COMPARISON OF STRESS RECOVERY AND DISPLACEMENT RECOVERY TECHNIQUES IN ADAPTIVE FINITE ELEMENT SIMULATION OF SHEET FORMING OPERATIONS

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Extended Summary

The finite element method is an effective tool for simulating metal forming processes. However, the accuracy of finite element results depends upon the approximation of the mathematical model, manner of domain discretization, choice of scheme for solution of system equations and method employed for computing derivatives of the state variable. The computational accuracy of a finite element analysis is classically improved by the use of a uniformly refined mesh. Such refinement tends to increase the problem size and cost. User defined selective refinement in areas of sharp gradients is therefore preferred in large-scale simulation where there is some prior knowledge of the solution. However, prior knowledge of the exact solution is seldom available. Therefore, an adaptive technique that automatically determine the areas of insufficient accuracy and refines the mesh accordingly is viewed as a better approach for the reduction of computational cost.

In the present work, a comparative evaluation of the performance of stress and displacement recovery techniques during adaptive finite element analysis of sheet forming operations is presented. The simulation results are assessed on the basis of computational efficiency and accuracy. Whereas in the case of the stress recovery procedure, an element patch surrounding and including a particular node is considered for the smoothing process, an element patch consisting of all the elements surrounding and including the particular element is taken into account in the case of displacement recovery procedure. The solution error is estimated on the basis of an energy norm. An adaptive finite element code **AdSheet2** considering continuum elements has been developed. A new mesh is generated whenever the previous mesh gets overly distorted. The boundary conditions are set up automatically. A Von-Mises yield criterion is used. The incompressibility constraints have been introduced in the penalty form using reduced integration. Frictional effects have been included in the form of surface traction and stiffness contribution. The Newton-Raphson method with linear line search technique is used for solving the non-linear equations. The displacement of punch was modelled in incremental steps to tackle geometric non-linearity. It is shown with the help of an illustrative example of axisymmetric stretching of a metal blank by a hemispherical punch that the velocity recovery approach captures the deformation behaviour more accurately and at lower expense of CPU time.