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Utochnotin dependence calculation Speed Motion zernouborochnoho combine (HCC) with uchetom faktycheskoy-power engine dynamics and movement HCC. Opredelenы dopustymыe predelы workers velocity values for optimization Downloads threshing machine.

Co.mbayn balance-power, yield, propusknaya Ability, Search engine, threshing machine.

The elaborated dependency of calculation to velocities of motion grainharvesting combine (GC) with provision for actual engine size and speakers of motion GC. The possible limits of importance's worker velocities are determined for optimization of oading the thresher.

Combine, balance to powers, productivity, reception capacity, loading engine, thresher.

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LowersIng dynamic forces in the bridge crane BY optimization of the crane

VS Loveykin, PhD YA Romasevych, Ph.D.
VV Krushelnytskyi, a graduate student *

*** Supervisor - PhD VS Loveykin**

In this paper we solve the problem of minimizing the intensity change of horizontal loads in the elements of metal crane during its launch. The task solved by the method of the calculus of variations. The results are illustrated graphs that characterize the process of launching crane with minimal changes in the intensity of horizontal dynamic loads.

Kradistrict, cart, dynamic loads, dynamic model, reduced weight, beam crane, optimization.

Resolutionska problem. Manufacturerpidyomno- and modern transport vehicles seeking to improve their operational performance. It is known that during the crane mechanisms in metal crane are significant dynamic loads. Typically, these processes are accompanied by an increased consumption of electricity, they reduce the reliability of the crane and result in additional material costs for repairs. Therefore, when using cranes should be reduced to a minimum these adverse factors, such as dynamic forces in metal.

AnaLiz recent research. AndDeut [1] developed method for determining the residual life of the crane, with the additional loading cycles that significantly affect the dynamic stresses in metal faucet and cause vibrations of the bridge, which reduces the reliability cyclic bridge crane. This paper investigated, the forces on the motion of the crane runways irregularities, if any gaps in the joints and high altitude. In [2] the method of calculating the optimal characteristics of cranes moving mechanisms that allow to reduce the dynamic loads on the drive components and metal.

DTo calculate the braking characteristics rational mechanism for moving the crane, the method steep ascent. As a generalized criterion that should be optimized, using a generalized function of the desirability of Harrington. The proposed method can reduce the dynamic load on the crane structure, designed by optimal braking performance mechanisms.

In [3] the problems that characterize the dynamics of the mechanism of moving the crane, used seven mass dynamic model and digital model (package MATLAB / Simulink) mechanism for moving the bridge crane. In this robotand the resulting graphs transients elastic force in

Poslongitudinal and transverse beams metal crane. The disadvantages of replacement is flexible hanging on tight, as in studies of the dynamics of the bridge used an external force is applied to the drive wheels, and does not take into account the dynamic characteristics of the electric drive. In the study of the dynamic model of the bridge crane without transverse displacement character set of any mechanical vibrations in the application of the driving force.

In [4] studied the final conditions under which the oscillation elements bridge crane and cargo mounted on a flexible suspension eliminated by the end of the transition process by reducing
threevalosti fluctuations in the elements of the crane. The work done to optimize the transition process of the crane on the criterion standard deviation the driving force.

AndDeut [5] studied the rational for operational modes of the vertical movement of the bridge crane.
A use of electro-mechanical system based on microcontroller to control the rate of growth of dynamic loads at a given performance. To study the mechanical system used dvomasova dynamic model that does not
accurately describes the motion of "truck load".

In the Lipetsk branch of the International Institute of Computer Technology, conducted a study deskew bridge crane and damping vibrations cargo. The authors of [6] proposed to use a system of constraints skew bridge based on comparison of displacement of the bridge supports and bridge system limitations bias based on determining the position of the bridge support
relatively crane tracks in fuzzy controller.

In Donetsk National Technical University [7] involved in suppression of horizontal elastic waves traveling crane structures by modal synthesis regulator. At
dvomasova study used a dynamic model and package Comsol Multiphysics.

Based on the above mentioned study is proposed to reduce the dynamic force acting on the crane beam by the method of the calculus of variations.

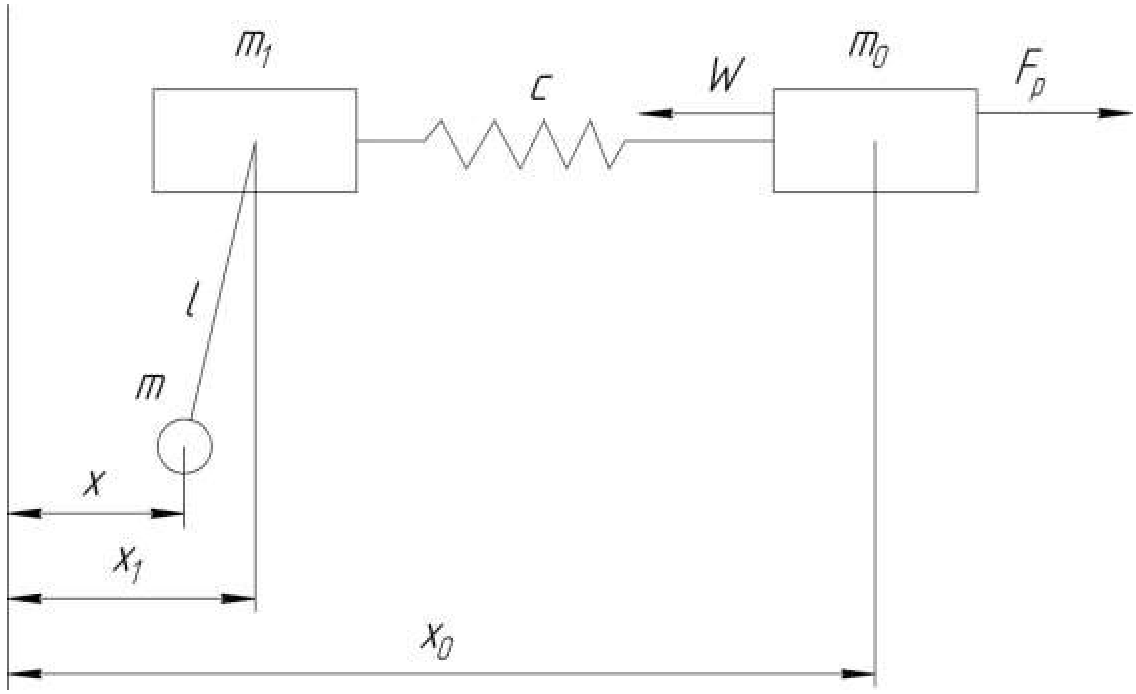
Metand research is to solve the problem of minimizing the intensity frommines horizontal loads during start-up overhead crane using the method of the calculus of variations.

DTo achieve this goal it is necessary to solve the following
objectives:

1. Staywool and dynamic mathematical models describing the movement of the bridge crane with a load.

2. Performand formulation optimization problem.
3. RoseKnit optimization problem.
4. Proanabution results.

Rezultaty dperssurvey findings. Dll contion daboutslidzhennya used sticksowl dynenomic Fashionthl moJV countryto from load on flexible suspension (Fig. 1).



Ric. 1. Trymasova dynamic model of the bridge crane.

Fig. 1 shows the reduced mass m_0, m_1, m respectively atwater and end beams, crane and trolley beams and cargo. Weight drive and end beams connected with a present weight crane trolley and crane beam elastic element of rigidity *with*.

Dat about mass and end beams are applied motive force Fr tand the resistance movement of the crane beams W. In this model, x, x_0, x_1 UGAhalneni coordinates mass load, and final drive crane trolley beams and beams, respectively, and *l*- The length of the flexible suspension cargo.

Dynenomic model (Fig. 1) is described by the following system of differential pivnyan pCCS (DOTandtod simvolom LakeNacha differentiation in time):

$$\begin{cases} m_0\ddot{x}_0 = F_p - W - c(x_0 - x_1) \\ m_1\ddot{x}_1 = c(x_0 - x_1) - \dfrac{mg}{l}(x_1 - x) \end{cases} \quad (1)$$

$$\ddot{x} = \frac{g}{l}(x_1 - x).$$

Funktsiya internal force acting on the bridge crane, described the following expression:

$$F_m = c(x_0 - x_1). \qquad (2)$$

Usestovuyuchy siSTEM dyferentsialnyh pivnyan (1),recordmo:

$$x_1 = x + \frac{l}{g}\ddot{x}, \qquad (3)$$

$$\dot{x}_1 = \dot{x} + \frac{l}{g}\dddot{x}; \qquad (4)$$

$$\ddot{x}_1 = \ddot{x} + \frac{l}{g}x^{IV}. \qquad (5)$$

As the optimization criterion we use the mean-value function point (2) acting on the bridge crane. It is an integrated functionality that is necessary to minimize:

$$IF = \left\{ \frac{1}{t_1}\int_0^{t_1} \left[m_1 \frac{l}{g} x^{IV} + (m_1 + m)\ddot{x}\right]^2 dt \right\}^{1/2} \to \min. \qquad (6)$$

DFor further calculations integrand expression (6) denote:

$$f = \left[m_1 \frac{l}{g} x^{IV} + (m_1 + m)\ddot{x} \right]^2. \qquad (7)$$

The condition of a minimum criterion (6) is the Euler-Poisson [8]

$$\sum_{i=0}^{n} (-1)^i \frac{d^i}{dt^i}\frac{\partial f}{\partial x^{(i)}} = 0, \qquad i = 0 \ldots n. \qquad (8)$$

We find some terms that are included in equation (8):

$$\frac{\partial f}{\partial \ddot{x}} = 2\left[m_1 \frac{l}{g} x^{IV} + (m_1 + m)\ddot{x} \right](m_1 + m) \qquad \frac{\partial f}{\partial x^{IV}} = 2\left[m_1 \frac{l}{g} x^{IV} + (m_1 + m)\ddot{x} \right] m_1 \frac{l}{g};$$

$$\frac{d^2}{dt^2}\frac{\partial f}{\partial \ddot{x}} = 2(m + m_1)\left[m_1 \frac{l}{g} x^{VI} + (m + m_1)x^{IV} \right]; \qquad \frac{d^4}{dt^4}\frac{\partial f}{\partial x^{IV}} = 2m_1 \frac{l}{g}\left[m_1 \frac{l}{g} x^{VIII} + (m_1 + m)x^{VI} \right].$$

As a result, we can write:

$$(m + m_1)\left[m_1 \frac{l}{g} x^{VI} + (m + m_1)x^{IV} \right] + m_1 \frac{l}{g}\left[m_1 \frac{l}{g} x^{VIII} + (m_1 + m)x^{VI} \right] = 0. \qquad (9)$$

Pislya transformation equation (9) has the form:

$$x^{VIII} + 2\frac{m + m_1}{m_1}\cdot\frac{g}{l}x^{VI} + \left[\frac{m + m_1}{m_1}\frac{g}{l}\right]^2 x^{IV} = 0. \qquad (10)$$

DA further solution of equation (10) we introduce the notation:

$$k = \sqrt{\frac{m + m_1}{m_1} \cdot \frac{g}{l}}. \qquad (11)$$

Runsmo substitution in (10) using the relation (11), resulting in we have:

$$\overset{VIII}{x} + 2k^2 \overset{VI}{x} + k^4 \overset{IV}{x} = 0. \qquad (12)$$

DA solution of equation (12) will make the characteristic equation:

$$r^8 + 2k^2 r^6 + k^4 r^4 = 0 \qquad (13)$$

.

DTo further bring that solution r^4fromand brackets:

$$r^4 (r^4 + 2k^2 r^2 + k^4) = 0. \qquad (14)$$

From equation (14) we find four roots:

$$r_1 = r_2 = r_3 = r_4 = 0; \qquad (15)$$

$$r^2 = p. \qquad (16)$$

Usebecoming the substitution (16), we obtain the quadratic equation: (17)

$$p^2 + 2k^2 p + k^4 = 0;$$

$$p_{1,2} = -k^2 \pm \sqrt{k^4 - k^4} = -k^2;$$

$$p_1 = p_2 = -k^2.$$

The roots of equation (17) are complex numbers:

$$r_5 = r_6 = ki; \quad r_7 = r_8 = -ki,$$

where i- The standard unit.

In light of the roots of the solution of (12) is as follows:

$$x = (c_1 + c_2 t)\ \mathrm{Sin}\ kt + (c_3 + c_4 t)\ \mathrm{Cos} kt + c_5 t^3 + c_6 t^2 + c_7 t + c_8, \qquad (18)$$

where $with_1, with_2, ..., with_8$ – onindependently integration.

DTo reduce the dynamic forces in the elements of metal crane during its start-up, you need to performed the following boundary conditions:

$$\begin{cases} t = 0; x_0 = x_1 = x = 0; \dot{x}_0 = \dot{x}_1 = \dot{x} = 0, \\ t = t_1; x_0 = x_1 = x = \dfrac{Vt_1}{2}; \dot{x}_0 = \dot{x}_1 = \dot{x} = V, \end{cases} \qquad (19)$$

where t_1- The movement of the bridge crane at the end of acceleration to speeds established;

V- Speed of bridge crane.

DTo solve the optimization problem requires that the constant of integration in equation (18) was equal to the number of boundary conditions (19). Equation (18) does not provide the above mentioned conditions, so further solving the problem required a higher order equation. After transformation of equation (2), the function of the driving force acting on the bridge crane is as follows:

$$\dot{F}_m = m_1 \frac{l}{g}\overset{V}{x} + (m_1+m)\ddot{x}. \qquad (20)$$

As the optimization criterion we use the mean-square value of intensity functions effort (20) acting on the bridge crane. It is an integrated functionality that is necessary to minimize:

January 1

$$I_1 = \left\{\frac{1}{t_1}\int_0^{t_1}\left[m_1\frac{l}{g}\overset{V}{x}+(m_1+m)\ddot{x}\right]^2 dt\right\}^{1/2} \to \min. \qquad (21)$$

DFor further calculations integrand equation (21) Denote:

$$f=\left[m_1\frac{l}{g}\overset{V}{x}+(m_1+m)\ddot{x}\right]^2. \qquad (22)$$

Find the the separateE daboutDunk, uabout entranceaboutdyat in pivnyannya (8) fromhurrayinto account (22):

$$\frac{\partial f}{\partial \ddot{x}} = 2\left[m_1\frac{l}{g}\overset{V}{x}+(m_1+m)\ddot{x}\right](m_1+m) \qquad \frac{\partial f}{\partial \overset{V}{x}} = 2\left[m_1\frac{l}{g}\overset{V}{x}+(m_1+m)\ddot{x}\right]m_1\frac{l}{g};$$

$$\frac{d^3}{dt^3}\frac{\partial f}{\partial \ddot{x}} = 2(m+m_1)\left[m_1\frac{l}{g}\overset{VIII}{x}+(m+m_1)\overset{VI}{x}\right];$$

$$\frac{d^5}{dt^5}\frac{\partial f}{\partial \overset{V}{x}} = 2m_1\frac{l}{g}\left[m_1\frac{l}{g}\overset{X}{x}+(m_1+m)\overset{VIII}{x}\right].$$

As a result, we can write:

$$(m+m_1)\left[m_1\frac{l}{g}\overset{VIII}{x}+(m+m_1)\overset{VI}{x}\right]+m_1\frac{l}{g}\left[m_1\frac{l}{g}\overset{X}{x}+(m_1+m)\overset{VIII}{x}\right]=0; \qquad (23)$$

Pislya transformation equation (23) has the form:

$$\overset{X}{x}+2\frac{m+m_1}{m_1}\cdot\frac{g}{l}\overset{VIII}{x}+\left[\frac{m+m_1}{m_1}\cdot\frac{g}{l}\right]^2\overset{VI}{x}=0. \qquad (24)$$

DA further solution of equation accept:

$$k=\sqrt{\frac{m+m_1}{m_1}\cdot\frac{g}{l}}. \qquad (25)$$

Runsmo substitution in (24) using dependence (25):

$$\overset{VIII}{x} + 2k^2 \overset{VI}{x} + k^4 \overset{IV}{x} = 0. \quad (26)$$

Dla Rosebundlepivnyannya (26) withforlademo characteristic pivnyannya:

$$r^{10} + 2k^2 r^8 + k^4 r^6 = 0. \quad (27)$$

DTo further bring that solution r^6fromand brackets:

$$r^6(r^4+2k^2r^2+k^4)=0. \qquad (28)$$

From equation (28) we find six roots:

$$r_1=r_2=r_3=r_4=r_5=r_6=0, \qquad r^2=p. \qquad (29)$$

Usebecoming the substitution (29), we obtain the quadratic equation: (30)

$$p^2+2k^2p+k^4=0;$$

$$p_{1,2}=-k^2\pm\sqrt{k^4-k^4}=-k^2; \quad p_1=p_2=-k^2.$$

The roots of equation (30) are complex numbers:

$$r_7=r_8=ki; \quad r_9=r_{10}=-ki.$$

In light of the roots of the solution of (26) is as follows:

$$x=(c_1+c_2t)\ \text{Sin}\,kt+(c_3+c_4t)\ \text{Cos}kt+c_5t^5+c_6t^4+c_7t^3+c_8t^2+c_9t+c_{10}. \qquad (31)$$

where $with_1, with_2, ..., with_{10}$ – onindependently integration.

Number of permanent integration in equation (31) is not equal to the number of boundary conditions (19), so for further solving the problem required equation is of the highest order. After transformation equation (20), the function changes force acting on the bridge crane is as follows:

$$\dot{F}_m=m_1\frac{l}{g}\overset{VI}{x}+(m_1+m)\overset{IV}{x}. \qquad (32)$$

As the optimization criterion we use rms intensity change of function point (32) acting on the bridge crane. The integrated functionality that is necessary to minimize is:

$$I_{\ddot{F}}=\left\{\frac{1}{t_1}\int_0^{t_1}\left[\dot{F}_M\right]^2dt\right\}^{1/2}=\left\{\frac{1}{t_1}\int_0^{t_1}\left[m_1\frac{l}{g}\overset{VI}{x}+\left(m+m_1\right)\overset{IV}{x}\right]^2dt\right\}^{1/2}\to \text{min}. \qquad (30)$$

DFor further calculations integrand equation (33) Denote:

$$f=\left[m_1\frac{l}{g}\overset{VI}{x}+(m+m_1)\overset{IV}{x}\right]^2.$$

The condition of a minimum criterion (33) is the Euler Poisson (7) at $n=6$Of which received:

$$\overset{XII}{x}+2k^2\overset{X}{x}+k^4\overset{VIII}{x}=0. \qquad (34)$$

Solution'Connection equation (34) is as follows:

$$x=(c_1+c_2t)\ \text{Sin}kt+(c_3+c_4t)\ \text{Cos}kt+c_5t^7+c_6t^6+c_7t^5+c_8t^4+c_9t^3+c_{10}t^2+c_{11}t+c_{12}. \qquad (35)$$

where $with_1, with_2, ..., with_{12}$

– onindepen dently integration.

Number Craiovax onconstantly andntehruvannya (35), responsible forilkosti boundary conditions (19). This feature will provide removal whenfluctuations. From a mathematical model (1) convert to define boundary conditions and final drive beams:

$$m_1\left(\ddot{x} + \frac{l}{g} x^{IV}\right) = cx_0 - c\left(x + \frac{l}{g}\ddot{x}\right) - m\ddot{x}. \qquad (36)$$

From the expression (36) define a generalized coordinate and drive end beams:

$$x_0 = m_1 \frac{l}{cg} x^{IV} + \left(\frac{m+m_1}{c} + \frac{l}{g}\right)\ddot{x} + x = x + \left(\frac{m+m_1}{c} + \frac{l}{g}\right)\ddot{x} + \frac{m_1 l}{cg} x^{IV}. \qquad (37)$$

Dla toyznachetion wvydkosti atwater and forintsevyh BaLok prodyferintsiyuyemo dependence (37) Time:

$$\dot{x}_0 = \dot{x} + \left(\frac{m+m_1}{c} + \frac{l}{g}\right)\dddot{x} + \frac{m_1 l}{cg} x^{V}. \qquad (38)$$

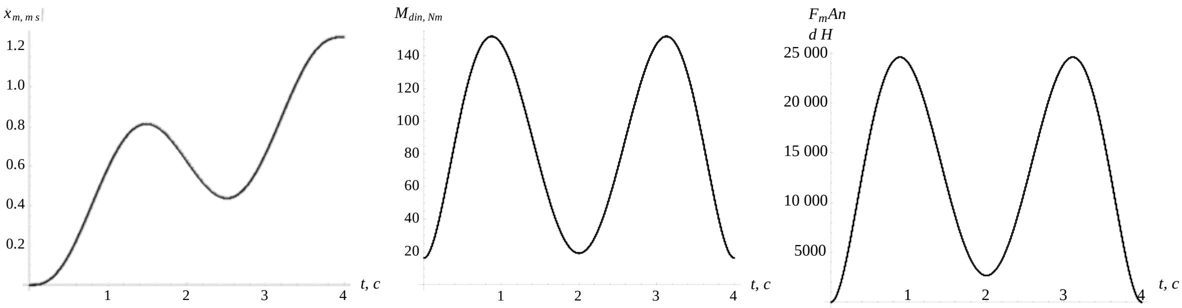
DTo define acceleration prodyferentsiyuyemo expression (38) Time:

$$\ddot{x}_0 = \ddot{x} + \left(\frac{m+m_1}{c} + \frac{l}{g}\right) x^{IV} + \frac{m_1 l}{cg} x^{VI}. \qquad (39)$$

Given the expressions (3) - (5) and (37) - (39), the boundary conditions (19) have the form:

$$\begin{cases} t = 0; x = 0; \dot{x} = 0; \ddot{x} = 0; \dddot{x} = 0; x^{IV} = 0; x^{V} = 0; \\ t = t_1; x = \frac{Vt}{2}; \dot{x} = V; \ddot{x} = 0; x^{IV} = 0; x^{V} = 0. \end{cases} \qquad (40)$$

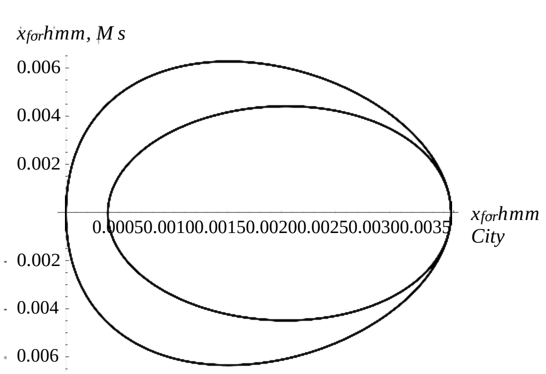
Usebecoming toISHCHth UMOyou tocasaneither (40), edgemo Retrievedand next grafics, asand Convidnyyprocwith xarakteryzuyut puUWC bridge crane (Fig. 2, Fig. 3).



and to to

Ric. 2. Schedule changes: a) the speed of the bridge crane, b) since the drive motor, c) dynamic force acting on the valve.

Yesconditions and ensure the fluctuations of the bridge's ultimate beams and load fluctuations relative to the bridge after the start of the process.



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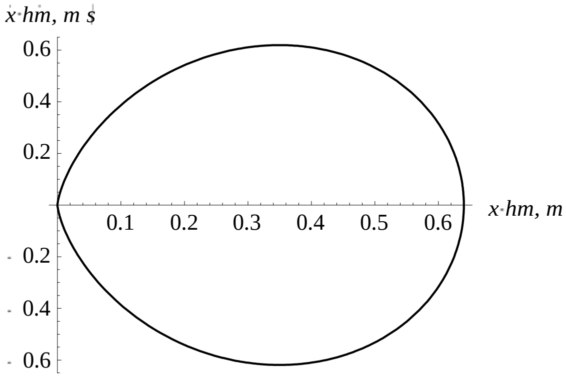

to

Ric. 3. Phase portrait of motion: a) load, b) bridge crane.

Conclusion. Hand a mathematical model of the dynamics of traffic traveling crane with a load on a flexible suspension and electrical characteristics of induction motor with squirrel cage, made optimization mode start-up that reduces to a minimum the dynamic stresses in metal. From the resulting phase portrait shows that after the start-up process variations in cell crane removed.

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In the work task solutions mynymyzatsyy intensity of horizontal Changed in nahruzok element metallo constructions tap Start ego in the process. Postavlennaya problem solutions with pomoshchju method varyatsyonnoho yschyslenyya. Result of the work proyllyustryrovaпы graphics, tap Start harakteryzuyuschye process with mynymalnoy yntensyvnostyu Dynamic Changes of horizontal loads.

Kradistrict, cart, Dynamic load, dynamycheskaya model Present Massa, beam crane, optimization.

The paper solved problem of minimizing intensity change of horizontal loads in metal elements of crane during its start-up. Tasked solved by method of calculus of variations. The work illustrated with diagrams, describing process of launching crane with minimal change in intensity of horizontal dynamic loads.

Crane, trolley, dynamic loading, dynamic model, reduced weight, beam crane, optimization.

UDC 378.4: 63: 631.3

Information and communication TECHNology in teaching technical subjects in EDUCATIONAL INSTITUTIONS I-II OF ACCREDITATION

T.YU. Osipova, Candidate of Science AA Zabolotko, Ph.D.

Fulfilltion analysis software teaching tools used in agricultural education. We consider information and communication tractor-driver training in agricultural production.

Information and communication technologies, programmable didactic materials, profession, tractor-driver curriculum.

Resolutionska problem. Deepand and dynamic changes occurring in agricultural economics, intellectualization of labor, the development of computer technology and information and communication technologies, development of market relations lead to the urgent need for training future agrarian accordance with