CONDITIONS OF CUTTING OF WOOD

УСЛОВИЯ РЕЗАНИЯ ДРЕВЕСИНЫ

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Abstract:

Process of cutting as the established process which is characterized by force of cutting is considered. Formulas for calculation of forces of cutting, the capacity, spent on cutting of a shaving, work and volume of the cut off shaving which influences on filling groove of shaving are offered. The conditions influencing on power parameters and quality of the processed surface are considered.

KEYWORDS: CUTTING, CUTTER, WOOD, SURFACE, FORCE, SPEED, POWER

1. Introduction

Cutting ability of a cutter is understood as ability to form in wood new surfaces. The paramount role in this ability is played with a cutting edge, which activity depends on its structure and a degree of a continuity of action on wood in the thin layer, adjoining to a formed surface /1,2/. As the layer is thinner, a roughness of a surface is closer to a qualitative surface.

Cutting ability of a cutter depends on a material of which it is made, from the form and a microstructure of forming flat and its curve surfaces – sides, and also from an arrangement and movement of a cutter concerning a surface of cutting. Special influence on process of cutting puts edges – lines of crossing of sides.

Cutting edge is a surface of a complex structure. Its initial form is determined by half-finished product of a cutter at which its sides (surface) are updated by cutting from them a superficial layer by abrasive grains. The roughness of a surface changes in limits $\mathbf{R_a}$ = 0,16..0,32 a micron. A cutter, moving with speed of $\mathbf{v}$ m/s, cuts from motionless half-finished product a layer – a shaving with thickness $\mathbf{e}$ mm and width $\mathbf{b_c}$ mm (Fig.1). In a direction of movement the cutter operates on wood with force of cutting $\mathbf{Q}$.

2. Cutting process

In a tree trunk allocate three main mutually perpendicular directions: axial, radial and tangential. In conditions of manufacture exact parallelism of a vector $\mathbf{v}$ to anyone from mainstreams of a tree trunk seldom /3/. Usually a vector $\mathbf{v}$ coincides with mainstreams of a trunk with the corners distinguished from zero and $\pi/2$ radians.

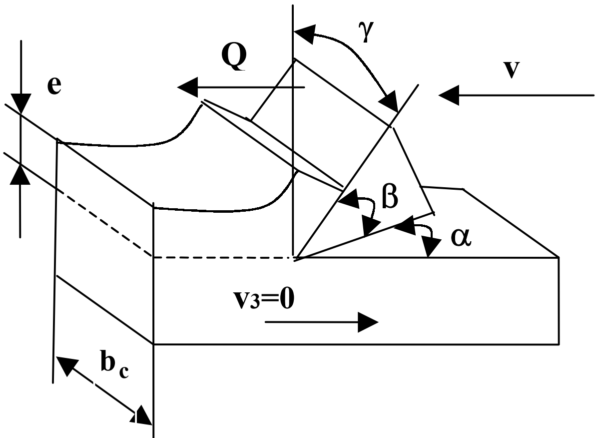

Fig. 1. Scheme of cutting

There are sizes of a corner β of a point, corners α, δ of installation and corner φ_c of a bias change over a wide range. From told follows, that cutting of wood – process difficult enough. Change of conditions of cutting results in infinite number of their combinations – modes, various on a degree of complexity and on quality of a formed surface.

Let's consider process of cutting as the established process which is characterized by an invariance of force $\mathbf{Q}$ of cutting though in practice to reach it inconveniently. In addition there are no changes of an intense condition in any point of a cutter and the wood having constant coordinates concerning mobile axes connected to a cutter.

There are fields of pressure and the deformations, caused by a cutter in wood, moves in it with speed of cutting. Any non-observance any of the general conditions of simple cutting complicates it. The degree of complexity depends on what conditions and in what amount is not observed.

Force $\mathbf{Q}$ is equal to the sum of projections to a direction of speed $\mathbf{v}$ of cutting of all normal and tangents of the forces working on surfaces of contact of a cutter and wood at cutting of a shaving.

Work of force $\mathbf{Q}$ is equal to the sum of works of all specified forces, named work of force of cutting. Force of cutting is included into the formula on which expect the power $\mathbf{N}$ (expressed in W) spent on cutting of a shaving:

$$N = Q \cdot v = K\, s\, v = K\, V_s \,, \tag{1}$$

where

$Q = K\, s$	- force of cutting, N;	(2)
$K = \dfrac{Q}{s}$	- specific force of cutting, N/ mm²;	(3)
$s = b_c e$	- the area of across section, mm²;	(4)
$V_s = s\, v$	- frequency of volume of the cut off shaving, cm³/s;	(5)
$K_s = \dfrac{N}{V_s}$	- specific work of cutting, J/ cm³;	(6)

$$Q_s = \frac{Q}{b_c} = K\,e$$

- specific force of cutting on unit of length of a cutting edge, N/mm. (7)

If speed of cutting is not known, but the design length $\mathbf{L}$ of the shaving equal to moving of a cutter is determined, the work $\mathbf{A}$ (expressed in J) spent on cutting, is calculated under the formula

$$A = Q \cdot L = K\,s\,L = K\,V = Q_s b_c L > \qquad (8)$$

which is received with replacement speed v in the formula (1) with parameter $\mathbf{L}$ expressed in m. Here the volume $\mathbf{V}$ of a shaving is expressed in cm³.

There are formulas (3) and (6) specify, that the parameter $\mathbf{K}$ has two various dimensions. The numerical solution of parameter K at chosen of other parameters above in formulas (1) and (8) is analogical, therefore these dimensions it is necessary to observe always. Two above-stated formulas are received by consideration of the general circuit of cutting of one shaving. But they can be used in all cases of cutting on machine tools.

At simple cutting by each cutter, the work spent on cutting off one shaving, pays off under the formula (8). There is number $\mathbf{n}$ of shavings per second, cutting off. We count up the total length $L = \sum_{i=1}^{n} L_i$ of shavings and volume $V_s = e\,b_c L = e\,b_c v$. It is equal to volume which is included into the formula (1) and the formula can be used for calculation of capacity $\mathbf{N}$ of cutting.

3. Solving of cutting process

If there is common cutting, $\mathbf{K}$ is a constant. When cutting is complex, one or several conditions of cutting vary continuously, and therefore parameters $\mathbf{K}$ and $\mathbf{Q}$ are variables. The work spent on cutting of a shaving in length $\mathbf{L}$ in this case, we determine under the formula

$$A = \int_0^L Q\,dx\,, \qquad (9)$$

where $L > x > 0$.

At the constant sizes of the area of across section of a shaving the formula (9) can be written down as

$$A = s\int_0^L K\,dx\,, \qquad (10)$$

where $K = f(x)$.

Calculation of force and the capacity, spent on cutting, in this case is possible, if parameter $\mathbf{K}$ during each moment of time is known. There is definition of parameter $\mathbf{K}$ under various conditions of cutting – one of the primary goals of theoretical and its experimental studying. It is necessary to note, that theoretical definition of parameter $\mathbf{K}$ is difficult, especial when at cutting one shaving its thickness and a direction of speed of cutting varies. Therefore it is necessary to use more experimental methods and means of definition of average of parameter $\mathbf{K}$ at any process of cutting of wood. It enables to write down the formula (10) as

$$A = s\int_0^L K\,dx = s\,K_a L\,. \qquad (11)$$

Then the capacity spent on cutting, can be determined under the formula (1) which have been written down as

$$N = K_a V_s\,. \qquad (12)$$

Last two formulas show, that for calculation of capacity $\mathbf{N}$ of cutting it is necessary to know value of $\mathbf{K_a}$. For this purpose at carrying out of experiences directly measure parameters $\mathbf{e}$, $\mathbf{b_c}$, $\mathbf{L}$, $\mathbf{A}$ and $\mathbf{N}$, then under formulas (11) and (12) is calculated $\mathbf{K_a}$. Received values of $\mathbf{K_a}$ we systematize and it is used as known for calculation of parameters $\mathbf{A}$ and $\mathbf{N}$. Accuracy of their calculation as more, as conditions of the given task from conditions at which the parameter has been received less differ.

In handbooks average values of parameters of specific work (or cutting) are usually given - together $\mathbf{K_a}$ is written $\mathbf{K}$.

As a result of cutting wood the surface formed at cutting by a cutter of a shaving turns out. A cutting cutter is not a plane, but a wedge creating in wood fields of pressure and deformations down to destruction /4/. The surface of cutting with a natural roughness can be received, if the field of deformations and destructions is limited only to volume of a shaving. Such organization of cutting is connected to significant difficulties; therefore in most cases the roughness of a surface of cutting is more. It especially concerns to formation of a face surface, normal to an axis of a tree trunk. Under such surface are formed not only residual deformations, but also destructions as deep cracks. Requirements to quality of a surface of cutting depend from conditions further use of half-finished product (detail).

4. Conclusion

In the conclusion it is necessary to note the conditions influencing on power and quality of cutting. It is necessary relate to the basic variable conditions of cutting: a structural formation of wood, physic mechanical properties of wood, the form of a cutter and structure of its surfaces (sides), an arrangement of a cutter concerning the basic directions of a tree trunk, value and a direction of movement speed of a cutter concerning the same directions, the form of a shaving and the sizes of its across section.

Any change of conditions (modes) of cutting influences change of force $\mathbf{Q}$, specific work $\mathbf{K_s}$ and specific force $\mathbf{K}$, and also parameters of quality of a formed surface.

5. Literature

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