MODELING AND STUDY OF THE PROCESS OF BILLETS EXTRUSION WITH ADDITIONAL BACK-PRESSURE IN EQUAL CHANNEL STEP MATRIX

МОДЕЛИРОВАНИЕ И ИССЛЕДОВАНИЕ ПРОЦЕССА ПРЕССОВАНИЯ ЗАГОТОВОК С ДОПОЛНИТЕЛЬНЫМ ПРОТИВОДАВЛЕНИЕМ В РАВНОКАНАЛЬНОЙ СТУПЕНЧАТОЙ МАТРИЦЕ

S.N. Lezhnev, As.R.Toleuova, E.A. Panin
Karaganda state industrial University, Kazakhstan, Temirtau

Abstract: *This work is devoted to the study of stress-strain state and power parameters in the simulation of the process of extrusion billets with additional back-pressure in equal channel step matrix. Analyzing the obtained results we can conclude that the matrix without backpressure cannot achieve complete closing of internal defects of a deformable metal. The backpressure created by the increase of the roughness of the output channel of the matrix, has a beneficial effect on the stress-strain state of the metal, which in turn allows you to provide the best structured deformable metal*
KEY WORDS: *EXTRUSION, EQUAL CHANNEL STEP MATRIX, STRESS-STRAIN STATE, POWER PARAMETERS, SIMULATION.*

Introduction

One of the promising methods of obtaining metal from sub-ultrafine grained structure is equal channel pressing in angular and step matrices. Thus it is proved that if the compression of the metal to be implemented in equal channel angular matrix with backpressure, it creates a more favorable stress-strain state to produce the metal with sub-ultrafine grained structure in comparison with the pressing in this matrix without backpressure. In works [1-4] were studied various investigations of this kind of deformation.

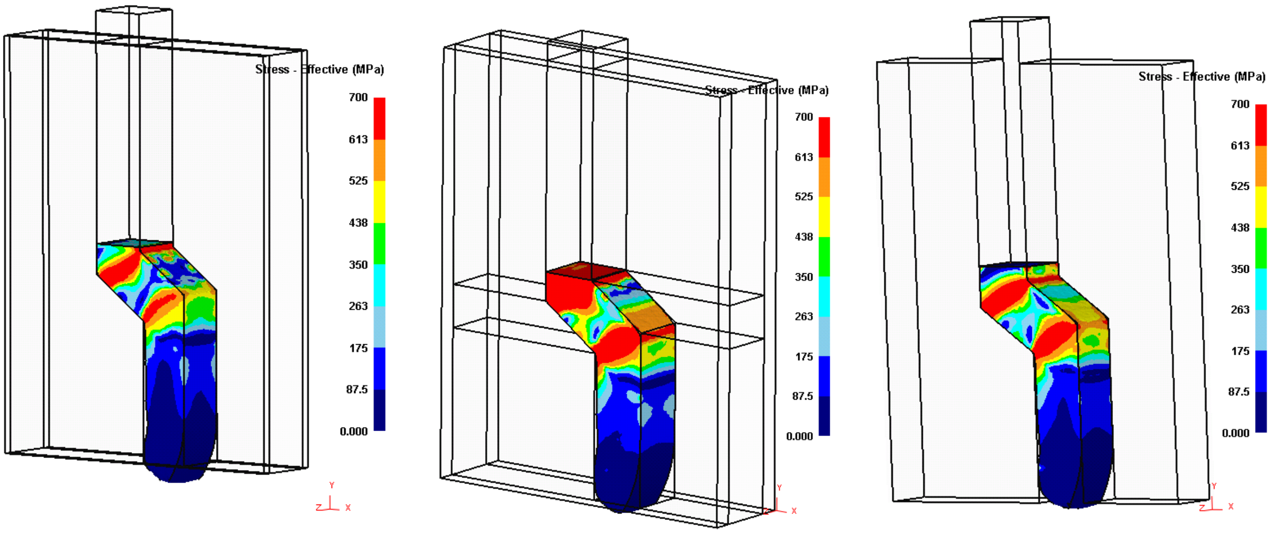
One of the options to create a backpressure in the pressing process of the metal in equal channel angular matrix is the narrowing of the output channel of the matrix. During compaction of metal in equal-channel step matrix, unlike in the angular matrix, the pressure already created by the presence of the second junction of the channels of the matrix. The additional backpressure during equal channel pressing in step matrix can be achieved, as with angular pressing by narrowing the output channel of the matrix, or through the use of this matrix with the output channel roughness higher than the surface roughness of the input and intermediate channels of the matrix.

This work is devoted to the study of stress-strain state and the power parameters in the simulation of the process of extrusion billets with additional backpressure in equal channel step matrix in the software package DEFORM to determine optimum conditions to create a more favourable stress-strain state for obtaining a metal from sub-ultrafine grained structure with little energy consumption..

Study of stress-strain state

The stress-strain state during compaction in equal-channel step matrix with the backpressure was analyzed according to the results of stress distribution, strain intensity and force of deformation.

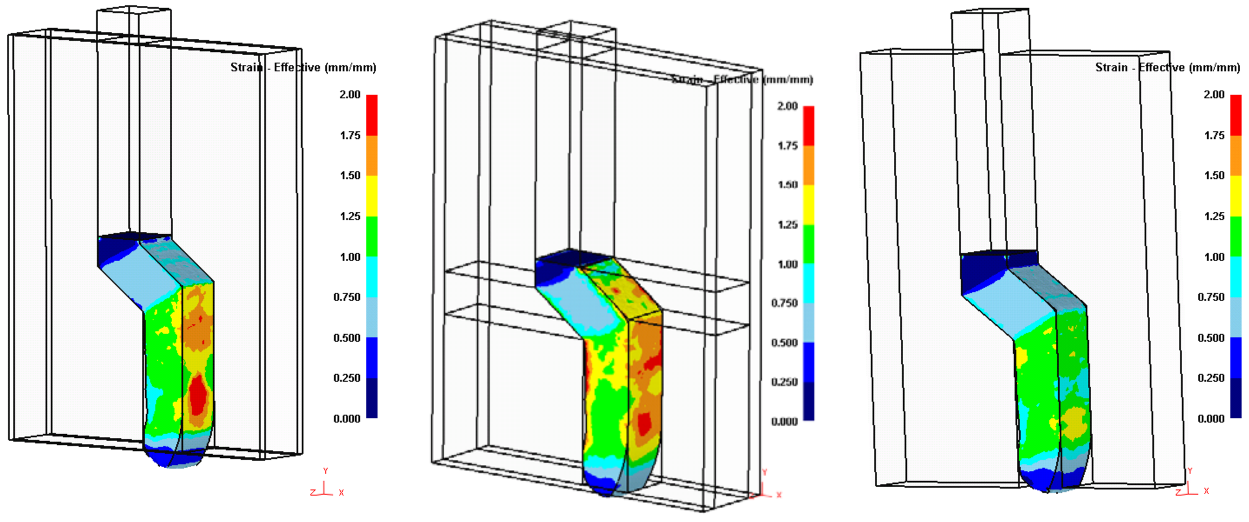
The presence of internal compressive stresses positive effect on the brewing internal defects and the quality of the metal (fig. 1). Comparative analysis of the stress distribution over the cross section of the workpiece shows that mainly dominated by compressive stresses. The overall compression scheme provided in the most part of the cross section, guarantees the absence of macro - and microcracks in the metal and conducive to the maximum degree of plasticity of a deformable workpiece.



a b c

Fig. 1 *- Stress distribution: a) with narrowing output channel, b) with different degree of roughness, c) without backpressure*

The distribution of equivalent stress shows that the maximum value reaches at the junction of channels. In the matrix with a narrowing output channel maximum value of equivalent stress reaches 700 MPa at the junction of channels; in an inclined channel prevails to 280 MPa, in the third channel equivalent stress is reduced from 175 to 0 MPa (fig. 1a). In the matrix with different roughness maximum value of equivalent stress reaches 700 MPa, after the first junction of channels it is 263 – 350 MPa, and after the second is reduced to 0 MPa (fig. 1b). However, equivalent stress in the third channel different from the previous example: here the area is exposed to tension, much more. In the matrix without back pressure maximum value of equivalent stress equal to the value of the previous matrices and after the second junction channels in the matrix, value is reduced to zero (fig. 1c).

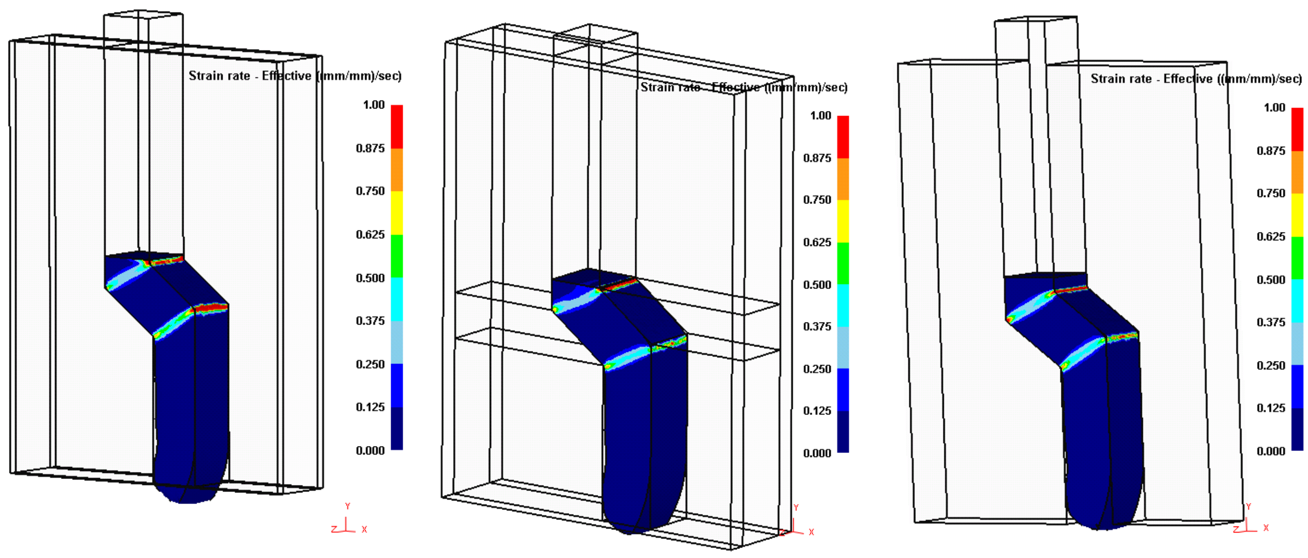


a b c

Fig. 2 *- Strain distribution: a) with narrowing output channel, b) with different degree of roughness, c) without backpressure*

Analyzing the strain distribution we can say that the increase in the coefficient of friction between the workpiece and the tool leads to increased efforts of deformation (fig. 2).

In the first two cases, the largest equivalent strain is achieved when workpiece is moving from the second channel in the third and its value is 0.75 to 1.0. In the matrix with narrowing output channel, the average value of equivalent strain is in the range from 1.0 to 1.25 (fig. 2a). In the matrix with different roughness with the increase of the coefficient of friction is significantly increased and the accumulated deformation, which averages 1,0 – 1,50; sometimes, on the inner surface of the third channel, reaches 2.0 (fig. 2b). In the matrix without backpressure the value of equivalent strain is in the range 0,75 - 1,25 (fig. 2c). The figures show that the matrix with different degrees of roughness can increase the value of equivalent strain.



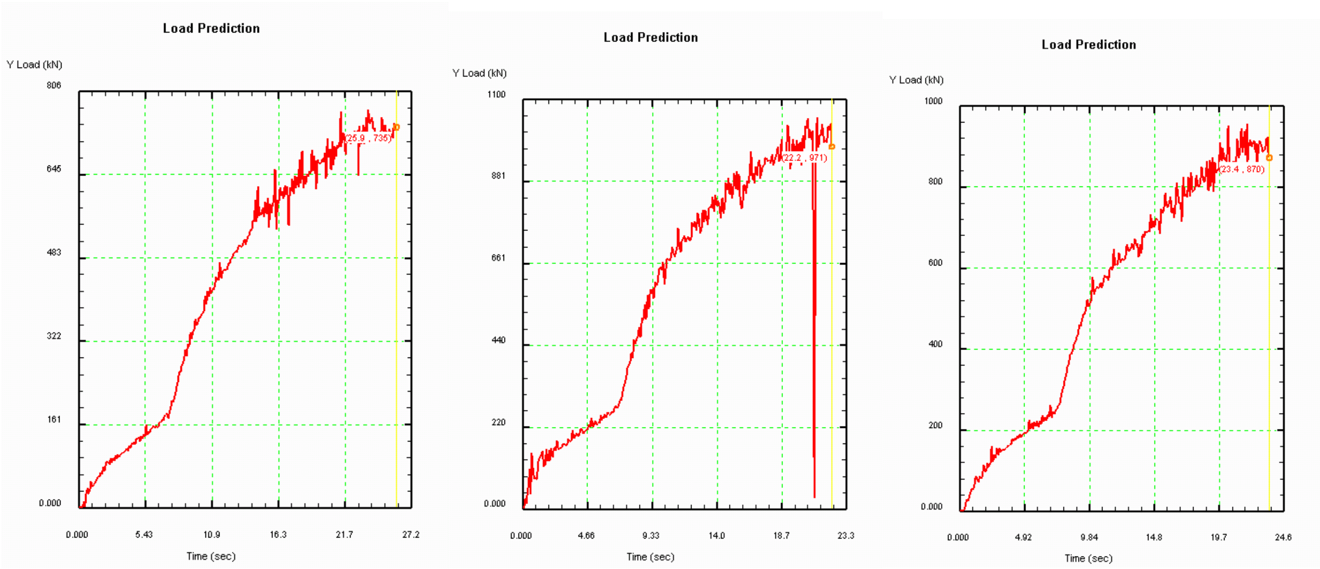
a b c

Fig. 3 *– Shear strain distribution: a) with narrowing output channel, b) with different degree of roughness, c) without backpressure*

The analysis of the distribution of shear strain shows significant strain localization at the zone of intersection of the channels and near the borders of the fracture profile of the matrix, hence, the workpiece passes through the localization zone of intense shear deformation.

Study of extrusion force

Then was examined the effect of narrowing channel and increasing of roughness degree of the channels on the force of deformation. This dependence will be determined from the graphs that have been constructed according to the simulation results.



a *b* *c*

Fig. 4 *– Force of deformation: a) with narrowing output channel, b) with different degree of roughness, c) without backpressure*

Fig. 4 shows that the force is zero until the moment when the workpiece stops on the first joint in the matrix. The variation of these dependences shows that during the compression in the step matrix occurs in a two-step increase in force. At the initial stage the increasing force related to overcoming resistance in the first joint of channel in matrix. The second joint of the channel leads to the next stage of force increasing. Further, the force increases uniformly due to the fact that the volume of deformed metal.

The use of equal-channel step matrix with narrowing output channel the maximum force is 735 kN, while the curve increases smoothly (fig. 4a). In the matrix with different degrees of roughness, due to the increase of the friction coefficient in the output channel, the value of force increases to 971 kN, the curve is on a steeper trajectory, since a higher coefficient of friction increases the deformation resistance (fig. 4b), but this value is not significantly different from the value of the force when using a matrix with narrowing the output channel. In the matrix without backpressure the maximum force is 870 kN (fig. 4c).

Conclusions

Analyzing the obtained results we can conclude that the matrix without backpressure cannot achieve complete brewing internal defects of a deformable metal, unlike matrices, which uses the backpressure. The application of the narrowing channel, as a way of additional backpressure in the forming process is not quite acceptable, as is a reduction of the original size of the workpiece, and this leads to the fact that after each cycle of deformation it is necessary to change the tooling. The backpressure created by the increase of the roughness of the output channel of the matrix, has a beneficial effect on the stress-strain state of the metal, which in turn allows you to provide the best structured deformable metal.

References

1. O. Krivtsova et al., 2014, Advanced Materials Research, 1030-1032, 1337.

2. S.N. Lezhnev et al., 2015, Advanced Materials Research, 1095, 722.

3. S. Lezhnev, A. Naizabekov, I. Volokitina, O. Chalaya, 22nd International Conference on Metallurgy and Materials, Metal 2013, May 15-17.2013, Brno, Czech Republic, 329-334.

4. Naizabekov, A.B., Ashkeev, Zh.A., Lezhnev, S.N., Toleuova, A.R. Billet deformation in uniform-channel stepped die (2005). Steel in Translation, 35 (2), pp. 37-39.