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SOI: 1.1/TAS DOI: 10.15863/TAS

International Scientific Journal

Theoretical & Applied Science

p-ISSN: 2308-4944 (print) **e-ISSN:** 2409-0085 (online)

Year: 2023 **Issue:** 09 **Volume:** 125

Published: 13.09.2023 **http://T-Science.org**

Issue Article

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EFFECT OF SHEET METAL THICKNESS ON PRODUCT FORMABILITY

Abstract: *The evaluation of the formability of thin-walled blanks made of deformable aluminum alloy after deep drawing with a blank holder was presented in this article. The distribution of crack, risk of crack, severe thinning, inadequate stretch, wrinkles, wrinkle tendency and safe on the area of the deformed part was analyzed.*

Key words: *blank, formability, thickness, deep drawing.*

Language: *English*

Citation: Chemezov, D., et al. (2023). Effect of sheet metal thickness on product formability. *ISJ Theoretical & Applied Science, 09 (125),* 252-254.

Soi: http://s-o-i.org/1.1/TAS-09-125-26 ***Doi***: https://dx.doi.org/10.15863/TAS.2023.09.125.26

Scopus ASCC: *2206.*

Introduction

The formability of the material during plastic deformation is characterized by the following states: safe, wrinkle tendency, wrinkles, inadequate stretch, severe thinning, risk of crack and crack [1-2]. Each phenomenon is characterized by the degree of

deformation of the material. The safe condition is characterized by the absence of deformation or minimal deformation of the material. Wrinkles and their tendency are characterized by the formation of excess material in the volume of the blank and lead to a change in the geometry of the semi-finished product. Inadequate stretch and severe thinning are characterized by critical stretching of the material, leading to a risk of crack and, if these deformations are not eliminated, partial destruction of the material.

Evaluation of the formability of the material during plastic deformation is important at the design stage of the technological process, as it allows you to identify critical deformations and take the necessary measures to reduce them [3-8]. The totality of the results of computer and production studies obtained and analyzed for various cases of plastic deformation of materials improved the process of formability of some products [9-10].

The purpose of this study was to determine the dependence of the formation of critical deformations in the material of the blank on its thickness during deep drawing by direct method.

Materials and methods

To implement the plastic deformation process in the LS-DYNA program, solid-state models of a die, a punch, a blank holder and five round-section blanks with thicknesses from 0.5 to 5 mm were built. Since the purpose of the study was to analyze the formability of the deformable blank, the elements of the drawing die were taken as absolutely solid bodies. The models of the blanks were given the properties of a deformable aluminum alloy. The drawing of blanks was carried out to a depth of 80 mm. The formability assessment of each blank was carried out in the FLD (Formability) module. The FLD criterion is assumed to be 0.21.

Results and discussion

After the calculation, the values of the following parameters of deformation of the blank material were obtained: allowable thinning – 0.3, essential thinning – 0.02, allowable thickening – 0.01.

Figure 1 shows the results of computer modeling in graphical form.

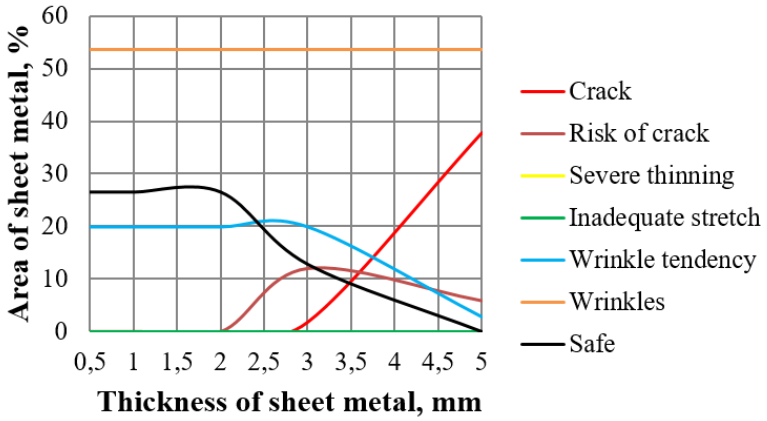

Figure 1. The dependence of the distribution of various types of deformation of the material after deep drawing on the thickness of the sheet metal.

It is noted that deep drawing of blanks of small thickness (up to 2 mm) is characterized by the largest distribution of minimally deformed material on the blank area. However, there is also a wrinkle tendency on 20% of the area of the entire blank. With an increase in the thickness of the blank (over 2 mm), the wrinkle tendency on the blank area decreases, but there is a risk of crack, which reaches its maximum value after drawing of the sheet metal with a thickness of 3 mm. At the same time, cracks appear in the material, and they increase with increasing thickness of the blank. The most dangerous deformed state of the material is observed after drawing of the blank with a thickness of 5 mm. It is characterized by the maximum distribution of cracks on the surface area of the blank and the absence of minimally deformed material. Inadequate stretch and severe thinning of walls of the semi-finished product are not observed. The distribution of wrinkles on the surface area of the blanks at different thicknesses does not change and makes up 54% of the entire area of the deformable product.

Conclusion

With an increase in the thickness of the sheet metal, the distribution of such effects as the wrinkle tendency and safe on the surface area of the semi-finished product decreases. With great care, it is necessary to carry out deep drawing of blanks with a thickness of 3 mm or more, since in this thickness range there is a maximum risk of crack in the material. The forecast of the formation of wrinkles is more than

50% of the total surface area of the semi-finished product when drawing of the sheet metal in the studied thickness range.

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