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Investigation of metal flow direction during double-core rod rolling in slitting oval pass

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In this work the results of numerical analyses of double-rod slit rolling process were presented. For the simulation of the process, the FORGE3® commercial program was used. The results of the numerical simulation were compared with the experimental data and confirmed good ability of proposed mathematical model.

1. INTRODUCTION

The multi slit rolling technology (MSR) finds more and more use in both processes rolling of round rods also to rolling of small flat rods and small squares. Possibility of production from one added strand two, three, four rods are the main idea of multi slit rolling technology. Essence of the MSR technology is using the special calibrating of rolls in group of rolling – mill stands finishing off, following cutting shape pass: pre – cutting pass named “dog - bone” and cutting pass named “slit – pass”. The construction of “dog - bone” pass consist of enough symmetrical knives . Distribution of square batch two parts in this shape follows preliminary. Formation of separate rods joined by narrow bridge is made in “slit – pas”. Finally separation of two rods is made in special equipment case – slit box. It is made by tearing bridge joining rods. The slitting is realized by two distributing rolls.

To simulation double core slit rolling was applied calibrating of rolls in Steelwork Zawiercie to rolling round ribbed rods Ø=19,4 mm (Figure 1). Computer simulation of the process was executed at Institute of Modelling and Automation of Plastic Forming Processes.

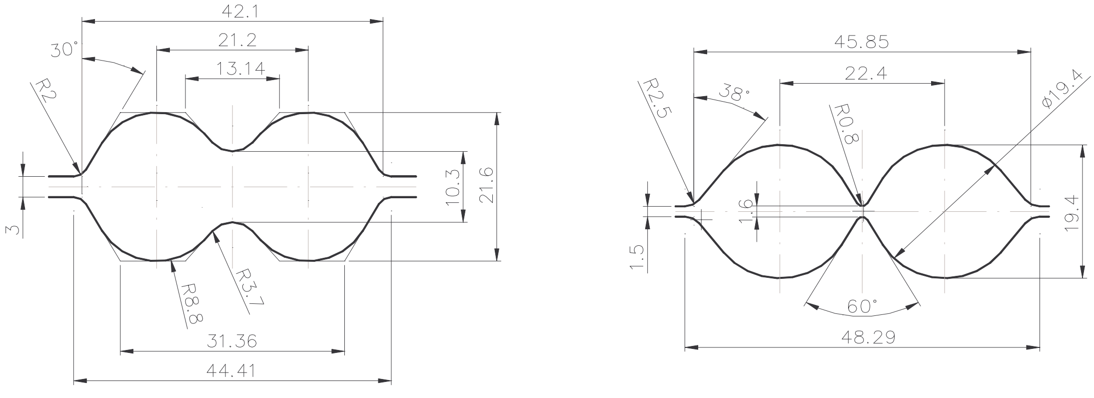


Figure 1. “Dog - bone” and “slit – pass” used in Steelwork Zawiercie in ribbed rod rolling process

2. NUMERICAL MODELING

The numerical simulation of double – core slit rolling were made in commercial packet Forge3 ® based on finished element method. Steel BSt500S was used as the stock. Stress – strain curve was obtained by plastometrical investigations. Samples were taken from rolling ribbed rods produced in Steelwork Zawiercie. The horizontal symmetry was given regard to character of process. Figure 2. shows the composition of tools used in simulation: the composition of tools: working roll (Dw = 370 mm), pusher and stock is presented in Pic. 2. Velocity for the working roll (V_w = 6,1 m/s) and pusher was set.

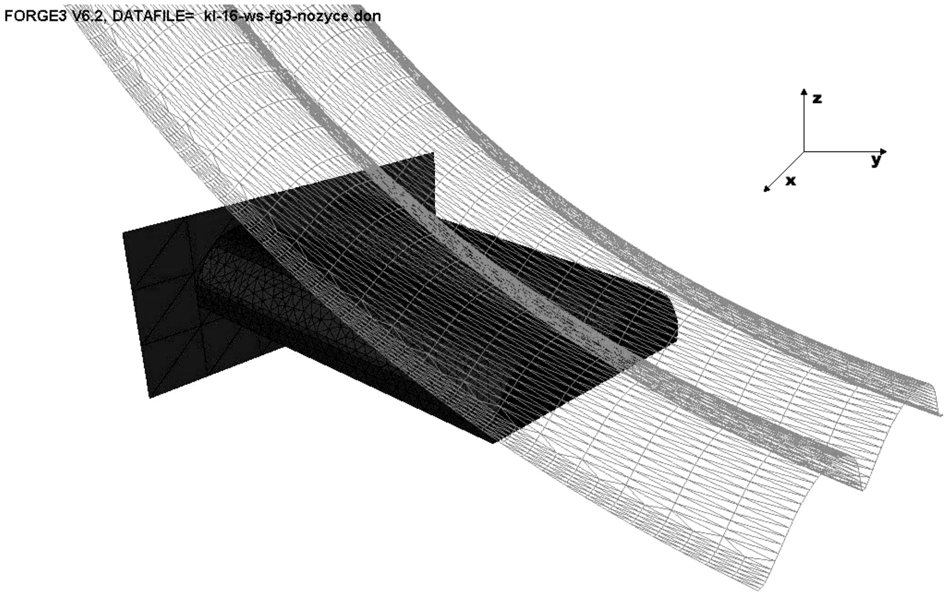


Figure 2. The composition of dies and stock used in simulation of rolling in slit - pass

The following parameters of process were given : stock temperature t = 1100^0C, tools temperature 60^0C, external temperature 20^0C, transfer coefficient between material and dies α = 3000 W/Kmm^2, transfer coefficient between material and air α_{air} = 100 W/Kmm^2, friction conditions between material and dies μ = 0,3 and m = 0,6. The length of the deformation zone was ld = 39,2 mm.

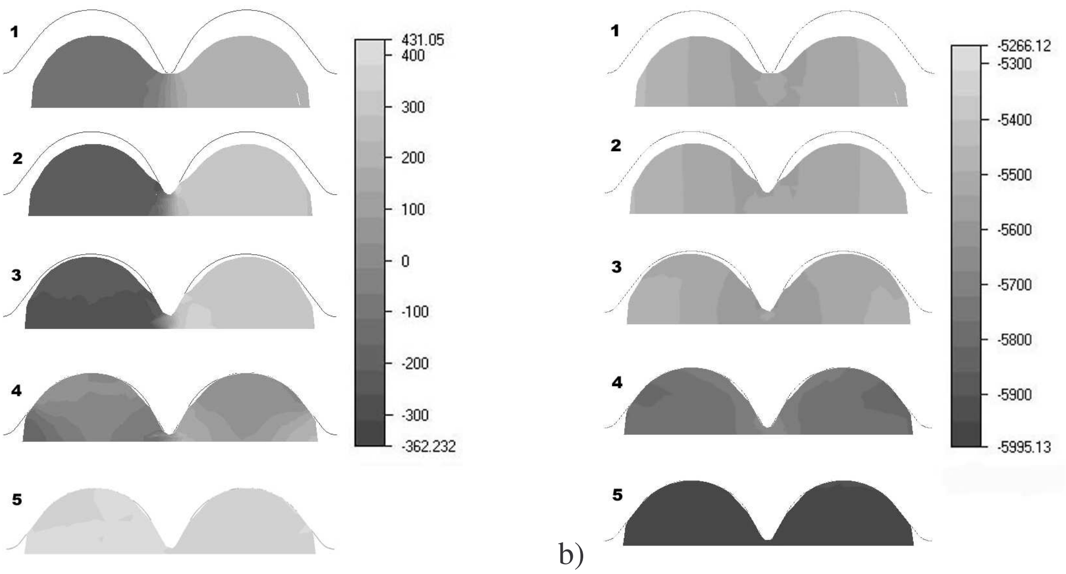
3. COMPUTATION RESULTS AND ANALYSIS

The results of numerical calculation were compared with real data from process of rolling ribbed rods in Steelwork Zawiercie, table 1.

Table 1. Comparison of strand dimension (computer simulation vs. rolling process)

	Data from Steelwork Zawiercie	FEM simulation	Error [%]
Cross – sectional area [mm^2]	616	610	-1

Figure 3 present distributions of metal flow velocity V_x (change in width) and V_y (change in length) in deformation zone. Point 1 represents the plane of entry (coordinate 39,2 mm), and point 5 represents the plane of exit (coordinate 0 mm) . Following coordinates are in remaining points: 2 - 29,4 mm, 3 - 19,6 mm, 4 - 9,8 mm.

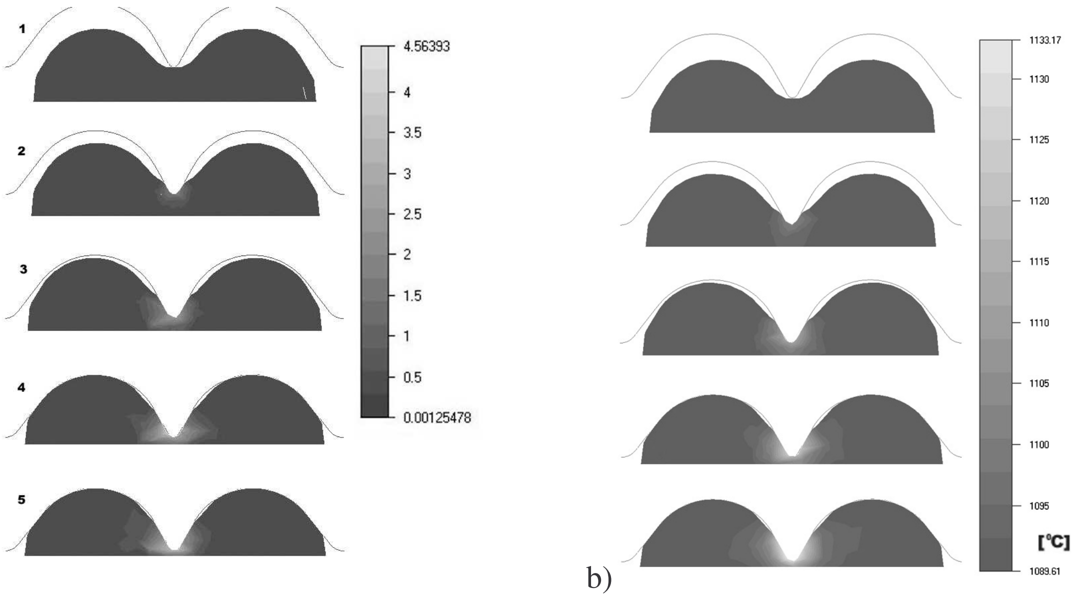


a) b)

Figure 3 Distribution of metal flow velocity a) V_x b) V_y

Distribution of equivalent strain rate and temperature in slit – pass in analogous points of deformation zone was presented in figure 4. The largest deformation of metal is in zone of neck which joining rods, that causes the considerable growth of temperature in this zone.

"Slit – pass" is characterized by small coefficient of extension $\lambda \approx 1{,}15$. The most important is forming and division of stock on two rods. The symmetry of distributions testifies about exact introduction of strand in slitting shape. In industrial practice this is realized by the use of special guides.



a) b)

Pic. 4 Distribution of a) equivalent strain rate and b) temperature in slit – pass.

3. SUMMARY AND CONCLUSIONS

The numerical simulation gives similar results as obtained in real process. In “slit – pass” metal is the most intensive deformed in narrow bridge joining two rods zone. The assurance of proper insert of strand in slitting shapes is the most important technological aspect.

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