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DEVELOPMENT OF CONTROL SUSPENSION OF ATTACHMENT OF A BULLDOZER

Abstract. Analysis of research in the field of improving the working equipment of the bulldozer showed that the applied kinematic schemes of the bulldozer attachments do not allow changing the cutting angles in accordance with ground conditions, in connection with which the possible reduction of soil resistance to cutting and energy consumption of earth-transport vehicles is not ensured. There is a methodology of settling the definitions of rational parameters of hanging equipment of bulldozer, which provides depth of the tool with the angle of cut α=55÷60° and is next automatical decreace till α=20÷25° at definite thickness of shavings, dependent on the category of cultivated soil. Change of angle of cut and its characteristics will be settled according to definite analytical dependence. It lowers the energy capacity to 8.1÷67.8% because of the increase of shaving thickness or rising the working speed and creates conditions for lowering the working expenditures 17.5%, the basic cost of works - 18.8%, specific investment of the machine - 15.6% and given expenditures - 18.5%.

Key words: bulldozer, suspension, knife, cutting angle, brace, ground.

Introduction. The bulldozer is a widespread earth-moving transport vehicle (EMM) due to its simplicity of construction, versatility and relatively low cost. To ensure the penetration of the blade into the ground, it is installed with a cutting angle of 55-60°, which reduces the resistance when buried, but creates additional resistance when cutting the soil. Improvement of the construction of the suspension of the working equipment (WE) of the bulldozer, which ensures the adaptation of its cutting angle in the process of digging, depending on the indices of the physical and mechanical properties of the soil and the operating mode, is a promising direction that increases the efficiency of EMM.

The creation of a suspension, which will ensure a synchronous change in the angle and depth of cutting, improves the technical and economic indicators and simplifies the construction of the WE bulldozer. Therefore, the rationale for the rational kinematic parameters of the WE suspension of a bulldozer with a variable cutting angle is an urgent task.

The purpose of the work is to increase the efficiency of EMM by reducing the energy consumption of the cutting process of soils by adapting the cutting angle when the blade is buried, taking into account the soil category provided by the parameters of the bulldozer's WE suspension [17,18].

Scientific novelty of work consists in justifying the parameters of the bulldozer RO suspension with synchronous change of the angle and depth of cutting, depending on the category of the ground being developed, which significantly reduces the energy consumption of the EMM [1,4,11].

Methods. The considered resistance to penetration of the bulldozer knife with a stationary machine. Deepening of the working body of the bulldozer into the ground is represented as pressing into an array of a stamp having a complex shape, on which the force developed by the drive mechanism acts. Under the action of the gravity of the working element and the force developed by the drive, a stress occurs in the soil massif on both sides of the knife edge (front and rear), the size and distribution of which depend on the load, the geometric parameters of the knife and the parameters of the soil. The forces acting on the edge of the knife with indentation are determined by the method of S.S. Golushkevich.

An increase in the cutting angle reduces the size of the projection of the implanted part of the blade to the horizontal plane, and, accordingly, reduces the area of contact with the ground and the volume of the prism of the bulging. As a result, the specific vertical pressure of the knife on the ground increases and its resistance to the introduction of the blade decreases. Consequently, the burial of the working body of the bulldozer into the ground with a stationary machine must be carried out with a large cutting angle.

Deepening the working body of the bulldozer into the ground while the machine is moving ahead of the cutting blade creates a strained ground condition on only one side, located in front of the knife in the course of travel. Therefore, the resistance to burial of the blade when driving the machine is less than when the machine is stationary. Thus, this allows the blade to be embedded in the ground with smaller cutting angles. From this it follows that the most rational trajectory of the working motion of the blade of the suspension to be investigated is the one that, at the moment of its introduction into the ground, the cutting angle has a maximum value and then decreases it, which is optimal by minimizing the energy consumption of the cutting process.

This can be realized by the WE suspension of the bulldozer with a hinged brace. When the blade is buried, the cutting angle in this case will automatically change, which will simplify the construction of the WE bulldozer and significantly reduce the fatigue of the driver. Reduction of the cutting angle when the blade of the bulldozer WE suspension is buried is determined by the coordinates of the points of attachment of the hinged brace to the tractor base and on the dump, the length of the splitting a and the depth of the dump, and does not depend on the parameters of the physical and mechanical properties of the soils [1,2,3,4].

The scheme [5,6,7,15] of the suspension of the WE bulldozer is represented in the form of a flat mechanism consisting of links connected by hinges. In this case, the suspension is a four-link shunting arm of the *ABCD* (figure 1, a) in the form of a closed four-link chain with one degree of freedom, in which the driving link *AB* (brace), the connecting rod *BC*, the distance between the points of fastening of the bracing and the pushing bar on the dump) and the fixed link *AD* distance between the points of attachment of the brace and the pushing bar on the base machine). In mechanisms with one degree of freedom, one generalized coordinate completely determines the position of all links of the mechanism. By changing the slope angle φ of the *DC* link, it is possible to determine the slope angle ψ of the department link *AB*, and also vice versa, knowing the position of the master *DS* and the follower AB links, determine the angle λ of the turn of the connecting rod link *BC*. For this purpose, in the scheme of the four-link mechanism we select conditionally the parallelogram *ABB'D*. From the *BCB'* and *DCB'* , by the cosine theorem we determine the length of the *CB*:

$$/CB'/ = L^2 + l^2 - 2Ll\cos\lambda\,; \quad /CB/ = R^2 + r^2 - 2Rr\cos(\varphi - \psi)$$

where L - is the length of the fixed link *AD*; l - length of the connecting rod of the aircraft; λ - is the angle of rotation of the connecting rod link *BC* to the fixed link *AD*; R - is the length of the *DC* link; r - length of the driven link *AB*; φ - is the angle of inclination of the *DC* link to the vertical axis; ψ - is the slope angle of the follower link *AB* to the vertical axis.

Equate the value $/CB'/$ and converting the resulting expression, we find the value of the angle λ:

$$\lambda = \arccos\left(\frac{L^2 + l^2}{2Ll} - \frac{R^2 + r^2}{2Ll} + \frac{Rr}{Ll}\cos(\varphi - \psi)\right). \quad (1)$$

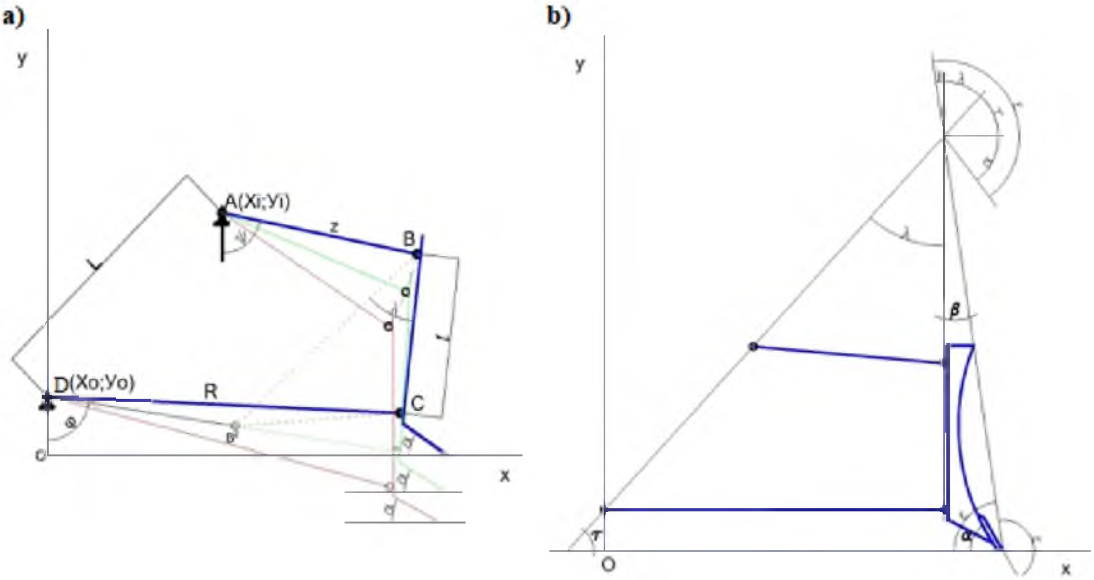


Figure 1 – Suspension scheme (a) with articulated luxury and determination of cutting angle (b)

The angle of rotation of the crank arm on the articulated four-link diagram corresponds to the angle of rotation of the blade of the bulldozer under actual conditions when its position changes.

The main angles $\lambda, \omega, \tau, \beta_0$, that characterize the suspension but also the structure of the dump will be transferred to the point O_1 of the intersection of the line connecting the points of fastening of the pushing beam and the brace on the base machine, with the line of fastening of the same elements on the dump (figure 1, b). The cutting angle will be:

$$\alpha = \omega - \beta_0 - \tau - \lambda, \tag{2}$$

where ω- is the angle between the line connecting the upper edge of the dump surface with the cutting edge of the blade knife and the dummy blade element, ω = 160°; τ - is the angle between the line connecting the points of fastening of the bracing and the pushing bar on the base of the tractor, and the horizontal axis:

$$\tau = arctg\left(\frac{Y_i - Y_0}{X_i - X_0}\right)$$

where X_i, Y_i - are the coordinates of point A; X_0, Y_0 - are the coordinates of point D; β_0 - is the angle between the line connecting the points of fastening of the bracing and the pushing beam on the dump, and the line connecting the upper edge of the dumping surface with the cutting edge of the middle knife blade, $\beta_0 = 19 \div 21°$.

We set the angles $\lambda, \omega, \tau, \beta_0$ in equation (2) and obtain:

$$\alpha = 141^{\circ} - arctg\left(\frac{Y_i - Y_0}{X_i - X_0}\right) - \arccos\left(\frac{L^2 + l^2}{2Ll} - \frac{R^2 + r^2}{2Ll} + \frac{Rr}{Ll}\cos(\varphi - \psi)\right). \tag{3}$$

The value of the cutting angle α in expression (3) is determined by the points of fastening of the brace on the base of the tractor and on the dump, i.e. the length of the brace, and also the depth of the blade (with the value of φ and ψ). Thus, the obtained expression makes it possible to determine the cutting angle of the WE bulldozer for all intermediate values (the thickness of the cut chips).

During the operation of the bulldozer, the soil resistance to digging is composed of the main parts: soil resistance *Wp*, resistance to movement of the chip along the blade *Wc* and resistance to movement of the prism of the inclusion *Wnp* [8,9,10,12].

$$W_k = W_p + W_c + W_{np} \quad (4)$$

Resistance of cutting the soil taking into account the cutting angle on the basis of the results of research by A.N. Zelenin and N.G. Dombrovsky looks like this:

$$W_p = K_a K_p bh \quad (5)$$

where K_α - is a coefficient that depends on the cutting angle; K_p - specific resistance to cutting; b - length of blade; h - depth of cut.

Based on the graph proposed by Yu.A. Vetrov, for describing the changes in the cutting force going to overcome the frontal resistance of the knife for different ranges of the cutting angle, expression (5) can be expressed by the following spline function:
at a cutting angle of 45° <α<60°:

$$W_p = K_p bh\left[1 - 0.033\left(60^0 - \alpha\right)\right] \quad (6)$$

at an angle of 37° <α<45°

$$W_p = 0{,}5K_p bh\left[1 - 0.029\left(45^0 - \alpha\right)\right]; \quad (7)$$

at a cutting angle of 20° <α<37.5°

$$W_p = 0{,}35K_p bh\left[1 - 0.019\left(37{,}5^0 - \alpha\right)\right]; \quad (8)$$

Forces to overcome the resistance to displacement of the prism of drawing is determined by the formula:

$$W_{np} = \frac{bH^2}{2K_{np}} p_{zp} g \mu_2 , \quad (9)$$

where g - is the acceleration due to gravity; H - blade height without visor; K_{np} - coefficient depending on the characteristics of the soil and the shape of the blade; ρ_{zp} - is the density of the groove; μ_2 - is the coefficient of internal friction of the soil.

Forces to overcome the resistance to movement of chips on the dump is determined by the formula:

$$W_C = \frac{bH^2}{2K_{np}} p_{zp} cos\alpha \left(\frac{\mu_1 + \mu_2}{2}\right) \quad (10)$$

where μ_1 - is the coefficient of external friction of the soil.

Thus, the components of the digging forces of the displacement of the prism and chips are approximately conserved on other soils. This is because the parameters of gravity and friction of loosened soils vary in relatively small limits. Only the cutting depth that the bulldozer can provide for pulling force is significantly changed.

Results. The results of experimental studies of the effect of attachment points and articulated brace on the cutting angle, depth of cutting and resistance to digging. Experimental studies were carried out for various variants of attachment of a hinged brace, one end of which is set from the top downwards along the height of the botulinum on its rear side (points 1,2,3,4,5,6,7,8 and 9). The other end is fixed on the tractor base: on the horizontal line from right to left on the side of the engine frame (points 1 ', 2', 3 ', 4', 5, 6 'and 7) or on the vertical line from the bottom up the side of the engine cooler (points 1", 2", 3", 4", 5", 6" 7"), while the points 3 and 3" are combined [7,8].

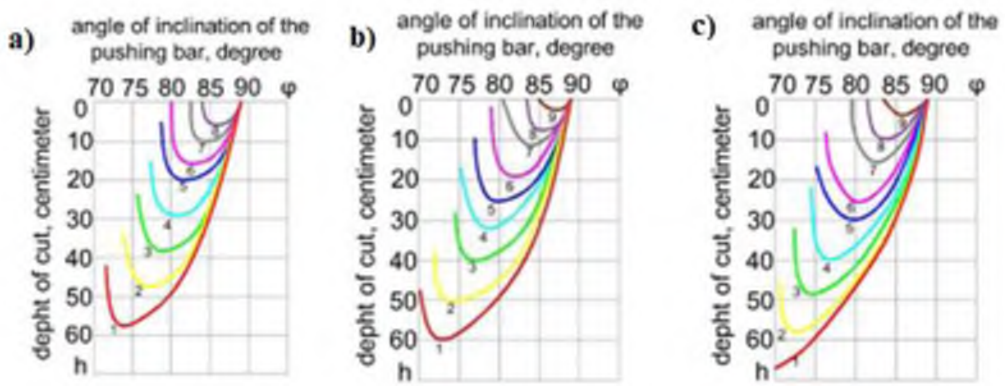
The change in the position of the suspension bracket WE when the dump is buried is accompanied by a change in the angle of the inclination of the pushing bar (figure 2).

The displacement of the pushing bar downward to a certain angle is accompanied by an increase in the cutting depth to a certain value, further angular displacement of the pushing bar is accompanied by a sharp turn of the blade, which leads to a deepening of its cutting edge and a decrease in the depth of cutting. Such a change in depth of cut is retained when the hinged brace is attached to the tractor base both horizontally and vertically. In both cases, the point of change in the cutting depth is characteristic, after which the cutting edge is deepened, is determined by the length of the brace. Its increase when moving the fixing point of the brace on the back of the blade from point 1 to point 9 leads to an increase in the thickness of the chips, at which a sharp turn of the blade occurs.

Processing of the results of experimental studies allowed to establish the maximum depth of cutting, at which the cutting edge extends depending on the parameters of the suspension, the RO bulldozer with a hinged brace:

$$h_{\max} = -1.6 \cdot 10^3 + 2.2 \cdot 10^{-4} \cdot L^2 + 5.009 \cdot 10^{-4} (l + r)^2 + 5.7824 \cdot 10^{-12} (l + r)^2 \cdot L^2 . \quad (11)$$

This dependence simplifies the calculation of the maximum depth of cutting of the bulldozer, since the value of the coordinated parameters is averaged. Therefore, the expression obtained can be used for any kinematic suspension parameters with a hinged brace [9,10].



a, b, c - attachment points on the side of the engine frame, respectively 5', 6' and 7'; 1,2,3,4,5,6,7,8, and 9 - points of attachment on the blade

Figure 2 – The relationship between the angle of inclination of the pushing beam and the depth of cut when the coordinates of the points of attachment of the hinged brace change

When the dump is buried, the enlarged pendant WE of the bulldozer increases the cut-off chips and reduces the cutting angle. When a certain critical depth of cut is reached, it begins to decrease with a leading tendency to reduce the cutting angle. The change in the depth and angle of cutting is determined by the coordinates of the points of attachment of the hinge brace (figure 3).

The suspension of the bulldozer WE controls the spatial movement of the blade with simultaneous changes in the depth and angle of cutting. This leads, in turn, to a change in the resistance to cutting, the movement of chips along the dump surface, the displacement of the prism of drawing, and the resulting resistance to digging. Therefore, the evaluation of the effectiveness of the coordinates of different points of attachment of the hinge brace can be carried out only from the standpoint of energy indicators. In this regard, consider the emerging resistance when using the bulldozer's WE suspension and changing the coordinates of the points of attachment of the hinged brace for I, II, III and IV soil categories.

As a result of the processing of the machine experiment, the equation of regression of resistance to cutting of soil of the first category, in kN:

$$W_p = 10{,}193 + 328{,}33\alpha h \quad (12)$$

The graph of this dependence for various attachment points of the hinged brace is shown in figure 5 from which it is evident that when the blade is lowered, an increase in chip thickness results in an increase in the cutting resistance to a certain depth, further lowering of the blade results in its intensive rotation, which is accompanied by a deepening of the cutting edge with a sharp decrease in the cutting angle. As a result, the resistance to cutting is reduced and its dependence on depth in graphical form is expressed in the form of a loop.

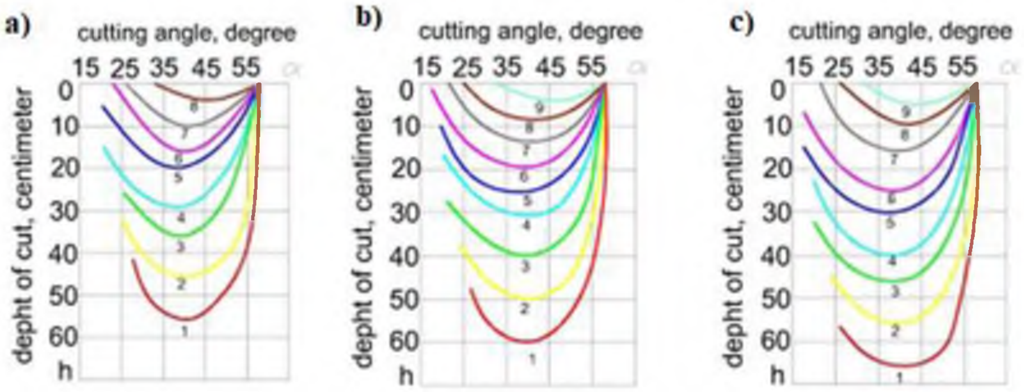
The resulting resistance to cutting is not the determining energy indicator of the process of soil development, so it is advisable to analyze the total resistance to digging. The nature of the change in resistance to digging for I, II, III and IV soils is similar to the described dependence of the change in the cutting force, and the absolute values increase. Because the power plant power of a particular basic machine.

Constant, then increasing the emerging resistances digging the ground leads to a decrease in chip thickness. From this it follows that it is necessary to find the position of the coordinates of the points of attachment of the hinges of the brace, which would satisfy the requirements of all categories of soils.

Analysis of the influence of the coordinates of the points of attachment of the hinged brace on changes in the angle and depth of cutting, resulting in the resistance to cutting and digging, showed the multiplicity of solutions to the variants of the brace. The category of soil affects the location of the brace, for practical conditions it is necessary to have a minimum number of permutations of the brace on the blade and the base tractor. The processing of experimental data by mathematical statistics allowed us to establish the relationship between the parameters of the WE suspension of a bulldozer with a variable cutting angle and digging resistance for I-IV soil categories, which has the form in kN:

$$W_к = 27{,}17 + 5{,}21 K_p \alpha h \qquad (13)$$

This dependence makes it possible to determine the resistance to digging with a variable cutting angle depending on the kinematic parameters of the bulldozer's WE suspension. It is valid for any suspension parameters.



a, b, c - attachment points on the side of the motor frame, respectively, 5', 6' and 7'; 1,2,3,4,5,6,7,8 and 9 - fixing points on the blade.

Figure 3 – The relationship between the angle and the depth of cut when changing the coordinates of the hinge brace

Increasing the thickness of the chip to be cut increases the resistance to digging, the rate of increase is somewhat lower than that of chip thickness, due to the reduction in the cutting angle. So, for example, when one end of the brace is set at point 7 and the other end of the brace is moved from point 6 to point 3, the maximum depth increases from 25 cm to 47 cm, i.e. 1.88 times, and resistance to digging increases in this case for the I category from 62 kN to 105 kN (1.69 times), for the IV category from 229 kN to 373 kN (1.63 times). This leads to a disproportionate distribution of the cost of resistance to digging for 1 cm of the thickness of the cut chips.

In real conditions, the thickness of the chips cannot increase indefinitely, since the power of the power plant of a particular tractor is constant, assume that the pulling force of the basic T-130 tractor is fully realized on digging the soil, on the basis of this assumption, we determine the maximum possible depth and resistivity for digging for different variants of points fixing the brace taking into account the soil category [13,14,15,16].

Analysis of the variants of the braces with the minimum values of the resistivity to digging shows that the braces with fastening along the vertical line of the base tractor have higher specific indicators. This indicates that in these cases, the suspension does not ensure proper minimization of the cutting angle, which leads to higher values of the resulting resistances. Therefore, such options for fastening the hinge brace are excluded from further analysis.

To assess the effectiveness of the adopted options for fastening the hinged brace, we determine the deviation from the best value of the energy index and the depth of digging. With a pulling force of 100 kN for the 1st category of soil, the minimum value of the specific resistance to digging and the maximum chip thickness is provided by the variant of the brace 7'-4. Recommended brace 5'-3, which increases energy consumption by 9.3% and reduces the maximum depth by 12.5%. For category II, the best option is the

6-6 variant of the brace, the recommended option for paccos 5'-5 raises energy costs by 0.4%, but increases the maximum depth by 5.3%. For category III, the best value corresponds to a brace - 4'-6, the recommended brace 5'-7 raises energy consumption by 3.1% and reduces the maximum depth by 9.1%. The greatest deviation corresponds to the IV category of the soil, because the chip thickness is small (5 cm) and its deviation even by 1 cm is expressed by a large number of percentages

Comparative analysis by the energy cost criterion and the maximum digging depth of the most effective variants of attaching the hinged brace and the unified recommended version of the brace shows that the deviations are within the accuracy of the engineering calculation.

Reducing the cutting angle with the burial of the dozer blade reduces the digging resistance, which allows increasing the thickness of the cutter chip at a constant power of the base tractor engine or increasing the cutting speed of the ground. In both cases, the productivity of the proposed equipment is increased in comparison with the basic cutting angle 55^0.

Changes in the productivity of the proposed basic equipment - DZ 27C (table 1) in the construction of the embankment of a 1.0 m high road in real conditions of the WE bulldozer suspension in comparison with the base leads to an increase in productivity for the 8.1 and 13.2%, respectively, of the I-II ground categories, up to 38.0 and 67.8 % on soils of III - IV categories and gives a significant reduction in labor costs by 17.5%, a decrease in the prime cost of soil development - 18.8%, unit investment in a complex of machines - 15.6% and a reduction of the reduced costs - 18.5%.

Conclusion. The proposed suspension of the working equipment of the bulldozer provides the adaptation of the cutting angle in the conditions of changing ground background, which increases the productivity of the machine complex by building embankments from side reserves by 8.1% for soils of the 1st category for 13.2% of category II, 38% for the III category and for reducing labor costs on 17.5%, prime cost of working out of a ground 18.8%, specific investments on a complex of cars of 15.6% and the resulted expenses of 18.5%.

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БУЛЬДОЗЕРДІҢ АСЫНДЫ ЖАБДЫҒЫНЫҢ БАСҚАРМАЛЫ АСПАСЫН ӘЗІРЛЕУ

Аннотация. Бульдозерлер топырақты қабатпен қазуға арналған және оны кейіннен қайырма күрегінің алдында жерүсті бойынша шағын қашықтыққа жылжытады. Ойық пен үйінді салу, траншея мен қазан шұңқырды қайта жабу, жер бетін қатаң жоспарлау, қиғаш терраса салу, сусымалы жүк өңдеу және орнын ауыстыру, жекелеген ағаш құлату, тас жою, бетін қоқыстан, қардан тазарту, аршу жұмыстарында, сондай-ақ итергіш скреперлер ретінде пайдаланылады. Бульдозер жұмысының тиімділігі базалық трактор өткізгіштігіне және оның тарту-тіркеу қасиеттеріне байланысты.

Бульдозердің жұмыс жабдығын жетілдіру саласындағы зерттеулерді талдау бульдозердің аспалы жабдығының қолданылатын кинематикалық схемалары топырақ жағдайларына сәйкес кесу бұрыштарын өзгертуге мүмкіндік бермейтінін көрсетті, осыған байланысты топырақ кедергісінің кесу және жер қазу-тасымалдау машиналарының энергия шығыны қамтамасыз етілмейтінін байқатты.

Бульдозердің жұмыс жабдығын асындысының кинематикалық параметрлеріне байланысты топырақ санаттарын есепке ала отырып кесу бұрышын есептеу үшін теңдеу ұсынылды. Бұл теңдеуді талдау үйінді қозғалысының ең ұтымды траекториясы енгізу кезінде кесудің ең жоғарғы бұрышын (α=55÷60°) қамтамасыз ететін, кейіннен оны азайту (α=20÷25°).

Машиналық эксперимент нәтижесінде регрессиялық теңдеу алынды, жұмыс орны аспасының кинематикалық параметрлерінен кесу тереңдігі оған жеткен кезде үйіндінің кесетін жиегін тереңдетіледі, бұл топырақты әзірлеу үдерісінің энергия сыйымдылығын азайтуды және бульдозер өнімділігін орташа 8÷17%-ға арттыруды қамтамасыз етеді.

Машиналық эксперимент деректерін статистикалық өңдеу нәтижесінде көшіруге толық кедергіні анықтау бойынша регрессия теңдеуі алынды, ол I-IV санатты топыраққа арналған жұмыс жабдығы аспасының параметрлерін оңтайландыруға мүмкіндік туғызады.

Бұл жұмыста бульдозердің аспалы жабдығының үйлесімді өлшемдерін анықтау әдістемесі берілген. Үйлесімді параметрлер α=55÷60° кесу бұрышы бар қайырманы тереңдету және жер қабатының өңдеу категориясына, белгілі бір қалыңдықта кесілген жаңқаға байланысты қайырманың кесу бұрышы α=20÷25°-қа дейін азайтылады. Кесу бұрышының өзгерісі және оның сипаттамасы белгілі бір аналитикалық тәуелділік арқылы анықталады. Жаңқаның көлемін үлкейту немесе жұмыс жылдамдығын арттыру арқылы кесу үдерісінің энергосыйымдылығын азайтуға және өнімділігін 8.1÷67.8%-га көбейтуге болады, бұл еңбек күшінің шығынын 17.5%-га, жұмыстың өзіндік құнын 18.8%-га, машинаның күрделі қаржы бөлу үлесін 15.6%-га, келтірілген шығынды 18.5%-га азайтуға мүмкіндік береді.

Түйін сөздер: бульдозер, асынды, пышақ, кесу бұрышы, қима, топырақ.

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РАЗРАБОТКА УПРАВЛЯЮЩЕЙ ПОДВЕСКОЙ НАВЕСНОГО ОБОРУДОВАНИЯ БУЛЬДОЗЕРА

Аннотация. Бульдозеры предназначены для послойной разработки грунтов с их последующим перемещением перед рабочим органом (отвалом) по поверхности земли на небольшие расстояния. Их используют при сооружении выемок и насыпей, обратной засыпке траншей и котлованов, грубой планировке земляной поверхности, устройстве террас на косогорах, штабелировании и перемещении сыпучих грузов, подготовительных работ для валки отдельных деревьев, удаления камней, расчистки поверхности от мусора, снега, на вскрышных работах, а также в качестве толкачей скреперов. Эффективность работы бульдозеров в значительной мере зависит от проходимости базового трактора и его тягово-сцепных свойств.

Анализ исследований в области совершенствования рабочего оборудования бульдозера показал, что применяемые кинематические схемы навесного оборудования бульдозера не позволяют изменять углы резания в соответствии с грунтовыми условиями, в связи с чем не обеспечивается возможное снижение сопротивления грунтов резанию и энергозатрат землеройно-транспортных машин.

Предложено уравнение для расчета угла резания в зависимости от кинематических параметров подвески рабочего оборудования бульдозера с учетом категорий грунтов. Анализ этого уравнения показывает, что наиболее рациональной траекторией движения отвала является та, которая обеспечивает максимальный угол резания в момент внедрения (α=55÷60°) с последующим его уменьшением (α=20÷25°).

В результате машинного эксперимента получены регрессионные уравнения, максимальной глубины резания от кинематических параметров подвески рабочего оборудования бульдозера, при достижении которой происходит выглубление режущей кромки отвала, что обеспечивает снижение энергоемкости процесса разработки грунтов и повышение производительности бульдозера в среднем на 8÷17%.

В результате статистической обработки данных машинного эксперимента по определению полного сопротивления копанию получено уравнение регрессии, которое позволяет оптимизировать параметры подвески рабочего оборудования для грунтов I-IV категорий.

Разработана методика определения рациональных параметров навесного оборудования бульдозера, обеспечивающая глубину резания инструмента с углом α=55÷60°, в последующем автоматически уменьшается до α=20÷25° при определенной толщине стружки, зависящей от категории обрабатываемого грунта. Изменение угла резания и его характеристика будет определяться по определенной аналитической зависимости. Это снижает энергоемкость до 8,1÷67,8% из-за увеличения толщины стружки или увеличения скорости обработки и создает условия для снижения трудовых затрат на 17,5%, себестоимости разработки грунта – 18,8%, удельных капиталовложений на машину – 15,6% и приведенных затрат – 18,5%.

Ключевые слова: бульдозер, мотыга, нож, угол резания, сечение, грунт.

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