DETERMINATION OF THE SHAPE AND DIMENSIONS OF DEFORMING ELEMENTS ACCORDING TO A GIVEN SHAPE AND DIMENSIONS OF THE CONTACT ZONE

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ABSTRACT

In modern mechanical engineering, the development of a technological process for processing stamping forms on shaped surfaces remains the most important task of today. Before processing the shaped surfaces, it will be necessary to study the working surfaces of the stamping molds. This article describes methods for determining the geometric parameters of the surface when processing stamping forms on shaped surfaces, in particular, the drawing structures of the cutting zone of shaped surfaces, the penetration of the cutter into the cutting zone and data on the conditions of editing in the cutting zone.

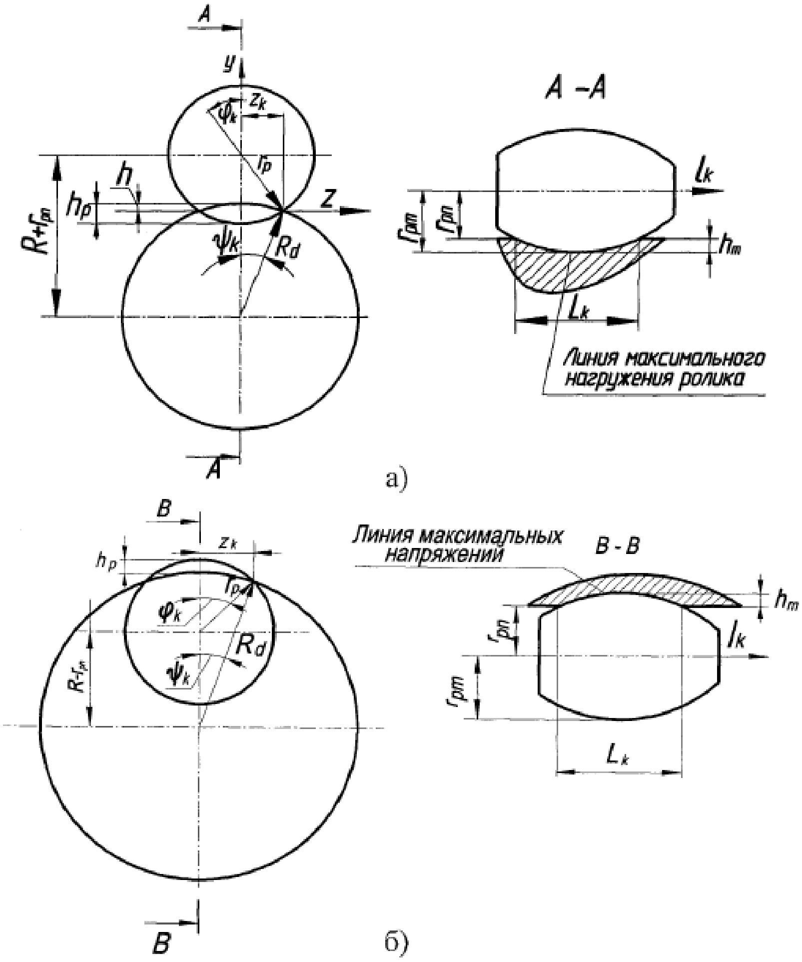
Keywords: cutting area, consistency, durability, punching, punching design, cutting parameters.

Based on the selected criteria, it is necessary to simulate the necessary stress-strain state within its limits, to determine the optimal geometric parameters and conditions of the processing process.

The chosen similar formulation of the problem allows us to determine the necessary patterns that cannot be determined by its direct solution. To determine the influence of the sizes of deforming elements on the deformation force and the depth of hardening or the influence of the contact shape at a given area on the same values, it is necessary to set the contact zone in shape and size.

The contact dimensions and their shape are not determined unambiguously by setting a single equation. Complementing its geometric parameters is the equation change in the depth of the deforming element along the line of maximum loading.

For the geometric parameters of the deforming elements that provide a given contact, it is also necessary to take into account the diameter and type of the surface to be treated. Consider the introduction of a deforming element into the surface of the shaft and the hole (Fig.1).



а)

б)

Fig. 1. Schemes for changing the radius when processing shafts (a) and holes (b) according to a given shape of the contact zone

Consider the case when the axes of the deforming element and the part are located parallel to each other. Calculations of the change in the radius of the roller and the depth of its insertion along the line of maximum loading can be determined:

- When processing shafts:

$$r_{pв} = \sqrt{\frac{\mathrm{C}}{2} + \sqrt{\frac{\mathrm{C}^2}{4} + B^2 + 4 \cdot D^2 \cdot z_k^2}} \qquad (1)$$

$$h_p = r_{pв} - r_n \qquad (2)$$

To shorten the record, the notation $C=2\cdot B+4\cdot D^2$; $D=R_в-r_n$; $B= R_в^2-D^n$ where, $R_в$ is the radius of the treated surface; r_n is the initial radius of the roller; z_k is the change in the half-width of the contact zone along its length.

- Changing the radius of the roller when processing holes:

$$r_{po} = \sqrt{(R_o + r_n)^2 + R_o^2 - 2R_o(R_o - r_n)\sqrt{1 - (\frac{z_k}{R_o})^2}}$$

(3)

The radius of the roller r at the beginning of processing is chosen arbitrarily and depends on the design parameters of the tool and the number of rollers installed along the arc of the circumference of the part determined from the specified criteria of a technological or constructive nature.

Changes in the half-width of the contact zone according to it can be any equations of piecewise smooth curves.

Figure 1 shows the most widely used elliptical and teardrop contacts and they have the following contour line equations.

The teardrop contact consists of two sections: the entrance section located on the length L_1, and the escape section located on the length L_2, the teardrop contact is half an ellipse with semi-axes. The half-width of the contact will be determined using the following dependency.

$$z_{k1} = z_{kmax}\sqrt{1-(\frac{l_k-0,5L_1}{0,5L_1})^2} \quad 0 \le l_k \le L_1 \tag{4}$$

and the escape site

$$z_{K2} = \frac{z_{kmax}\cdot(L_k-l_k)}{(L_k-L_1)} \quad L_1 \le l_k \le L_k \tag{5}$$

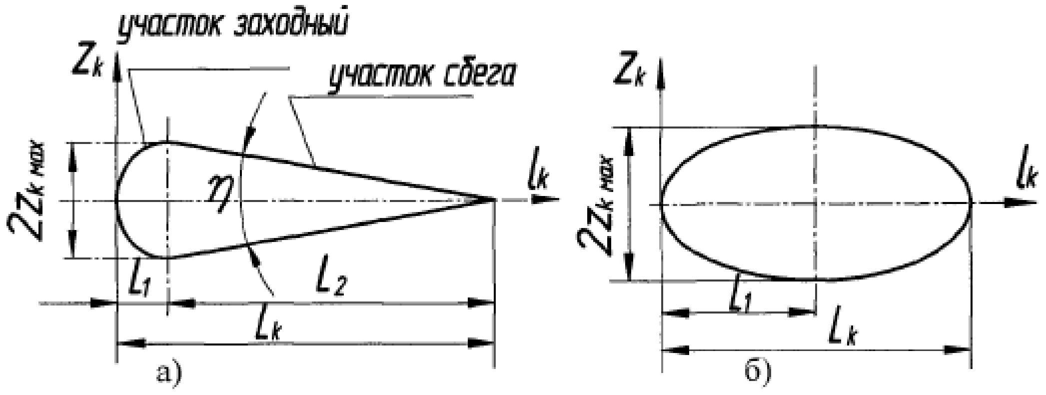


Fig. 2. Forms of contact zones most often used in practice: a)-teardrop shape of the contact zone; b)-elliptical shape of the contact zone

The elliptical shape of the contact is shown in Figure 2.) and is determined by the following dependence:

$$z_{k1} = z_{kmax}\sqrt{1-(\frac{l_k-0,5L_1}{0,5L_1})^2} \quad 0 \le l_k \le L_k \tag{5}$$

When processing surfaces with balls that have arbitrary curvature in at least one direction, an elliptical contact is formed.

The effect of roller deformation on the geometric parameters of the contact

To determine the main solutions, we will consider the deformation of the roller by force P in the form of a cylindrical roller of unit length

During processing, under the influence of the deformation force, the cross section of the roller turns from a circle into an oval, which can be represented as an ellipse. The equation of this ellipse can be written as

$$z = a\sqrt{1-\frac{y^2}{b^2}} \qquad (6)$$

where a and b are the major and minor semi-axes of the ellipse.

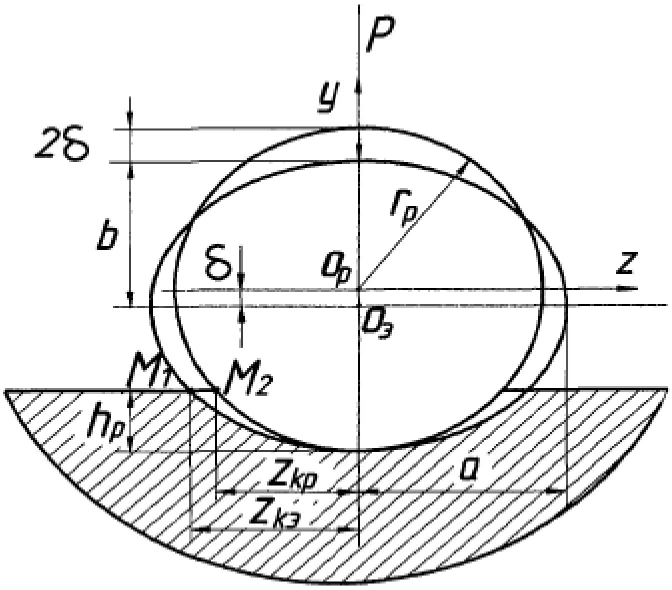


Fig. 3. Diagram of the deformation of the cross-section of the roller by the force of R.

After loading the deforming roller with force P, its radius should decrease by an amount

$$\Delta r_p = 2P\frac{1-\mu^2}{\pi E}(0{,}41 + ln\frac{4r_p}{\sqrt{\frac{P\cdot 2r_p}{E}}}) \qquad (7)$$

Hence, the small semi-axis will be equal to the radius of the roller, reduced by its deformation under the action of the loading force

$$b = r_p - \Delta r_p \qquad (8)$$

The cross-sectional areas of the roller before and after deformation will be equal and for a circle and an ellipse the areas will be equal

$$S_{kp} = \pi r^2,\ \ S_э = \pi ab \qquad (9)$$

Then

$$a = \frac{r_p^2}{b} \qquad (10)$$

If we assume that the cylindrical roller is embedded in a flat surface to a certain depth hr. Then the half-width of the contact when the roller is inserted into the flat surface of the rigid and deformed rollers will be equal, respectively

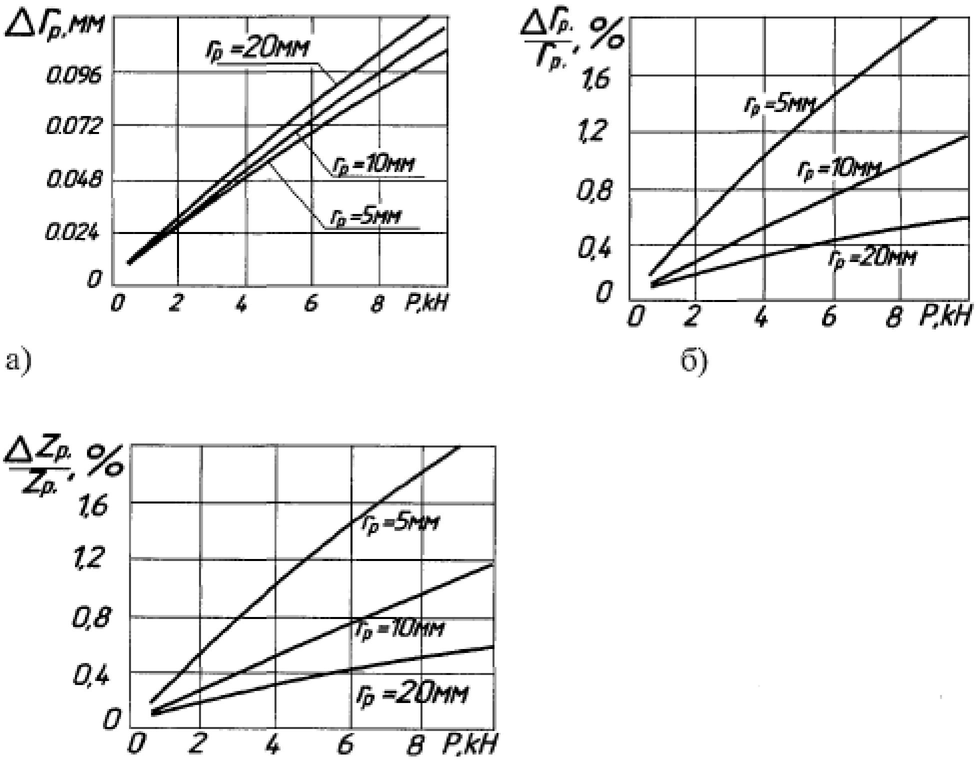
$$z_{kp} = \sqrt{r_p^2 - (r_p - h_p)^2} \qquad (11)$$

$$z_{kэ} = \sqrt{r_p^2 - (r_p - h_p)^2} \qquad (12)$$

The difference between the contact half - widths is determined from the expression

$$\Delta r_{rk} = z_{kэ} - z_{kp} \qquad (13)$$

The main results of the calculations are shown in the form of graphs in Fig. 4.



а) б)

в)

Fig. 4. The change in the radius of the roller due to deformation and from the force a) its percentage ratio b) and the percentage of the change in the half-width of the contact due to deformation i) depending on the deformation force.

The above calculation results show a change in the half-width of the contact at a load of up to ten kilonewtons does not exceed 1.6%. Hence, the optimal radii of the rollers should be in the range of five to eight millimeters and the deformation force for these sizes should not exceed five kilonewtons. Thus, the change in the half-width of the contact will not be less than one percent, therefore, in practical calculations, the change in the half-width of the roller contact can not be taken into account.

CONCLUSION

Analysis of the obtained expression shows that the larger the diameter of the first insert and cutting tool, the higher the cutting depth parameter on the previously untreated surface, and the larger the radius of the machined surface, the lower the machining depth. The main task is to remove the deposit on the surface to be treated. In this case, the cutting parameters of the cutting tool and the thickness of the layer to be cut are important. When moving a cutting tool along a complex shaped surface, it is necessary to establish the optimal movement of the machining trajectory in CAD / CAM / CAE systems. Because the parameters of the cutting part of the cutting tool can be eaten, broken, the parameters of the cutting part can be changed during processing along the trajectory. This in turn affects the surface quality of the surface being cut. In this paper, the capabilities of CAD / CAM / CAE systems were used in machining the working part of stamp molds.

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