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CRACK PROPAGATION IN A GURSON DUCTILE MATERIAL USING X-FEM

J.P. Crété[1], P. Longère[2], J.M. Cadou[3] and J. Wolf[4]

[1] Université de Bretagne Sud (UBS), Laboratoire d'Ingénierie des MATériaux de Bretagne (LIMATB, EA 4250), rue de Saint-Maudé BP92116 56321 Lorient Cedex France, jean-philippe.crete@univ-ubs.fr

[2] Université de Toulouse, Institut Supérieur de l'Aéronautique et de l'Espace (ISAE), Institut Clément Ader (ICA, EA 814), 10 avenue Edouard Belin BP54032 31055 Toulouse Cedex 4 France, patrice.longere@isae.fr

[3] Université de Bretagne Sud (UBS), Laboratoire d'Ingénierie des MATériaux de Bretagne (LIMATB, EA 4250), rue de Saint-Maudé BP92116 56321 Lorient Cedex France, jean-marc.cadou@univ-ubs.fr

[4] Université de Toulouse, Institut Supérieur de l'Aéronautique et de l'Espace (ISAE), Institut Clément Ader (ICA, EA 814), 10 avenue Edouard Belin BP54032 31055 Toulouse Cedex 4 France, johannes.wolf@isae.fr

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The present work aims at reproducing numerically the crack propagation in engineering materials whose failure results from void initiation, growth and coalescence. With this aim in view, a methodology is proposed combining a modified Gurson based, finite strain, (ductile) damage-(visco)plasticity coupled constitutive model and the eXtended Finite Element Method (X-FEM), both implemented as user subroutines (umat and uel respectively) into the engineering finite element computation code Abaqus.

The GTN model version considered in the present work has been proposed by Longère et al. [1] to reproduce the void growth induced damage in shear, in addition to the combined effects of strain hardening, thermal softening and viscoplasticity.

Concerning the X-FEM formulation, the technique consisting in increasing significantly the number of integration points, see Elguedj et al. [2], of the original finite element has been retained here to capture the crack propagation.

To attenuate the mesh dependence, the indicator of the transition from continuous damage to crack formation considers quantities averaging over an area (a patch) located at the crack tip, as applied by Haboussa et al. [3].

The crack is assumed here to initiate as soon as an averaged, stored energy related quantity around the crack tip reaches a critical value. In the line of the works by Huespe et al. [4], the crack formation is assumed to result from a deformation localisation process and its orientation is accordingly deduced from the bifurcation analysis (in the sense of Hill [5]).

The performance of the methodology is evaluated considering the numerical simulation of the tension loading of a symmetrically notched plate and of an asymmetrically notched plate. Comparisons are also conducted with other methodologies and with experimental results.

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