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BASED ON THE CONSTRUCTIVE DIMENSIONS OF THE SOIL PROCESSING UNIT DRUM WITH HINGED CONNECTION PILES

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Abstract: In the article based on the results of the studies conducted on the development of the structural dimensions of the drum with hinged connection piles of the soil tillage aggregate.

Key words : soil from planting before processing give , cut grinding drum, plow, elevator.

In order to theoretically justify the constructive dimensions of the hinged pile drum of the tillage unit, it is necessary to consider its interaction with the soil lumps (Fig. 1).

In studying this issue:

- the impulses of the frictional force when the pile and the elevator are affected by the soil lumps are assumed to be zero;

the direction at the time of impact, the cutting speed is considered to be directed along a straight line, perpendicular to the drum pile, parallel to the elevator surface;

- the force impulse acting on the drum from the gears during the impact is not taken into account;

- the forces acting on the drum piles and the drum lie in the same plane, that is, the movements of bodies in the plane are studied;

- speed recovery coefficient K is assumed to be constant ;

- the speed of the piece before the impact is equal to the speed of the elevator ($V_{B1} = V_{el}$).

So, when the drum piles hit the cutting with a blow, the impulse force $S_{A\ \text{from the pile}}$ acts on the drum, and its direction is opposite to the direction of the speed of the drum. This makes it possible to write the equation of the change of the amount of movement of the drum and the kinetic moment relative to the point O in the following form [1]:

$$Q_{q2} - Q_{q1} = S_A - S_B \qquad (1)$$

$$K_{x2} - K_{x1} = S_A R_б - S_B (R_б + L_x), \qquad (2)$$

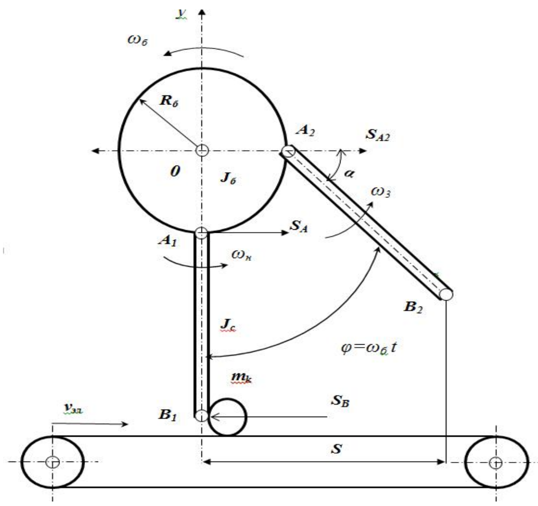
where $Q_{q2,} Q_{q2}$ is the amount of movement of the drum pile before and after the impact; $K_{q1,} K_{q2}$ - the kinetic moment of the drum pile before and after impact; C_B - the impulse on the drum pile created by the impact of the cut;

of the pile relative to the axis O are determined as follows:

$$Q_q = m_q Vs \qquad (3)$$

$$K_к = m_к V_c \left(R_б + c\right) + I_c(\omega_б + \omega_к). \qquad (4)$$

where m_q is pile mass, kg; V_s - speed of the center of inertia, m/s; ω_b - angular speed of the drum, 1/s; ω_q- angular velocity of the pile, 1/s; s is the distance from the point where the pile hangs to the center of inertia, m; I_c - moment of inertia of the pile, kg · m ^{2} .



1 **. Interaction of a drum with hinged piles with soil clods**

The speed of the center of inertia of the drum pile is expressed as follows.

$$V_c = \omega_б \left(R_б + c\right) + \omega_К \cdot c \qquad (5)$$

Putting expressions (3) and (4) into expressions (1), (2) and taking into account (5), we get the following expressions.

$$m_К c \Delta\omega_К + m_К \left(R_б + c\right) \Delta\omega_б = S_A - S_B \qquad (6)$$

$$[I_c + m_К \left(R_б + c\right) \Delta\omega_К + [I_c + m_К \left(R_б + c\right)^2] \Delta\omega_б = S_A R_б - S_B \left(R_б + L_К\right), \qquad (7)$$

where $\Delta\omega_b = \omega_{b2} - \omega_b$ is the change in the angular speed of the drum as a result of the impact; $\Delta\omega_q = \omega_{q2} - \omega_q$ is the change in the angular velocity of the drum pile as a result of impact.

When the drum pile collides with the cut, an impulse force S_A is exerted on the drum by the pile, the direction is opposite. On this basis, the ratio of the change in the kinetic moment of the drum to the axis of rotation of the drum can be written as follows [1]:

$$I_б \Delta\omega_б = -S_A \ R_б , \qquad (8)$$

where I_b is the moment of inertia of the drum, kg.m ^{2}.

Drum pile V point speed

$$V_B = \omega_b (R_b + L_q) + \omega_q L_q \qquad (9)$$

where ω_b is the angular velocity of the drum, 1/s; R_b - the radius of the drum, m; L_q is the length of the drum pile, m.

It can be determined from the expression (9) that the angular velocity of the drum pile changes during the beat

$$\Delta\omega_{к} = \frac{\Delta V_B}{L_к} - \Delta\omega_{б}\frac{R_б + L_к}{L_к} \qquad (10)$$

and $\Delta V_B = V_{B2} - V_{B1}$ B is a point speed beat the next change .

(10) Expressions (6) and (7) are expressions put ib and expression (8). based on the following expressions we write

$$\left(m_к c L_к - I_A\right)\Delta\omega_б + I_A \Delta V_B = -S_B L_к^2, \qquad (11)$$

$$\left[I_б L_к + m_к R_б^2 \left(L_к - c\right)\right]\Delta\omega_б + m_к c R_б \Delta V_B = -S_B L_к R_б, \qquad (12)$$

this is $I_A = m_к \cdot c \cdot L_к$ the inertia of the pile torque [2].

(8) we determine the $\Delta\omega_б$ change in the angular speed of the drum

$$\Delta\omega_б = \frac{S_B L_к^2 + I_A \cdot \Delta V_B}{(I_A - m_к c L_к) Rб}, \qquad (13)$$

Putting this connection in equation (9), we get the following expression

$$\left\{\frac{m_к c R_б^2\left(I_A - m_к c L_к\right) + I_A\left[I_A L_к + m_к R_б^2 \cdot (L_к - c)\right]}{R_б^2\left[I_A \cdot L_к + m_к R_б^2 (L_к - c)\right] + R_б^2 L_к (I_A - m_к c L_к)}\right\}\Delta V_B = -S_{B.} \qquad (14)$$

The expression in large brackets can be called the mass of the pile brought to point V :

$$m_{пр} = \frac{m_к c R_б^2\left(I_A - m_к c L_к\right) + I_A\left[I_A L_к + m_к R_б^2 \cdot (L_к - c)\right]}{R_б^2\left[I_A \cdot L_к + m_к R_б^2 (L_к - c)\right] + R_б^2 L_к (I_A - m_к c L_к)}. \qquad (15)$$

So, due to the fact that the amount of momentum acting from the drum pile on the drum is equal to S_B and in the opposite direction, based on the law of conservation of momentum, the following relationship can be written:

$$m_{пр}(V_{B2} - V_{B1}) = -m_к (V_{K2} - V_{K1}), \qquad (16)$$

where m_{pr} is the given mass of the pile; (expression in figure brackets), kg; m_k – mass of the piece, kg; B_{B1}, B_{B2} – the speed of point V of the pile before and after impact, m\s; V_{k1}, V_{k2} are the speed of the piece before and after the impact, m\s.

Hurry up after the hit recovery using the coefficient [1] :

$$K = \frac{V_{K2} - V_{B2}}{V_{B1} - V_{K1}} \qquad (17)$$

the impact point *V of the drum pile* and the speed of the piece after it hits the pile:

$$V_{B2} = \frac{(m_{пр} - K m_K) V_{B1} + m_K (1 + K) V_{K1}}{m_{пр} + m_K} \qquad (18)$$

$$V_{K_2} = \frac{m_{пр}(1+K)V_{B1}+(m_K-Km_{пр})V_{K1}}{m_{пр}+m_K} \quad (19)$$

When the drum pile collides with the cut, energy is used to crush the cut in the drum-pile-cut system.

The kinetic energy of the system can be expressed as follows:

$$T_c = \frac{1}{2}m_K V_K^2 + \frac{1}{2}J_б\omega_б^2 + \frac{1}{2}m_к V_c^2 + \frac{1}{2}J_c(\omega_б + \omega_к)^2 \quad (20)$$

Loss of kinetic energy in impact

$$\Delta T_c = T_{c1} - T_{c2} \quad (21)$$

where T_{s1}; T_{s2} - kinetic energy of s i stem before and after impact.

If we assume that the stress in the section changes according to the linear law when a blow is given

$$\sigma_{xк} = \sigma_к \frac{x}{\ell_K}, \quad (22)$$

where s_k is the maximum stress in the section; ℓ_K- the length of the cut;

x- the distance to the section in question.

dx is expressed as follows:

$$dA_K = \frac{y_K^2 \cdot F_K \cdot x^2}{2\ell_K^2 \cdot E_K} dx \quad (23)$$

where F_k is the face of the cross-section of the cut; *Ek is the modulus of elasticity of the soil* .

this expression in the interval from *x=0* , $x = \ell_K$ we get the formula for determining the complete work done in deforming the section

$$A_K = \frac{\sigma_K^2 \cdot F_K \cdot \ell_K}{6 \cdot E_K} \quad (24)$$

Equating this expression to deformation with the change of kinetic energy as a result of impact, we get the following expression

$$\Delta T_c = \frac{\sigma_K^2 \cdot F_K \cdot \ell_K}{6E_K} \quad (25)$$

in this $m_K = F_K \ell_K \cdot \rho_K$ taking into account that $\Delta T_c = \frac{\sigma_K^2 \cdot m_к}{6 \cdot \rho_к \cdot E_к}$;

$\rho_к$- bulk density, kg/m ^{3}; *E* - modulus of elasticity of the soil,

henceforth

$$\sigma_к = \sqrt{\frac{6\rho_к \cdot E_к \Delta T_c}{m_к}} \quad 26)$$

$m_к = \frac{\Delta T_c}{Ан.и.}$ for being

$$\sigma_к = \sqrt{6\rho_к \cdot E_к A_{н.и.}} \quad (27)$$

will be

Using this expression, it is possible to determine the maximum tension that is enough to crush the piece from the hammer.

, if S $_{b}$ =0, *that is, there is no momentum,* the moment of inertia of the pile relative to point $I_A = m_қ \cdot cR_қA$ determines the dynamic equilibrium condition and the connection between the parameters of the moving pile.

The condition of dynamic balance of the drum with a movable pile makes it possible to determine the connections between its structural size and the kinematic work plan:

$h_қ + \Delta r \leq l_{пр}$ $\quad l_c \leq l_{np}$,

where $h_q = h_b - (R_b - R_q)$ *is* the distance from the tip of the pile to the elevator; l_c- the distance between the piles;

Δr —the thickness of the layer to be processed.

$$\Delta r = (R_қ + R_б)\left\{1 - cos\frac{\pi v_{эл}}{Z_қ\left[\omega_б\left(R_б + R_қ\right) - v_{эл}\right]}\right\}$$

where Z $_q$ is the number of piles on the circumference of the drum.

The angular speed of the drum $\sigma_к > \sigma_{сж}$ is one rotation of the drum to satisfy the condition $n_б = \frac{2\pi}{\omega_б}$ pile 0.5; 1.5; 2.5 etc. will need to vibrate. So, the relationship between drum rotation and pile vibration can be expressed as follows.

$$n_б = \frac{1}{2} zT_қ$$

where : z is an odd whole number ; T_q is the periodicity of pile vibration .

$$T_қ = \frac{2\pi}{\omega_0}\left(1 + \frac{\alpha^2 max}{16}\right);$$

free swing of the peg $\alpha = \omega_0^2 \cdot sin\alpha = 0$ from this

$$\omega_0^2 = \frac{m_қ \cdot \omega_б^2 \cdot R_б \cdot c}{I_A}$$

The moment of inertia of the pile and the distance from the center of gravity to the point of connection are expressed as follows

$$I_A = \frac{1}{3} m_{ст} R_{қ}^2; \quad c = \frac{m_{ст} R_{қ}}{2 m_{қ}}$$

here is m_{CT} −the mass of the rack ; $m_{қ} - қозиқча$ mass $R_{қ}$ −the length of the pile.

Using these expressions and expression (15), $R_{қ}$ $ва$ $R_{б}$ it is possible to determine the acceptable ratio of the dimensions:

$2 \le \frac{R_{к}}{R_{б}} \le 3 \quad m_{пр} \approx \frac{1}{3} m_{CT}$

Based on the above expressions, we write the expression that determines the dimensions of the drum:

$$R_{қ} = \frac{4R_{б}}{\left(1 + \frac{\alpha_{мах}^2}{16}\right)^2}$$

As a result of theoretical and practical research, the following design dimensions of the pile drum were determined: I_A=0.0096 kg · $м^2$; $m_{қ}$=0. 36kg ; $R_{б}$=0. 32 m ; $R_{қ}$=0. 150 m ;

The above expressions can be used to justify the dimensions of other agricultural machines with similar working parts.

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