Advances in Characterization of sheet metal forming in JSTAMP/NV

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1 Introduction

Lightweighting material, especially high strength materials are very common in Asia comparing hot stamping and aluminum parts in European automobile industry. Sheet metal forming simulation has been widely applied with the developing of automobile industry during last decades. JSTAMP/NV[Fig.1], an integrated sheet metal forming system developed by JSOL, is rapidly increasing in Asia area these years because of its capability of accurate spingback prediction. Three items are important to predict springback accurately. First is manufacturing condition in simulation should be close enough with real manufacturing. Then is proper material model to identify real materials stress-strain behavior. Finally it is accurate material parameters for the material in mass production. JSTAMP/NV provides a sophisticated pre-processor to catch real stamping machine condition. The latest material model, material databases are always developed so as to get complicated stress-strain behavior in sheet metal forming. This material will introduce JSTAMP/NV's characterization of sheet metal forming. A typical material model developed by JSOL, named Yoshida-Uemori material model to do sprinback simulation for high strength steel and aluminum. To identify material parameters for Yoshida-Uemori model, a material identification tool MatPara is also introduced. In addition, using Yoshida-Uemori model and MatPara, a benchmark example of NUMISHEET2016 will be included so as to verify its capability.

2 Yoshida-Uemori material model

Yoshida-Uemori[2] proposed a model of large-strain cyclic plasticity that well describes the stress-strain responses in reverse deformation [Fig.2], as well as cyclic hardening characteristics, such as:

- two stages of the Bauschinger effect: (i) the transient Bauschinger deformation characterized by early re-yielding and smooth elastic-plastic transition with a rapid change of workhardening rate; and (ii) the permanent softening characterized by stress offset observed in a region after the transient period;
- plastic strain dependent Young's modulus;
- the workhardening stagnation appearing at a certain range of reverse deformation;
- strain-range and mean-strain dependency of cyclic hardening, e.g., the larger the cyclic strain range the larger the saturated stress amplitudes.

Yoshida-Uemori model assumes the kinematic hardening of the yield surface, describes the transient Bauschinger deformation characterized by early re-yielding and the subsequent rapid change of workhardening rate.

JSOL developed a subroutine based on Yoshida-Uemori model and proposed to Japanese customers. It has been extremely evaluated since its outstanding accuracy comparing traditional isotropic hardening material model.

3 What is MatPara?

MatPara[Fig.3] is a tools to identify a set of material parameters of several elasto-plasticity constitutive models, e.g. Yoshida-Uemori model, from stress-strain experimental data by means of an optimization technique. It offers a GUI environment for stress-strain data-input, calculation of stress-strain responses, as well as displaying experimental/calculated results and output numerical data and graphic data; MatPara can prepare appropriate experimental data by smoothing noisy and find strain reversal points. Additionally, it calculates the stress-strain response with a selected constitutive model for a given cyclic straining condition. Furtherly, by minimizing the difference in stress between experimental and the corresponding numerical results, MatPara identifies material parameters for different models. It helps JSTAMP/NV customers to get material database and conduct sprinback simulation easily and accurately even without uniaxial and cyclic experimental data. JSOL is distributing MatPara to customers in the world.

4 Figures

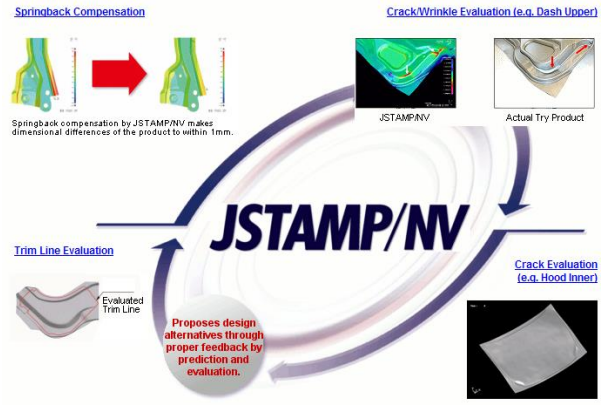

Fig.1: General descrition of JSTAMP/NV

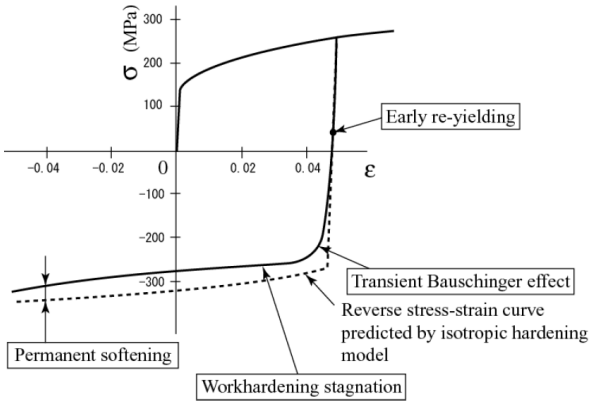

Fig.2: An example of stress-strain response in a forward-reverse deformation

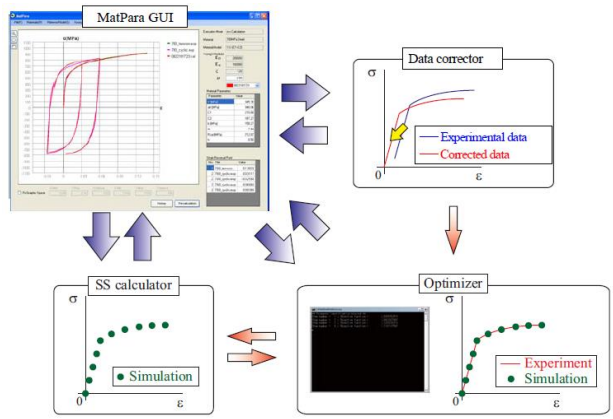

Fig.3: MatPara's schematic illustration structure.

5 Summary

To satisfy the high strength steel forming needs in Asia area, a sheet metal forming system, JSTAMP/NV which provides an accurate springback prediction solution has been introduced. A well-known sheet metal forming material model, Yoshida-Uemori model and related parameter identification tool, MatPara are also included. A Numisheet2016 benchmark model was introduced.

6 Literature

[1] http://www.jstamp.jp/en/index.html JSTAMP URL , JSOL Corporation
[2] Yoshida, F. and Uemori, T.: *Int. J. Mechanical Sciences*, 45, 2003, 1687-1702
[3] MatPara theory manual CEM 2012