DEEP DRAWING FAILURE MAP OF A COATED METAL SHEET BASED ON THE PROCESS PARAMETERS

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ABSTRACT
Fracture and wrinkling are two main failure modes in deep drawing of a coated metal sheet. With the development of damage mechanics and finite element modelling, it is possible to exactly predict the failure mode of a material during deep drawing. In this paper, a coated metal sheet during deep drawing is studied by finite element simulation and dimensional analysis. Based on a few dimensionless process parameters, a failure map is established, which can be divided into three regions including fracture, wrinkling and success.

Keywords: failure map, deep drawing, metal sheet, finite element simulation.

INTRODUCTION
Coated and pre-coated metal sheets have been widely used in engineering due to their excellent mechanical properties. Before the application of these coated metal sheets, they could undergo complex deformation processes such as deep drawing during which two main failure modes of fracture and wrinkling may appear.

Ductile damage models are introduced into sheet metal forming as a failure criterion in finite element modeling to predict the forming limit diagram. Tasan et al (Tasan et al. 2009) described the physical understanding of sheet metal micro-mechanics by addressing the influence of damage evolution on localization and eventually ductile fracture in different strain paths. On the other hand, wrinkling can be predicted by many methods in finite element simulation (Sheng et al. 2004). Therefore, the two primary failure modes of the metal sheet can be predicted by finite element simulation in the deep drawing process. Yossifon et al (Yonnssifon et al. 1992) obtained the acceptable blank-holder force range in deep drawing without wrinkling and fracture. Ahmetoglu et al (Ahmetoglu et al. 1995) determined the wrinkling and fracture limits under a certain process conditions. Their results do not describe actually a failure map which can tell somebody what will happen in the deep drawing process with certain conditions. Until now, two questions are remaining: whether the forming process is successful, and what kind of failure mode will take place in a certain forming conditions. In this paper, we try to establish such a map based on the coated metal sheets.

RESULTS AND CONCLUSIONS
According to the theoretical approach, for given materials and process parameters, one limit curve can be plotted, as shown in Fig. 1(a), and the materials will fracture in the deep drawing process, as shown in Fig. 1(b).
The failure map is influenced by the process parameters as shown in Fig. 2. There are three districts in the failure map with the increasing blank holder force, viz. fracture zone, success zone and success zone.

**REFERENCES**


