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SUBSTANTIATE THE COVERAGE WIDTH OF A COMPREHENSIVE CHISEL CULTIVATOR

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Annotation

This article provides information on the development of a comprehensive chisel cultivator and the results of theoretical research to determine its coverage. Based on the results of calculations, the coverage width of the chisel cultivator for aggregation with tractors ARION-630C, AXION-850, ARES-697 and NewHolland T7060 is in the range of 4.6-5.8 m, for tractors “Magnum” 8940, MX-255, It should be 7,2 m.

Keywords: Chisel-cultivator, coverage width, gravity resistance, softener claw, story claw.

Introduction

Based on the results of research on improving the agro-technical performance of existing chisel cultivators, reducing material and energy consumption, as well as the analysis of scientific and technical literature, a comprehensive design scheme and technological process of chisel cultivator was developed.

The comprehensive chisel-cultivator is designed as a suspension and consists of a central (1) and two lateral (right 2 and left 3) sections.

The side sections are connected to the central section by longitudinal hinges, which are transferred from the working position to the transport position and from the transport position to the working position by means of hydraulic cylinders [1].

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Research Methods

We determine the coverage width of the chisel cultivator by the following expression [2].

$$B \le \chi \frac{P_H}{q}, \qquad (1)$$

in this χ – tractor traction utilization factor; P_H – rated traction power of the tractor, H; q – the specific gravity of the chisel cultivator, ie the resistance corresponding to the width of one meter, H.

Results

The traction resistance of a chisel cultivator is mainly due to the traction resistance of its working bodies. Therefore, its specific resistance to gravity can be determined with sufficient accuracy by the following expression

$$q = \frac{R_1 + R_2}{2a_k}, \qquad (2)$$

in this R_1,R_2 – traction resistance of the working bodies mounted on the first and second rows of the chisel-cultivator, ie the softener and axial claws, respectively, H; a_k – width between traces of working bodies, m.

Given expression (2), expression (1) has the following appearance

$$B \le 2\chi \frac{P_H a_\kappa}{R_1 + R_2}. \qquad (3)$$

The softening claw of the chisel cultivator deforms the soil towards the field surface, ie towards the open surface, and the curved claw deforms towards the side softened side, and their tensile resistance can be determined by the following expressions [3]

$$R_1 = Tt_T^{ю} b_ю + [k_c] \frac{\left[b_ю + htg(\frac{\pi}{4} - \frac{\phi_2}{2}) \right] h}{\cos^2 \frac{1}{2}(\alpha_ю + \phi_1 + \phi_2)} \cos\phi_2 \sin(\alpha_ю + \phi_1) +$$

$$+ b_ю h \rho (l_ю g + V^2 \sin\alpha_ю) tg(\alpha_ю + \phi_1)(1 + \frac{W}{100}), \qquad (4)$$

and

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$$R_2 = 2\left\{\frac{Tt_T^{ў} b_{ў}}{\sin\gamma_{ў}} + [k_c]\left\{b_{ў} - \frac{\left[\sqrt{[k_c]^2 + 4q_o[k_c]b_{ў}\frac{tg\alpha_{ў}\sin(\alpha_{ў}+\varphi_1)}{\cos\varphi_{ў}\cos(\gamma_{ў}+\varphi_1)}} - [k_c]\right]\cos(\gamma_{ў}+\varphi)\cos\varphi_1}{2q_o tg\alpha_{ў}\sin(\alpha_{ў}+\varphi_1)}\right\}\times\right.$$

$$\times\frac{\left[\sqrt{[k_c]^2 + 4q_o[k_c]b_{ў}\frac{tg\alpha_{ў}\sin(\alpha_{ў}+\varphi_1)}{\cos\varphi_1\cos(\gamma_{ў}+\varphi_1)}} - [k_c]\right]}{q_o\sin\gamma_{ў}\, tg\alpha_{ў}\sin(\alpha_{ў}+\varphi_1)}\times$$

$$\times\left[\sin(\gamma_{ў}+\varphi_1)+\cos\gamma_{ў}\sin\varphi_1\right]\cos^2\varphi_1 + h\rho b_{ў}\times$$

$$\times\left\{l_{ў} g\frac{\sin\alpha_{ў} + (\cos\gamma_{ў} ctg\gamma_{ў} + \sin\gamma_{ў}\cos\alpha_{ў})tg\varphi_1}{\cos\alpha_{ў} - \sin\gamma_{ў}\sin\alpha_{ў} tg\varphi_1} + \right.$$

$$\left.\left. + K_T V^2\frac{\sin^2\gamma_{ў}\left[\sin\alpha_{ў} + \sin\gamma_{ў}(ctg^2\gamma_{ў} + \cos\alpha_{ў})tg\varphi_1\right]}{ctg\alpha_{ў} - \sin\gamma_{ў} tg\varphi_1}\right\}(1+\frac{W}{100})\right\}, \qquad (5)$$

in this T – soil hardness, Па; $t_T^{ю}$ – the thickness of the softening claw blade, м; g – free fall acceleration, м/с²; ρ – soil density, кг/м³; V – the speed of movement of the chisel-cultivator during operation, м/с; W – soil moisture, %; $t_T^{ў}$ – the thickness of the axial claw blade, м; $l_{ў}$ – the width of the axial claw wing, м; K_T – in the presence of softened zones on the side of the working body ... the resistance generated by the inertial force of the soil during operation ..the coefficient taking into account the decrease in force; $b_{ю}$ – the width of the softening claw, м; k_c – specific resistance of soil to shear, Па; h – processing depth, м; q_0 – coefficient of volumetric compaction of soil, Н/м³; $\alpha_{ю}$, $\alpha_{ў}$ – the angle of entry of the softener and axial claws into the ground, respectively, degrees; φ_1, φ_2 – the external and internal friction angles of the soil, respectively; $b_{ў}$ – half of the width of the occlusal claw cover, м; $\gamma_{ў}$ – opening angle of axial claw wings, degrees; $l_{ю}$ – the length of the working surface of the softening claw, м.

R_1 and R_2 We set the values of (4) and (5) to (3). In that case

$$B \le 2\chi a_k P_H / \left\{Tt_T^{ю} b_{ю} + [k_c]\frac{\left[b_{ю} + htg(\frac{\pi}{4} - \frac{\varphi_2}{2})\right]h}{\cos^2\frac{1}{2}(\alpha_{ю}+\varphi_1+\varphi_2)}\cos\varphi_2\sin(\alpha_{ю}+\varphi_1) + \right.$$

$$+b_{ю}h\rho(l_{ю}g+V^{2}\sin\alpha_{ю})tg(\alpha_{ю}+\varphi_{1})(1+\frac{W}{100})+$$

$$+2\left\{\frac{Tt_{T}^{ў}b_{ў}}{\sin\gamma_{ў}}+[k_{c}]\left\{b_{ў}-\frac{\left[\sqrt{[k_{c}]^{2}+4q_{o}[k_{c}]b_{ў}\frac{tg\alpha\sin(\alpha_{ў}+\varphi_{1})}{\cos\varphi_{1}\cos(\alpha_{ў}+\varphi_{1})}}-[k_{c}]\right]\cos(\gamma_{ў}+\varphi_{1})\cos\varphi_{1}}{2q_{o}tg\alpha_{ў}\sin(\alpha_{ў}+\varphi_{1})}\right\}\times\right.$$

$$\times\frac{\left[\sqrt{[k_{c}]^{2}+4q_{o}[k_{c}]b_{ў}\frac{tg\alpha_{ў}\sin(\alpha_{ў}+\varphi_{1})}{\cos\varphi_{1}\cos(\alpha_{ў}+\varphi_{1})}}-[k_{c}]\right]}{q_{o}\sin\gamma_{ў}tg\alpha_{ў}\sin(\alpha_{ў}+\varphi_{1})}\times$$

$$\times\left[\sin(\gamma_{ў}+\varphi_{1})+\cos\gamma_{ў}\sin\varphi_{1}\right]\cos^{2}\varphi_{1}+h\rho b_{ў}\times$$

$$\times\left\{l_{ў}g\frac{\sin\alpha_{ў}+(\cos\gamma_{ў}ctg\gamma_{ў}+\sin\gamma_{ў}\cos\alpha_{ў})tg\varphi_{1}}{\cos\alpha_{ў}-\sin\gamma_{ў}\sin\alpha_{ў}tg\varphi_{1}}+\right.$$

$$\left.\left.+K_{T}V^{2}\frac{\sin^{2}\gamma_{ў}\left[\sin\alpha_{ў}+\sin\gamma_{ў}(ctg^{2}\gamma_{ў}+\cos\alpha_{ў})tg\varphi_{1}\right]}{ctg\alpha_{ў}-\sin\gamma_{ў}tg\varphi_{1}}\right\}(1+\frac{W}{100})\right\}. \quad (6)$$

χ =0,9; a=0,2 м, T=2·10^{6} Па, $t_T^{ю}=t_T^{ў}$ =0,0005 м, k_c=2,0·10^{4}Па, q_o=10^{7} Н/м^{3}, ρ=1200 кг/м^{3}, $b_ю$=0,05 м, $b_ў$=0,17 м, h=0,20 м, $l_ю$=0,15 м, f=0,5; $l_ў$=0,05 м, $\alpha_ю=\alpha_ў$= 25^0, $\gamma_ў$= 30^0, φ_1= 30^0, φ_2= 40^0, W=16 %, K_T=0,9; g=9,81 м/с^2 ва V =2,2 м/с Accepted and calculated according to (6), the coverage width of the chisel cultivator for aggregation with tractors ARION-630C, AXION-850, ARES-697 and NewHolland T7060 is in the range of 4.6-5.8 m, "Magnum" 8940, MX- For 255 tractors, it should be 7.2 m.

Conclusion

The coverage width of the chisel cultivator for aggregation with high-power tractors such as Magnum 8940, MX-255, ARES-697, ARION-630C, AXION-850 and NewHolland T7060 used in the country is adjustable in the range of 4.6-7.2 m. Up to 36 working bodies should be installed.

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