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МАШИНОСТРОЕНИЕ И ТЕХНОСФЕРА XXI ВЕКА

Сборник трудов

XIII
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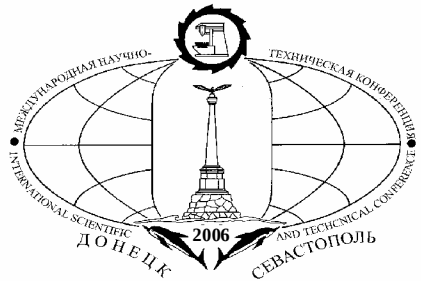
Том 4

11-16 сентября 2006 г. в городе Севастополе



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В сборник включены материалы XIII международной научно-технической конференции «Машиностроение и техносфера XXI века», отражающие научные и практические результаты в области обработки изделий прогрессивными методами, создания нетрадиционных технологий и оборудования. Представлены современные достижения и перспективные направления развития технологических систем, металлорежущего инструмента и оснастки. Освещены современные проблемы материаловедения в машиностроении. Рассмотрены вопросы механизации и автоматизации производственных процессов, управления качеством и диагностики технических систем. Приведены сведения об особенностях моделирования, экономических проблемах производства, вопросах инженерного образования и других актуальных проблемах техносферы.

Предназначен для научно-технических работников, ИТР и специалистов в области машиностроения и техносферы.

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SCALY ARISING IN BROACHING PROCESS

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Process of formation scaly in broaching processes is characterized by geometrical parameters of the broaches and cutting speed. There are offered physical explanations of scaly arising and results of metallographic research. The roughness forms of surface and its quality is estimated too. Influence of conditions on geometrical parameters of surface and quality of processed surface are considered.

Introduction

Plastic deformation and a metal collapse conditions in cutting zone affect the process of quality upper layer formation. That depends on treatment various roughness forms of surface are developed. Roughness of surface has influence on the wear of equipments parts, the friction and stability of tools. There is taken into consideration mutual disposition of forms classifying roughness by its types. Roughness of surface has characterized by some types of roughness complexes with regular recurrence.

Having treatment via cutting speed about 1..12 m per minute on hardly workable surface of blank the scales and duplicate roughness of cutting edge micro relief are arisen. There is chance to reduce roughness enlarging cutting speed up to 12..50 m per minute. By treating steels the scaly as product of decay of tool built-up edge is one of roughness basics. That is

why research of scaly arising by metallographic method has been provided with great attention.

Conditions of research

Rules of scaly arising on surface were explored in order of rake angle value (10º..20º), cutting speed (1..10 m/min) and a thickness of cut layer (0,02..0,60 mm). There was taken a steel P18 and P6M5 as the material of broach. Cutting process was performed with and without using a coolant.

Scaly of surface is product of periodical collapsed tool built-up edge base. Thereby it is observed arising of two type scales – normal scales and maximal scales. Last type of scale has greater height and size. On workable surfaces both types of scales arise in such way: at first the couple of normal scales arise, after that maximal scale and so on.

In process of tool built-up edge shaping cutting layer is broached under the angle ψ against geometrical cutting line. As result the metal layers that are cut extra passes into chip and built-up edge increasing its amplitude and amount of foot. That in other turn is promoted increase of force arising at action of entrance built-up edge in blank with periodical collapse its base. Effect of such collapse is normal scales. Each of next scale top is settled below geometric cutting line. This feature of built-up edge base collapse and cut off layer conduction set increase of built-up edge and amplify resistance of penetration in the blank. A slice of built-up edge is separated from direct part by geometric cutting line or under it and stay on processed surface as maximal scaly.

Physics of process and calculus

On foot of material disjoining maximal scales are coming up in form which is alike with the cutting tooth of broach. (Fig. 1). Such analogy has physical meaning too, if there are took into account contact of machines friction pair when as result of micro cutting scales there are removed metal layers from conjugate surfaces calling out greater wear-out. In accordance with that the surfaces of scales are divided as rake surface 1, flank surface 2 and back surface 3. The rake surface is part of built-up edge flank surface before scale is separated. The flank surface of built-up edge is as an area on which built-up edge collapse was happened. The back surface is formed during disjoining a removed layer from blank under angle ψ against geometrical cutting line. The flank angle of scale against that line is equal nil or near them.

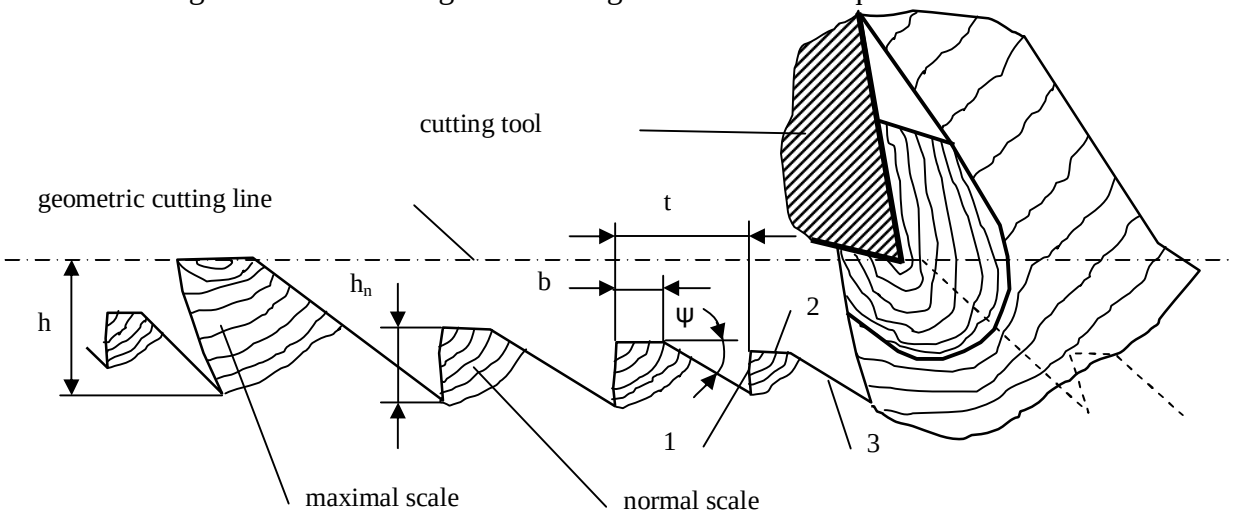

Fig.1. Arising scales and its schema of mutual disposition.

There are offered primary scaly character values:

- t –step of normal scales, distance between tops of two immediate normal scales gauged into the broach movement direction;
- ψ – the back angle of scale anent geometric cutting line;
- h_n – height of normal scale;
- h - height of maximal scale;
- b – length of top of scale.

There are calculated some of pointed character values with presumption that step t is equable for every case of scaly which is under consideration. It is presumed that the flank angle of maximal scale as a normal scale conform to geometric cutting line. As mentioned above the flank surface of normal scale is displaced below identical flank surface of previous scale for value

$$\Delta \mathbf{h}_{\mathbf{n}} = \frac{\mathbf{h} - \mathbf{h}_{\mathbf{n}}}{\mathbf{n}}, \tag{1}$$

where n – number of normal scales between two maximal scales.

Distance between geometric cutting line and the flank surface of normal current scale is calculated as follows

$$\mathbf{h}_{\mathbf{i}} = \frac{\mathbf{h} - \mathbf{h}_{\mathbf{n}}}{\mathbf{n}} \cdot \mathbf{n}_{\mathbf{i}}, \tag{2}$$

where n_i - number of scales order in cutting direction.

The angle ψ is determined from an orthogonal triangle, where one cathetus is $\mathbf{h}_{\mathbf{n}} + \frac{\mathbf{h} - \mathbf{h}_{\mathbf{n}}}{\mathbf{n}}$, but other $\mathbf{t} - \mathbf{b}$. As it is explored $\mathbf{b} = 0{,}2 \cdot \mathbf{t}$. Then

$$\mathbf{tg}\,\mathrm{y} = \frac{\mathbf{h} + \mathbf{h}_{\mathbf{n}} \cdot (\mathbf{n} - 1)}{0{,}8 \cdot \mathbf{t} \cdot \mathbf{n}}. \tag{3}$$

After rewriting formula (3), when n>1, height of normal scale is

$$\mathbf{h}_{\mathbf{n}} = \frac{0{,}8 \cdot \mathbf{t} \cdot \mathbf{n} \cdot \mathbf{tg}\,\mathrm{y} - \mathbf{h}}{\mathbf{n} - 1}. \tag{4}$$

If is not in action the micro polish, thickness of layer may be determined with metal layers cutting from a painted surface of the work piece sequentially until the paint is removed completely.

Total thickness of cut layer was recorded by the equipment of an indicator with value of point 0,002 mm.

I f the back angle ψ is presumed with mean value, formula (3) get simplified

$$\mathbf{h}_{\mathbf{n}} = 0{,}8 \cdot \mathbf{t} \cdot \mathbf{tg}\,\mathrm{y}. \tag{5}$$

Processing steel 10X17H13M3T the back angle ψ is considerably less (ψ=2,5º..3,5º) than for processing steel E295 (DIN EN 10025) (ψ=7º). Respectively, if steps is equal then height of scales is less on the surface of blank from steel 10X17H13M3T. Accordingly calculation of height h_n get easy because it is necessary to gauge the step t only.

Metallographic research

Types of roughness that are obtained by changing some parameters are shown in following table 1. Increasing rake angle a schema of changing scaly is same than schema at ψ=10º.

Table 1.Types of roughness of broaching surface.

Cutting speed v, m/min	Thickness of cut layer a, mm/tooth	Types of roughness
3	0,02..0,20 >0,20	moire scaly
5	<0,25 >0,25	scaly decrease scaly increase
7,5	<0,05 0,05..0,20 0,20..0,35 >0,35	scaly arising beginning scaly increase scaly decrease scaly disappearance
10	0,02..0,35	Scaly is away, on surface duplicate roughness of cutting edge micro relief arise

Results of metallographic research allow performing conclusions as follow about scaly influence on cutting process and shaping quality surface:

1. Scaly affect a wear of broach teeth and is one of the main reasons of changing upper layer physical and mechanical properties.
2. Remarkable hardness of scaly and its geometry promote more intensive wear of related surfaces, because its actual contact square is considerably less but actual load greater then calculated value.
3. Scaly reduce calculated interference of related surfaces and can change a type of joint.

Let us inspect a wear-out schema of the broach teeth (Fig. 2). It is presumed that scaly surface arises by cutting with roughing cut tooth of broach. Cutting conditions of the following tooth is different from cutting conditions of the previous tooth and depend upon scaly and thickness of cut layer. There are two cases by cutting scaly surface.

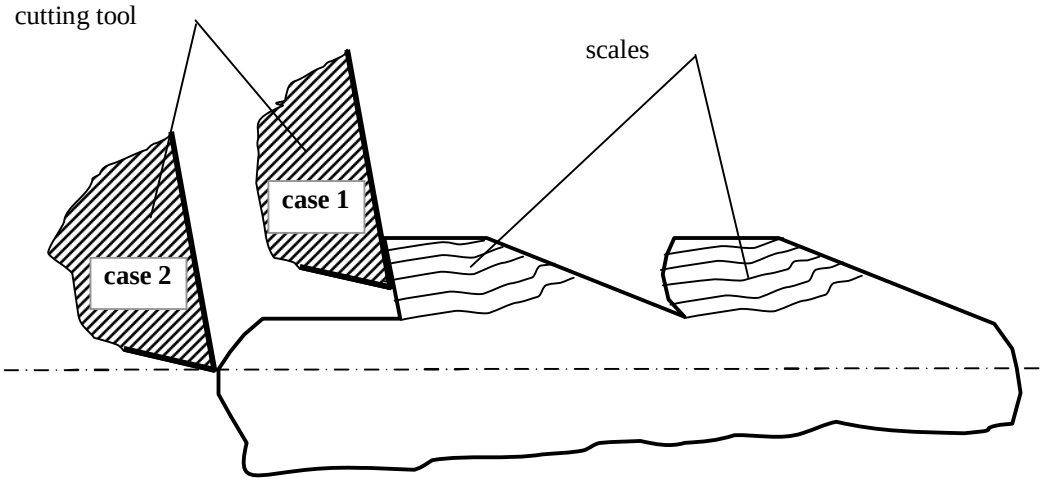

Fig. 2. Schema of scaly influence on the wastage of cutting tools.

In the first case flank of cutting tooth and cutting edge gets contact with scales having great hardness near hardness of built-up edge. Therefore a wear of teeth are intensive and its character is abrasive. Besides impacts can arise on time of cutting tooth edge contact with scales that multiply a wear of sintered-carbide teeth.

In the second case cutting edge of teeth get contact with treated material. The wear of teeth happens not so quickly, cutting force is greater than in the first case and it is why the square of cut layer is greater then in scales scission.

So long as thickness of cut layer increases, strength of broach grows because its teeth work in a blank material. If the thickness of layer is less then the height of scales cutting happens at its foot or along the top with calling an extra tool wear. As result of presentment previously scaly arises in definite range of cutting speed and removing layer thickness.

Conclusion

If there are considered analysis of a roughness zones in conclusion it is necessary to note:

1. increasing the rake angle (γ till 20º) and using a liquid of cooling scaly is decreasing;
2. increasing the thickness of cut layer, primarily cutting speed grow at which scaly is disappearing, but after that growth is dropping off;
3. scaly does not appear on the processed surface at definite ratio of cutting speed (5..12 m/min), thickness of the cut layer (0,02..0,35 mm) and the rake angle of the cutting teeth of broach (10º..20º).

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