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ROUGHNESS PARAMETERS DURING MECHANICAL PROCESSING ACCORDING TO INTERNATIONAL STANDARDS

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ABOUT ARTICLE

Key words: Roughness, arithmetic mean deviation of the profile, base length, average roughness, root-mean-square roughness; asymmetry, kurtosis, maximum height of the profile peak, maximum depth of profile depressions, height at 10 points, maximum profile height.

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Abstract: This article discusses the parameters of roughness during machining. The requirements for surface roughness are setby specifying the roughness parameter.

INTRODUCTION

Surface irregularities are characterized by the parameters of roughness and waviness.

Surface roughness is a set of irregularities with relatively small steps that form the surface relief of a part and are considered within the base length ℓ.

Roughness after machining is a geometric trace of the cutting tool, distorted as a result of plastic and elastic deformation and vibration of the technological system accompanying the cutting process.

Base length - the length of the base line used to highlight the irregularities that characterize the surface roughness and to quantify its parameters. The numerical values of the roughness are measured from the baseline, which is taken as the middle line of the profile *m***,** having the shape of a nominal profile and drawn so that within the base length, the standard deviation of the profile along this line would be minimal.

1. Requirements for surface roughness should be established based on the characteristic purpose of the surface to ensure the specified quality of products. If the surface is not involved in mating during assembly, then the requirements for the roughness of this surface are not established and the roughness of this surface should not be controlled.

2. Requirements for surface roughness should be set by specifying the roughness parameter (one or more) from a number of values.

According to GOST 2789–73, there are 6 roughness parameters:

Ra is the arithmetic mean of the absolute values of the profile deviations within the basic length; *Rz*is the sum of the average absolute values of the five largest protrusions in the profile and the five smallest depressions within the base length; *R max* - the highest height of the profile roughness or the distance between the line of protrusions and the line of depressions; *Sm* is the average step of the profile roughness; *S* is the average roughness step along the vertices; *tp*- relatively - the reference length of the profile.

The international standard ISO 4287–97 uses 8 roughness parameters: *Ra* – average roughness; *Rq*is the rms roughness; *Rsk*- asymmetry; *Rku*- kurtosis; *Rp*is the maximum profile peak height; *Rv*is the maximum depth of profile depressions; *Rz*– height by 10 points; *Rt*is the maximum profile height.

3. Requirements for surface roughness do not include requirements for surface defects, therefore, when controlling surface roughness, the influence of surface defects must be excluded. If necessary, requirements for surface defects should be specified separately. It is allowed to establish requirements for the roughness of individual surface areas (for example, for surface areas enclosed between the pores of a large-porous material, for sections of the cut surface that have significantly different irregularities). The requirements for surface roughness of individual sections of the same surface may be different.

4. Designation of surface roughness on the drawings in accordance with GOST 2.309-73 using special icons.

Consider the change in roughness according to GOST 2789-73 and GOST 2789-59.

Arithmetic mean profile deviation**(** R_a **)** - the arithmetic mean of the absolute values of the profile deviations within the base length

$$R_a = \frac{1}{n}\sum_{i=1}^{n}|y_i| , \qquad (1)$$

wheren is the number of selected profile points within the base length ℓ**;** y_i– profile deviation – distance between the profile point and the base midline.

In integral form, the expression for R_a can be written as:

$$R_a = \frac{1}{\ell} \int_0^{\ell} |y(x)| dx \quad , \qquad (2)$$

The height of the profile irregularities at ten points **(Rz)** - the sum of the average absolute values of the heights of the five largest protrusions of the profile and the depths of the five largest depressions of the profile within the base length

$$R_z = \frac{1}{5} \left(\sum_{i=1}^{5} |y_{pi}| + \sum_{i=1}^{5} |y_{vi}| \right), \qquad (3)$$

where y_{pi} is the height of the i-th largest protrusion of the profile, determined by the distance from the middle line of the profile (m) to the highest point of the protrusion of the profile; y_{vi}- - the depth of the i-th largest profile cavity, determined by the distance from the middle line of the profile to the lowest point of the profile cavity;

The greatest height of the profile irregularities **(Rmax)** is the distance between the line of the protrusions of the profile and the line of the profile depressions within the base length.

The average step of profile irregularities **(Sm)** *is* the average value of the step of profile irregularities within the base length.

$$S_m = \frac{1}{n} \sum_{i=1}^{n} S_{mi} \quad , \qquad (4)$$

The average step of the local protrusions of the profile **(S)** *is* the average value of the steps of the local protrusions of the profile, which are within the base length.

$$S = \frac{1}{n} \sum_{i=1}^{n} S_i \quad , \qquad (5)$$

Relative profile reference length **(tp)**- the ratio of the reference length of the profile to the base length

$$t_p = \frac{\eta_p}{\ell} \quad , \qquad (6)$$

where η_p- reference length of the profile at a given level of the profile section p. The section level is specified as a percentage of starting from the ledge line. Designation t_{10}means that the parameter t_p is defined for the section level of 10%.

$$\eta_p = \sum_{i=1}^{n} b_i \ . \qquad (7)$$

Parameter *tp* characterizes the distribution of the material in the rough layer. It is possible to imagine roughness models that would have the same height and step parameters but different shapes of irregularities (Fig. 1.)

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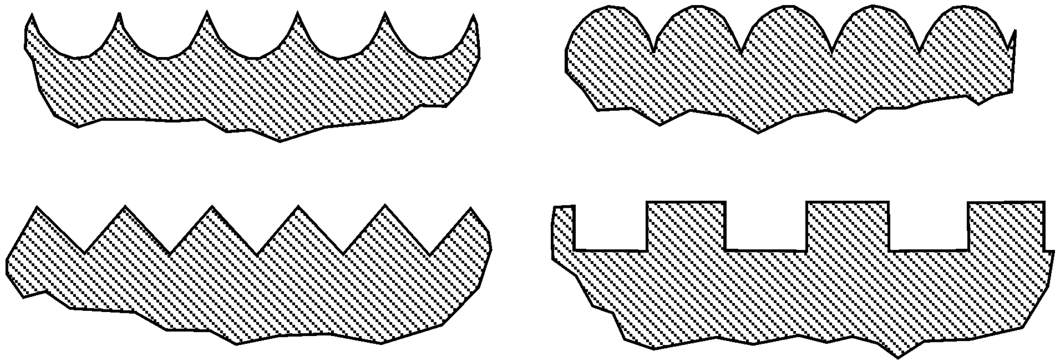

Fig. 1. Idealized surface profiles

Obviously, the operational properties of parts with such irregularities can be different. A visual representation of the distribution of material in a rough layer and the average shape of irregularities is given by the construction of a reference curve. When it is constructed along the abscissa axis, the values of the parameters $\mathbf{t_p}$at different levels of sections **p** , as a percentage of $\mathbf{R_{max}}$(Fig. 2).

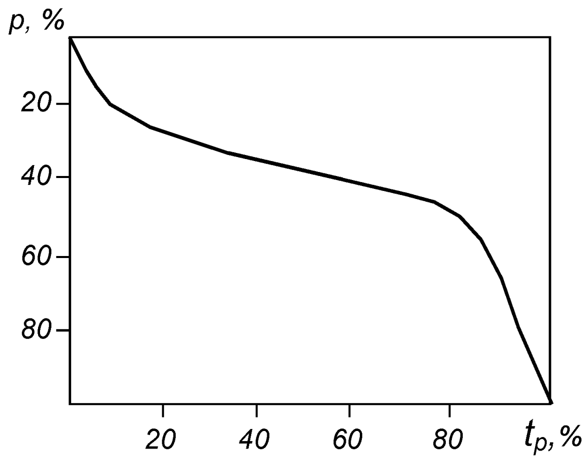

Fig. 2. Profile reference curve

Having determined $t_p$for different levels p, setting the latter as a percentage of R_{max}, you can build a curve of the bearing surface, which gives a complete picture of the distribution of material in the rough layer and the average shape of the irregularities.

Surface cleanliness classes. Discharges of surface cleanliness.

GOST 2789-59. Surface roughness.

To designate all classes of surface cleanliness, one sign is established - an equilateral triangle ∇, next to it the class number and category are indicated, for example: ∇7.

The numerical value of the surface roughness limits only the maximum value of the roughness in terms of the parameter *Ra* or *Rz*; for example ∇9 includes surfaces with *Ra* not more than 0.32 μm. In cases where it is required to limit the maximum and minimum roughness values, two numbers of classes or categories should be indicated in the designation, for example, ∇9-10 indicates that the roughness should be at least 0.16 μm in *Ra and not more than 0.32 μm.*

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Roughness of surfaces rougher than the 1st class is indicated by a sign, above which the height of irregularities in microns is indicated, for example 500. All surfaces can be roughly divided into the following four groups by cleanliness:

1st - rough machining (turning, drilling, milling, gouging, etc.);

2nd - reaming, as well as semi-finish turning, milling, planing, etc.;

3rd - clean, scraping, reaming or processing on machines - grinding, broaching, etc.;

4th - very clean, obtained by filing with files (very small numbers), grinding.

Table 1.

Designation of surface cleanliness classes according to GOST 2789-59		∇1	∇2	∇3	∇4	∇5	∇6	∇7	∇8	∇9	∇10	∇11	∇12	∇13	∇14
Designation of surface roughness according to GOST 2789-73	**Rz=Rmax micronRa most-neck meaning**	R_z320	R_z160	R_z80	R_z40	R_z20									
		80√	40√	20√	10√	5√	2.5√	1.25√	0.63√	0.32√	0.16√	0.08√	0.04√	0.02√	0.01√
	Ra preferred meaning	50√	25√	12.5√	6.3√	3.2√	1.6√	0.8√	0.4√	0.2√	0.1√	0.05√	0.025√	0.012√	

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