mixing. This makes it possible to change the composition Forage mixture for different age-sex groups of animals without compromising on quality indicators process directly in the distribution of food.

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Opredelenы Experimental dependence of influence structurally rezhymnыh mixer parameters kormorazdatchyka streaming-type process to smeshyvanyya and vыdachy kormovыh mixture. Conducted analysis of influence factors on vzaymodeystvyy Criteria otsenki process.

Analysis, mixer-kormorazdavach, Streaming smeshyvanye, Experimental dependence, kormovыe mixture, structurally rezhymnыe Options, Criteria otsenyvanyya.

Determined experimental depending on influence of constructive and operating parameters mixer-cattle-feeder of stream type to process mixing and deliveries of forage mixtures. The analysis of influence of co-operations of factors is conducted on criterion of estimation of process.

Analysis, mixer-kormorazdavach, data-flow blending, experimental associations, fodder mixtures, constructive-regime parametres, criteria of marking.

UDC 631.520.2

OPTIMIZATION OF REGIME PUSKU Swing mechanism boom cranes BY rms driving MOMENT

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In the article the way the fluctuations of cargo during the steering jib cranes. Optimization mode triggers turning the tap is performed using methods of variations. The paper used criterion rms over the driving

moment, which is subject to minimization. For the control parameter is selected force acting on the steering on the part of the drive mechanism.

Fluctuations load optimization, transition regime movement.

Problem. It is known [5] That when working jib cranes pendulum oscillations observed cargo that cause uneven motion units mechanisms create additional load on the power components, which reduces their reliability and leads to discomfort in their operation and increase the risk of accidents.

Solving the problem of reducing the load fluctuations on flexible suspension provide a more efficient operation of crane equipment.

Analysis of recent research. The problem of the fluctuations of cargo on a flexible suspension for several decades. Recent studies on this issue are based on

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use mathematical theory of optimal processes (maximum principle, variational calculus). Note that modern methods of eliminating vibrations offered to sell the goods through certain steps to control steering during transient states of motion (acceleration, braking).

In [1,2,8] Option is selected by managing power to the drive mechanism of action: to eliminate the need to manage fluctuations in load torque on the motor shaft rotation mechanism. Management action has a relay character, resulting in increased dynamic loads on the valve. This approach is unacceptable in terms of optimality.

By using the theory of the calculus of variations, as is done in [6], We can ensure a smooth change of kinematic characteristics of the mechanism of rotation and eliminate vibrations load on flexible suspension.

The purpose of research. The aim of the study is to optimize the motion mode steering boom crane with a load during the transition. To achieve this goal it is necessary to solve the following problems:

1) choose a dynamic model of the crane boom rotation mechanism and on its basis to construct a mathematical model;

2) choose criterion optimization mode turn the tap to set the conditions for its minimum;

3) identify the optimal mode of dispersal steering and to analyze the results.

Methods of research. Surveys take dvomasovu model steering valve (Fig. 1), the construction of which provides the following assumptions [3]:

1) suspended load hanging freely like a pendulum;

2) weight traction element is neglected;

3) assume that the centrifugal load fluctuations compared with radial is small and their effect is not considered.

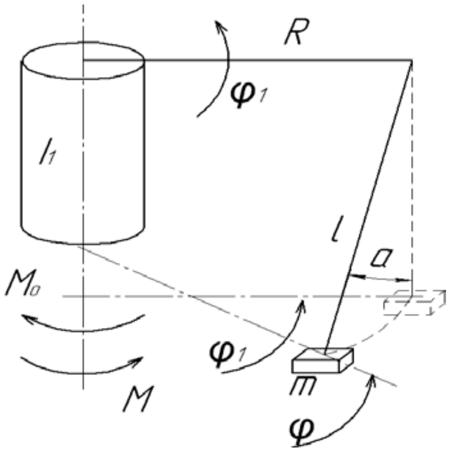

Fig. 1. Design model of the "column-load."

These assumptions in studies give very small error, which is confirmed by practical research [4].

Present design model (Fig. 1) is described by a system of differential equations:

$$\begin{cases} I_1\ddot{\varphi}_1 + \dfrac{mR^2}{l} g\left(\varphi_1 - \varphi\right) = M - M_0; \\ \ddot{\varphi} - \dfrac{g}{l}\left(\varphi_1 - \varphi\right) = 0, \end{cases} \tag{1}$$

where I_1 - Moment of inertia of the column erected to the axis of rotation of the crane and drive mechanism; φ and φ_1 - Generalized angular coordinates aggregate weight of the goods and columns; m - Bulk cargo; R - Boom; l - The length of the flexible suspension of cargo; g - Acceleration of gravity; M_0 - Static torque resistance, elevated to the axis of rotation of the column; M - Driving time on the motor shaft, built to the axis of rotation of the column; α - angle from vertical cargo rope. From the second equation of (1) we find:

$$\begin{aligned} \varphi_1 &= \varphi + \frac{l}{g}\ddot{\varphi}; \\ \dot{\varphi}_1 &= \dot{\varphi} + \frac{l}{g}\dddot{\varphi}; \\ \ddot{\varphi}_1 &= \ddot{\varphi} + \frac{l}{g}\overset{IV}{\varphi}. \end{aligned} \tag{2}$$

A criterion optimization process start rms take the driving moment [6]:

$$I_M = \left(\frac{1}{t_1}\int_0^{t_1} M^2 dt\right)^{1/2} \to \min, \tag{3}$$

where $M = I_1\ddot{\varphi}_1 + \frac{mR^2}{l} g(\varphi_1 - \varphi) + M_0 = I_1\left(\ddot{\varphi} + \frac{l}{g}\ddddot{\varphi}\right) + \frac{mR^2}{l} g \cdot \frac{l}{g}\ddot{\varphi} + M_0;$

$$M^2 = \left[I_1 \frac{l}{g}\ddddot{\varphi} + \ddot{\varphi}\left(I_1 + mR^2\right) + M_0 \right]^2. \tag{4}$$

Condition of minimum criterion (3) is determined from the Euler-Poisson [9]:

$$\frac{dM^2}{d\varphi} - \frac{d}{dt^2}\frac{dM^2}{d\dot{\varphi}} + \frac{d^2}{dt^2}\frac{dM^2}{d\ddot{\varphi}} - \frac{d^3}{dt^3}\frac{dM^2}{d\dddot{\varphi}} + \frac{d^4}{dt^4}\frac{dM^2}{d\overset{IV}{\varphi}} = 0, \tag{5}$$

which in this case can be written as follows:

$$\overset{VIII}{\varphi} + 2\frac{I_1 + mR^2}{I_1 \frac{l}{g}}\overset{VI}{\varphi} + \left(\frac{I_1 + mR^2}{I_1 \frac{l}{g}}\right)^2 \overset{IV}{\varphi} = 0. \tag{6}$$

Enter the following replacement for the natural oscillation frequency accepted model of steering the crane:

$$k = \sqrt{\frac{I_1 + mR^2}{I_1 \frac{l}{g}}}. \tag{7}$$

As a result, we obtain the differential equation that corresponds to minimum criterion (3) on the basis of (4):

$$\overset{VIII}{\varphi} + 2k^2\overset{VI}{\varphi} + k\overset{IV}{\varphi} = 0. \tag{8}$$

For solving the resulting differential equation is convenient to use the program Wolfram Mathematica v.8, which lets you search for symbolic solutions of differential equations [3].

Consider the process triggers turn the tap and set the boundary conditions for this process:

$$\begin{cases} t = 0; \varphi_1 = \varphi = 0; \dot{\varphi}_1 = \dot{\varphi} = 0; \\ t = t_1; \dot{\varphi}_1 = \dot{\varphi} = \omega_y; \ddot{\varphi}_1 = \ddot{\varphi} = 0. \end{cases} \tag{9}$$

Express the boundary conditions $\varphi_1, \dot{\varphi}_1, \ddot{\varphi}_1$ the coordinates φ and its derivatives. For this we use dependencies (2). After transformations we obtain the final boundary conditions start in terms of the coordinate φ and its derivatives:

$$\begin{aligned} &t = 0; \varphi = 0; \dot{\varphi} = 0; \ddot{\varphi} = 0; \dddot{\varphi} = 0; \\ &t = t_1; \dot{\varphi} = \omega_y; \ddot{\varphi} = 0; \dddot{\varphi} = 0; \overset{IV}{\varphi} = 0. \end{aligned} \tag{10}$$

As a result of differential equation (8) for the boundary conditions triggers rotation (10) and its design, kinematic and dynamic parameters: J1 = 7200 kg·m2; m = 600kh; R = 2.5 m; l = 4m; g = 9,8 m / s2; Mo = 47

N·m; $\omega_{íîì}$ = 0.32rad / s; t1 = 1,9 s.- acceleration time, which corresponds to the time of dispersal in natural mechanical characteristics, the graphs start kinematic characteristics of the column and load (Fig. 2 - Fig. 5).

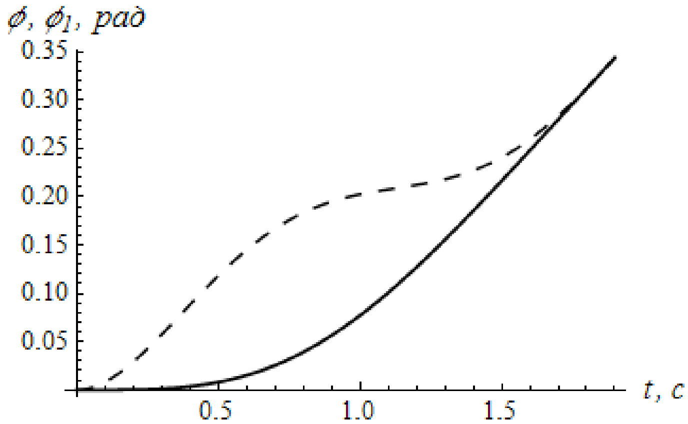

Fig. 2. Graphs of functions moving column φ_1 and cargo φ.

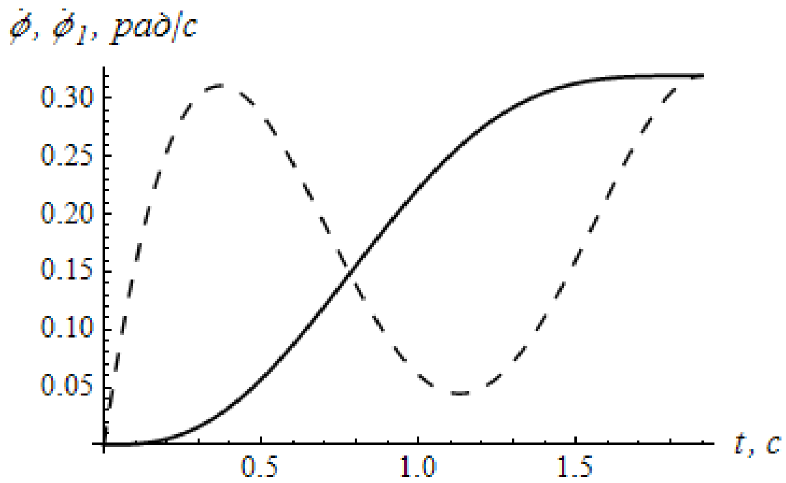

Fig. 3. Graphs of functions speed column φ_1 and cargo φ.

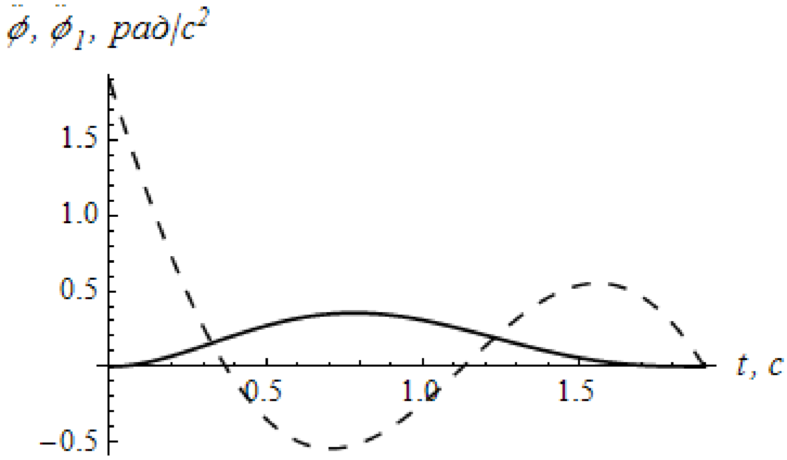

Fig. 4. The graphics acceleration features columns φ_1 and cargo φ.

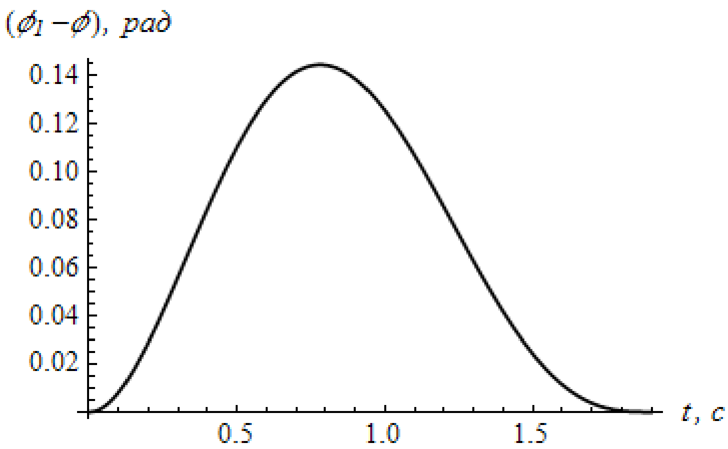

Fig. 5. Schedule features flexible suspension deflection angle from the vertical load.

The solid line shows the kinematic characteristics of movement of goods and dashed lines depict the kinematic characteristics of motion of the crane column.

Fig. 6 - Fig. 9 shows the graphs obtained kinematic characteristics of the column and the load during *t1* ($t_1 = \dfrac{2\pi}{k} = 3{,}25$c. - Start time equal to the period of natural oscillations of cargo on a flexible suspension). The solid line shows the kinematic characteristics of movement of goods and dashed lines depict the kinematic characteristics of motion of the crane column.

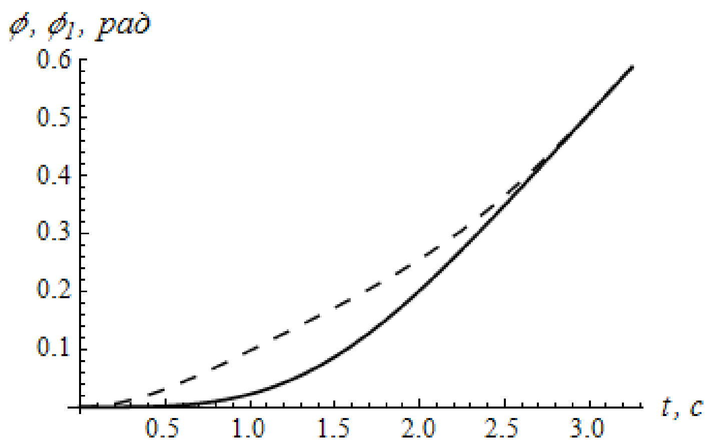

Fig. 6. Graphs of functions moving column φ_1 and cargo φ.

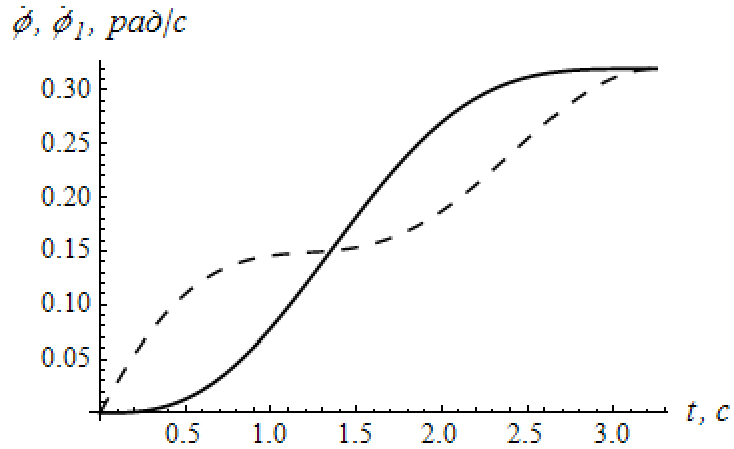

Fig. 7. Graphs functions speed column φ_1 and cargo φ.

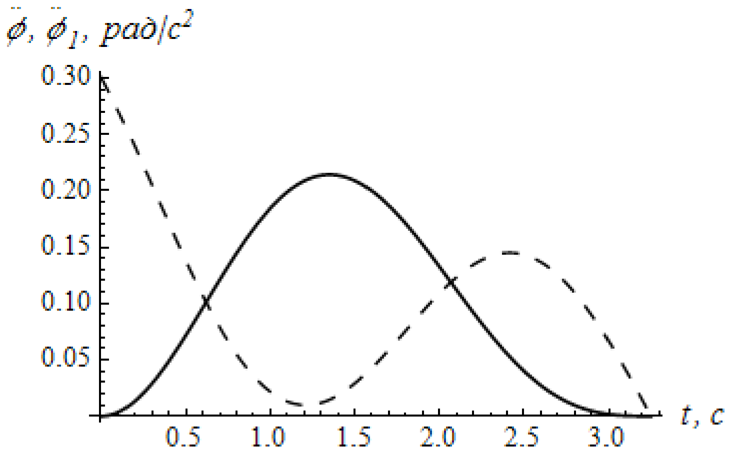

Fig. 8 graphics acceleration features columns φ_1 and cargo φ.

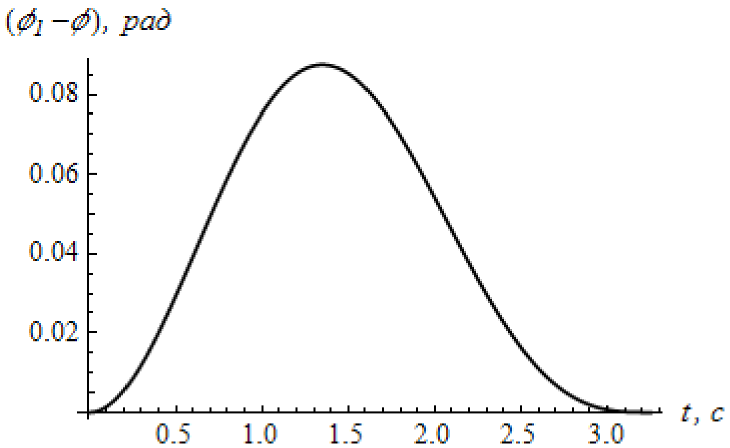

Fig. 9. Schedule features flexible suspension deflection angle from the vertical load.

In addition, in Fig. 10 shows a graphic changes the driving moment at t1 = 1,9 s. (Solid curve) and t1 = 3,25s. (Dashed line).

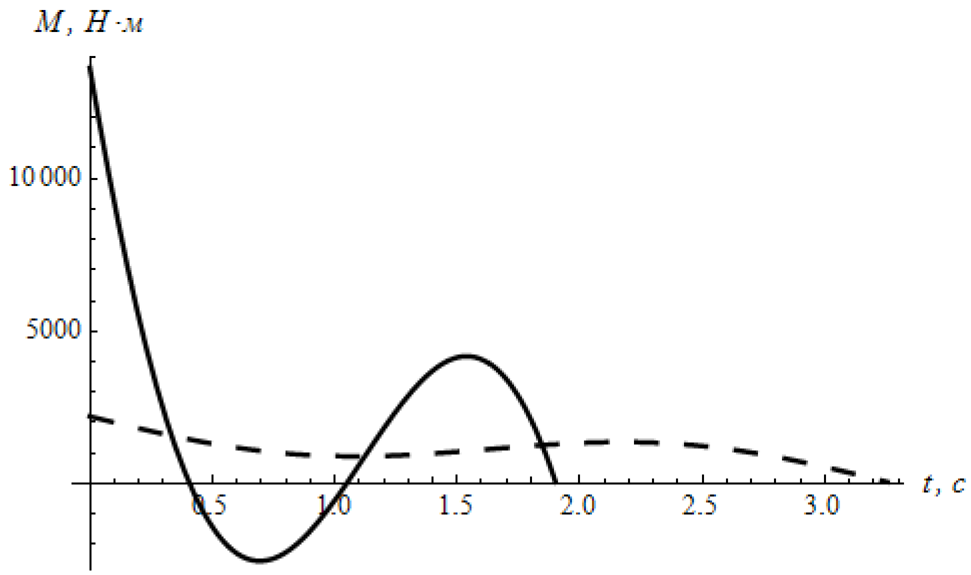

Fig.10. Schedule the driving point: ----- at t1 = 3.25sek, ——— at t1 = 1.9 s.

Analyze graphs obtained kinematic characteristics at start-up duration t1 = 1,9 s (Fig. 2 - Fig. 5) and duration start t1 = 3,25 s (Fig. 6 - Fig. 9). With schedules and cargo movements column (Fig. 2 and Fig. 6) shows that in the first case the established steering movement begins with coordinates *φ1* = *φ* =0.35 Councils, and the second *φ1* = *φ* =0.6 boards, which indicates that the benefits of the first start-up mode for the second. The maximum deviation coordinates *φ1-φ* in the first case is 0.14 Councils, and the second 0,084 rad. This figure indicates the superiority of the second mode start.
With schedules angular velocities (Fig. 3 and Fig. 7) we can see that change in the rate of rotation of the column is sufficiently smooth in the first and second cases start the process. However, the speed of rotation of cargo in the first case has a large amplitude oscillations (Fig. 3), which is not the start of the second mode (Fig. 9). Here there are fluctuations in load, but they are minor compared to the first start mode.

A similar pattern is observed when comparing the acceleration turn arrows and load (Fig. 4 and Fig. 8). From these graphs shows that the acceleration arrows in the first and second modes start changing quite smoothly and their maximum values not exceeding 0.3 rad / s2. However, the nature of the change acceleration load at the first and second modes start different.

If the first mode start accelerating cargo accepted as positive and negative values (there is a process of braking load), then the second mode start accelerating take only positive values (starting process is carried out without braking load).

Moreover, in the first mode, the maximum starting acceleration load (Fig. 4) is $\ddot{\varphi}_{\text{мах}} = 1{,}9$ rad / s2, while the second mode start $\ddot{\varphi}_{\text{мах}} = 1{,}9$ rad / s2 (Fig. 8). This enabled us to start in the second mode significantly reduce the maximum value of the driving point (Fig. 10) Mmah = 210 Nm compared to the first mode Mmah = 13600 Nm.

Thus, the optimal use of the criterion of mean value since the driving mode turn triggers boom crane start duration equal to the period of natural oscillations of cargo makes it possible to significantly reduce the effect of dynamic loads and energy costs compared to other optimal mode on the same criteria, but another length start-up.

Fig. 11 shows a three-dimensional phase portrait modes for optimum start, duration 1.9 s (corresponding to the length of the start for natural mechanical characteristics, shown by a solid line) and a duration of 3.25 s (corresponding period of natural oscillations of cargo on a flexible suspension, shown by the dashed line).

From the phase portrait shows that in the first and second cases before the start of the process of steady traffic load fluctuations are eliminated. However, in the first case there are much larger deflection velocity and acceleration and rotation of the column load compared to the second case, the process start. However, in the first case, a shorter duration of acceleration, which makes it possible to increase the productivity of the crane by reducing the length of the entire cycle of the steering.

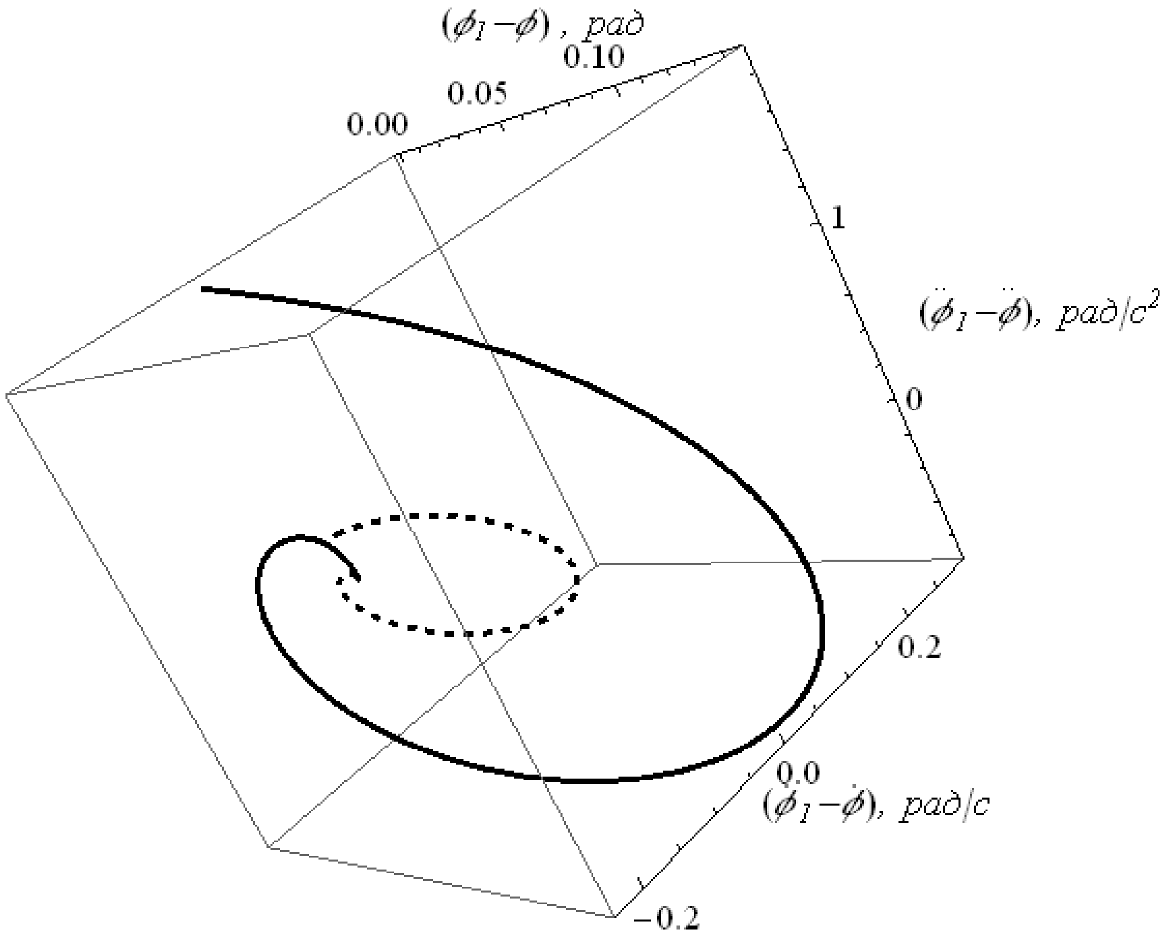

Fig. 11. Three-dimensional dynamic phase portrait of the system "column-load" ----- at t = 3.25 s, ——— at T = 1.9 s.

Conclusions

The obtained results allow the following conclusions:

- solving the problem of the fluctuations on a flexible suspension using variational calculus is justified because management found effect on steering satisfies the task;
- the chosen optimality criterion traffic steering allows you to get control laws that ensure the fluctuations of load and improve transient modes of movement;
- to implement control system "column-load" efforts need to select the drive on which imposed certain restrictions;
- Optimum implement the laws of motion can be achieved by use of an automated control system steering.

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In Article rassmotrenы Elimination Methods fluctuations in the work of cargo hoisting and transportnыh machines. Optimization mode start-up mechanism turns the tap proyzvodytsya with pomoshchju varyatsyonnoho yschyslenyya. Yspolzovano criterion srednekvadratycheskoho value dvyzhuscheho moment kotorыy podlezhyt mynymyzatsyy. AS A upravlyayuscheho parameter vыbrano usylye, kotoroe deystvuet Mechanism turns on co storony drive mechanism.
Fluctuations of cargo, optimization, perehodnыy mode motion.

The paper deals with how to eliminate vibrations when working cargo handling machines. Optimization of start slewing crane is performed using variational calculus. Used criterion rms driving torque that is to be minimized. As control parameter selected force, which acts on part of mehanizm turn actuator.
Fluctuations of cargo, optimization, connecting mode of motion.

UDC 666.266.4: 669.018.25: 631.3

STRENGTHENING OF WORKING SURFACES SHVYDKOZNOSHUVALNYH AGRICULTURAL MACHINES tungsten carbide

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The article regularities obtaining wear-resistant materials such as powder karbidostaley based systems "chrome steel, chromium carbide" and development on the basis of working parts of agricultural machines.

Working bodies, abrasive wear, chromium steel, composite materials, durability, chromium carbide.

Problem. The majority of modern machines and mechanisms is movable combination that provides the ability to perform their job functions, so the creation and development of new effective materials industry that can operate reliably in different conditions, represent an important problem in engineering and transport. From materials require low values of energy loss due to friction, high wear resistance, and in some cases, high corrosion resistance for use in harsh environments. These materials include powder materials with nerivnovazhenoyu structure without tungsten hard alloys and karbidostali. Carbide powders are heterogeneous composite materials, which consist of solid refractory compounds distributed in the plastic matrix of iron triad metals.

Bezvolframovi hard alloy is an alloy based on titanium carbide and karbonitridu cemented nickel-molybdenum-binding. They are characterized by a lower modulus of elasticity and a higher coefficient of thermal expansion that is sensitive to shock and thermal loads than tungsten-cobalt alloys, hard, and in some cases contain expensive and scarce nickel and molybdenum.

A distinctive feature of powder structural materials is their porosity, which may be adjustable within a wide range of physical and mechanical properties of manufactured parts. There are several methods for structural parts of high density. This is repeated pressing and sintering, hydrostatic, and hot isostatic pressing, rolling metal powder compaction