In paper the scientific and applied aspects of the use of modern methods of economic evaluation and analysis of innovative-investment projects are analyses in the process of management by innovative activity of enterprises and reasonably authorial going near the decision of separate debatable questions implant their practical application .

Innovations, investments, projects, enterprises, discounted cash flows, net present value, internal rate of return*.*

UDC 621,923

Development of mathematical models of deformation LOADING OF WORKING WITH VIBROOBROBTSI AGRICULTURAL MACHINERY

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The mathematical model of deformation loads at vibroobrobtsi work of agricultural machinery that allows for the transition of power in plastic and pruzhnoplastychnu strain, allowed to analyze the impact of processing parameters and set the frequency of the load has virtually no effect on the changes in the working layer, while the amplitude and time have a significant impact strengthening the processes.

Formulation of the problem.

This method is widely used to strengthen local critical parts, but a number of issues devoted to defining the optimum treatment regime based on an analysis of theoretical models of the process have been insufficiently studied. Existing models relate mainly to the deformation process and does not take into account the peculiarities of vibration tools.

The purpose of research - Development of a mathematical model of deformation under load vibroobrobtsi work of agricultural machinery

Material and methods of research. To strengthen the vibration treatment applied to specially made stand with a frequency of 10-35 Hz deformation (700-2000 cycles per minute), 0,25-0,75 mm amplitude with

a specific pressure of 1.42 MPa within 20-30 with. The design of the stand included the installation of two discs - creating a strengthened and vibration on the cutting edge. Before processing vibration disk sandblasted subjected to conventional modes. To investigate the influence degree of strengthening vibroobrobkoyu examined samples of steel 10. Steel according to GOST 1050, contains,%: C 0,07-0,14, 0,05-0,17 Si, 0,35-0,65 Mn, to 0,15 Cr, rest iron. The investigated samples belonged to one of the swimmers and contained,% C 0,10, 0,05 Si, 0,45 Mn, 0,05 Cr. Completed evaluation of such opportunities to strengthen steel vibroobrobkoyu inner surface of the cylindrical sample.

Results. This article examines the rod loaded with concentrated force (P), which varies in time according to the law $P\sin\omega t$. This experiment was conducted in the study of plastic deformation and hardening of metals. Analyzing the impact of processing parameters revealed that the frequency of load virtually no effect on the expansion of the sample with such a deformation, while the amplitude and time had a significant impact.

By cyclic loads, in particular, forced vibrations. Thus, there is a transition of power from the external applied force. Clearly, some of it goes into the kinetic energy is spent on overcoming the resistance of the material, and a large part is converted into heat, which corresponds to a basic representation [5]. However, this assumption is not confirmed. As shown by our study of the energy goes into plastic deformation and pruzhnoplastychnu. This process is accompanied by structural changes and phase transformations.

Analyze (without vibrations) is one of variational principles of equilibrium in which potential energy is the entropy [6]

$$Entr = Py - E(\frac{y}{h} + y_1)^2 Fh = \min , \qquad (1)$$

where: P - External force; E - Modulus of elasticity; F - Square rod; h - Height rod; y - Move in the cyclic deformation; y_1 - Residual deformation.

Differentiate (1) to y and equate the derivative to zero:

$$\frac{dEntr}{dy} = P - 2E(\frac{y}{h} + y_1)F = 0 . \qquad (2)$$

Get:

$$y = \frac{P - 2EFy_1}{2EF}h . \qquad (3)$$

Framed (3) (1), we get:

$$Entr_{\min} = \frac{Ph(P - 4EFy_1)}{4EF} . \qquad (4)$$

The second component in (1) $-E(\frac{y}{h} + y_1)^2 Fh$ turns to $-\frac{P^2}{4EFh}$ That is

not dependent on y_1. With increasing y_1 entropy decreases linearly, and work elastic strain remains constant. Denote the number of i deformation cycle, and a $x_i = \dfrac{y_i}{h}$ - on i-in room cycle. Then:

$$x_i = \frac{y_i}{h} = \frac{P - 2EFy_{1i}}{2EF}.$$ (5)

The basic idea is that the hypothesis used by which each cycle is accumulated residual deformation based relationship:

$$y_{1i+1} = y_{1i} + kx_i ,$$ (6)

where: k - A ratio that can be selected with the experimental data.

Let reduce for recording (see. Equation (5)).

$$a = \frac{P}{2EF}.$$ (7)

Then,

$$x_i = a - y_{1i},$$ (8)

$$y_{1i+1} = y_{1i} + kx_i = y_{1i} + \frac{k}{h}y_i = y_{1i-1} + \frac{k}{h}(y_{1i-1} + y_i) = \ldots = y_{11} + \frac{k}{h}\sum_{j=1}^{i} y_j .$$ (9)

Then we can write inequality:

$$y_{11} + \frac{k}{h}\sum_{j=1}^{i} y_{\min} \le y_{1i+1} \le y_{11} + \frac{k}{h}\sum_{j=1}^{i} y_{\max} ,$$ (10)

and

$$y_{11} + i\frac{k}{h}y_{\min} \le y_{1i+1} \le y_{11} + i\frac{k}{h}y_{\max} .$$ (11)

It seems that y_{1i} and y_i connected close to a linear relationship. To use these formulas counted value output dependencies for $E = 21000\dfrac{\kappa\Gamma}{\text{мм}^2}$, $F = 1\text{мм}^2, h = 5\text{мм}$. Size k changed from $2500 \cdot 10^{-9}$ to $20000 \cdot 10^{-9}$ increments $2500 \cdot 10^{-9}$.

For everyone k calculated three treatment options based on the different behavior of structural composite materials (ferrite, pearlite, austenite and looked Ntsykl = 0, 50,000 and 100,000 cycles.

From the data it appears that the increasing number of cycles i size y_{1i} grows, and y_i decreases. Entropy (potential energy $Entr = Py_i - EFh(\dfrac{y_i}{h} + y_{1i})^2$) Decreases, job strain $EFh(\dfrac{y_i}{h} + y_{1i})^2$ unchanged (Table. 1, Tab. 2).

With calculation formulas mean that with the growth factor k value $EFhy_{1i}^2$ just close to that of $2EFhy_iy_{1i}$. Probably, there is perenaklep metal as evidence of significantly reduced or even become negative.

Using the same source data, but with a greater sample size for the number of cycles of Influence k and the degree of load using regression analysis (least squares method). Calculations showed that both factors k

and Ntsykl important and they the same order. In addition, it is shown that the linear regression model is acceptable for such tasks. The correlation coefficients are within 0.87 - 0.96. Noteworthy is the fact that the marks at equal coefficients, which means there is a direct relationship between k and the number of cycles. It was considered more complex model for when k depends on the depth zone strengthening. The dependence may be different, but considered as an example of change k linearly.

1. Effect of loading cycles factors in the model analyzed.

The number of loading cycles (Ntsykl)	The results of calculation components of the model deformation vibrations, × 109						
	The remaining deformed-tion y_{1i}	True strain y_i	$EFhy_i^2$	$2EFhy_i y_{1i}$	$EFhy_{1i}^2$	Job strain $EFh(\frac{y_i}{h} + y_{1i})$	Potential energy - entropy $Entr = Py_i - EFh(\frac{y_i}{h} + y_{1i})^2$
2500	0	17238	1248	0	0	1248	1248
	209	16193	1101	142	5	1248	1097
	405	15212	972	259	17	1248	955
5000	0	17238	1248	0	0	1248	1248
	405	15212	972	259	17	1248	955
	763	13425	757	430	61	1248	696
7500	0	17238	1248	0	0	1248	1248
	589	1491	858	354	36	1248	821
	1078	11848	590	536	122	1248	468
10000	0	17238	1248	0	0	1248	1248
	763	13425	757	430	61	1248	696
	1357	10456	459	596	193	1248	266
2500	0	17238	1248	0	0	1248	1248
	925	12611	668	490	90	1248	578
	1602	9227	358	621	270	1248	88
15000	0	17238	1248	0	0	1248	1248
	1078	11847	589	536	122	1248	467
	1819	8143	278	622	347	1248	69
17500	0	17238	1248	0	0	1248	1248
	1222	11129	520	571	157	1248	364
	2010	7186	217	607	424	1248	-207
20000	0	17238	1248	0	0	1248	1248
	1357	10455	459	596	193	1248	266
	2179	6342	169	580	499	1248	-330

2. Impact factor k and the number of cycles Ntsykl factors in

the model.

numbers s / n	The regression equation factors model, × 109	significance		The correlation coefficient
		k	$Ntsykl$	
1	2	3	4	5
1	$y_{1i} = -408{,}369 + 0{,}039 \times k + 0{,}161 \times N_{цикл}$	5.52	5.77	0.95
2	$y_i = 19279{,}917 - 0{,}196 \times k - 0{,}803 \times N_{цикл}$	5.51	5.77	0.95
3	$EFhy_i^2 = 1474{,}274 - 0{,}024 \times k - 0{,}097 \times N_{цикл}$	6.31	6,64	0.96

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Continued Table. 2

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1	2	3	4	5
4	$2EFhy_i\,y_{1i} = -157{,}302 + 0{,}019 \times k + 0{,}078 \times N_{цикл}$	6,88	7.29	0.96
5	$EFhy_{1i}^2 = -69{,}223 + 0{,}005 \times k + 0{,}019 \times N_{цикл}$	2.54	2.59	0.87
6	$Entr = Py_i - EFh(\dfrac{y_i}{h} + y_{1i})^2 = 1543{,}488 - 0{,}028 \times k - 0{,}116 \times N_{цикл}$	5.51	5.77	0.95

The rod broke in height m Equal parts:

$$Entr_i = P\sum_{j=1}^{m} y_{ji} - EF\sum_{j=1}^{m}(\frac{my_{ji}}{h} + y_{1ji})^2 \frac{h}{m} = min \,, \qquad (12)$$

where: m - The number of divisions rod height; i - Number of the cycle; P - External force; E - Modulus of elasticity; F - Square rod; h - Height rod; y_{ji} - Move from a section number j; y_{1ji} - Residual deformation in a section with a number j.

Differentiate (12) to y and equate the derivative to zero:

$$\frac{dEntr_i}{dy_{ji}} = P - 2E(\frac{my_{ji}}{h} + y_{1ji})\frac{m}{h}F\frac{h}{m} = 0. \qquad (13)$$

Get:

$$y_{ji} = \frac{P - 2EFy_{1ji}}{2EF}\frac{h}{m}, \qquad (14)$$

$$y_{1ji+1} = y_{1ji} + k_j y_{ji} = y_{1ji} + k_j \frac{P - 2EFy_{1ji}}{2EF}\frac{h}{m}. \qquad (15)$$

If y_{1j} independent of j, The amount (14) to j also coincide exactly with (3). If y_{1j} depends on j (For this and brought the withdrawal of the formula (14)), the amount (14) to j in general, does not coincide with (3). Let substituting amount (3) (1), and obtain:

$$Entr_{mini} = \sum_{j=1}^{m} \frac{Ph(P - 4Ey_{1ji})}{4EF}. \qquad (16)$$

In the below graph (Fig. 1, Fig. 2) shows the true and residual strain y_j and y_{1j} Corresponding law changes k the depth of hardened layer vibration loading:

$$k_j = [10000 \pm (j-1)500] \cdot 10^{-9}.$$

In assessing the impact of 10,000 cycles used to strengthen the surface layer:

$$E = 21000 \frac{\kappa \Gamma}{\text{мм}^2}, F = 1\text{мм}^2, h = 5\text{мм}.$$

Residual strain in addition to strengthening and slander and accompanied by structural changes. In this case, the true strain can be equated with the average of the absolute values of Laplacian, and under residual - understand the changing structure (describing it, such as neutrality).
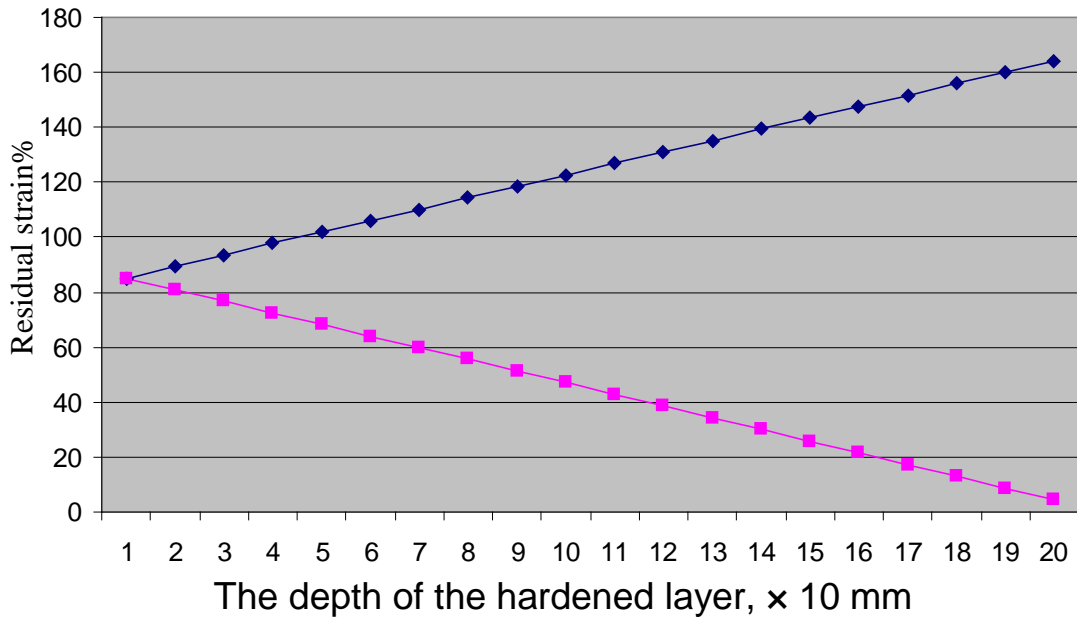

Fig. 1. Change the residual strain y_{1j} depending on the values k: ▪ - Coefficient of residual strain decreases (process zalichuvannya defects); ◆ - Coefficient increases (the consolidation).
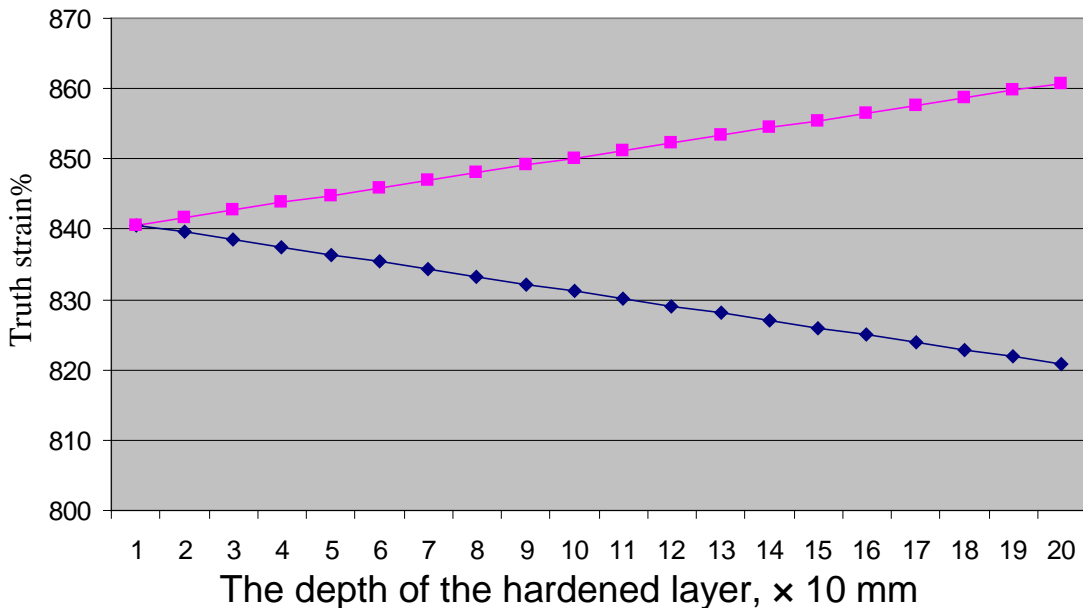

The depth of the hardened layer, × 10 mm

Fig. 2. Change the true strain y_{1j} depending on the values k: —■— - Coefficient of residual strain decreases (process zalichuvannya defects); —♦— - Coefficient increases (the consolidation).

Descending blue line corresponds to permanent deformation coefficient of reduction k, Red - the rise of permanent deformation of increase k. Accordingly, in the first case, the residual deformation depth increases, the second - decreases. Blue line to include zalichuvannya defects, and red - to strengthen. There is no contradiction with the average values of the received energy dissipation structures relevant photos.

Consider a similar model with residual effect after the cycle load. Given the strain rate:

$$Entr_i = P\Delta t \sum_{j=1}^{m} v_{ji} - F \sum_{j=1}^{m} S_j (v_{ji}\Delta t + l_{1ji})^2 \frac{h}{m} = \min , \qquad (17)$$

where: m - Number of partition rod height; i - Number of the cycle; P - External force; S_j - Kinematic viscosity of a section number j; F - Square rod; h - Height rod; Δt - Cycle time; v_{ji} - Velocity of a section number j; l_{1ji} - Residual movement in the number of the section j with cyclic deformation.

Differentiate (12) on derivative and equate to zero:

$$\frac{dEntr_i}{dv_{ji}} = P\Delta t - 2S_j\Delta t(v_{ji}\Delta t + l_{1ji})F\frac{h}{m} = 0 . \qquad (18)$$

Get:

$$v_{ji} = \frac{Pm - 2S_j Fhl_{1ji}}{2S_j Fh\Delta t} , \qquad (19)$$

$$l_{1ji+1} = l_{1ji} + k_j v_{ji}\Delta t = y_{1ji} + k_j \frac{Pm - 2S_j Fhl_{1ji}}{2S_j Fh} . \qquad (20)$$

Then $F \sum_{j=1}^{m} S_j (v_{ji}\Delta t + l_{1ji})^2 \frac{h}{m}$ independent of l_{1ji} .

The minimum entropy is:

$$Entr_{\min i} = \sum_{j=1}^{m} \frac{P(mP - 4S_j Fhl_{1ji})}{4S_j Fh} . \qquad (21)$$

Consider the equation of longitudinal vibrations of a rod. Previously considered the effect of cyclic loading on the rod without the inertial forces, but the process vibroobrobky their impact is significant. Excluding dynamic oscillation pattern changes in the structure of the metal will be incomplete. Consider a simple task:

$$-m\frac{\partial^2 y}{\partial t^2} + EF(y - \frac{P_{\min}}{EF}) = P_{\min} + (P_{\max} - P_{\min})|\sin \omega t| , \qquad (22)$$

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where: m - Weight; $-m\dfrac{\partial^2 y}{\partial t^2}$ - The product of the mass by the acceleration of the opposite sign - a force of inertia; E - Modulus of elasticity; F - Square rod; P_{min} - The minimum strength of the vibrator; P_{max} - The maximum power of the vibrator; $\dfrac{P_{min}}{EF}$ - Minimum displacement; y - The desired move; $EF(y-\dfrac{P_{min}}{EF})$ - Strength elastic resistance; $P_{min}+(P_{max}-P_{min})\left|\sin\omega t\right|$ - External variable power of the vibrator; ω - Frequency vibrator; t - Time.

The equation takes the form $-m\dfrac{\partial^2 y}{\partial t^2}+EFy=2P_{min}+(P_{max}-P_{min})\left|\sin\omega t\right|$.

Consider the difference scheme. Divide height rod h on n Equal parts of step $\Delta h=\dfrac{h}{n}$. So points with coordinates $y_{qi}=q\Delta h$ (index i refers to the time) attribute weight $m_q=\dfrac{\gamma F\Delta h}{g}$ Where: $\gamma=7850\cdot 10^{-9}\,\dfrac{\kappa\Gamma}{\text{мм}^3}$ - specific weight; g - Acceleration of gravity

For acceptable accuracy calculation time broke on a small number of steps: $\Delta t=2\pi\omega\cdot 10^{-6}$ with. Calculations showed that such a step on time, below difference scheme is stable.

The first time derivative in the form of difference in time i: $\dfrac{y_{qi-1}-y_{qi}}{\Delta t}$. The first derivative of the time difference in kind corresponds to time $i+1$: $\dfrac{y_{qi}-y_{qi+1}}{\Delta t}$. Subtracting the first and second formula for dividing Δt We obtain for the second derivative of the formula: $\dfrac{y_{qi-1}-2y_{qi}+y_{qi+1}}{\Delta t^2}$. Difference scheme is as follows:
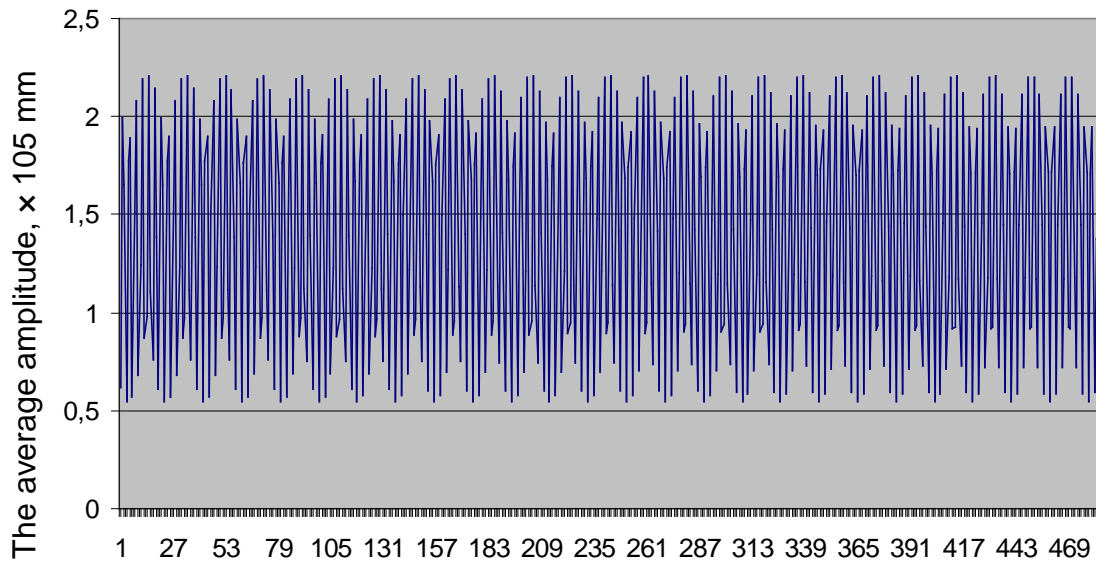
$$-m_q\frac{y_{qi-1}-2y_{qi}+y_{qi+1}}{\Delta t^2}+EFy_{qi+1}=2P_{min}+(P_{max}-P_{min})\left|\sin\omega i\Delta t\right|.\qquad (23)$$

Where,

$$y_{qi+1}=\frac{m_q(y_{qi-1}-2y_{qi})+[2P_{min}+(P_{max}-P_{mi\Delta B\Delta n})\left|\sin\omega i\Delta t\right|]\Delta t^2}{EF\Delta t^2-m}.\qquad (24)$$
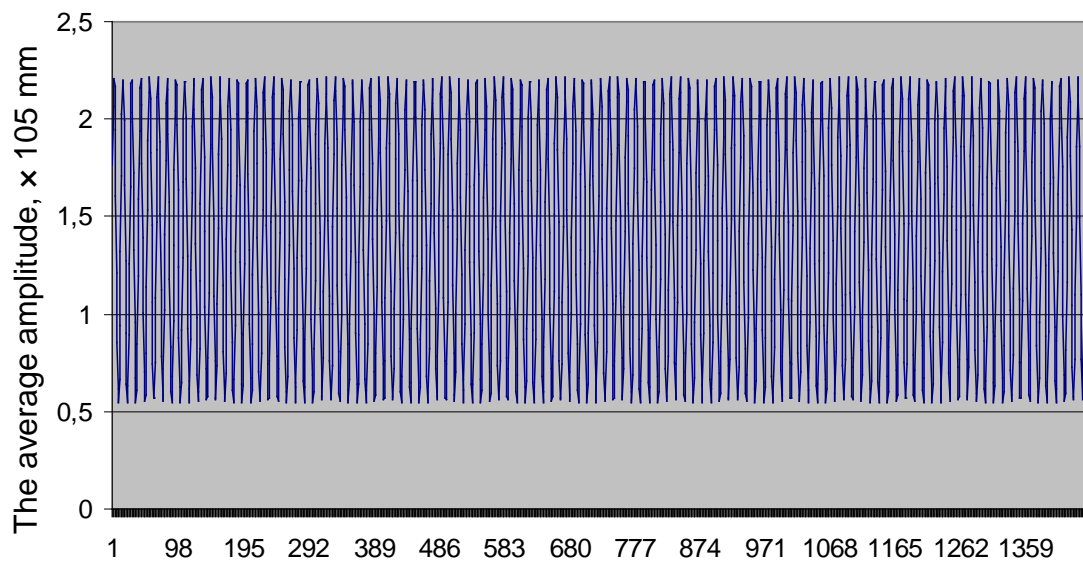
Put thus provides for the same task amplitude at all points of the rod (Fig. 3).

Fig. 3. The nature of the same amplitude oscillations with a frequency of 33 Hz.

The average amplitude for frequencies 33 Hz and 11 Hz was 1.379 $\cdot 10^{-5}$ mm.

Fig. 4. Nature amplitude oscillations with a frequency of 11 Hz.

Conclusion. For the first time developed a mathematical model of deformation loads at vibroobrobtsi work of agricultural machinery that allows for the transition of power in plastic and pruzhnoplastychnu strain revealed that the frequency of load 33 Hz and 11 Hz virtually no effect on the changes in the working layer, while the amplitude and time are essential impact on strengthening processes. Residual strain in addition to strengthening and slander and accompanied by structural changes. In

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this case, the true strain can be equated with the average of the absolute values of Laplacian, and under residual - understand the changing structure (describing it, such as neutrality).

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Razrabotanna matematycheskaya model deformatsyonnыh nahruzok at vybroobrabotke workers organs selskohozyaystvennoy technics kotoraja uchytыvaet switching parts of energy in plastychnuyu and upruhoplastycheskye deformation, pozvolyla proanalyzyrovat Effect parameters handling and establish, something frequency load Virtually no vlyyaet on Changes in workers sloe, zato amplitudes & Time ymeyut suschestvennoe Effect on uprochnenyya processes.

Disk digger, vybroobrabotka workers organs, matematycheskaya model deformatsyonnые nahruzhenyya.

The worked out mathematical model of the deformation loading at vibrotreatment of working organs of agricultural technique that takes into account passing of part of energy to plastic and pruzhnoplastychnu deformations allowed to analyse influence of parameters of treatment and set that frequency of loading practically does not influence on changes in a working layer, but amplitude and time have substantial influence on the processes of strengthening.

Disk, vibrotreatment of working organs, mathematical model, deformation loading.

UDC 631.3

Failure analysis tools for distribution PRYHOTUVANNYAI FEED

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