Study of the technological process of mechanical processing of parts with shaped surfaces in milling machines

Akmaljon Mavlonjonovich Gafurov
smyalik1989@mail.ru
Abdumalik Khasanjon ogli Khamidjonov
Fergana Polytechnic Insitute

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

Determination of geometric parameters of untreated surfaces

When developing a control program, the CAM system itself calculates only the trajectory of the cutting tool. The technologist-programmer sets the following parameters:

Working push; thrust of the first cutter; adding cutting tools and adding thrust; accelerated push value; the number of revolutions of the spindle.

It should be noted that the values of these parameters do not change during the processing of the control program.

It is necessary to develop a new method that allows influencing the forming process by means of algorithms of control of cutting parameters in any part of the treated surface.

Batuev V.V. suggests the following relationships to calculate the change in shear forces:

$$dP_z^{\Sigma} = \sum_{n-1}^{z} 1{,}15\sigma_1 \int_{\varphi_N}^{\varphi_k} \frac{a}{sin\beta_1} cos\beta R_{\text{фр}}\, d\varphi + 0{,}252\mu\sigma_1 \int_{\varphi_N}^{\varphi_k} I_3 R_{\text{фр}} d\varphi \ (1)$$

$$dP_z^{\Sigma} = \sum_{n-1}^{z} 1{,}15\sigma_1 \int_{\varphi_N}^{\varphi_k} \frac{a}{sin\beta_1} \beta cos\beta R_{\text{фр}}\, d\varphi + 0{,}252\sigma_1 \int_{\varphi_N}^{\varphi_k} I_2 cos\varphi R_{\text{фр}} d\varphi \ (2)$$

$$dP_z^{\Sigma} = \sum_{n-1}^{z} 1{,}15\sigma_1 \int_{\varphi_N}^{\varphi_k} \frac{a}{sin\beta_1} sin\beta sin\varphi R_{\text{фр}}\, d\varphi + 0{,}252\sigma_1 \int_{\varphi_N}^{\varphi_k} I_3 sin\varphi R_{\text{фр}} d\varphi (3)$$

Here:

z-number of milling teeth; s1-intensive shear stress, Pa; a-cut layer thickness; b1-turning angle of the cutting plane; b-the angle between the cutting line and the direction of the resultant force Rfr; µ-friction coefficient; φ-milling shape angle; Rfr- milling radius, mm; The degree of curvature of the I3 tooth, mm; phk-the angle between the axis of the cutter and the upper point of intersection with the work piece; φN-the angle between the cutting axis and the bottom point of the milling cutter intersecting with the work piece.

In the expressions, the relationship between the geometric parameters and the cutting force is established in milling with finger cutters, but the integral form is not accepted for the use of RDB machines, and the milling procedure is not taken into account in these expressions, there is a need to change these expressions.

Considering the cutting speeds from V=1000 m/min to V=0.1 m/min and the value of thrust in the range of S=0.001 mm/tooth to S=0.2 mm/tooth S tooth=0.2 mm values are shown in the expressions in clauses 1-2 :

$$dP_z^{\Sigma} = 0{,}252\sigma_i R_{\text{фр.}}(\varphi_a - \varphi_H)\left(15{,}87 S_{\text{тиш}} \sqrt{\frac{t}{2R_{\text{фр.}}}} + I_2 tg\left(80 + \lambda - 2arcsin\frac{1}{K}\right)\right) (6)$$

$$dP_z^{\Sigma} = 0{,}252\sigma_i R_{\text{фр.}}(\varphi_a - \varphi_H)cos\varphi\left(5{,}24 S_{\text{тиш}} \sqrt{\frac{t}{2R_{\text{фр.}}}} + I_2 tg\left(80 + \lambda - 2arcsin\frac{1}{K}\right)\right) (7)$$

$$dP_z^{\Sigma} = 0{,}252\sigma_i R_{\text{фр.}}(\varphi_a - \varphi_H)sin\varphi\left(5{,}24 S_{\text{тиш}} \sqrt{\frac{t}{2R_{\text{фр.}}}} + I_2 tg\left(80 + \lambda - 2arcsin\frac{1}{K}\right)\right) (8)$$

The resulting expressions allow determining the changes in the cutting force in a wide range of thrusts and speeds with different geometrical parameters of the cutting surface. Their simplified form is optimal for automatic use at the program level in RDB milling machines, and their calculated parameters differ less than 5% from the parameters of expressions (1)-(3).

The maximum thickness of the cut layer during milling varies from zero to the maximum value for a part of the milling cycle. It is determined by the angle ps measured in the direction of the radius (Fig. 1), the largest value is calculated according to the following formula:

$$\alpha_{\text{жад}} = S_{\text{тиш}} \sin\psi = 2S_{\text{тиш}} \sqrt{\frac{t}{D} - \frac{t^2}{D^2}} \ (9)$$

The resulting formula:

$$\alpha_{\text{жад}} = 2S_{\text{тиш}} \sqrt{\frac{t}{D}} \ (10)$$

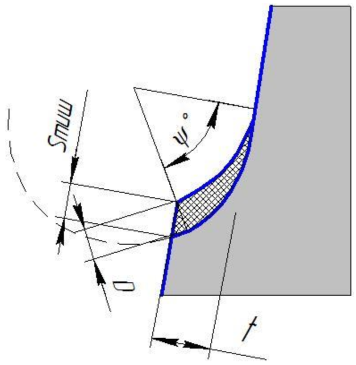

Figure 1. Calculation scheme of the section of the cut layer

It is taken into account that the thrust parameters do not exceed 0.3 mm during clean processing of surfaces, and then the development of control programs can be simplified. This expression applies to the bevel angle of the machined surface, the part perpendicular to the axis of the cutting tool, and the first pass of the end mill.

Below is a comparison of the recommended correlations and a graphic model of a ø20 milling cutter with each tooth Stish=0.3 mm.

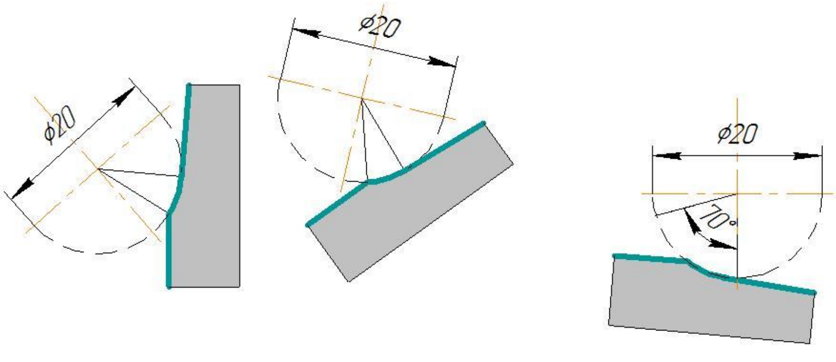

Figure 2. Sections of the cut layer at different angles of the shaped surfaces

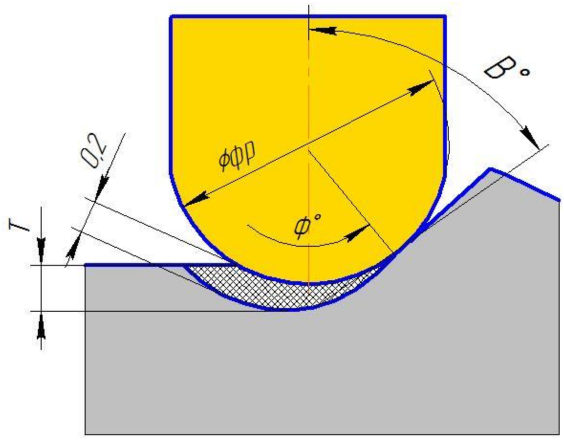

Figure 3. Sections of the cut layer when cutting the previously untreated surface

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