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Opredelenы statystycheskye characteristics lateral deflection angle trajectories Airplane semyan in vertykalnыh planes in relationships for tsentralnoj (teoretycheskoy) plane after oblique blow at semyan ploskuyu surface.

Obliquely blow traektoryya Airplane semyan, ugol lateral deflection, statystycheskye characteristics, utilization rate variation.

Identified the statistical characteristics of a lateral deviation angle trajectories seeds in vertical planes relative to the center (theoretical) after the oblique hitting a flat surface of the seed.

Oblique impact, Trajectory of seed, angle of lateral deviation, statistical characteristics, coefficient of variation.

UDC 534.1

DIRECT METHOD OF ANALYSIS MODES linearization stimulated (sub / SUPERHARMONICHNYH) VIBROUDARNYH VIBRATIONS MECHANICAL SYSTEMS

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The proposed method of direct linearization JG Panovka analysis modes super- and subharmonic forced oscillations in

vibroudarnyh systems. The resulting closed form solution by the action of an arbitrary periodic force.

Physical and mechanical modeling, mathematical and analytical software, computer aided design (CAD), vibroudarni mechanical system, method, direct linearization, analysis, profiles, forced oscillations, super- and subharmonic modes closed form solution, the effect of periodic power.

Problem. Modern systems and vibration protection vibrotehniky usually is nonlinear, ie those in which no linear reconstructive-regenerative force is not small.

Analysis of a large number of exact solutions in nonlinear non-autonomous oscillating systems suggests that basic nonlinear effects in these systems is a manifestation of internal vibrational properties of the system, ie free oscillations. This approach assumes that in systems with fluctuating decisive role played by the elastic restoring force. Therefore, it is possible based on the analysis of free oscillations of the system parameters and involuntary force allow for certain nonlinear effects without the usual mathematical transformations. In this work are found in close to exact periodic solutions of forced oscillations (and superharmoniynyh sub) systems with standard piecewise linear elastic characteristics. Since the mechanical oscillating system is often rude systems, the existence of approximate solutions and construct maps of areas that attract periodic regimes for systems with different typical nonlinear characteristics allow confident enough to predict the behavior of other relatives nonlinearities, for which exact solutions unknown.

Analysis of recent research. There are many exact and approximate methods for studying these systems [1, 2]. However, no reasonable methods of analysis and sub superharmonichnyh nonlinear oscillations (vibroudarnyh) systems, which would be based on an analytical approach without using a PC.

The purpose of research. Explore forced modes (sub / superharmoniynyh) fluctuations in nonlinear systems with viscous friction by direct linearization JG Panovka [1]. It can get a closed form solution by the action of an arbitrary periodic forces [3].

Results. The object of study. The equations of motion oscillatory system with one degree of freedom of movement.

In the study of oscillatory processes that occur in the machines and mechanisms for building industry (and in particular, construction materials, mixtures, etc.), It is usually possible to distinguish three groups of forces that determine the behavior of dynamic systems: 1) Recover elastic; 2) dissipative; 3) forced labor. In this approach, the equations of motion oscillatory system with one degree of freedom can be written as:

$$m\ddot{x} + f(x) + R(x,\dot{x}) = H(t), \qquad (1)$$

where $x-$generalized (linear) coordinate; $m-$weight; $f(x)-$Healing elastic force (elastic response); $R(x,\dot{x})-$ power dissipation (dissipative characteristics); $H(t)-$periodic external force (forced power) period T.

In cases where the system (1) is a linear (or made its linearization by JG Panovka [1]), $f(x) = \tilde{p}^2 x,$ and $R(x,\dot{x}) = 2\tilde{n}x,$ and it established a period of periodic oscillations (eg, multiple period of involuntary force H (t)).

The procedure of direct linearization (by JG Panovkom [1]) for systems with analytical elastic characteristics.

In [2] The exact value for the frequency of free oscillations of nonlinear systems (p). However, there are many methods of finding the approximate frequency of free oscillations in such systems based on linearization elastic characteristics. At this point the work the method of direct linearization proposed JG Panovkom [1]. This method of determining the dependence $p(a)$ (Where $a-$free oscillation amplitude) with significant ease has, in addition, is also highly accurate. In some cases, the accuracy of the method of direct linearization accuracy than most widespread method of harmonic linearization [4, 5].

According to the method of direct linearization [1], the frequency of free oscillations for a symmetric system (ie, $f(x) \equiv -f(-x)$) determined by the formula:

$$p^2 = \frac{5}{a^5}\int_0^a f(x)\cdot x^3 dx; \qquad (2)$$

for asymmetric (ie, $f(x) \neq -f(-x)$) Is defined by the formula:

$$p^2 = \frac{5}{2a^5}\int_{-a}^{a} f(x_1 - \Delta a)\cdot {x_1}^3 dx_1,$$

(3)

where

$$\Delta a = (a_2 - a_1)/2, \ \ a = (a_1 + a_2)/2. \qquad (4)$$

Here $a_{1,2} = \max \ a$; $a_1 = \max \ a$ at $x > 0$; $a_2 = \max \ a$ at $x < 0$.

Consider a few examples of determining the frequency of free oscillations for the following elastic properties $f(x)$.

A. The system with bilinear elastic characteristic.

Elastic characteristic is:

$$f(x) = \begin{cases} {p_1}^2 x, \ \ x \leq \Delta, \\ {p_2}^2 x - ({p_2}^2 - {p_1}^2)\cdot\Delta, \ \ x > \Delta. \end{cases} \qquad (5)$$

B. The system of asymmetric trohlantsyuhovoyu elastic characteristics.

Elastic characteristic is:

$$f(x) = \begin{cases} {p_2}^2 x - ({p_2}^2 - {p_1}^2)\cdot\Delta_1, \ \ x \geq \Delta_1, \\ {p_1}^2 x, \ -\Delta_2 \leq x \leq \Delta_1, \\ {p_3}^2 x + ({p_3}^2 - {p_1}^2)\cdot\Delta_2, \ \ x \leq \Delta_2. \end{cases} \qquad (6)$$

(In particular, it may be ${p_3}^2 = {p_2}^2$).

B. The system of trohlantsyuhovoyu symmetric elastic characteristics.

Elastic characteristic is:

$$f(x)=\begin{cases} {p_1}^2 x, & |x|\le\Delta, \\ {p_2}^2 x-({p_2}^2-{p_1}^2)\cdot\Delta\cdot signx, & |x|\ge\Delta. \end{cases} \tag{7}$$

For the system (6) with ${p_3}^2={p_2}^2$ and for the system (7) with $a\ge\Delta$ in [2] obtained solutions which are as follows:

$$(6)\Rightarrow p^2={p_2}^2+\frac{\left({p_2}^2-{p_1}^2\right)}{8}\cdot\left\{(\gamma_1-\gamma)^5-(\gamma_2-\gamma)^5-5(\gamma_1-\gamma_5)\right\}, \qquad (6$$

*)

where $$\gamma=\frac{\Delta a}{a}=\frac{a_2-a_1}{2a};\gamma_1=\frac{\Delta_1}{a};\gamma_2=\frac{\Delta_2}{a};a=\frac{(a_1+a_2)}{2}.$$

(8)

$$(7)\Rightarrow p^2={p_2}^2+\frac{1}{4}\cdot\left({p_2}^2-{p_1}^2\right)\cdot\left(\frac{\Delta^5}{a^5}-5\cdot\frac{\Delta}{a}\right). \tag{9}$$

To $f(x)$ (5) and $f(x)$ (6) (with ${p_3}^2\ne{p_2}^2$) Expressions for p obtained below.

$$\Rightarrow p^2=\frac{\left({p_1}^2+{p_2}^2\right)}{2}+\frac{\Delta^5}{2a^5}\cdot\left({p_1}^2-{p_2}^2\right)+\frac{5}{2a^5}\times \times\left\{\begin{matrix}\frac{{p_1}^2\cdot\Delta a}{4}\cdot\left(a^4-\Delta^4\right)-\frac{{p_2}^2\cdot a^4}{4}\cdot(\Delta a+\Delta)+ \\ +\frac{{p_1}^2\cdot\Delta\cdot a^4}{4}+\frac{{p_2}^2\cdot\Delta a\cdot\Delta^4}{4}+\frac{\left({p_2}^2-{p_1}^2\right)\cdot\Delta^5}{4}\end{matrix}\right\} \tag{10}$$

$$(6)\Rightarrow p^2=\frac{5}{2a^5}\cdot\left\{\begin{matrix}\frac{{p_1}^2\cdot\left({\Delta_1}^5+{\Delta_2}^5\right)}{5}-\frac{{p_1}^2\cdot\Delta a}{4}\cdot\left({\Delta_1}^4-{\Delta_2}^4\right)+\frac{{p_2}^2\cdot\left(a^5-{\Delta_1}^5\right)}{5}-\frac{{p_2}^2\cdot(\Delta a)\cdot\left(a^4-{\Delta_1}^4\right)}{4}+ \\ +\frac{\left({p_1}^2-{p_2}^2\right)\cdot\Delta_1\cdot\left(a^4-{\Delta_1}^4\right)}{4}+\frac{{p_3}^2\cdot\left(-{\Delta_2}^5+a^5\right)}{5}-\frac{{p_3}^2\cdot\Delta a\cdot\left({\Delta_2}^4-a^4\right)}{4}+ \\ +\left({p_3}^2-{p_1}^2\right)\cdot\Delta_2\cdot\frac{\left({\Delta_2}^4-a^4\right)}{4}\end{matrix}\right\}. \tag{11}$$

In (11) believe that ${p_3}^2\ne{p_2}^2$.

3. A closed form solution by the action of an arbitrary periodic force.

Given the viscous resistance, the basic equation of forced oscillations take the form:

$$\ddot{x}+\frac{2\tilde{n}}{m}\cdot\dot{x}+\frac{\tilde{p}^2}{m}\cdot x=\frac{H(t)}{m}. \tag{12}$$

We introduce the notation:

$$\frac{2\tilde{n}}{m}=2n;\ \frac{\tilde{p}^2}{m}=p^2. \tag{13}$$

Use the approach [3] and define $x(t)$ to equation (12), which is right on the interval $0<t<T,$ where $T-$ the period of forced power $H(t)$ random-law changes over time $t.$ We have the following structure solution:

$$x(t)=\frac{\exp(-nt)}{mp_*}\cdot\left\{\frac{C\cdot\left[e^{nT}\sin p_*(t+T)-\sin p_*t\right]-S\cdot\left[e^{nT}\cos p_*(t+T)-\cos p_*t\right]}{1-2e^{nT}\cos p_*T+e^{2nT}}+\right.$$

$$\left.+\int_0^t H(\tau)e^{nT}\sin p_*(t-\tau)d\tau\right\},\ 0<t<T,\ \ p_*=\sqrt{p^2-n^2},C=\int_0^T H(\tau)e^{n\tau}\sin p_*\tau d\tau,$$

$$S=\int_0^T H(\tau)e^{n\tau}\sin p_*\tau d\tau. \qquad (14)$$

If superrezonansnyh modes when the condition:

$$T=r\cdot T_*=\frac{2\pi\cdot r}{p_*},\ \ r\in N,\ \ \omega=\frac{p_*}{r},\ \ p_*=\omega\cdot r,\ \ \omega=\frac{2\pi}{T}. \qquad (15)$$

Given (15) $\sin p_*T=0;\cos p_*T=1,$ then from (14) we have:

$$x(t)=\frac{\exp(-nt)}{m\cdot\omega\cdot r}\cdot\left\{\frac{C\left[e^{nT}-1\right]\cdot\sin(p_*t)-S\left[e^{nT}-1\right]\cdot\cos(p_*t)}{\left(e^{nT}-1\right)^2}+\int_0^t H(\tau)e^{nT}\sin p_*(t-\tau)d\tau\ \right\}=$$

$$=\frac{e^{-nt}}{m\omega r}\left\{\frac{C\sin(p_*t)-S\cos(p_*t)}{e^{nT}-1}+\int_0^t H(\tau)e^{nT}\sin\{p_*(t-\tau\}d\tau\right\}. \qquad (16)$$

From (16) it follows that the amplitude $x(t)$ in the case of "superrezonansnyh conditions" (15) decreases with increasing r.

If the condition subrezonansnyh modes:

$$T=\frac{T_*}{\tilde{m}}=\frac{2\pi}{p_*\tilde{m}};\frac{\omega}{\tilde{m}}=p_*,\tilde{m}\in N,p_*T=\frac{2\pi}{\tilde{m}}. \qquad (17)$$

From (14) the conditions (17) follows:

$$x(t)=\frac{e^{-nt}\cdot\tilde{m}}{m\cdot\omega}\cdot\left\{\frac{C\left[e^{nT}\sin p_*(t+T)-\sin p_*t\right]-S\left[e^{nT}\cos p_*(t+T)-\cos p_*t\right]}{1-2e^{nT}\cos\left(\frac{2\pi}{\tilde{m}}\right)+e^{2nT}}+\int_0^t H(\tau)e^{nT}\sin p_*(t-\tau)d\tau\right\}. \qquad (18)$$

From (18) we can see that the amplitude $x(t)$ in the case of "subrezonansnyh conditions" (17) increases with increasing $\tilde{m}$.

If there is a resonance $\frac{r}{\tilde{m}}-$order, ie:

$$p_*=\frac{\omega\cdot r}{\tilde{m}}, \qquad (19)$$

then to $x(t)$ we have:

$$x(t)=\frac{e^{-nt}\cdot\tilde{m}}{m\cdot\omega\cdot r}\cdot\left\{\frac{C\left[e^{nT}\sin p_*(t+T)-\sin p_*t\right]-S\left[e^{nT}\cos p_*(t+T)-\cos p_*t\right]}{1-2e^{nT}\cos\left(\frac{2\pi\cdot r}{\tilde{m}}\right)+e^{2nT}}+\right.$$

$$\left.+\int_0^t H(\tau)\cdot e^{nT}\cdot\sin\{p_*(t-\tau)d\tau\}\right\}. \qquad (20)$$

Thus, the presence of resonance $\frac{r}{\tilde{m}}-$order amplitude $x(t)$ is $\sim\frac{\tilde{m}}{r}$.

Conclusions

1. Application of the method of direct linearization JG Panovka to determine the natural frequencies of oscillations nonlinear systems with bilinear and trylantsyuhovu (symmetrical / unsymmetrical) elastic response.

2. The established laws of motion systems $x(t)$ the conditions and sub- superharmonyiynyh resonance in linear systems with viscous friction and arbitrary periodic (with period T) Forced force. The amplitudes of the resonances $\frac{r}{\tilde{m}}$ – order directly proportional $\frac{\tilde{m}}{r}$.

3. it is presented in the analytical value can be used to further improve the engineering methods of calculation of such systems, which is quite widely used in modern vibration (vibroudarnyh) technology of construction materials, mixtures (including compaction of powder materials).

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Predlozhennыy Direct linearization method JG Panovko for analysis vыnuzhdennыh regimes and super-subharmonychnyh fluctuations in vybroudarnыh systems. Poluchennaya zamknutaya form solutions in action proyzvolnoy peryodycheskoy force.

Physical and mehanycheskoe Modeling, Mathematical and Information and analytycheskoe Provision, system auto-matyzyrovannoho Designing (CAD) vybroudarnыe mehanycheskye system, process, pryamaya linearization, analysis, regimes, vыnuzhdennыe fluctuations, and super-subharmonychny regimes, zamknutaya form solutions, Action, Periodic power.

The method of direct linearization (so called YG Panovko's method) for analysis of regimes of forced super- and sub-harmonic oscillations of vibro-impact systems is proposed. The closed form of solution for the action of arbitrary periodic force is received.

Rhysical and mechanical modeling, mathematical and informational supply, systems of automatic projecting (SAPR),

vibro-impact mechanical systems, method, direct linearization, analysis, regimes, forced oscillations, super- and sub-harmonic regimes of oscillations, closed form of solution , action, periodic force.

UDC 371.13

PRATSEOHORONNI PRINCIPLES IN THE EDUCATIONAL PROCESS OF AGRICULTURAL UNIVERSITIES

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For the improvement of safety in agricultural universities should ensure proper teaching pratseohoronnyh subjects with established volumes teaching standards comply annual allocations for implementation of health and safety of all sources of funding universities. The condition of practical training in NDH or other

bases of practice should be the development of Passports of workplace practical training.
Health, universities, training on health, practical training, funding for safety.

Problem. The Law of Ukraine "On Education" states that science teachers should be provided with appropriate conditions of work and rest, provided with medical care. The right to safe and favorable conditions of classroom and practical training during leisure time and living in the dorms with pupils, students, cadets, students, interns, graduate and doctoral students.

For violation of legal acts on health (NPAOP), default orders officials of state supervision of work for school leaders, of teaching staff and other members of the educational process established certain responsibilities under current legislation pratseohoronnym.

Organization pratseohoronnoyi work in agricultural higher education institutions (HEIs) has a number of features that must be considered in the educational process. This applies in particular to ensure adequate (safe) under local practices, compliance with the