

# Centro di Simulazione Numerica Avanzata – CeSNA

## Istituto Universitario di Studi Superiori

In collaborazione con

Università degli Studi di Pavia  
Dipartimento di Meccanica Strutturale

Istituto di Matematica Applicata e Tecnologie Informatiche  
IMATI – CNR – Pavia

### A new Mixed Finite Element based on Different Approximations of the Minors of Deformation Tensors

by P. Wriggers, J. Schröder and D. Balzani

Finite element formulations for arbitrary hyperelastic polyconvex strain energy functions need still consideration. The main goal of this contribution is to provide an improved mixed finite element for quasi-incompressible finite elasticity. The polyconvexity condition checks convexity of the strain energy function with respect to the minors of the deformation gradient, see e.g. Ball (2010). These minors have also a mechanical interpretation since they transform infinitesimal line-, area- and volume elements from the (undeformed) reference configuration to the (deformed) actual configuration. This motivates to consider these quantities when constructing suitable approximations in the sense of a finite element discretization. Since the minors of the deformation gradient depend on the deformation in different orders, we propose to use different approximation orders for the individual minors as well. With respect to the standard interpolation of a P1/Q0 element with a constant interpolation for the third invariant it seems logical to introduce linear shape functions for the terms related to the second invariant and then quadratic interpolations for the terms related to the first invariant. This choice will lead to a new "double mixed" finite element with quadratic, linear and constant interpolations. It has the advantage that all mixed variables can be eliminated on element level leading to a pure displacement element.

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*Venerdì 10 Settembre, ore 11.00*  
*Aula conferenze IMATI*  
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SEMINARIO