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ON FINITE STRAIN ELASTO-PLASTIC ANALYSIS USING ELEMENTS BASED ON MIXED INTERPOLATION OF TENSORIAL COMPONENTS

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RESUMEN

En este trabajo resumimos brevemente los últimos desarrollos del Grupo de Mecánica Computacional de CINI en el area de análisis de problemas elasto - plásticos con deformaciones finitas.

ABSTRACT

In this paper we briefly summarize the latest developments of CINI's Computational Mechanics Group in the field of finite strain elasto-plastic analysis.

INTRODUCTION

In this paper we review our latest developments in the field of large-strain elasto plastic analysis of metals. The formulations we developed are based on:

- Lee's multiplicative decomposition of the deformation gradient.
- An hyperelastic expression of the Von Mises flow theory developed using the principle of maximum plastic dissipation (associated plasticity) by Argyris and Doltsinis and Simo and Ortiz.
- The method of mixed interpolation of tensorial components (MITC) developed by Bathe and Dvorkin.

In our Total Lagrangian Hencky (TLH) formulation we use an hyperelastic constitutive equation in terms of Hencky's logarithmic strain tensor [1,2].

THE QMITC-TLH FORMULATION FOR 2D ANALYSIS

For the displacements and covariant components of the total Hencky strain tensor we use the interpolation functions developed in Ref.[3].

In Ref.[1] we used a radial return algorithm for integrating the stress-strain law and developed an algorithmic consistent and symmetric tangent stiffness matrix.

In Fig.1 we present some numerical results provided by the

QMITC-TLH element.

THE MITC4-TLH SHELL ELEMENT

In Ref. [2] we reformulated the MITC4 [4] shell element for the case of finite strains interpolating the covariant components of the Hencky total strain tensor. The resulting MITC4-TLH shell element incorporates thickness stretching degrees of freedom that are condensed at the element level imposing the consistently the *in-layer* plane stress condition.

In Ref. [2] we also developed an iterative algorithm for calculating thickness stretchings, stresses and plastic variables.

For the incremental formulation we developed an algorithmic consistent and symmetric tangent stiffness matrix.

In Fig. 2 we present some numerical results.

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[3] E.N. Dvorkin and S.I. Vassolo, "A Quadrilateral 2D Finite Element Based on Mixed Interpolation of Tensorial Components", Engg. Computations, Vol. 6 (1989), pp. 217-224.

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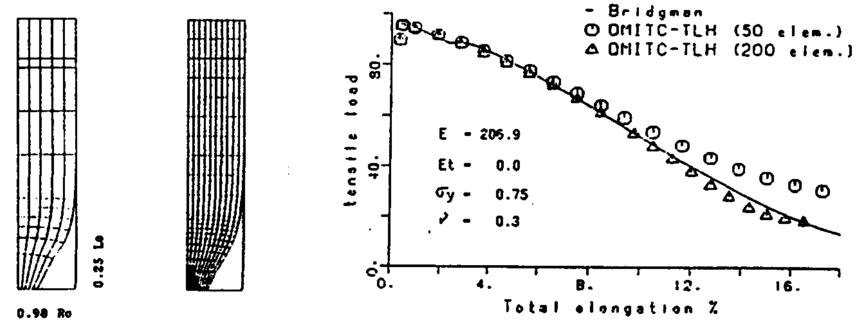

50 elements 200 elements

(a) Deformed meshes, 18% elongation

(b) Load-elongation relation

Fig. 1 - Necking of a circular bar

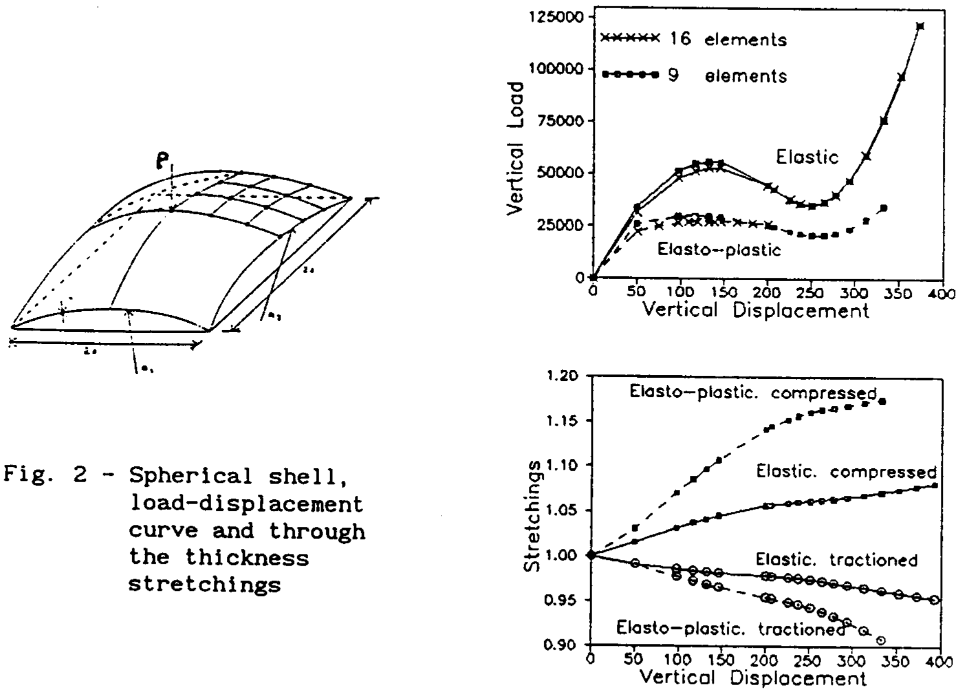

Fig. 2 - Spherical shell, load-displacement curve and through the thickness stretchings