ISSN 2181-8622

Manufacturing technology problems

Scientific and Technical Journal Namangan Institute of Engineering and Technology

INDEX COPERNICUS INTERNATIONAL

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SLIB.UZ Scientific library of Uzbekistan

Volume 10
Issue 3
2025

THE STUDY TORSION FLUCTUATIONS PACKET WORKER ORGAN WITH PROVISION FOR INFLUENCES OF THE CORRELATION LONGITUDAL ACERBITY THEIR ELEMENT

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Abstract: In article about torsion fluctuation worker of the organ, consisting of package compressed by sprained gross disc element, working as monolithic body, and influence upon its torsion of the fluctuation of the sidebar internal effort, formed by package and gross and is shown way of the analytical account of this influence.

Keywords: disc element; the effort of the compression; the torsion of the fluctuation; longitudal deformation; mechanical work; the potential energy; the kinetic energy; differential equation.

Introduction. The use of composite structures in technology.

On a number of machines of the textile and light industry working organs are used, which are composed of a package of alternating flat working and spacer disc elements, formed by the longitudal effort of the compression imparted by the sprained central gross, sufficient for its operation as a monolithic body and performing the main technological functions.[1]

The operating experience of such machines indicates that torsion of the fluctuations occur in them, caused by the random oscillations in the technological load, which not only have a negative effect on the technological process, but can also cause the tightening nut of the sprained gross to unwind until the package of the efforts of the compression is completely eliminated with the formation of an emergency. [2]

The issue of the influence of external longitudinal force factors on the of bending fluctuations and its consideration in the design and calculation works has been well studied and covered in the technical literature . However, to date the issue of the influence of the force factors that make the internal sidebar has not been studied, and there is not information about this in adistinctive literature. [3]

These circumstances indicate the relevance of the study of the torsion of the fluctuation, packet working bodies of cotton ginning machines, in which they are widely used, the most characteristic representatives of which are sawing cylinders of gins, linters and sawing fiber [4]–[6].

The torsion of deformation of the packet working organ is also accompanied by a linear deformation in the longitudal direction. The presence of longitudal deformations also means the appearance of longitudal displacements of the points of the packet worker body.

As the points to be moved are under the action of the efforts of the compression or tensile that make a sidebar within the packet working body, mechanical work will be performed.

Certainly, the amount of performed mechanical work will change the internal energy of deformation of the elements of the batch working body. Thus, during torsion of fluctuations, there is a change in the potential deformation energies of the elements accumulated by them during their compression and tension in the process of the assembly of the working organ.In this case, the work performed and the corresponding alternation in the potential deformation energies of the gross and the pack of disk elements have the opposite signs. [7]–[9]

This is owing to the fact that if the gross is in a state of tension, then the package, on the contrary, is in a state of compression, and the corresponding additional deformations of the gross and the package, associated with fluctuations, have equal magnitudes and the same signs. Therefore, with any additional deformation of the working body, the total energy variation is equal to the difference in the values of the change in the deformation energies of the gross and the package. The overall change in the deformation energy will always have the sign of a reversal in the energy of the element with a greater acerbity. [10]

This suggests that under conditions when the efforts of the compression and tensile of structural elements constitute a sidebar, with the same acerbity of the stretched and compressible elements, the total change in potential energy is zero. This also takes place in a solid body, in the volume of which, with a substantial number of separate compressed and sprained small volumes, their total acerbity are on average equal to each other. The refore, in such a body, the total variation of the potential energy upon additional deformation is equal to zero and, accordingly, internal pressures affect not the frequencies of torsion of the fluctuation of the body. In this case, the influence of internal stresses on fluctuation processes will reflect in an increase of the area of the hysteresis sidebar and an increase in the damping decrement of the fluctuations.

As a result of the study of the change in the values of the potential energy, subject to the determination of the longitudal acerbity of the package according to, an expression was obtained for the overall reformation in the potential energy of the packet working organ during the torsion of fluctuation:

$$U_p = \frac{1}{2}\int_0^L (E_b F_b \varepsilon_b^2)dz - \frac{1}{2}\int_0^L \left[\frac{(l_p+l_n)E_p F_p E_n F_n}{l_p E_n F_n + l_n E_p F_p}\varepsilon_n\right]dz \qquad (1)$$

As follows: $F_b,\ F_p,\ F_n$ – area of the cross-sections of the gross, working and spacer disks of the gross;

$E_p,\ F_{p,}\ E_n$ – modules of elasticity of gross materials, working and spacer disks;

μ –longitudalacerbity function of the package;

$l_{p,}\ l_n$ – thickness of working and spacer discs;

ε – the magnitude of an additional longitudal deformation during fluctuations.

It is important to remember that the value of the additional deformation during fluctuations is minor, but has a finite magnitude, therefore, the terms containing ε are not excluded from the consideration, as they are usually done.

It shows that the total reversal in potential energy does not depend on the value of the axial assembly force on the gross and on the package, but is dependent on the ratio of the gross acerbity and, if they are equal, their indicator is equivalent to zero. Let us express the value of the longitudal deformation of the package in the first approximation through its angular deformation during the torsion of fluctuation. [11]

Geometrical constructions can illustrate that the longitudal deformation of the generatrix of the batch working organ can approximately be defined as follows:

$$\varepsilon = \frac{1}{2}\left(\frac{\partial\eta}{\partial z}\right)^2 = \frac{R^2}{2L^2}\left(\frac{\partial\theta}{\partial z}\right)^2$$

Wherein: $\frac{\partial\eta}{\partial z}$ –the angle of rotation of the straight generatrix during the torsionof the fluctuation;

R and L –radius and length of the package.

Then the expression for the total reversal in the potential energy of a packet workerorgan performing the torsion fluctuation will have the form:

$$U_p = \frac{1}{2}\int_0^L \left[\frac{R^4 E_b F_b}{4L^4}\left(\frac{\partial\theta}{\partial z}\right)^4\right] dz - \frac{1}{2}\int_0^L \left[\frac{(l_p+l_n)E_p F_p E_n F_n}{l_p E_n F_n + l_n E_p F_p}\left(\frac{\partial\theta}{\partial z}\right)^4\right] dz \qquad (2)$$

An acquired outcome of the experiment shows that the total change in potential energy during the torsion of the fluctuation depends only on the ratio of the values of the longitudal acerbity of the sprained gross and the packet of disk elements.

To date, we can solve the problem of free torsional fluctuations of a packet worker organ by taking into account the influence of the ratio of the longitudal acerbity of its elements.

According to and using (2) and (3), we compose the equations of potential and kinetic energies for torsion of the fluctuations in the following form:

$$U_p = \frac{1}{2}\int_0^L G_b J_{kb}\left(\frac{\partial\theta}{\partial z}\right)^2 d + \frac{1}{2}\int_0^L \left[\frac{R_b^4 E_b F_b}{4L^4} - \frac{R_n^4 (l_p + l_n) E_p F_p E_n F_n}{4L^4 (l_p E_n F_n + l_n E_p F_p)}\left(1 - e^{\frac{2A_k N}{N_0}}\right)^4\right]\left(\frac{\partial\eta}{\partial z}\right)\partial z^4 + \frac{1}{2}\int_0^L \left[\frac{(l_p + l_n) G_p J_{kp} G_n J_{kn}}{l_p G_n J_{kn} + l_n G_p J_{kp})}\left(1 - e^{\frac{2A_k N}{N_0}}\right)^4\right]\left(\frac{\partial\theta}{\partial z}\right)\partial z \qquad (3)$$

$$T = \frac{1}{2}\int_0^L \rho_b J_{pb}\left(\frac{\partial\theta}{\partial t}\right)^2 dz + \frac{1}{2}\int_0^L \left[\frac{l_p P_p J_{pp}}{l_p + l_n} + \frac{l_n P_n J_{pp}}{l_p + l_n}\right]\left(\frac{\partial\theta}{\partial t}\right)^2 dz \qquad (4)$$

Here: A_k, A_n – functions of unaccounted factors in the phenomenological determination of torsional and longitudinal acerbity;

N, N_0 – current and fixed values of the packet compression force;

J_{kb}, J_{kp}, J_{kn} – functions of moments of inertia during the torsion of the gross, working and spacer discs;

J_{pb}, J_{pp}, J_{pn} –polar moments of inertia of the cross-sections of the gross, working and spacer discs;

G_b, G_p, G_n – shear elastic modules of gross materials, working and spacer discs.

To solve the problem, having (3) and (4), we will use the Hamilton principle and Lagrange equations of the second kind, as a result of which we obtain the equation of the torsion of the fluctuation of the saw cylinder, while considering the influence of the ratio of the longitudalacerbity of the gross and the package of saws and gaskets in the following form:

$$\frac{\partial^2}{\partial z^2}\left[\left(\frac{R_b^4 E_b F_b}{4L^4}\frac{R^4(l_p+l_n)E_pF_pE_nF_n}{4L^4(l_pE_nJ_{kn}+l_nG_pJ_{kp})}\left(1-e^{\frac{2A_kN}{N_0}}\right)\frac{\partial^2\theta}{\partial z}\right)\right]+\frac{\partial}{\partial z}\left(G_bJ_{kb}\frac{\partial\theta}{\partial z}\right)-\rho_bJ_{pb}\frac{\partial^2\theta}{\partial z\partial t}+\frac{\partial}{\partial z}\left[\frac{(l_p+l_n)G_pJ_{kp}G_nJ_{kn}}{l_pG_nJ_{kn}+l_nG_pJ_{kp})}\left(1-e^{\frac{2A_kN}{N_0}}\right)\frac{\partial\theta}{\partial z}\right]-\left(\frac{l_pP_pJ_{pp}}{l_p+l_n}+\frac{l_nP_nJ_{pn}}{l_p+l_n}\right)=0 \tag{5}$$

The analysis of the results of the calculated determination of the frequencies of free torsional fluctuations in accordance with (5) of a widespread working body in the form of a packet rotor of a saw cylinder of a genie, taking into account the influence of the correlation of the ratio of the longitudal acerbity of their elements, demonstrated that the correction in this case can be comprised of 0.64% at the extreme values of the reverse in the magnitude of the compression force of the package, which indicates the need to take this influence into account in accurate and precise calculations.[4]

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