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MATHEMATICAL MODEL OF VIBROROLLING, BASED ON LINEAR PROGRAMMING

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ABSTRACT
The essence of vibrorolling is cold plastic process of deformation – rolling with ball, which differ from known rolling scheme, that instrument, ball or diamond ferrule in direction of feeding have additional motion, which speed is characterized by rotation number per minute and amplitude. Varying these parameters we can practical interminable limit and change all parameters of surface micro relief. Using method of linear programming we form mathematical model of vibrorolling. This model includes technical limits and simplifies form of valuation function, which is set to linear by logarithm. Quality and safety of mathematical model depends on choice of technical limits. The first task, which must be solved – it is to make all technical limits and estimate them in linear form. Adapting for mathematical model optimum processing conditions determination task, it brings at all possible undeniable meaning searching, where optimization function obtain maximum value. Processing these conditions the mathematical model can be expressed in graphic form. In this case every technical limit gets described like a borderline, which determine half plane, where possible solution of inequality system exists.
The experiment for deforming power determination was carrying. Getting power we can put in technical limit and find optimum criterion of vibrorolling process. Final cause is providing this process such, that quality of processed surface agree high exactness measure requirement.
Keywords: vibrorolling, linear programming, technical limit, power.

1. IDEA OF LINEAR PROGRAMMING

This model includes set of technical limits and simplifies form of valuation function, which is linear by logarithm [1]. Central goal of linear programming consist is in undeniable variable meanings calculation, which results a system of limitation in way linear similarities and dissimilarities and which provide meaning of linear function maximum (or minimum) – optimum criterion. The first task that has been solved was setting of all technical limits and estimation of them in linear form. Conversion of technical limits in linear form and describing them as inequality system has gave mathematical model of machining process. The goal of fixation machining regime optimum of mathematical model was find from all possible undeniable meanings x_1 and x_2 system such $x_1$opt and $x_2$opt meanings, at whose linear function is at maximum meaning ($f_0$max).
Processing conditions, based on given mathematical model can be expressed in graphical form. In this case each technical limit is described as borderline, set of these determine half-plane, where exists the possible solution of inequality system. Borderlines crossing make polygon, inside which every point satisfy everyone bar none dissimilarities.
That is why this polygon named solution polygon. It is shown in Fig.1.

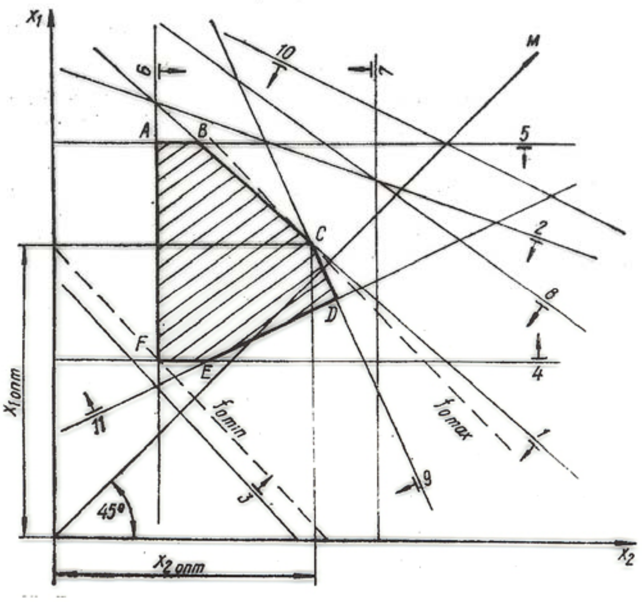

Figure 1: Body of optimum function limit after linearization.

2. POWER OF DEFORMATION

Quality and effectiveness of mathematical model depends on choice of technical limits. The choice of technical limits is based on technical, construction and organizing – industrial character conditions.

Technical limits of vibrorolling are:

Durability of instrument;

Principal movement capacity of electric motor;

Machine tool claiming productiveness;

The highest and the lowest permissible processing speeds;

The highest and the lowest permissible feedings;

Stiffness and durability of instrument holder;

Stiffness of the blank;

Durability of machine tool feeding mechanism;

Required surfaces roughness.

All technical limits depend on deformation's power. To express technical limits in linear form, we had to calculate power. From E. Rygow, A.Suslow and V. Fyodorow [2] experiment signify power, which transfigure in linear form with method of logarithm.

$$P = \exp\left(\frac{\ln k_0 + k_1 \ln v + k_2 \ln s + k_3 \ln t + k_4 \ln R_B + k_5 \ln \gamma_1 + k_6 \ln \alpha + k_7 \ln r_{kp}}{k_9}\right) + \\ + \left(\frac{k_8 \ln r_p + k_{10} \ln D + k_{11} \ln s_q + k_{12} \ln v_q - \ln y_i}{k_9}\right)$$

Where

k_0, k_1, k_2...k_{12} – coefficient for determination of surface quality parameters;

v, s – cutting speed and turning feed;

t – cutting depth;

R_B – tool tip radius;

α - tool angle;

P – deformation's power;

D – roller diameter;

s_q, v_q – detail feed and speed in surface plastic deformation case;

γ - cutting edge radius of curvature;

r_{kp} – cutting edge radius of roundup.

Putting into practice those results will regulate surface quality processed by surfaces plastic deformation. Acquired deformation power is inserted in given technical limits. In this case goal is getting definite profile.
On property height of micro roughness profile in case of strengthening processing significant effect has previous processing. Looking to the connection between surfaces property after plastic deformation and surface properties obtained in previous processing we can see, that every finally processed quality of surfaces property can affect some characteristic of previous processing.
Having regard of characteristic of previous processing (turning, milling), power P in MPa of vibrorolling plastic deformation was calculated depending on surfaces roughness R_{max} for cylindrical surfaces for various materials (steel 20, 40, 75). This depends can show in figure 2. Getting power insert in technical limits, we will get graphical mathematical model of vibrorolling.

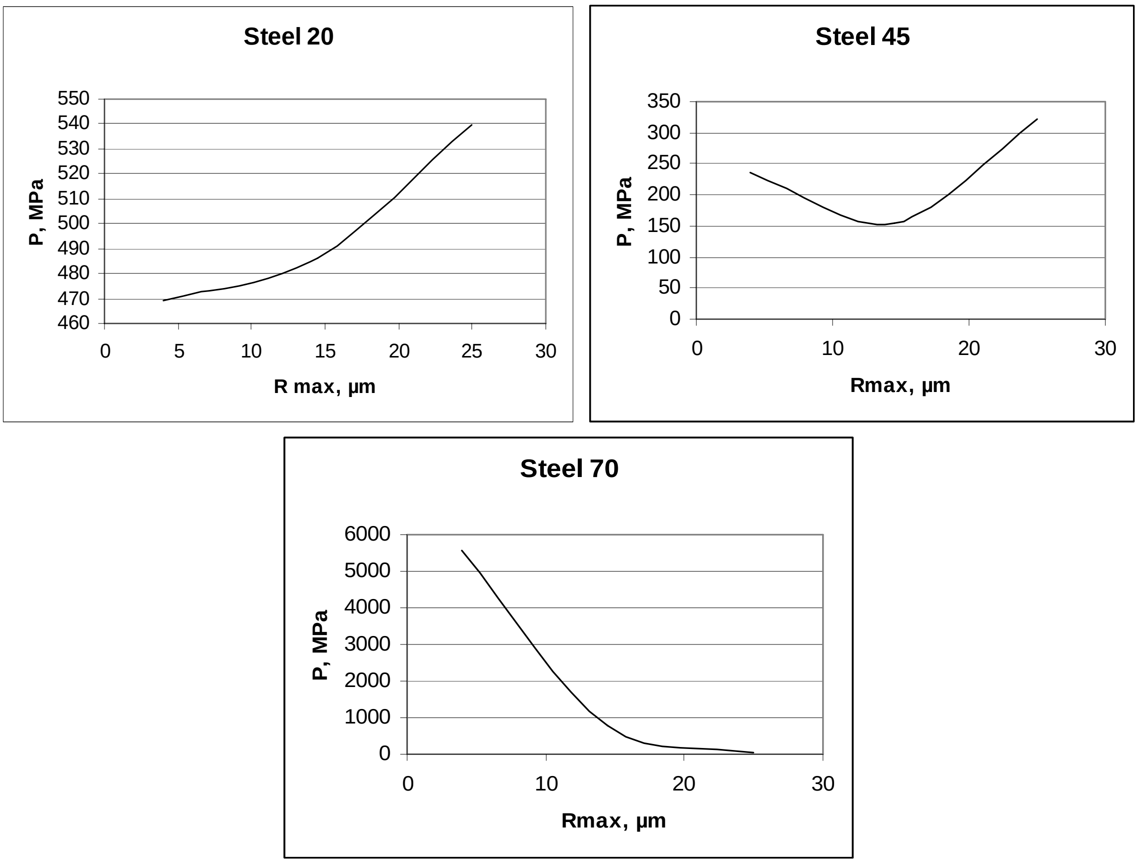

Figure 2. Power of vibrorolling plastic deformation for cylindrical surfaces for various materials.

3. ACKNOWLEDGEMENT
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4. REFERENCES
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