УДК 621.9.01 **doi: 10.20998/2078-7405.2022.97.05**

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CALCULATION OF SHEAR ANGLE WHEN CUTTING WITH A TOOL OF A NEGATIVE RAKE ANGLE

Abstract. *The article considers the results of the study of the cutting process in order to obtain the calculated dependences of the shear angle oF the physical and mechanical properties of hard-worked iron-carbon steels and alloys in thermobaric conditions of the cutting process and the value of the negative rake angle which is a typical tool for processing with polycrystalline superhard materials (PSHM) cutting tools. When cutting, the formation of chips occurs in the plastic flow of metal in the area of cutting or fracture with the formation and subsequent development of cracks and the subsequent separation of elemental or stepped chips. A well-known chip shaping scheme with one plane shift and the value of the contact area of the front surfaces of the cutting elements with the allowable material to be removed are used to describe the contact phenomena in the chip forming zone and calculate the shear angle in this plane. It is established that the inverse relationship between the shear angle and the negative rake angle of the cutting element indicates that the increase in the negative value of the rake angle leads to a decrease in the shear angle. The specific elongation and shortening of the processed material at the cutting temperature are defined by the authors as the characteristics of shear plasticity and selected for use in the calculation of the values of shear angles during blade processing. As a result of this work, the calculated dependences of the shear angle values on the physical and mechanical properties of heavy-duty ferro-carbon steels and alloys in thermobaric conditions of the cutting process and the value of the negative rake angle, which is characteristic of machining with tools of PSHM equipped.*
Keywords: *cutting process; rake angle; chip shrinkage; iron-carbon alloys; relative plastic characteristics; shear angle.*

Introduction. In single point cutting with chip removal: milling, turning or boring, drilling, drawing, etc., the characteristics of both cutting and machining materials are important, and most importantly – their ratio. In the case of milling or interrutting turning, there are also impulse loads on the cutting edge. However, the basis for understanding the process of chip formation, stress-strain state, the load on the cutting edge in any method of machining are natural processes occurring in the cutting zone.

Depending on the ductility of the metal during cutting, the formation of chips occurs in the plastic flow of metal in the zone of cutting or destruction with the formation and subsequent development of cracks and subsequent separation of elemental or stepped chips [1, 2].

Known methods for assessing the nature of deformation in the cutting zone can effectively solve the problem of deformation-stress state, but this is not always enough to fully disclose the physical nature of phenomena and quantify processes [3–5].

One of the main provisions of the science of metal cutting is the dependence of chip shrinkage on the degree of deformation of the layer of allowance material. Chip shrinkage is one of the main characteristics that allows to recognize the phenomena in the cutting zone, to make numerical calculations using this indicator [2].

However, it is well known that measuring the length and width of chips, weighing them and obtaining the final results of calculations of the actual values of shrinkage of chips are high complexity, have significant errors and are extremely inconvenient in practice in research and industrial production.

It is especially difficult to obtain the value of chip shrinkage in the formation of elemental and articular types of chips, the total length of which is almost impossible to determine without errors [1].

Using the well-known chip shaping scheme with one plane shift and knowing the contact area of the front (rake) surfaces of the cutting elements with the allowable material to be removed, we can describe the contact phenomena in the chip formation zone and calculate cutting forces [3]. As is known [6], the separation of the metal occurs in the cutting zone, where it received a final deformation, which is extreme, and if the tension is equal to the ultimate strength of the compacted metal.

When in contact with the rake surface of the cutter, the stress in the chips will also reach its limits. The author [7] believes that chips are formed as a result of the occur and development of cracks in the immediate vicinity of the cutting edge of the tool.

The aim of this work was to obtain the calculated dependences of the shear angle values of the physical and mechanical properties of heavy-duty iron-carbon steels and alloys in thermobaric conditions of the cutting process and the value of the negative rake angle, which is a typical tool for processing, equipped with polycrystalline superhard materials (PSHM).

Research methodology. In fig. 1 shows a textured chip root – a micro section of the chip-forming element, the texture of which depends on the location in the cutting zone.

The direction of the texture leads to the end of the plane in which the metal is extremely hardened and subject to shear, which separates the allowance material and turns it into chips.

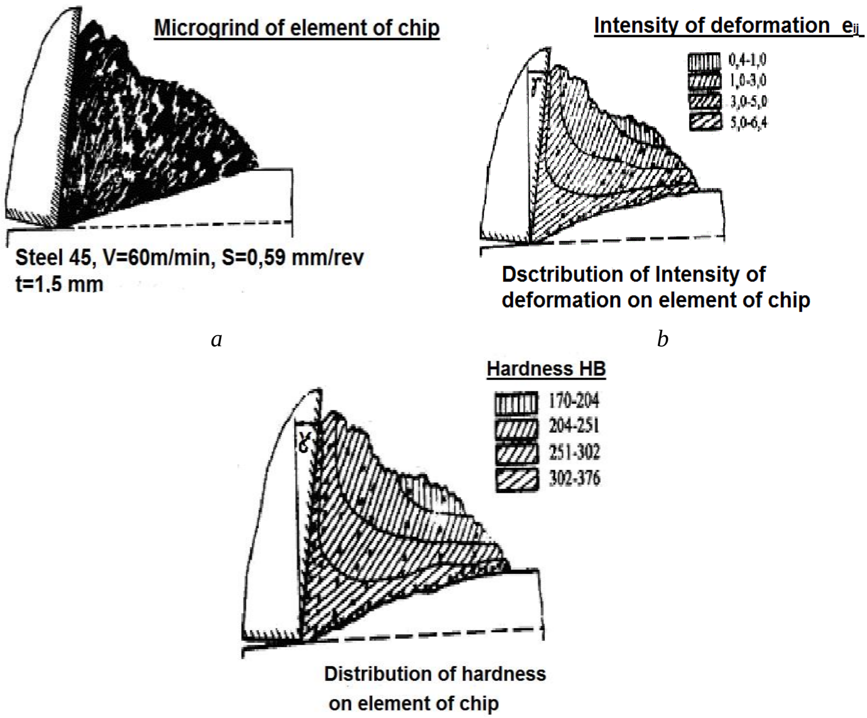
The consequence of the contact interaction of the chips with the rake surface of the cutter is additional heating of the chips due to its friction on the front surface of the cutter and internal friction and subsequently the texture of softened chips already formed by the rake surface of the tool and the internal friction of the chips [9].

There are several modern models of the deformation zone during turning, both with one and with several shear planes, which reflect the process of chip formation as a result of plastic deformation shear of the allowance material.

Conditionally, according to the limit values of fluidity and strength, ferrocarbon materials can be divided into highly plastic at $\sigma_т(\sigma_{0,2})/\sigma_в$ = 0,45–0,55; plastic at $\sigma_т/\sigma_в$ =

0,55–0,70; σ_T/σ_B = 0,55–0,70; low-plastic, having a ratio of σ_T/σ_B = 0,70–0,90 and brittle, which practically do not correlate with each other [10].

Despite the fact that the model with a developed deformation zone looks more realistic, analytical studies using models with a displacement in one plane have a fairly complete view and when using high-speed turning and milling finishes are still more acceptable. This is especially evident when working with brittle and low-plastic materials [1].



a *b*

c

Figure 1 – Micrognd of a detachable chip element with the formed texture and hardness of the chip element [8]

Images of the deformation zone, the corners of the texture of the root chips with their measured values are shown in fig. 2, which shows a cutter with a zero rake angle that was used during processing.

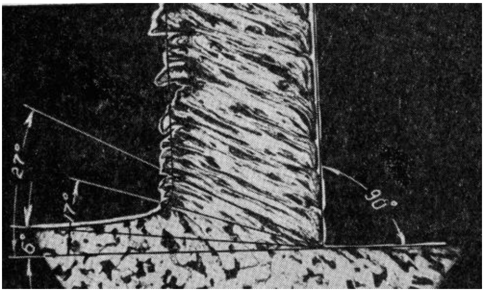


Figure 2 – Image of the boundaries of the deformation zone in the formation of chips and the angle of the texture when free rectangular cutting of steel 20H; velocity v = 0,7 m/min, slice thickness a = 0,065 mm [2]

Numerous microgrinds that reveal the texture of the shear line that passes to the chips, as best described in [2]. The sequence of deformation of the allowance and the formation of the chip element, when processing steel type 20H in the records, high-speed film camera with a frequency of 1500 frames per second are shown in fig. 3.

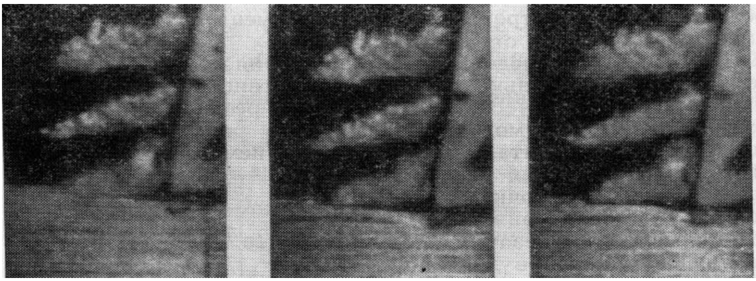


Figure 3 – The sequence of formation of elements of chips and textures with a frequency of high-speed filming of 1500 frames per second when processing cold-formed steel type 20G. The thickness of the cut is 0,25 mm

According to these indicators, almost all hardened steels, bleached and high-alloy cast irons, heat-resistant and similar alloys should be classified as low-plastic materials.

High-speed turning, shown in fig. 3, orthogonal rectangular free cutting of steel type 20H with a cutting speed of 40 m/min and a cut thickness of 0,25 mm, allowed to trace the main sequences of the chip formation process. At the stage of formation of the chip element in the material to be separated, the texture lines are visible and more clearly observed in the individual chip elements. In this case, the direction of the shift lines is the same. As long as the normal stresses in the elementary volume of the deformable material are balanced by tangential stresses on the rake surface of the cutter, movement does not occur, the allowance material is plastically deformed and applied to the rake surface of the cutter, but not yet separated in the form of chips. As soon as the compressive stresses reach the strength of the material, the deformed allowance material is shifted along the shear lines forming a texture, moved along the rake (front) surface of the cutter and then separated as a chip element. [10].

As rightly insisted [12], the force of chip formation during cutting initiates significant compressive stresses and, as a consequence, elastic-plastic deformations of the metal to be cut, followed by plastic shear.

Consider a modified negative front angle Merchant scheme [1], which illustrates the relationship between the cutting angle, shear angle and rake angle of the cutter, as well as the thickness of the cut in orthogonal rectangular cutting, as shown in fig. 4.

Taking into account the fact that the displaced metal is of constant density and neglecting lateral deformations across the width of the section, the condition of continuity can be represented in equal volumes of derived metal before its deformation and deformed immediately before its shift [13].

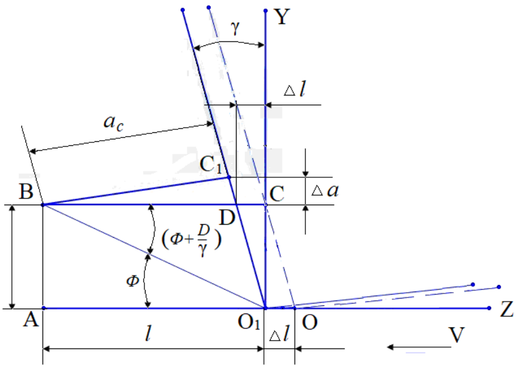


Figure 4 – Scheme for determining the relationship between the shear angle, the front angle of the cutter, the thickening and shortening of the allowance metal, which is deformed during chip formation; Δa – thickening of the metal along the thickness of the cut; Δl – shortening of the metal along the length of the cut

Assuming the constancy and invariance of the cut width and taking into account the constant density of the metal passing into the chips, we can proceed to the equality of the planes of quadrilaterals OABC and O_1ABC_1.

The area of the OABC quadrilateral will be

$$S_{OABC} = a \cdot l + 0{,}5a \cdot \Delta l \cdot \tag{1}$$

And the area of the quadrilateral $O_1ABC_1$is equal to

$$S_{O_1ABC_1} = S_{O_1ABC} + S_{DBC} - S_{DBC_1} \cdot \tag{2}$$

The area of a rectangle and triangles together will be equal to:

$$S_{O_1ABC_1} = a \cdot l + \frac{0{,}5 \cdot \Delta a \cdot l \cdot \cos(\Phi + \gamma)}{\cos\gamma \cdot \cos\Phi} - 0{,}5a \cdot \Delta l \cdot \tag{3}$$

After reduction we have

$$\frac{0{,}5l \cdot \Delta a \cdot \cos(\Phi + \gamma)}{\cos\Phi \cdot \cos\gamma} = 0 \cdot \tag{4}$$

After revealing the sum of angles and transformations, we have

$$\frac{\sin\Phi \cdot \sin\gamma}{\cos\Phi \cdot \cos\gamma} = 1 \tag{5}$$

or

$$tg\Phi = ctg\gamma \tag{6}$$

As shown in fig. 3 and 4, subject to continuity will be the following

$$\frac{a}{l} = \frac{\Delta a}{\Delta l} = tg\Phi \tag{7}$$

From the resulting equation (6) the obvious inverse relationship between the shear angle and the negative rake angle of the cutting element indicates that an increase in the negative value of the front angle leads to a decrease in shear angle, ie, assuming that the machined material is completely plastic and there is no friction on the surfaces in contact with the cutting tool, if there was a zero front angle, the deformation of the section thickness would reach infinity and stresses on the thickness and length of the section would be equal when assigning the rake angle $\gamma = 45°$.

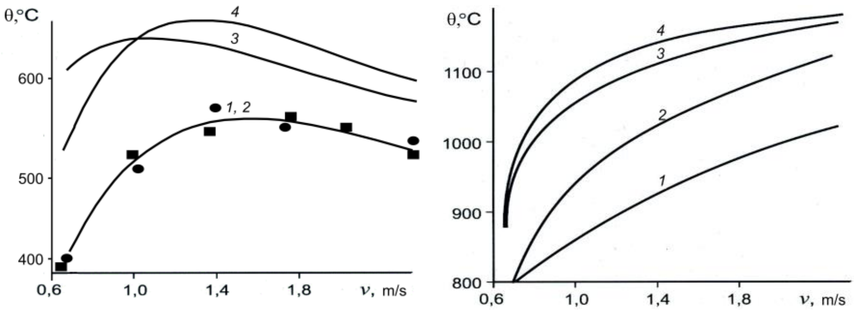
However, structural and tool materials are not ideal and have certain properties that are manifested in their plastic deformation, including milling in high temperatures.

There are many studies of the characteristics of materials at temperatures close to the turning temperature results. These data are contained both in the standard documentation for most steels and alloys (state standards, specifications) and in numerous references.

But it is extremely difficult to determine the actual local temperature in the contact zone during turning, drilling or milling. Heat release is the result of deformation in the cutting area, as well as the friction of the cutter tooth against the rear surface and the chips running on the rake surface of the cutting element.

Direct methods of measuring the temperature in the area of the shear zone estimate the temperature values depending on the temperature of the workpiece, chips and tool is too inaccurate, because in this case there is a fairly high temperature gradient. There are modeling methods for determining the temperature in the deformation zone, based on the similarity theory proposed in [12].

Fig. 5 shows graphical images illustrating the dependence of temperature in the movement zone and the temperature on the front surface of the cutter depending on the cutting speed of different tool materials by complex criterion *F* taking into account the effect of tool geometry and thermal conductivity ratio of tool and workpiece material.



a *b*

Figure 5 – Dependence of the temperature in the shear plane (*a*) and the temperature on the front surface of the cutter (*b*) on the cutting speed [10]

The study shows that the temperature on the rake surface of the cutting element varies from 800 to 1200 °C (depending on the tool used) and the shear temperature at the optimum cutting speed of the tool – from 500 to 700 °C, and for the type of polycrystalline cubic Boron Nitride (PcBN) cyborite – narrower range from 500 to 550 °C [14].

Taking into account the relationship between longitudinal and transverse deformations in equation (7), based on the conditions of continuity (scheme in fig. 4), and analyzing the relationship between longitudinal and transverse deformations when testing the strength of machined materials, we can assume that longitudinal deformation Δl when cutting will be proportional to the relative narrowing δ, and the deformation in the thickness of the cut Δa is proportional to the relative elongation ψ in static or dynamic test, in addition, in a certain temperature range, these characteristics are almost identical [14]. In this case, equation (7) can be represented as follows

$$\frac{a}{l} = \frac{\Delta a}{\Delta l} = \frac{\delta}{\psi} = tg\Phi \tag{8}$$

Based on the scheme for determining the ratio of the thickness of the cut and the thickness of the chips depending on the value of the shear angle (fig. 4) we obtain: the equation (8) can be represented as follows

$$\frac{a}{\sin\Phi} \cdot \cos(\Phi + \gamma) = a_c \tag{9}$$

a – slice thickness; a_c – chip thickness.

The ratio of the thickness of the cut to the thickness of the chips will be the shrinkage of the chips

$$\frac{a_c}{a} = \frac{\cos(\Phi + \gamma)}{\sin\Phi} = \xi \tag{10}$$

Taking into account the dependence of the shear angle, friction angle and rake angle of the cutter according to Merchant's equation

$$\Phi = \frac{\pi}{4} - 0{,}5(\eta - \gamma) \tag{11}$$

or according to Oxley's equation:

$$\Phi = 50^0 - 0{,}8(\eta - \gamma) \tag{12}$$

we can find the friction angle for known values of the shear angle and the specified rake angle of the cutter.

The table shows the reference values of relative strain values at appropriate shear zone temperatures for some types of alloy and tool steels to be machined by cutting in the hardened state and calculated by the above formulas to determine chip shrinkage and friction angle. The obtained values of the shear angle are used when finding the friction angle by formulas (11) or (12).

The table summarizes the data obtained as a result of calculations according to the method proposed on the quantitative characteristics of shear angles, coefficients of friction and shrinkage of chips in the processing of typical representatives of hardened to high hardness low-alloy, medium-alloy, tool and high-alloy steels. Indicators of relative elongation and relative narrowing are given from the reference data of the properties of steels [7].

Fig. 6 shows graphs of the dependence of chip shrinkage from the hardness of the steel being processed and the cutting speed.

Table – Shear angles, friction angle, coefficients of friction and shrinkage of chips in steel processing

Steel brand		Test temperature, °C	Relative		Angle		Coefficient of friction μ	Shrinkage of chips ζ
			lengthening δ, %	narrowing ψ, %	shear angle Φ, degree	friction η, degree (γ = = –10°)		
Medium alloyed	20H	500	26	75	$19^0 07'$	$41^0 46'$	0,9105	2,67
		600	35	77	$24^0 34'$	$30^0 52'$	0,5977	1,99
		800	51	90	$29^0 02'$	$21^0 54'$	0,4090	1,60
	30H	600	32	90	$19^0 35'$	$40^0 50'$	0,8642	2,60
		650	35	90,5	$21^0 11'$	$39^0 48'$	0,8282	2,15
		800	48	79	$31^0 27'$	$17^0 06'$	0,3060	1,44
	40H	500	25	78	$17^0 46'$	$44^0 32'$	0,9838	2,90
		600	26	81	$17^0 48'$	$44^0 24'$	0,9850	2,90
		800	48	94	$27^0 48'$	$24^0 44'$	0,4606	1,70
	40HGN	500	25	78	$17^0 46'$	$44^0 32'$	0,9838	2,90
		600	27	85	$17^0 37'$	$44^0 46'$	0.9925	2,91
		800	57	96	$30^0 52'$	$18^0 16'$	0,3496	1,51
	12HN3A	500	26	75	$19^0 08'$	$41^0 42'$	0,8909	2,66
		600	35	65	$28^0 08'$	$23^0 42'$	0,4390	1,67
		700	43	67	$32^0 42'$	$14^0 36'$	0,2606	1,36
Tooi steels	ShH-15	614	13	37	$19^0 22'$	$41^0 04'$	0,8714	2,33
		650	14,5	48	$17^0 48'$	$44^0 24'$	0,9737	2,19
		695	21	50	$22^0 47'$	$34^0 26'$	0,6856	2,17
	U8A	500	40	77	$27^0 28'$	$25^0 04'$	0,4677	1,72
		600	48	85	$29^0 24'$	$21^0 06'$	0,3859	1,57
		800	58	100	$30^0 07'$	$19^0 46'$	0,3594	1,52
	U10A	500	38	77	$26^0 17'$	$27^0 26'$	0,5191	1,89
		600	46	85	$28^0 24'$	$23^0 12'$	0,4286	1,62
		800	52	100	$31^0 20'$	$17^0 20'$	0,3121	1,44
	U12A	500	32	68	$27^0 28'$	$25^0 04'$	0,4677	1,72
		600	44	82	$28^0 23'$	$23^0 14'$	0,4259	1,65
		800	52	96	$32^0 48'$	$14^0 24'$	0,2567	1,33
High alloyed	12H13	600	41	80	$28^0 17'$	$23^0 26'$	0,4338	1,66
		800	62	98	$32^0 19'$	$15^0 22'$	0,2748	1,38
	12H18N9T	650	17	43	$21^0 24'$	$37^0 12'$	0,7590	2,26
		800	24	51,5	$24^0 59'$	$32^0 02'$	0,6253	1,94

Chip shrinkage is calculated by equation (10).

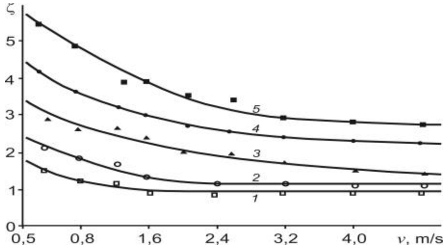


Figure 6 – Dependence of chip shrinkage on the initial hardness of the processed HVG steel and the cutting speed of PcBN ismit [13]: $\gamma = -5°$, $\varphi = 45°$, cutting depth $t = 0{,}2$ mm, feed $S = 0{,}084$ mm/rev; *1* – 61 HRC, *2* – 55 HRC, *3* – 45 HRC, *4* – 37 HRC, *5* – 23 HRC

Research results. If we compare the value of the texture angle shown in fig. 2, obtained by M. M. Zorev when turning steel 20H, with calculated data for this grade of steel, shown in the table, the arithmetic mean of the shear angle, calculated for the temperature in the conditional shear plane in the range from 600 to 800 °C, it almost coincides with that shown in fig. 2. As can be seen from fig. 5, the temperature in the conditional shear plane is in the range from 500 to 750–800 °C, and shown in fig. 6 dependences of chip shrinkage on the cutting speed when processing steels of high (curves *1*, *2*) and medium (curve *3*) hardness are just close to those calculated by formula (10) and are in the range of values from 2.5 to asymptotically close to one.

Thus, we have practically proven conclusions about the legitimacy of the application of the relative plasticity characteristics of the processed iron-carbon materials at a temperature equal to the cutting temperature to calculate the shear angle, which is an extremely important characteristic of the cutting process. Confirmation of this legitimacy are the approximate values obtained experimentally and calculated using the obtained values of the shear angles of the values of shrinkage of chips.

References: **1.** *Armarego, I. Dzh. A.* Obrabotka metallov rezaniyem / I. Dzh. A. Armarego, R. Kh. Braun. – Moscow. : Mashinostroyeniye, 1977. – 326 p. **2.** *Zorev, N. N.* Voprosy mekhaniki protsessa rezaniya metallov / N. N. Zorev. – Moscow. : Mashgiz, 1956. – 364 p. **3.** *Mazur, M. P.* Osnovi teoríí rízannya materíalív : pídruchnik / M. P. Mazur, Yu. M. Vnukov, V. L. Dobroskok ta ín. – L'vív : Noviy Svít-2000, 2010. – 422 p. **4.** *Chou, Y. Kevin.* Experimental investigation on CBN turning of hardened AISI 52100 steel / Y. Kevin Chou, Chris J. Evans, Moshe M. Barash // J. of Mater. Proc. Technology. – 2002. – № 124. – pp. 274–283. **5.** *Petrusenko, L. A.* Raschot napryazheniy, voznikayushchikh v opasnoy zone lezviynoy chasti rezhushchego instrumenta / L. A. Petrusenko, V. S. Antonyuk // Vísnik NTU Ukraïni «Kiïvs'kiy polítekhníchniy ínstitut». Mashinobuduvannya – Kyiv. : NTU Ukraïni «KPÍ», 2016. – Vyp. 77. – pp. 147–156. **6.** Fiziko-matematicheskaya teoriya protsessov obrabotki materialov i tekhnologii mashinostroyeniya : v 10 t. – T. 3 : Rezaniye materialov lezviynymi instrumentami / F. V. Novikov i dr. – Odessa : ONPU, 2003/ – 546 p. **7.** *Poletika, M. F.* Matematicheskoye modelirovaniye protsessa rezaniya / M. F. Poletika, M. G. Gol'dshmidt, Yu. P. Stefanov // Vopr. mekhaniki i fiziki protsessov rezaniya i kholodnogo plasticheskogo deformirovaniya : sb. nauch. tr. – Kyiv. : ISM im. V. N. Bakulya NAN

Ukrainy, 2002. – pp. 33–43. **8.** *Rozenberg, Yu. A.* Rezaniye materialov : ucheb. dlya tekhn. vuzov / Yu. A. Rozenberg. – Kurgan : Poligraf kombinat, Zaural'ye, 2007. – 294 p. **9.** *Ostaf'yev, V. A.* Fizicheskiye osnovy protsessa rezaniya. / V. A. Ostaf'yev, V. S. Antonyuk, S. P. Visloukh i dr. – Kyiv. : Vishcha shk., 1976. – 136 s. **10.** *Korolev, P. N.* Soprotivleniye materialov : sprav. po raschetno-proyekt. rab. / P. N. Korolev. – Kyiv. : Vishcha shk., 1974. – 288 p. **11.** *Novikov, N. V.* Raschet sily struzhkoobrazovaniya pri slozhnoprofil'nom tochenii reztsami, osnashchennymi kruglymi plastinami / N. V. Novikov, A. S. Manovitskiy, S. A. Klimenko // Nadezhnost' instrumenta i optimizatsiya tekhnologicheskikh sistem : sb. nauch. tr. – Kramatorsk : DGMA, 2008. – Vyp. № 23 – pp. 3–11. **12.** *Silin, S. S.* Metod podobiya pri rezanii materialov / S. S. Silin. – Moscow. : Mashinostroyeniye, 1979. – 152 p. **13.** *Polukhin, P. I.* Soprotivleniye plasticheskoy deformatsii metallov i splavov / P. I. Polukhin, G. Ya. Gun, A. M. Galkin. – M.: Metallurgiya, 1976. – 488 p. **14.** Sverkhtverdyye materialy. Polucheniye i primeneniye : v 6 t. / pod obshchey red. N. V. Novikova. – T. 5 : Obrabotka materialov lezviynym instrumentom / pod red. S. A. Klimenko. – Kyiv. : ISM im. V. N. Bakulya, IPTS «ALKON» NAN Ukraïni, 2006. – 316 p.

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РОЗРАХУНОК КУТА ЗСУВУ ПРИ РІЗАННІ ІНСТРУМЕНТОМ З ВІД'ЄМНИМ ПЕРЕДНІМ КУТОМ

Анотація. *У статті розглядаються результати дослідження процесу різання з метою отримання розрахункових залежностей значень кута зсуву від фізико-механічних властивостей важкооброблюваних залізо-вуглецевих сталей і сплавів в термобаричних умовах процесу різання та величини негативного переднього кута, що є характерним при обробці інструментом, оснащеним полікристалічними надтвердими матеріалами (ПНТМ). При обробці різанням, утворення стружки відбувається в пластичному потоці металу в зоні різання або руйнування з утворенням і подальшим розвитком тріщин і наступним відділенням елементної або ступінчастої стружки. Одним з основних положень науки про різання металів є залежність усадки стружки від ступеня деформації шару матеріалу припуску. Усадка стружки - одна з основних характеристик, яка дозволяє розпізнати явища в зоні різання, зробити числовії розрахунки з використанням цього показника, проте визначення дійсної довжини та ширини стружки, її зважування та отримання остаточних результатів розрахунків фактичних величин усадки стружки пов'язані з високою трудомісткістю, мають значні похибки та надзвичайно незручні при практичному застосуванні при проведенні досліджень та в промисловому виробництві, особливо - елементних та суглобистих типів стружок. Використана загальновідома схема формування стружки з одним площинним зсувом та значення площі контакту передніх поверхонь ріжучих елементів з матеріалом припуску, що підлягає видаленню, для надання опису контактних явищ в зоні формування стружки та розрахунку кута зсуву у цій площині. Встановлено, що наявнв зворотна залежність між кутом зсуву і негативним переднім кутом ріжучого елемента вказує, що зростання в негативному значенні переднього кута веде до зменшення кута зсуву, тобто, матеріал, підданий механічній обробці, не є ідеальним і має певні властивості, які проявляються при його пластичному деформуванні, в тому числі при фрезеруванні в умовах високих температур. Питоме подовження та вкорочення оброблюваного матеріалу при температурі різання визначені авторами, як характеристики пластичності при зсуві і обрані для використання в розрахунках значень кутів зсуву при лезовій обробці. Внаслідок виконання даної роботи було отримано розрахункові залежності значень кута зсуву від фізико-механічних властивостей важкооброблюваних залізо-вуглецевих сталей і сплавів в термобаричних умовах процесу різання та величини негативного переднього кута, що є характерним при обробці інструментом, оснащеним ПНТМ.*

Ключові слова: *процес різання; передній кут; усадка стружки; залізо-вуглецеві сплави; відносні пластичні характеристики; кут зсуву.*