



**HAL**  
open science

# Numerical predictions of ductile fracture limits in deep drawing processes

Hocine Chalal, Farid Abed-Meraim

► **To cite this version:**

Hocine Chalal, Farid Abed-Meraim. Numerical predictions of ductile fracture limits in deep drawing processes. 6th International Conference on Mechanics and Materials in Design (M2D'15), Jul 2015, Ponta Delgada, Portugal. ⟨hal-05110128⟩

**HAL Id: hal-05110128**

**<https://hal.science/hal-05110128v1>**

Submitted on 12 Jun 2025

**HAL** is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



HAL Authorization

PAPER REF: 5460

## **NUMERICAL PREDICTIONS OF DUCTILE FRACTURE LIMITS IN DEEP DRAWING PROCESSES**

Hocine Chalal<sup>(\*)</sup>, Farid Abed-Meraim

LEM3, UMR CNRS 7239 - Arts et Métiers ParisTech, 4, rue Augustin Fresnel, 57078 Metz Cedex 03, France

<sup>(\*)</sup>*Email*: hocine.chalal@ensam.eu

### **ABSTRACT**

In this work, two numerical ductile fracture criteria based on finite element (FE) simulations are proposed for the prediction of ductile fracture limits (DFLs) for sheet metals. An elastic–plastic model coupled with the Lemaitre continuum damage theory has been implemented into the ABAQUS/Explicit software to simulate simple sheet stretching tests as well as the Nakazima deep drawing tests with various sheet specimen geometries. The first numerical criterion is based on the analysis of the thickness strain concentration and damage evolution in the central part of the specimens in order to determine the occurrence of ductile fracture. The second numerical criterion relies on a damage threshold at which is associated the occurrence of ductile fracture. The DFLs thus predicted by numerical simulations of simple sheet stretching with various specimen geometries and Nakazima deep drawing tests are compared with the experimental results.

**Keywords:** sheet metal forming, finite element simulation, damage, ductile fracture limits

### **REFERENCES**

Aboutalebi FH, Farzin M, Poursina M. Numerical simulation and experimental validation of a ductile damage model for DIN 1623 St14 steel. *International Journal of Advanced Manufacturing Technology*, 2011, 53, p. 157-165.

Aboutalebi FH, Farzin M, Mashayekhi M. Numerical prediction and experimental validations of ductile damage evolution in sheet metal forming processes. *Acta Mechanica Solida Sinica*, 2012, 25, p. 638-650.

ISO 12004-2. International organization for standardization, Metallic materials – sheet and strip – determination of forming-limit curves, Part 2: Determination of forming-limit curves in the laboratory, Published in Switzerland; 2008.

Hill R. A theory of the yielding and plastic flow of anisotropic metals, *Proc. Royal Soc. A*, 1948, 193, p. 281-297.

Lemaitre J. A continuous damage mechanics model for ductile fracture. *Journal of Engineering Materials and Technology*, 1985, 107, p. 83-89.

Lemaitre J. *A Course on Damage Mechanics*. Springer, Berlin, 1992.

Lemaitre J, Desmorat R, Sauzay M. Anisotropic damage law of evolution. *Eur. J. Mech. A Solids*, 2000, 19, 187-208.

Nakazima K, Kikuma T, Hasuka T. Study on the formability of steel sheets. *Yawata Technical Report*, 1968, 284, p. 140-141.

Ozturk F, Lee D. Analysis of forming limits using ductile fracture criteria. *Journal of Materials Processing Technology*, 2004, 147, p. 397-404.