Asociación Argentina
de Mecánica Computacional

Mecánica Computacional Vol XXXVII, págs. 1393-1393 (resumen)
A. Cardona, L. Garelli, J.M. Gimenez, P.A. Kler, S. Márquez Damián, M.A. Storti (Eds.)
Santa Fe, 5-7 Noviembre 2019

LAGRANGEAN-BASED INVERSE FINITE ELEMENT ANALYSIS OF SHELLS USING SIMPLE REDUCED-INTEGRATION HEXAHEDRAL ELEMENTS

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Keywords: Inverse finite elements, shells, simple hexahedral finite element, reduced integration, assumed natural strain, enhanced assumed strain.

Abstract. The Inverse Finite Element Method (IFEM) is basically the Finite Element Method (FEM) applied to the solution of the equilibrium equations when the configuration after large elastic deformations is given. IFEM is usually formulated on an Eulerian or spatial framework taking advantage of the knowledge of the domain of analysis. However, for finite elements affected by spurious locking like beams and shells, remedies were usually developed on a Lagrangean framework, which obliges to formulate a new locking-free Eulerian-based element prior to IFEM analysis. The Lagrangean-based IFEM approach spares this extra work whenever a Lagrangean-based FEM exists. Now, the governing equations are identical to those of the classical Lagrangean-based FEM for nonlinear geometric problems, enabling the re-usability of the available theoretical and algorithmic tools. Using this approach, to transform FEM into IFEM just amounts to interchange knowns and unknowns in the nonlinear equilibrium equations. Here, for the analysis of shells, recourse is made to the finite element proposed by Flores (Comput. Methods Appl. Mech. Engrg. 303: 260-287, 2016) in virtue of its great deal between simplicity and accuracy. This is a trilinear hexahedron that uses reduced integration (RI) and Assumed Natural Strain (ANS) techniques to prevent shear and membrane locking together with RI and Enhanced Assumed Strain (EAS) to avoid volumetric locking. Like the standard trilinear hexahedron, this solid-shell element eight vertex nodes, each one with three displacement degrees of freedom. Further, it has one scalar degree of freedom associated to EAS, which is easily condensed (i.e., eliminated) at the element level.