An Efficient and Fully Automatic 2D Remeshing Procedure for the Numerical Simulation of Double Cup Extrusion Test and Thixoforming Processes

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ABSTRACT

During the simulation of forming processes by the finite element method, large deformations often lead to distorted meshes, thus deteriorating the quality of the results. A possible solution consists in stopping the simulation to remesh the part; however issues may arise when restarting, especially when an implicit time integration scheme is used, because the newly defined configuration is no longer in equilibrium. The lack of equilibrium results both from errors in the interpolation of the new geometry and in the data transfer procedure from the old to the new mesh.

Indeed, after remeshing, some boundary nodes may exhibit large penetrations into the forming tools. When contact is enforced thanks to a penalty method, such penetrations induce significant artificial retraction forces, which generally prevent the simulation from starting again.

Here, we present a fully automatic 2D remeshing procedure, containing quality criteria to trigger remeshing, quadrangular mesh generation, advanced data transfer methods, and post-remeshing algorithms to restore equilibrium. These algorithms progressively apply a fraction of the unbalanced forces as external forces, both for dynamic and quasi-static simulations. This brings back the nodes that penetrated too deeply into contact tools close to the boundary, and adjusts the positions of internal nodes until equilibrium is reached. Hence, the restart procedure can be conducted efficiently.

The proposed procedure is then applied to study the Double Cup Extrusion Test. A comparison is made with the work of Schrader [1], which contains both experimental and numerical results, and with the work of Boman [2], where an Arbitrary Lagrangian Eulerian (ALE) formulation was used.

Afterwards, the extrusion of thixotropic materials is studied in a thermomechanical framework, and the advantages of the remeshing procedure are demonstrated through a comparison with both Lagrangian and ALE formulations. These simulations are conducted using the in-house finite element software Metafor [3].

REFERENCES

[1] T. Schrader, M. Shirgaokar and T. Altan, "A critical evaluation of the double cup extrusion test for selection of cold forging lubricants", *Journal of Materials Processing Technology*, 189(1–3):36–44, 2007.

[2] R. Boman, R. Koeune and J-P. Ponthot, "Numerical simulation of Double Cup Extrusion Test using the arbitrary Lagrangian Eulerian formalism". In Sergio R. Idelsohn, editor, *Numerical Simulations of Coupled Problems in Engineering*, volume 33 of *Computational Methods in Applied Sciences*, pages 29–53. Springer International Publishing, 2014.

[3] *Official website of Metafor*, "http://metafor.ltas.ulg.ac.be"