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Integration of a projection technique for the adaptive remeshing of thin sheets

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ABSTRACT

During the numerical simulation of forming processes (stamping, forging, bulging, etc..), the large plastic deformations imply large element distortion of the computational mesh. It is then necessary to frequently remesh the part in order to be able to carry out the simulation and, in particular, to capture the geometrical details of surfaces under contact with forming tools. The remeshing procedure must be automatic and robust. Several remeshing methods have been proposed during the last years. The remeshing techniques presented by Zienkiewicz et al [6], Fourment et al [5], Coorevits et al. [3], Coupez [4], Borouchaki et al [1] are based on the computation of a size map to govern a global remeshing of the part at each iteration. This kind of approaches needs a complete remeshing of the part and a reliable method to interpolate mechanical fields from the old mesh into the new mesh at each iteration. Cho and Yang [2] have proposed a mesh refinement algorithm which consists in splitting each deformed element in two elements along an edge. This procedure drags to the creation of small edges and consequently degenerate elements during repetitive refinement iterations.

This paper presents a new adaptive refinement-based remeshing procedure for numerical simulation of metal forming processes in two and three dimensions. The adaptive remeshing method is based on geometrical and physical criteria [7-8]. It is applied to the computational domain after each small displacement step of forming tools. It allows, thanks to the geometrical criterion, to refine the current mesh of the part under the numerical simulation of the forming process in the curved area with preserving shape quality element, and to coarsen this mesh in the flat area. The mesh refinement is necessary to avoid large element distortions during the deformation and ensures the convergence of the computation with an adequate representation of the geometry of the deformed domain. Thanks to the physical error estimation, the mesh is adapted to the physical behavior of the solution. In addition, at each load increment, fully damaged elements are identified and the macroscopic crack propagation is modeled by removing these elements. At each iteration, mechanical fields are simply induced from the old mesh to the new mesh.

In the case of numerical simulation of metal forming processes, the deformations are caused by the contact with other domains whose geometry is fixed (the tools are assumed to be rigid). The piece must take the shape of the geometry of the tool during the deformation. Our proposed mesh refinement adds new nodes on mesh edges and these nodes could belong to the inside of the tool, preventing to complete the computation. A projection procedure has been introduced in order to project the new created nodes on the boundary of the tools in the contact area.

The remeshing method including the projection technique has been implemented with triangular and quadrilateral elements and coupled with the ABAQUS solver. Some application examples are presented in order to show the efficiency of our approach.

REFERENCES

[1] Borouchaki, H., Cherouat, A., Laug, P., Saanouni, K., "Adaptive remeshing for ductile fracture prediction in metal forming", *C.R. Mecanique*, Vol. 330, pp. 709-716, (2002).

[2] Cho, J.-W., Yang, D.-Y., "A mesh refinement scheme for sheet metal forming analysis", *Proc. of the 5th International Conference*, NUMISHEET'02, pp. 307-312, (2002).

[3] Coorevits, P., Dumeau, J.-P., Pelle, J.-P., "Analyses éléments finis adaptatives pour les structure tridimensionnelles en élasticité", *Revue européenne des éléments finis*, Vol. **5**, 3, pp. 341-373, (1996).

[4] Coupez, T., "Génération de maillage et adaptation de maillage par optimisation locale", *Revue européenne des éléments finis* Vol. **9**, 4, pp. 403-422, (2000).

[5] Fourment, L., Chenot, J.-L., "Adaptive remeshing and error control for forming processes", *Revue européenne des éléments finis* Vol. **3**, 2, pp. 247-279, (1994).

[6] Zienkiewicz, O. C., Zhu, J. Z., "Adaptivity and mesh generation", *Int. J. Numer. Methods Eng.* Vol. **32**, pp. 783-810, (1991).

[7] Moreau, L., Borouchaki, H., et Cherouat, A., "Remaillage adaptatif pour la mise en forme des tôles minces", *Comptes Rendus de l'Académie des Sciences.Série II b, Mécanique,physique,astronomie*, Vol. 333, pp. 371-378, (2005).

[8] Giraud- Moreau, L., Borouchaki, H., et Cherouat, A., "Sheet metal forming using adaptive remeshing", *The 8th international Conference on Numerical Methods in Industrial Forming Process (Numiform 2004)*, Etats Unis. 6 p. , (2004).