regionэtyh parameters and values obespechyvayuschyh Implementation optimal mode of motion on Dynamic Criteria. Showing Results solutions hrafycheskymy dependence.

Cart, Cargo, fluctuations, optymalnыy mode Stability parameters.

These papers investigate impact of natural oscillations frequency and ratio between masses of trolley and load optimal dynamic motion. Areas of these parameters values which support optimal mode of motion for dynamic criteria. The results are shown graphically.

***Trolley, cargo, oscillations, optimal mode, parameters stability**.*

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MatATYCHNA MODEL contaminant separation process intensification FROM root vegetables

VM Baranowski, PhD Ternopil National Technical University named after Ivan Pul'uj

The method of developing deterministic mathematical models describing contaminant separation process intensification heap of root crops combined working bodies of transport and technological systems adapted root crop machinery.

Woroch root process, flow, input supply, components impurities differential equation.

Resolutionska problem. Barelyvnym criterion further intensification of the modern development of agricultural production is the material base of mechanization of production processes based software design and implementation of highly efficient energy-saving technology products harvesting crops [1].

The technological process of production of root crops, such as sugar, feed, table beets and carrots, which are valuable raw materials, feed and food crops, one of the
most labor-intensive operations are mechanized harvesting, which accounts for about 25 ... 40% of labor costs.

PROBLEMSma thathnichnoho KM, perser criterionwe VHIncas Wormsx showingers even dig separation of impurities from the roots, is particularly a relevanttion in terms of further development of the root crop technology, development and production of which in Ukraine in recent years almost stoply.

Suchadream machine direction of root crop (KM) provide the development and introduction of energy-saving agricultural production machines that are adapted to the simultaneous collection of roots of different cultures adapted root crop machine (AKM) [2].

AnaLease Finalnnih lit.idzhen. Rezultaty, asand CategoriesAveDenis to laborx [3, 4, 5, 6] comprehensively characterize only the basic principles of vykopuvalnyh and treatment of workers without criteria analysis of general trends and ways to improve the process of cleaning intensyfikatsiy Root of impurities or quality of AKM.

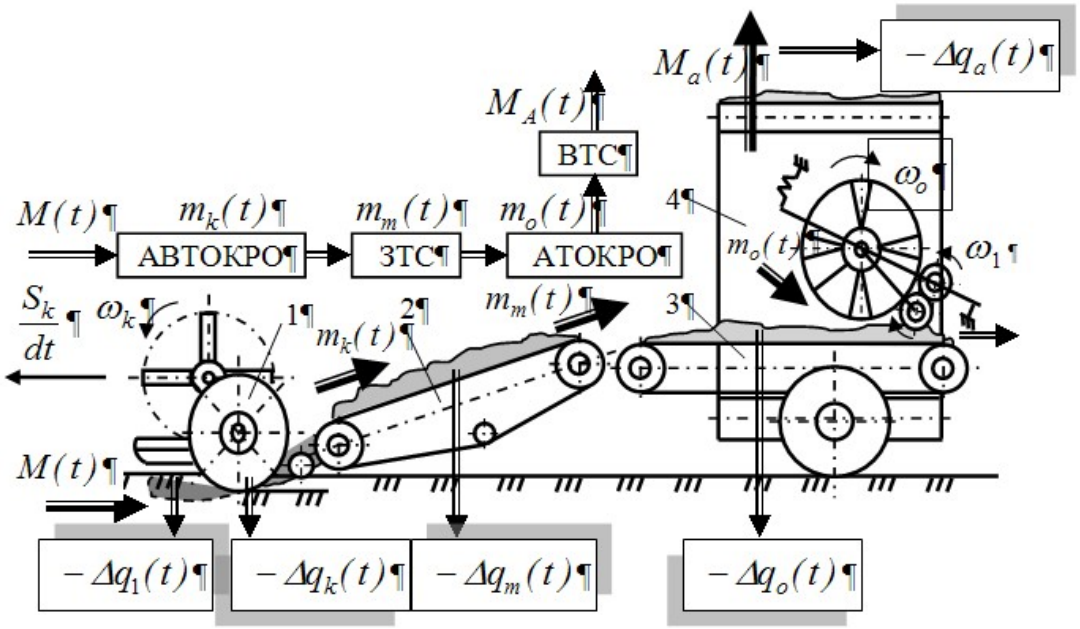
In the overall context of the complexity of the heap cleaning potatoes (VC), which is dug working bodies of hruntovo- Root environment functionally related to the need of significant separation of different in their physical and mechanical properties of soil conditions and plant impurities (4 ... 8 kg / p.m), which are relatively free of roots (Loose soil, small (20 ... 50 mm) and large (up to 100 mm) clumps of soil lost tops, weeds) and bound (adhering soil on the side of the body and remains tops in heads Koreneplodiv) states [7]. Therefore, the development and improvement construktyvno-Layouts AKM parameters and rationale of their work should be carried out taking into account the specific features of the environment that are particularly important and urgent for the cleanup heap, which comes quite a large amount of impurities VC (impurities soil - up to 80 ... 90% in including adhering soil - 3 ... 5% vegetable matter - 10 ... 15% residue on the tops heads roots - 5 ... 10% relative to the percentage of total VC impurities that are 30 ... 40%, depending on the circumstances of KM □7□) and the required quality of performance in accordance with the requirements of cultural practices.

Metand lit.idzhen. Pidvyschennya indicators thatproces processin the collection of roots through the development and optimization of the combined work of ACN.

Yesneither toslidzhennya there is hearthlshym Rosement noisedolohiyi tand technological aspects of methodology development processes

functioningof workers of transport and technological systems (TTS) AKM intended for simultaneous collection of sugar beet and potatoes, fodder beet and carrot.

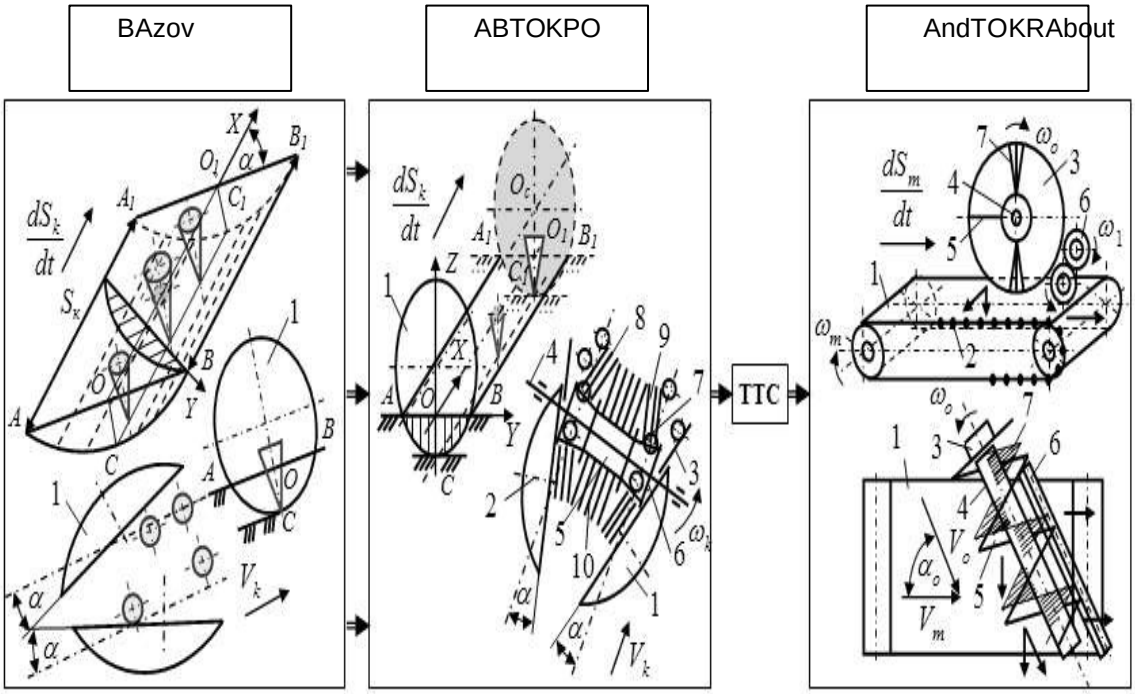
Rezultaty lit.idzhen. Dla Providetion pickstion Koreneplodiv sugar, fodder beet and carrot root crop one machine was developed structural and technological scheme AKM (Fig. 1), which is based on a modular blochno-. It consists of consecutive blocks PTS: vykopuvalnoho adapted transport and cleaning combined working organ (AVTOKRO) 1, connecting transport system (ZTS) 2 adapted transport and cleaning combined working organ (ATOKRO) 3 paged transport system (PTS) 4 .



Ric. 1. Structural and functional diagram of process intensification separation of impurities from the heap roots.

Funktsionalna scheme intensify the process of separating impurities from Root working bodies AKM involves three main stages and a final stage of purification from impurities dug VC: intensification stage VC dug purification from impurities in the process of excavation work by AVTOKRO 1; free separation of small impurities in the process of moving a connecting link ZTS 2, which is located between AVTOKRO ATOKRO and 3; intensification phase separation of impurities from the VC in the process of cleaning ATOKRO working bodies; the final stage of separation of impurities in the free download of roots working bodies PTS 4.

DTo build a deterministic mathematical model of the process of intensification of separation of impurities from VC PTS AKM zmodelyuyemo functional process of ACN as a complex dynamic technical system. Sectional flowchart process intensification separating impurities from PTS MC working bodies AKM shown in Fig. 2.



Ric. 2. The sectional block diagram of process intensification separating impurities from VC: AVTOKRO 1 - spherical disc; 2 - axis rotation of the disk; 3 - korenenapryamnyk; 4 - drive shaft;
5- Three-section drum; 6 - flange; 7 - axis; 8, 9, 10 - respectively, the elastic blade left, right, middle section; ATOKRO 1 - feeding conveyor; 2 - rod; 3 - screw; 4 - drum; 5 - turn the screw; 6 - vidmynalni rollers; 7 - elastic cleaning elements.

Andntensyfikatsiya process of separating impurities from VC AKM next working bodies. When moving spherical ACN
disc 1 (Fig. 2) digs in the number of $M(t)$ (Ric. 1) coming to
VC
Workings of AVTOKRO 1 wherein the impurities in the number $q_k(t)$
separated from the VC, that is the first stage of separation of soil and plant impurities from the roots, which is implemented as follows: by sieving of loose soil dug free and free small vegetable impurities in the translational and rotational movements of the disk; by separation of root crops residues tops of their heads and adhering soil due to the contact interaction of elastic blades

9, 10 (Fig. 2) drive shaft 4. In the second stage VC in number $m_k(t)$ (Ric. 1) enters the ZTS 2, where the impurities in the number $q_m(t)$ separated from the VC due to partial screening of small free

Decemberntovyh and roSalivary daboutbag
in clearanceand between MDPtkamy

Maynsportera. Later in the number of VC $m_n(t)$ remischuyetsya to Working3 of ATOKRO's where the impurities in the number $q_b(t)$ separated from the VC, that is the third stage of separation of soil and plant impurities from the roots, which is implemented as follows: by sifting free of loose soil and free small vegetable impurities in the gaps between the rods 2 (Fig. 2) supplying conveyor 1, or imposed on him AKM limits through the gap between the lower vidmynalnyh Rollers 6 and working branch transporter 1; by separation of root crops and residues adhering soil tops of their heads by, respectively, the contact interaction of elastic elements 7 treatment and removal of residues tops by vidmynannya vidmynalnymy

6. Further rollers in the number of $m_o(t)$ Categorieshellcomes to working bodies – VC

VTC 4 (Ric. 1), where Chastyna daboutbag $q_a(t)$ in forilkosti

separated from In theK, That is,about moDBUvayetsya Zaklyuchnyy ETAMr. separation of free soil and plant impurities from VC for raexpense of screening at boot time in the number of VC $M_a(T)$ in Maynsportnyy agent.

In theconsider, that before the digging of roots AKM input supply VC, which is associated with time $t$and widths AVTOKRO, abO lines with adequate N_kThat dug simultaneously is $M(t)$ tand consists of the sum of the incoming mass of roots $m_1(t)$ tand the total mass of $m_2(t)$. Accepted basic assumptions impurities

uo mass of roots $m_1(t)$ in procSea of movement of orgawe AKM changed only during excavation AVTOKRO (loss) and constituents $m_2(t)$ there is free and bound to

Koreneplodamy total ground $m_\rho(t)$ tand $m_p(t)$ impurities. Sumarneither rosalivary

In the general context based on the mass balance equation change byshaping overall migra-

onhouses des y
entranceidnoyi masi crib
VC edl
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$M(t)$ to AVTPrivately fromand Chawith

$$\frac{dM}{dt} = \frac{dm_1}{dt} + \frac{dm_2}{dt} = \frac{dm_1}{dt} + \frac{d\left(m_{\rho} + m_p\right)}{dt} = \frac{dm_1}{dt} + \frac{d\left(m_{1\rho} + m_{2\rho} + m_{3\rho} + m_{1p} + m_{2p}\right)}{dt}, \quad (1)$$

where – entranceidna mass of roots and impurities that dug

m_1, m_2

WorkingWe AVTOKRO bodies; m_ρ, m_p – entranceidna total weight soil and plant impurities; $m_{1\rho}$, $m_{2\rho}$, $m_{3\rho}$ – entranceidna plenty of spare loose soil clods of soil and soil adhering to the underground Chastyni Root; m_{1p}, m_{2p} – entranceidna free herbal weight contaminants and residues heads on tops of root crops.

Pivnyannya material balance technological change in mass flow over time $t$fromworthy of [8] each stage of process intensification separation of impurities from dug VC (Fig. 1) are as follows:

$$\left.\begin{aligned} & m_k(t) = M(t) - \Delta q_1(t) - \Delta qk\,(t); \\ & m_m(t) = m_k(t) - \Delta qm\,(t) = M(t) - \Delta q_1(t) - \Delta qk\,(t) - \Delta qm\,(t); \\ & m_o(t) = m_m(t) - \Delta q_o(t) = M(t) - \Delta q_1(t) - \Delta qk\,(t) - \\ & \quad - \Delta qm\,(t) - \Delta q_o(t); \\ & MA\,(t) = m_o(t) - \Delta qa\,(t) = M(t) - \Delta q_1(t) - \Delta qk\,(t) - \\ & \quad - \Delta qm\,(t) - \Delta q_o(t) - \Delta qa\,(t) \end{aligned}\right\} \quad (2)$$

where $m_m(t)$, $m_o(t)$, $MA(t)$ – tosidna amount of flow components VC $m_k(t)$, Sectionislya of AVTOKRO, ZTS, ATOKRO, MTC; $\Delta q_k(t)$, $\Delta q_m(t)$ $\Delta q_o(t)$, , Δqa – modokremlena forilkist flowin tobag In theK (t) workingand orgaus AVTPrivately,FromTC ATPrivately, MTC; $\Delta q_1(t)$ – forilkist Lost flow Root AVTOKRO working bodies.

Thendi fromworthily from (1), (2) Closedidne Initialve diferentsialne pivnyannya materialnoho pointsNSO frommines toandderivatives flowin thatproces weight over time tOr intensifying the process of separating impurities from VC working bodies each TTS and AKM in general is:

$$\left.\begin{aligned} & \frac{dm_k}{dt} = \frac{dM}{dt} - \frac{d(\Delta q_1 - \Delta q_k)}{dt}; \\ & \frac{dm_m}{dt} = \frac{dmk}{dt} - \frac{d\Delta q_m}{dt} = \frac{dM}{dt} - \frac{d(\Delta q_1 + \Delta q_k)}{dt} - \frac{d\Delta q_m}{dt}; \\ & \frac{dm_o}{dt} = \frac{dmm}{dt} - \frac{d\Delta q_o}{dt} = \frac{dM}{dt} - \frac{d(\Delta q_1 + \Delta q_k)}{dt} - \frac{d\Delta q_m}{dt} - \frac{d\Delta q_o}{dt}; \end{aligned}\right\} \quad (3)$$

$$\frac{dM}{dt} \quad \frac{dm}{dt} \quad \frac{d\Delta q}{dt} \quad \frac{dM}{dt} \quad \frac{d}{dt}(\Delta q + \Delta q) \quad \frac{d\Delta q}{dt}$$

$$\frac{d\Delta q}{dt}_{a} = \frac{d\Delta q}{dt}_{o} - \frac{d\Delta q}{dt}_{a} = \left| \frac{d\Delta q}{dt} - \frac{d\Delta q}{dt}_{1k} - \frac{d\Delta q}{dt}_{mo} - \frac{d\Delta q}{dt}_{a} \right|_{dt}$$

ababout from torainto account skmodal componentiv In theK tand components componntiv impurities VC, ie

$$\frac{dM}{dt}_{a} = \frac{d(m_1 + m_2)}{dt} - \frac{d(\Delta q_{1} + \Delta q_{1\rho k} + \Delta q_{2\rho k} + \Delta q_{3\rho k} + \Delta q_{1pk} + \Delta q_{2pk})}{dt} - \frac{d(\Delta q_{1\rho o} + \Delta q_{2\rho o} + \Delta q_{3\rho o} + \Delta q_{1po} + \Delta q_{2po})}{dt} - \frac{d(\Delta q_{1\rho m} + \Delta q_{1pm})}{dt} - \frac{d(\Delta q_{1\rho a} + \Delta q_{1pa})}{dt} \quad (4)$$

where $\Delta q_{2\rho k}$, $\Delta q_{3\rho k}$, Δq_{1pk}, Δq_{2pk}; $\Delta q_{1\rho o}$, $\Delta q_{2\rho o}$, $\Delta q_{3\rho o}$, Δq_{1po}, $\Delta q_{2\rho o}$ - $\Delta q_{1\rho k}$,

separated plenty of spare soil clods of soil adhering soil in the underground of the root vegetable free of impurities, balances on tops of heads of roots ML: AVTOKRO;

ATOKRO; $\Delta q_{1\rho\, m}$, $\Delta q_{1p\, m}$ – modokremLena mass of free soil, free rosalivary impurities from ZTS $\Delta q_{1\rho a}$, Δq_{1pa} – modokremlena number VC;

Free soil, free from impurities plant VC PTS; Root AVTOKRO lost Δq_1 - weight.

Technological process of separation of impurities from Root the separateMy PTS or AKM in general accordance with the provisions of [7] is represented by the linear differential equation:

$$a^{(i)} d\left[\Delta q_i(t)\right] = b^{(i)} \left(t-\tau_m\right) - c^{(i)} \left(t\right)$$

$$m_0 \frac{}{dt} \quad {}_{0\ ent\ i\ 0}\ {}_{rance.i\ Closed.i}\ , \qquad (5)$$

where a^i_0, b^i_0, c_i – fromMine coefficients as a function of working parameters

orgabers ACN, mechanicsnight owandstyvostey DecemberNTU, urozhaynosti Koreneplodiv that determined experimentally; $\Delta q_i(t)$ - separate amount of flow of incoming VC working orgaAKM us, $i = 1, 2 \ldots n$; τ_i – Chas delay the flow of mass ML; $MW_{.i\,x}$ $mvyh._i(t)$ - The number of input and output mass flow VC. $\left(t-\tau_i\right)$,

ThenDJ for any i-On stabilized mode, when rejecting an incoming flows minor workflow PTS or AKM whole, taking into account (2), (4) and according to (5) is described by the differential equation:

$$a_1^{(k)} \frac{d\left[\Delta q(t)\right]}{dt^1} + a_{1\rho}^{(k)} \frac{d\left[\Delta q(t)\right]}{{}_1 dt^k} = a_{1\rho}^{(k)} \frac{d\left[\Delta q(t)\right]}{dt^1} + a_{1\rho}^{(k)} \frac{d\left[\Delta q_{1\rho k}(t)\right]}{dt} +$$

$$+ a_{2\rho}^{(k)} \frac{d\left[\Delta q_{2\rho k}(t)\right]}{{}_\rho dt^0} + a_3^{(k)} d\left[\Delta q_{3\rho k}(t)\right] + a_{1p}^{(k)} d\left[\Delta q_{1pk}(t)\right] \qquad ; (6)$$

$$+ a^{(k)} \frac{d\left[\Delta q_{2pk}(t)\right]}{} = b\, M\left(t-\tau_m\right) - c^{(k)} \left(t\right)$$

$$a_0^{(m)} \frac{d\left[\Delta q(t)\right]}{dt^m} = a_{1\rho} \frac{d\left[\Delta q_{1\rho m}(t)\right]}{dt} + a_{1p} \frac{d\left[\Delta q_{1pm}(t)\right]}{dt} = \qquad ; \qquad (7)$$

$$= b_0^{(k)} m_k \left(t-\tau_m\right) - c_0^{(m)} m_m \left(t\right)$$

$$a^{(o)} \frac{d\left[\Delta q(t)\right]}{dt} \quad {}_{o\ (\rho)}\ d\left[\Delta q_{1\rho o}(t)\right]\ {}_{(\rho)}\ d\left[\Delta q_{2\rho o}(T)\right]\ {}_{(o)}\ d\left[\Delta q_{3\rho o}(T)\right]$$

$$= a_{1\rho} \qquad a_2 \frac{+}{\rho} \frac{}{3p\,dt} + a \frac{}{dt} + ; \qquad (8)$$

$$+ a_{1p}^{(o)} \frac{d\left[\Delta q_{1po}(T)\right]}{dt} + a_{2p}^{(o)} \frac{d\left[\Delta q_{2po}(T)\right]}{dt} = b_0^{(m)} m_m \left(t - \tau_o\right) - c_0^{(o)} m\left(t\right)_o$$

$$a_0^{(a)} \frac{d\left[\Delta q(t)\right]}{dt} = a_{1\rho}^{(a)} \frac{d\left[\Delta q_{1\rho o}(t)\right]}{dt} + a_1^{(a)} \frac{d\left[\Delta q_{1po}(t)\right]}{dt} = ; \qquad (9)$$

$$= b_0^{(o)} m_o \left(t - \tau_a\right) - c_0^{(a)} M_A \left(t\right)_p$$

$$
\begin{aligned}
&a_1^{(k)}\frac{d[\Delta q_1(t)]}{dt}+a_0^{(M)}\frac{d[\Delta q_M(t)]}{dt}=a_1^{(k)}\frac{d[\Delta q_1(t)]}{dt}+a_0^{(k)}\frac{d[\Delta q_k(t)]}{dt}+\\
&+a_0^{(m)}\frac{d[\Delta q_m(t)]}{dt}+a_0^{(o)}\frac{d[\Delta q_o(t)]}{dt}+a_0^{(a)}\frac{d[\Delta q_a(t)]}{dt}=\\
&=a_1^{(k)}\frac{d[\Delta q(t)]}{dt}+a_{1\rho}^{(k)}\frac{d[\Delta q_{1\rho k}(t)]}{dt}+a_{2\rho}^{(k)}\frac{d[\Delta q_{2\rho k}(t)]}{dt}+a_{3\rho}^{(k)}\frac{d[\Delta q_{3\rho k}(t)]}{dt}+\\
&+a_{1p}^{(k)}\frac{d[\Delta q_{1pk}(t)]}{dt}+a_{2p}^{(k)}\frac{d[\Delta q_{2pk}(t)]}{dt}+a_{1\rho}^{(m)}\frac{d[\Delta q_{1\rho c}(t)]}{dt}+a_{1p}^{(m)}\frac{d[\Delta q_{1pc}(t)]}{dt}+,\\
&+a_{1\rho}^{(o)}\frac{d[\Delta q_{1\rho o}(t)]}{dt}+a_{2\rho}^{(o)}\frac{d[\Delta q_{2\rho o}(t)]}{dt}+a_{3\rho}^{(o)}\frac{d[\Delta q_{3\rho o}(t)]}{dt}+a_{1\rho}^{(o)}\frac{d[\Delta q_{1\rho o}(t)]}{dt}+\\
&+a_{2p}^{(o)}\frac{d[\Delta q_{2po}(t)]}{dt}+a_{1\rho}^{(a)}\frac{d[\Delta q_{1\rho a}(t)]}{dt}+a_{1p}^{(a)}\frac{d[\Delta q_{1pa}(t)]}{dt}=\\
&=b^{(k)}M(t-\tau_k)-c^{(k)}m(t)+b^{(m)}m(t-\tau_m)-c^{(m)}m(t)+\\
&+b^{(o)}m(t-\tau_o)-c^{(o)}m(t)+b^{(o)}m(t-\tau_o)-c^{(a)}M(t)
\end{aligned}
\qquad (10)
$$

where $a_1^{(k)}, a_0^{(k)}, a_0^{(m)}, a_0^{(o)}, a_0^{(a)}, b^{(k)}, b^{(m)}, b^{(o)}, c^{(k)}, c^{(m)}, c^{(o)}, c^{(a)}, a_{1\rho}^{(k)}, a_{2\rho}^{(k)}, a_{3\rho}^{(k)}, a_{1p}^{(k)}, a_{2p}^{(k)}, a_{1\rho}^{(m)}, a_{1p}^{(m)}, a_{1\rho}^{(o)}, a_{2\rho}^{(o)}, a_{3\rho}^{(o)}, a_{1p}^{(o)}, a_{2p}^{(o)}, a_{1\rho}^{(a)}, a_{1p}^{(a)}$ – fromMine coefficients in functionsher working parameters of ACN: AVTOKRO; ZTS; ATOKRO; MTC, physical and mechanical properties of the soil, yield of roots, etc., which are determined experimentally;

$\tau_k, \tau_m, \tau_o, \tau_a$ – Chawith the delay of the mass movement of VC in the process, which is due to accumulation, compression, shear, etc. technological mass VC in the work area, respectively, PTS and AKM in general.

Podalshyy solution of equations (6) - (10) can be carried out byapplication of direct and inverse Laplace transform.

Conclusion. The resulting linearized differential equations (6) -(10) Is a deterministic mathematical models describing the dependence of the intensification of the process flow separation of the components of the VC dug during the time of structural and kinematic parameters of the PTS working and AKM in general and their working conditions, which (terms) according to the terminology of technical and scientific publications include PTS modes and AKM, agronomic and physical and mechanical characteristics of roots and physical properties of soil.

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The method development determynyrovannыh mathematical models, kotorые opysыvayut yntensyfykatsyyu process otdelenie impurities from heap korneplodov kombynyrovannыmy workers by transport and of technological systems adaptyrovannoy korneuborochnoy machine.

Woroch korneplodov, of technological process, flow, Input Massa, The components heap, dyfferentsyalnoe equation.

The method of development of determined mathematical models which describe intensification of process of separation of admixtures from lots of root crops combined workings organs of transport-technological systems of the adapted root-harvesting machine is pointed.

Beet-root tops, technological process, stream, entrance mass, components of lots, differential equalization.

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631.3

METOde flaw FOR DAMAGE DETECTION operational in detail and structural MOBILE AGRICULTURAL MACHINES

OV Voinalovych, Ph.D.