INFLUENCE OF STRAIN HISTORY ON LIMIT FORMABILITY IN METAL FORMING

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ABSTRACT

The paper gives definitions and explanations about forming limits for bulk metal forming and sheet metal forming. The significance of stress state and strain history for limit strains realization is emphasized above all. For the case of upsetting, indicators in the system of principle surface strains are specified, as well as classic example of FLD, as a dependence of limit strain on stress ratio coefficient. For the case of sheet metal forming – deep drawing, the example of determining FLD at classic and two-phase - proportional forming – is shown. The specified experimental results are related to the area of biaxial tension-stretching and the area of pure deep drawing of axis-symmetrical pieces.

KEYWORDS: Metal forming, Material formability, Strain path, Upsetting, Deep drawing

1. INTRODUCTION

When designing the technological processes of metal forming, it is extremely important to understand the concept of limit formability, which can be defined as the ability of materials to achieve permanent shape changes, i.e. ability of materials to accomplish maximal strains in the given forming conditions. The criterion for defining limit formability can be either fracture or forming instability (appearance of localizations). The influence of certain factors on the value of limit strain, as a numerical indicator of materials formability, can be implicitly expressed, by formability function /1/:

$$D_M = \varphi_e^l = f(H_M, S_M, T_o, \dot{\varphi}, T_\sigma) \tag{1}$$

where:

D_M – material formability,

φ_e^l – limit strain,

H_M – type of material, defined by a particular chemical content,

S_M – structural state of the material,

T_o – forming temperature,

$\dot{\varphi}$ – strain speed,

T_σ – stress state determined by stress tensor.

For established and unchangeable forming conditions (material, speed, temperature), the possibility for changing limit strain values is, obviously, most efficiently influenced by the change of stress state, i.e. $\varphi_e^l = f(T_\sigma)$. For that purpose, executive elements of the forming system should be created in such a way that the available formability potential could be exploited up to its maximum. Control of forming system – tools construction, geometry of initial work piece shape and tribological conditions – should have, as a final result, generation of appropriate stress components in the pressure zone and avoidance of stress in tension zone.