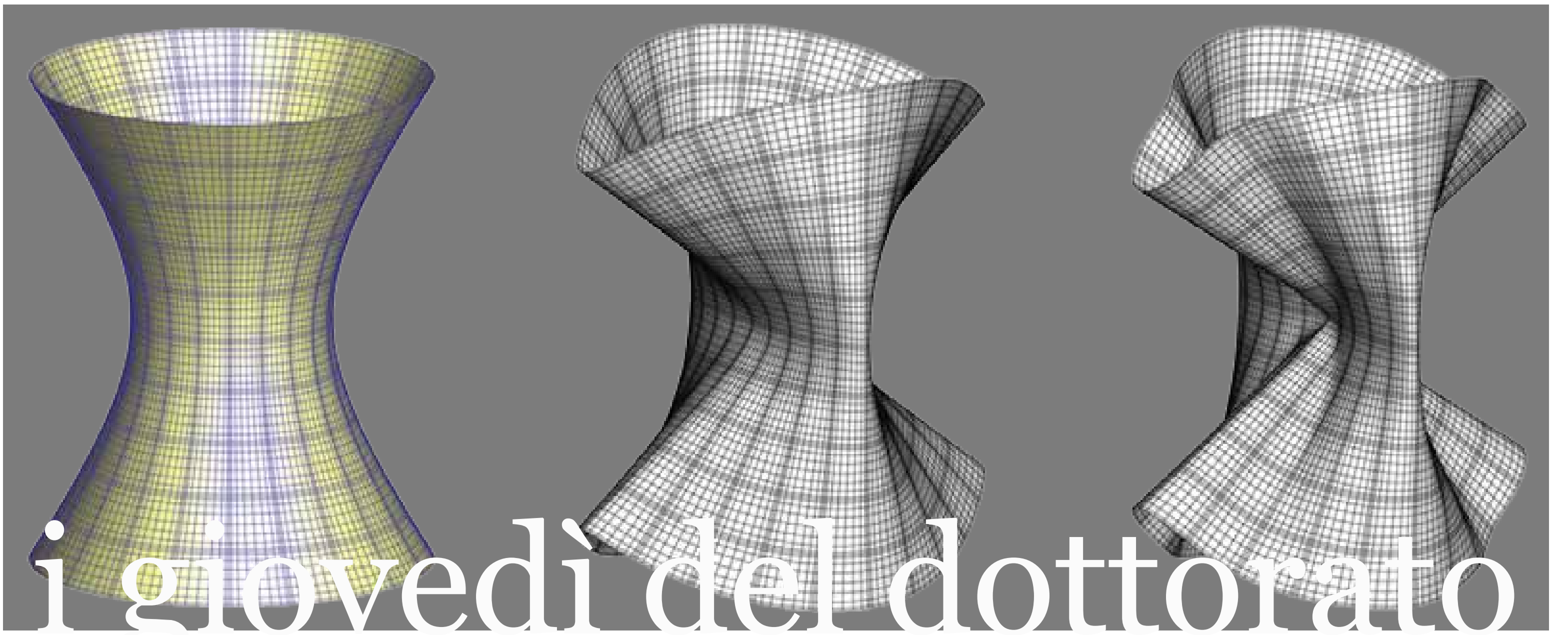

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dottorato di ricerca in ambiente, design e innovazione
dottorato di ricerca in ingegneria industriale e dell'informazione

On locking-free 7- and 12-parameter shell finite elements

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In this lecture, shell finite elements based on seven-parameter and twelve-parameter shell theories for large deformation analysis of composite shell structures are discussed. The seven-parameter shell element is based on a modified first-order shell theory using a seven-parameter expansion of the displacement field [1, 2]. The twelve-parameter shell element is developed using third-order thickness stretch kinematics [3]. Both theories require the use of fully three-dimensional constitutive equations. The virtual work statement is integrated numerically through the shell thickness at each quadrature point of the mid-surface; hence no thin-shell approximations are imposed in the numerical implementation. The finite element coefficient matrices and force vectors are evaluated numerically using appropriate high-order Gauss-Legendre quadrature rules at the appropriate quadrature points of the element mid-surface. For laminated composite shells, a user prescribed vector field (defined at the nodes) tangent to the shell mid-surface is introduced. This discrete tangent vector allows for simple construction of the local bases associated with the principal orthotropic material directions of each lamina. As a result, one is free to employ skewed and/or arbitrarily curved elements in actual finite element simulations. Through the numerical simulation of carefully chosen benchmark problems, it is shown that the developed shell elements are insensitive to all forms of numerical locking and severe geometric distortions and predict very accurate displacement and stress fields.

References

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2. M.E. Gutierrez Rivera and J.N. Reddy, Mechanics Research Communications, 78, 60-70, Dec 2016.
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9.20 **Introduzione**
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9.30 **On locking-free 7- and 12- parameter shell finite elements**
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10.30 **Discussione e conclusioni**

10.55 **Conclusione dei lavori**

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