorithm, the lower-order symmetric mechanisms are utilized to lead the structure smoothly transform into expected bifurcation paths. To verify the effectiveness of the proposed approach, several 2D linkages and 3D deployable structures are analyzed, which possess inherent cyclic symmetries. Numerical results indicate that the proposed approach can effectively trace the complex and independent bifurcation paths.

Keywords: deployable structure; bifurcation behavior; group-theoretic method; compatibility path; symmetry group; finite mechanism