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A HYBRID-TREFFTZ FINITE ELEMENT FOR THE POSTBUCKLING ANALYSIS OF COMPOSITE SHELL STRUCTURES

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The challenge of reducing weight and costs by letting structures go into the postbuckling regime during service has been giving a renewed attention to geometrically nonlinear analyses. Postbukling optimisation processes required to this end can however turn out to be computationally infeasible if the adopted geometrically nonlinear solutions are not robust and efficient.

Based on these considerations, we propose a finite element for the analysis of composite shell structures prone to buckling. The element, named MISS-4c, is developed on the basis of the hybrid-Trefftz method within a corotational formulation. The elemental geometry is flat and the number of kinematical degrees of freedom is 24, located at the four vertices. In particular, each node has three displacements and three rotations, including drilling. The element is isostatic and, therefore, the number of stress parameters is 18. Starting from the Hellinger-Reissner variational principle, stresses are assumed that a-priori satisfy both equilibrium and compatibility equations in a corotational reference system. Then, the displacement fields are assumed along the element contour only. All the element operators can be analytically evaluated through contour integrations.

A Koiter formulation is used to obtain the initial postbuckling response. This choice allows to further reduce the computational cost of the analysis and to analyse the imperfection sensitivity. Results show that MISS-4c exhibits accurate solution at coarse meshes and possesses good convergence properties in the linear solution, in the buckling analysis and in the evaluation of the initial postbuckling behaviour.

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