Dynamic Explicit Finite Element Code
for U-Bending Simulation and Springback Prediction

Agus Dwi Anggono[1, a], Tri Widodo Besar Riyadi[2,b] , Waluyo Adi Siswanto[3,c]

[1,2]Faculty of Engineering, Universitas Muhammadiyah Surakarta

Jl. Ahmad Yani Tromol Pos I Pabelan Kartasura Surakarta,

Jawa Tengah 57102, Indonesia

[3]Faculty of Mechanical and Manufacturing Engineering

Universiti Tun Hussein Onn Malaysia

Parit Raja, Batu Pahat, 86400 Johor, Malaysia

[a]agus.d.anggono@ums.ac.id, [b]Tri.Riyadi@ums.ac.id, [c]waluyo@uthm.edu.my

Abstract. In this paper, a dynamic explicit method was used to simulate U-bending processes of aluminium and its springback. The simulation was carried out using a free software of finite element analysis code namely Impact. The model was taken from a benchmark model in Numisheet'93. The numerical results of the dynamic explicit code were compared with the results of the experimental works. After the optimization was done using the simulation process, it was found that the springback results showed a good agreement with that done by the experimental results. The software Impact was capable of simulating the U-bending processes and predicting the occurrence of springback.

Introduction

Sheet metal forming (SMF) processes are shaping operations performed on a metal sheet. In SMF, springback always occurs where the shaped material has elastic property. Springback has become a crucial issue in the stamping field since it significantly infoluence the designed shape of the formed product. Modern FE codes for SMF and springback simulation have shown promising to produce a good result compared to the experimental [1,2]. Some of engineering codes which can be used for SMF simulation are Abaqus Implicit/Explicit, PAM-STAMP, LS-DYNA, Altair HyperForm and AutoForm [3].

Dynamic explicit of finite element (FE) analysis have proved to be useful for sheet metal forming simulation [4]. In an explicit method, the stiffness matrix based on the geometry changes and material changes will be updated at the end of each increment. Then a new stiffness matrix is constructed and the next increment of displacement or load is applied to the system. Rojek et al. [5] have presented the system of discretized equations of motion as follows:

$$M\ddot{r} + D\dot{r} = f - p \qquad (1)$$

where M and D are the mass and damping matrices, respectively. $\dot{r}$ is the nodal displacement vector. f and p are the vectors of external and internal nodal forces, respectively. At time t_n the solution for the next time is $t_{n+1} = t_n + \Delta t$. In the explicit formulation, the use of a diagonal mass matrix is becoming an effective solution.

The dynamic analysis of sheet forming can be extended to investigate the springback. In the last forming, the final deformation is obtained. To deliver the springback results, all boundary conditions are removed. An additional damping is necessary in dynamic explicit analysios to obtain a steady state solution.

In this paper, a free and open source software namely Impact was selected to simulate the U-bending sheet and predict the springback. The Impact is a FE code which is based on an Explicit Time stepping algorithm [6]. The code was written in Java.