15th World Congress on Computational Mechanics (WCCM-XV)
8th Asian Pacific Congress on Computational Mechanics (APCOM-VIII)
31 July – 5 August 2022, Yokohama, Japan

Modelling of forming processes using the Particle Finite Element Method (PFEM).

Josep M. Carbonell [*†1], Hadi Bakhshan[†2], Juan M. Rodríguez[‡3] and Eugenio Oñate[†4]

[*] MECAMAT group, Department of Engineering, Faculty of Science and Technology.
Universitat de Vic-Universitat Central de Catalunya (UVic-UCC)
Carrer de la Laura 13, 08500 Vic, Spain. e-mail: [1]cpuigbo@cimne.upc.edu

[‡] Department of Mechanical Engineering, EAFIT University,
Medellin, Colombia, South America. e-mail: [3] jmrodrigup@eafit.edu.co

[†] Centre Internacional de Mètodes Numèrics en Enginyeria (CIMNE)
Universidad Politècnica de Catalunya (UPC)
Campus Norte UPC, 08034 Barcelona, Spain
e-mails: [2]hbakhshan@cimne.upc.edu, [4]onate@cimne.upc.edu

Key Words: *Forming processes, thermo-mechanical problems, Particle methods, PFEM*

In this work we present the latest advances in the Particles Finite Element Method (PFEM) for the numerical modeling of forming processes. In the recent past, very good results of the method have been shown in the simulation of 3D cutting problems. The method has very good capabilities for treating large deformations in massive volumetric parts. Now the method is applied and extended to other forming operations: forging, blanking, minting, machining, etc., for metals and other materials.

One of the important aspects of these manufacturing techniques is the interaction with the molds and dies. Deformable contact interactions are needed to obtain a close correspondence between numerical and experimental results. The characterization of the thermomechanical interaction with the coatings of the tool plays an important role. Advances have been made in meshing techniques for treating three-dimensional parts and for the modeling deformable contact.

The characterization of friction and wear of the forming tools can be modeled considering also the lubrication on the surfaces. The purpose is to obtain the characteristics of the final shape of the workpiece, the areas that experience large plastic deformations and the residual stresses that remain in the processed material. This information is very valuable for the optimal design of the manufacturing operation.

To show the virtues of the method, several examples of forming operations are presented. The capabilities of the method are discussed, as well as the accuracy of the solutions.

REFERENCES

[1] J.M. Carbonell, J.M. Rodríguez and E. Oñate. “Modelling 3D cutting problems with the Particle Finite Element Method”, *Computational Mechanics*, 66, 603-624, (2020).

[2] Rodriguez, J.M., Larsson, S., Carbonell, J.M. and Jonsén, P. “Implicit or explicit time integration schemes in the PFEM modeling of metal cutting processes”, *Comp. Part. Mech.* (2021). https://doi.org/10.1007/s40571-021-00439-5