S.
4. *Zubko VN* Analysis stages of growth and development as a basis for the design of complex machines and their working bodies / VM Zubko // Journal of Kharkov National Technical University of Agriculture. P. Vasilenko. - H., 2013. - Vol. 148. - P. 204-208.
5. *Zubko VN* Features biological yield formation of winter wheat / VM Zubko // Scientific Bulletin of National University of Life and Environmental Sciences of Ukraine. - K., 2013. - Vol. 185, p. 3. - P. 328-334.

Article posvyaschena question Increase byolohycheskoy and "zachetnoy" yield winter wheat, putem optymalnыh uslovyy Provision for growth and development plants.

Ozymaya wheat Studies, Requirements plants, selskohozyaystvennaya machine Quality Provision harvest.

This paper is devoted to issue of increasing biological and "record" yield of winter wheat by providing optimal conditions for growth and development of plants.

Winter wheat, test, claims plant, agricultural machinery, assurance quality, yield.

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OPTIMIZATION motion mode JAWS HIDROZAHVATA CRITERIA FOR DYNAMIC

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The article presents a method of optimizing motion mode jaws grab hidrozahvata. Evaluation criteria selected acceleration energy system. Optimum dynamic mode of movement of the jaws, which provides a minimum dynamic loads on the mechanism of capture.

Hidrozahvat, optimization, dynamic loads, power grabbing, jaw.

Problem. Grapple for logs - a mechanism for wood, which can be attached to the crane system manipulyatornoho loader, logging tractors, forwarders, and other machines for loading, unloading, sorting and stacking operations in warehouses or forest groves. Grapples logging tractors are widely used in the timber industry for many years. Statistics show that feller packaging with utilization rate of 75 percent [1]. However, only a few references can be found on the mechanics of design or capture grab timber. Because grasping power is a key factor used to determine the structure and parameters bunk in the design process, it is necessary to develop more sophisticated models to understand how forces act admiration.

Analysis of recent research. Theoretical aspects grabs that should be considered in the design process - it forces acting on the grip, structural properties, parameters and kinematics motion [2]. Since 1950, several methods were used to analyze and calculate the resistance forces capture or capture logs grab. Development of the concept definition of force and resistance capture grabs Wood was first introduced and described Tauber [3]. Seizure resistance is also calculated based on the friction force between the logs. This approach is considered only for traffic logs regardless of the design of bunk. In this direction and performance of the resistance seizure can not be defined this approach. Models traffic logs also vary considerably depending on the circumstances of grab loaders.

The purpose of research. A method for optimizing traffic grab hidrozahvata that provides minimum dynamic loads on the engine.

Results. The power of seizure - a force acting on the jaw bunk and ensure their closure. Power of resistance is the reaction force capture. In order to simulate the power seizure in the first place should be defined resisted capture. The following assumptions are used in determining the resistance capture acting on the jaw bunk during capture:

1) clamshell keeps the overall weight of the captured logs when the jaws are closed;

2) during capture logs the force of friction between the logs on the outside jaws;

3) during capture logs resistance force acting on the jaw, is accepted with a fixed pattern of distribution. Dependence modeling for power capture logs from stack looks $p(x) = kx^2$ Where p (x) - a picture of the distribution of the resistance capture jaws; y - the vertical distance from the top to the extremity of the jaw; k - coefficient associated with the structure and weight of bunk.

When beginning to grapple grab logs, the ends of the jaws initially immersed in a crack between the logs, then gradually jaw closed. Since the capture of symmetrical structure, the forces acting on the capture bunk can be described as shown in Fig. 1 as well. Resistance is distributed on the outside of the jaw is taken discrete and usually does not match the model and varies depending on how you capture. Thus, the resultant force is used to represent the resistance in this model. Assuming that the resultant force R sum struggling ΣR, then struggled moment about the point O to bunk at its equilibrium state can be expressed as:

$$M_O(\varphi) = Pa(\varphi) = Rfd(\varphi) + mgl_1(\varphi) \quad (1)$$

where P - grasping power (W);

R- Part of the resistance capture;

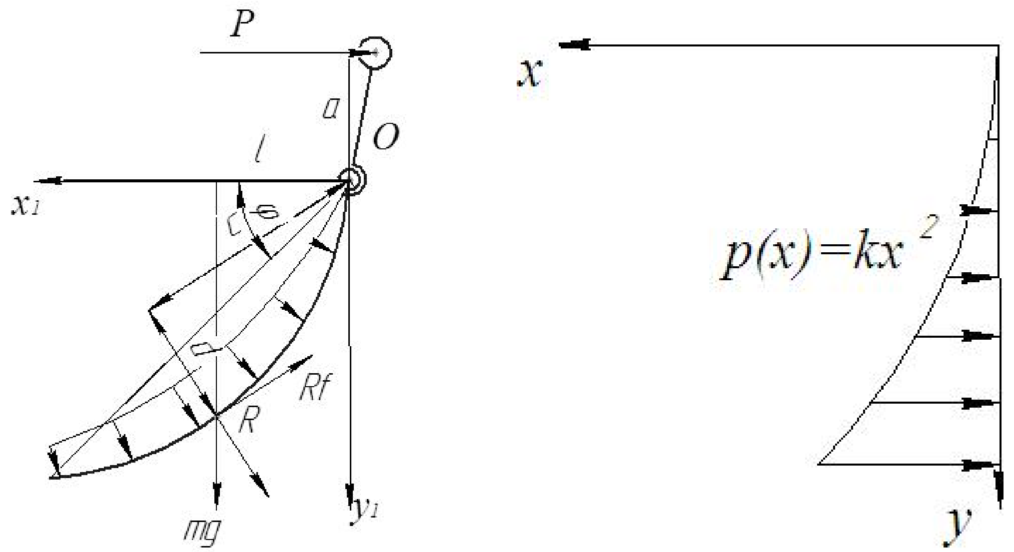
a, d, l - Position forces associated with the structure bunk;

f - coefficient of friction between the logs and grapple jaws (f = 0,4);

m - Mass of logs;

g - acceleration of gravity;

φ - angular coordinate rotation jaw.



a) b)

Fig. 1. Scheme of forces acting on the jaw bunk.

Thus capture power P acting on the jaw, expressed by the following relationship:

$$P = \frac{1}{a(\varphi)} \sum Rfd(\varphi) - mgl(\varphi) \quad (2)$$

Fig. 2, shown coordinate system: h1oy1 - fixed and xoy - moving coordinate system define the position of the jaws. Point actions resulting force R on jaw can be determined based on the distribution of the resistance delight. Fixed form distribution was used to model the seizure resistance of piles of logs (Fig. 1b), for $p(x) = kx^2$.

To determine the equation of the curve that describes the curvature of the jaw solve the differential equation of the third order $\dddot{y}(h) = 0$ with the following boundary conditions:

$$y(0)=0;\ y\left(\frac{4}{7}h\right)=0{,}14;\ y(h)=0 \quad (3)$$

and obtain:

$$y=f(x)=0{,}82x-1{,}17x^2 \quad (4)$$

where h = 0,7m - the distance from the point of attachment to the end of jaw.

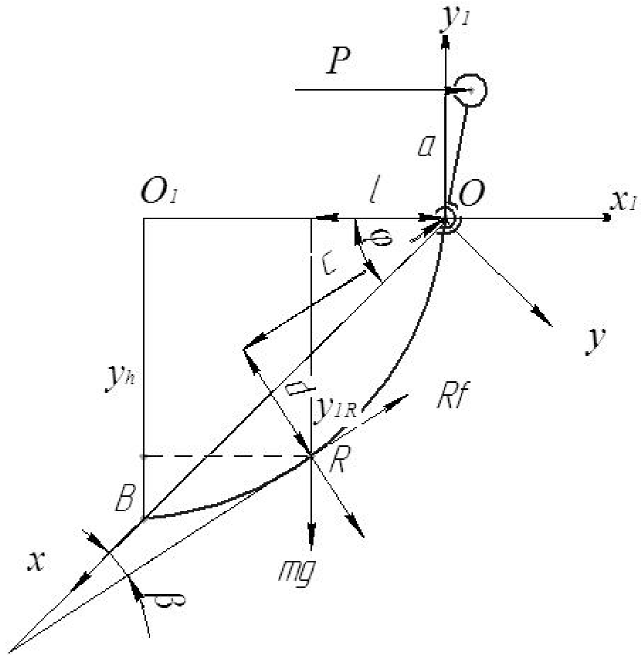


Fig. 2. Scheme of the resistance delight.

To determine the rotation angle of the jaw, use a fixed coordinate system x1oy1, using formulas to convert coordinates where the origin is not changed, and the axis of the moving coordinate system rotated angle φ relative to the fixed coordinate system [4]:

$$x_1 = x\cdot\cos(\pi-\varphi)+y\cdot\sin(\pi-\varphi); \quad (5)$$

$$y_1 = -x\cdot\sin(\pi-\varphi)+y\cdot\cos(\pi-\varphi). \quad (6)$$

Suppose that y1R - the vertical distance from the point of impact resulting force R to the frame and hidrozahvata y1h - the vertical distance between the end of the jaw and the frame (Figure 2), then we can find y1R (for $p(x)=kx^2$, Capture stack logs):

$$y_{1R}=\frac{\int_0^{y_h} xkx^2dx}{kx^2dx}=-\frac{3}{4}y_{1h}=-\frac{3h}{4}\sin(\varphi) \quad (7)$$

graph is shown in Fig. 3.

We find xR in the moving frame. To solve this equation (5) with respect to x1 substituting y = ax + bx2.

$$[b\cos(\pi-\varphi)]x_R{}^2+[a\cos(\pi-\varphi)-\sin(\pi-\varphi)]x_R-y_{1R}=0. \quad (8)$$

Let's make some replacements to simplify the calculations:

$$A = b\cos(\pi - \varphi); \quad B = a\cos(\pi - \varphi) - \sin(\pi - \varphi); \quad C = y_{1R},$$

and obtain $Ax_R^{\ 2} + Bx_R - C = 0$. Where we find two solutions of the equation and build their schedules:

$$x_{R1} = \frac{-B + \sqrt{B^2 - 4AC}}{2A} \quad x_{R2} = \frac{-B - \sqrt{B^2 - 4AC}}{2A}.$$

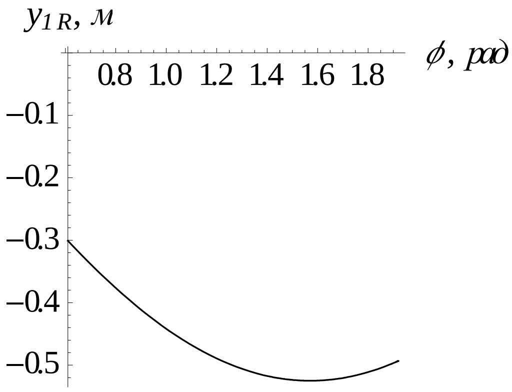


Fig. 3. A plot of the distance from the angle φ y1R jaw rotation.

From the graphs (Fig. 4) shows that one possible solution is:

$$x_{R2} = \frac{-B - \sqrt{B^2 - 4AC}}{2A}. \quad (9)$$

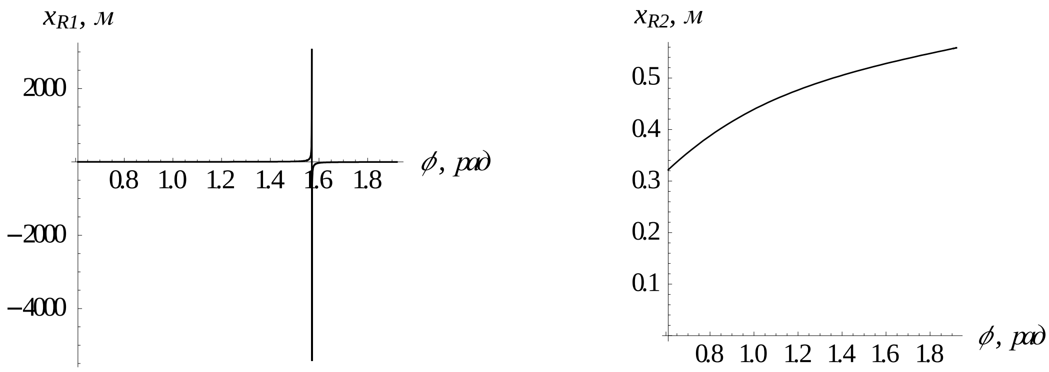


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Fig. 4. The relationship between the position point of application of resultant force R on the x-axis the angle φ.

To find the length l shoulder pending on the axis x1, substitute in equation (5) xR2 instead of x. Based on the calculations we construct a graph of the length of the shoulder mg applied force at the point R from the rotation angle of the jaw (Fig. 5).

The angle β (Fig. 2) shows the angle between the x-axis and the tangent line current point of application of resultant force R. Since the function y = *f* (x) is known, the dependence of β can be obtained as follows (Fig. 6):

$$\beta = arctg\left(-f`(x)\right). \quad (10)$$

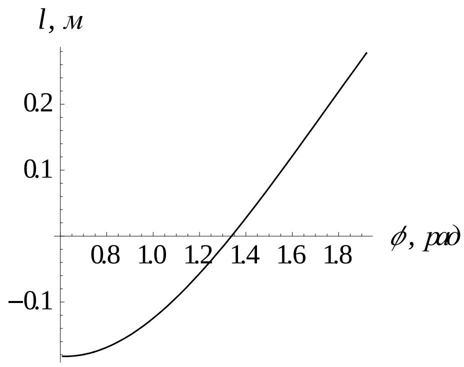


Fig. 5. Graph of length l from shoulder rotation angle of the jaw φ.

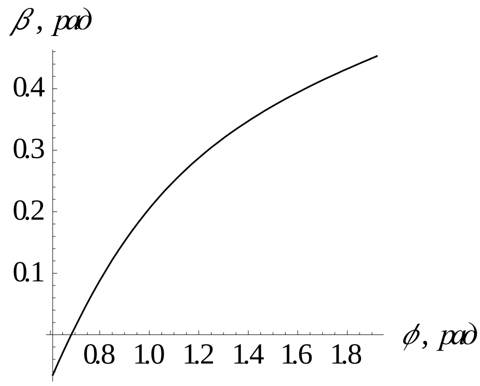


Fig. 6. The dependence of the angular coordinate β φ.

After performing some calculations, you can calculate the length of the shoulder at the point of application of forces resultant actions of the resistance R: c - shoulder strength and R d - shoulder application of force of friction on the outside of the jaw Rf:

$$c = l\cos(\beta - \varphi) - \sin(\beta - \varphi) y_{1R} \quad (11)$$

$$d = l\sin(\beta - \varphi) - \cos(\beta - \varphi)\sin\varphi y_{1R}. \quad (12)$$

The resistance R capture can be calculated as follows:

$$R = \frac{mg\cos(\varphi - \beta)}{2} \quad (13)$$

To capture parameters m = 270 kg, g = 9,8 m / s constructed a graph of force R from the rotation angle of the jaw (Fig. 7).

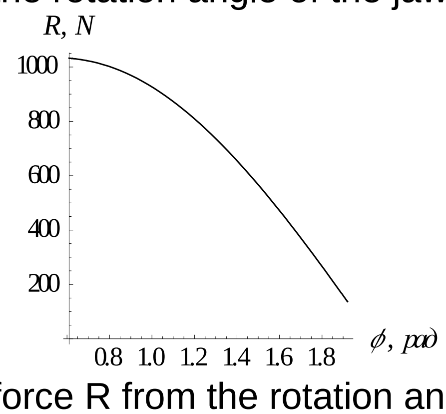


Fig. 7. Graph of force R from the rotation angle of the jaw.

Substituting the values of R, l and d in equation (2) determine the torque that occurs around the point O:

$$M_o(\varphi)=\frac{mg\cos(\varphi-\beta)}{2}\cdot l\sin(\beta-\varphi)-\cos(\beta-\varphi)\sin\varphi y_{1R}f+\frac{mgl}{2}. \quad (14)$$

The resulting expression is non-linear with respect φ, so for all settlements Replace this expression to another, that hold approximations. For the approximation will require that the polynomial approximation satisfy five conditions:

$$\begin{cases} M_{anp}(0)=0; \\ M_{anp}(0.71)=-298{,}2; \\ \dot{M}_{anp}(0.71)=0; \\ M_{anp}(1.92)=349.5 \\ M_{anp}(1.45)=0. \end{cases} \quad (15)$$

These conditions ensure equality of approximating functions and features (14) in four points: the initial, final, and the minimum value of zero quantity moment. As a result, we obtain a polynomial approximation:

$$M_{anp}=\varphi(-778.749+\varphi\,(378.895+(245.406-94.8538\,\varphi)\,\varphi)) \quad (16)$$

and build dependencies graphics (14) and (16) (Fig. 8), which show that the dependences are equivalent.

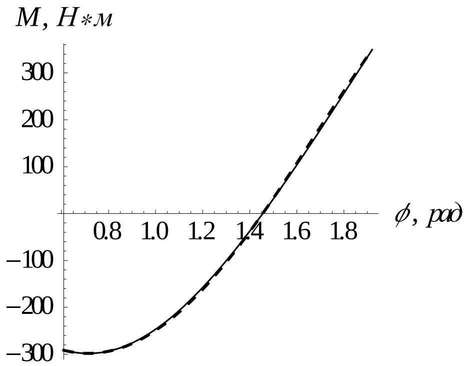


Fig. 8. Graph of force moment about the point O:, ~~graphic~~ approximated value of moment - - - - -.

Optimal dynamic mode motion capture grab jaws can be obtained by minimizing the functional integral

$$I_V=\int_0^{t_1}Vdt\to\min \quad (17)$$

where as the integrand used energy acceleration [5]:

$$V=\frac{1}{2}J_0\left(\ddot{\varphi}-\frac{M}{J_0}\right)^2 \quad (18)$$

where J0 = 8 kg · m2 - moment of inertia about the axis of rotation of the jaw; $\ddot{\varphi}$ - Angular acceleration jaw.

To do this, define the necessary condition for a minimum criterion (17) - Euler-Poisson

$$\frac{d^2}{dt^2}\frac{\partial V}{\partial \ddot{\varphi}} - \frac{d}{dt}\frac{\partial V}{\partial \dot{\varphi}} + \frac{\partial V}{\partial \varphi} = 0 \quad (19)$$

for which the reporting mechanism is as follows:

$$\frac{1}{J_O}(834251.4\varphi^4 - 34965\varphi^5 - 162943.7\varphi^6 + 35989\varphi^7 + \varphi\left(606450.7 - 1472.4\dot{\varphi}^2 - J_O 1515.6\ddot{\varphi}\right) + \\ + \varphi^2\left(-885191.8 + J_O 1138.2\dot{\varphi}^2 - J_O 1472.4\ddot{\varphi}\right) + \\ + \varphi^3\left(-477316 + J_O 758.8\ddot{\varphi}\right) + J_O(-757.8\dot{\varphi}^2 + 1557.5\ddot{\varphi} + J_O\varphi^4)) = 0. \quad (20)$$

The resulting equation is nonlinear homogeneous differential equation of second order. The solution of equation (20) is quite a challenge. Therefore, use the direct variational method. In the future, ask the differential equation:

$$\varphi^{VII} = 0 \quad (21)$$

which must be solved at the indicated boundary conditions:

$$\varphi(0) = \varphi_0;\ \dot{\varphi}(0) = 0;\ \ddot{\varphi}(0) = 0;\ \varphi\left(\frac{T}{2}\right) = q;\ \varphi(T) = \varphi_T;\ \ddot{\varphi}(T) = 0;\ \dot{\varphi}(T) = 0. \quad (22)$$

According to the method, we find supporting function, which is the solution of the boundary value problem:

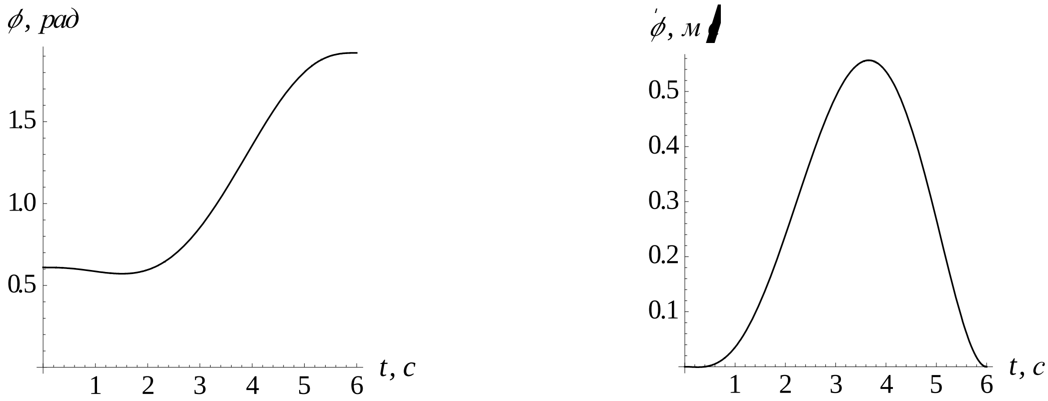
$$\varphi = \frac{-64qt^3(t-T)^3 - (2t-T)\left((t-T)^3\left(16t^2 + 5tT + T^2\right)\varphi_0 + t^3\left(16t^2 - 37tT + 22T^2\right)\varphi(T)\right)}{T^6}. \quad (23)$$

Substituting the resulting law of motion of the jaw in the integrand (18), functional (17) and find the integral. The scope of the expression that describes the integral is quite significant and therefore we are not leads. In order to minimize the integral value necessary to numerically solve the equations in such settings $(\varphi_0 = 0{,}61;\ \varphi_T = 1{,}92;\ T = 6c)$ For this use condition

$$\frac{\partial I}{\partial q} = 0. \quad (24)$$

Solving this equation, we obtain the approximate solution of the variational problem. Present graphics found kinematic functions jaw (Fig. 8).

From these graphs shows that the optimal dynamic mode jaw movement ensures its smooth movement throughout the period. This indicates that the mechanism to do so for large dynamic loads.



a) b)

Fig. 8. The graph of the function changes the rotation angle of the jaw (s) and its velocity (b).

Conclusion. Synthesized close to the optimal dynamic motion mode jaw grab mechanism that delivers minimum criteria. The law of motion (24) is a dynamic optimal mode of movement, providing a minimum dynamic loads and makes it possible to increase the durability of the drive mechanism and grab a whole.

References

1. *Thompson J. D.* 2001. Calculating utilization rates for rubber-tired grapple skidders in the Southern United States. Proceedings of the 24th Annual COFE Meeting. Snowshoe, West Virginia. July 18-19, 2001: pp. 29-31.

2. *Wang J.* 1990. Study on the theories of log grapples. Ph.D. Dissertation. Northeast Forestry University, Harbin, China. 311 pp.

3. *BA Tauber* Kynematyka mechanism of capture / BA // Moscow lesotehnycheskyy Tauber Institute. - 1957. - № 7. - S. 121.

4. *I. Bronstein* Handbook on mathematics for ynzhenerov uchaschyhsya and polytechnics / I. Bronstein, K. Semendyaev. - Moscow: Nauka. Home edition of Physical and Mathematical literature, 1981. - 720 p.

5. *Loveykyn VS* Raschetы optimal regimes of motion mechanisms of building machines / VS Loveykyn. - K .: CMD PA, 1990. - 168 p.

In the articles presented method optimization mode motion mouth grab hydrozahvata. Criteria otsenyvanyya vыbrana Energy uskorenyy system. Dynamic mode will provide a optymalnыy mouth movement, kotorыy obespechyvaet minimum of Dynamic loads.

Hydrozahvat, optimization, Dynamic load, power capture, mouth.

The paper presents methodology for optimizing the driving mode jaws grab hydraulic grips. Criteria for assessing the selected acceleration energy system. An optimal dynamic mode the motion of jaws, which provides a minimum of dynamic loads.