Thesis title: Numerical modeling of sheet metal forming using a shell based Micromechanical SPH method

This thesis deals with the development and extension of an original method called “Shell Smoothed Particle Hydrodynamics" (SSPH) for the numerical modeling of sheet metal forming processes, namely stamping and hydroforming. The numerical developments in the framework of the PhD thesis will concern the review and alleviation of numerical locking phenomena encountered in the classical SPH method such as non-consistency and instability in tension.

A shell SPH model based on the Discrete Kirchhoff theory coupled to a micromechanical material model for the modeling of thin metallic shell structures for stamping using a single layer of particles in the mid-plane of the shell contrarily to the standard continuum SPH method. This proposal is original, since based to our knowledge from scientific open literature; this work has never been done yet. The strong form of shell equilibrium equations will be discretized directly by the improved shell based SPH method and solved by an explicit dynamic type scheme.

An extension of the shell based SPH method will be made by the integration of elastoplastic constitutive law in large strains taking together with a micromechanical ductile damage model for the necking detection in the forming of thin metallic sheets.

The developments in this thesis will be done starting with MATLAB coding, and then will be implemented in the open source software CalculiX (http://www.calculix.de). Indeed, this software offers numerous advantages such as contact algorithms and various time integration schemes.

For the validation of the SSPH model, several benchmarks from the NUMISHEET and NUMIFORM international conferences will be evaluated and the results compared to those obtained by the classical finite element method.

This thesis subject is original and has never been addressed by the international scientific community of metal forming; hence the developments in this thesis will surely allow the publication of several articles in peer-reviewed international journals.

Keywords: Metal forming; SPH modeling; micromechanics; damage; large strains.

Required Background from the candidate: Metal forming; programming (MATLAB or C or Fortran), finite element modeling

References

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