THE PROCESS OF LAYING THE ROVER ON THE SURFACE OF THE CARTRIDGE

[1]Djurabekova.D.R., [2]Babadjanov.S.Kh., [3]Joldasova.A
[1]doctoral student.
[2]candidate of technical sciences, associate professor, Tashkent Institute of Textile and Light Industry, Tashkent
[3]Assistant of the Department of Industrial Technologies,
Karakalpak State University, Nukus

Annotation. *The article discusses the force acting on the roving turn in the winding body under various flooring conditions. When the thread touches the rigid chuck, on the surface of the roving package, if there is a thick layer of winding under the roving.*

Key words: *flyer, roving laying, chuck, roving sliding friction, roving section, foot clamp, tension.*

1. Introduction

The diagram of the interaction of the flyer foot with the roving turn laid on the chuck body is shown in Fig. 1. Divide the loop section into four segments, limited by sections 11-22, 22-33, 33-44, 44-55.

Consider a piece of roving 11-22. At this point, the roving passes the eye of the foot and experiences sliding friction on its surface, limited by the central angles α_1 and α_2. The tension of the roving T_3 in section 22 can be determined by the Euler formula.

$$T_3=T_2\ \varepsilon^{\mu(\alpha_1+\alpha_2)} \qquad (1)$$

2. Main part

Where μ is the coefficient of sliding friction of the roving on the foot blade. The roving section, limited by sections 22-33, is under the foot blade and experiences a complex stress state. It experiences tensile stress from forces T_3 and T_{13}, compression stress from the clamping force of the foot N_l. In addition, the blade of the foot slides along the winding surface along the roving branch if the end of the roving at the time of start-up is fixed on the surface of the chuck by some tenacity forces and causes the friction force F_l, determined by the formula

$$F_л = \mu_1 N_л \qquad (2)$$

Further, if the roving turn (section 22-33) will fit with the foot and begin to slide along the winding surface to the left, then the friction force $F_п$ will appear, determined by the formula

$$F_n=H+\mu_2 N_л \qquad (3)$$

where μ2 is the coefficient of sliding friction between roving and roving;
H - fiber tenacity.

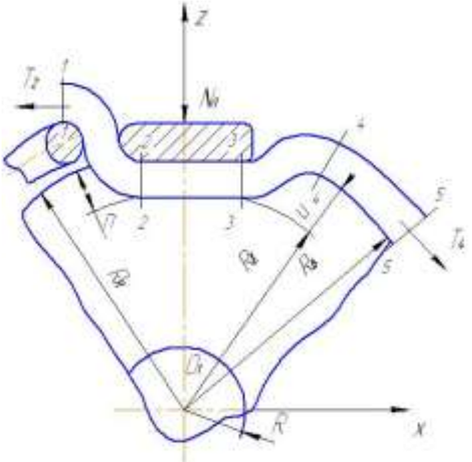

Fig. 1 Scheme of the influence of a flyer foot with a piece of roving on the chuck

The tension of the product on the package is determined, as is known / 1 /, by the expression

$$T = E_p F_p \varepsilon \qquad (4)$$

where E_p is the modulus of elasticity of the roving on the package surface;
F_p - cross-sectional area of the roving;
ε - relative deformation of the roving;

Let us also consider the case of equilibrium of the roving segment 22-33, when for some reason the tension of the turn behind the foot T_3 will be greater by ΔT.

Then it is possible to drag the roving between the foot and the winding body in the direction of greater force (to the right). If: $\Delta T > T_{MAX}$ then the tension of the thread will pass through the clamp of the presser foot and spread to the area between the package and the drafting system, causing a concealed draw.

Thus, the foot in contact with the winding body plays the role of a one-sided barrier, passing the roving tension force into the winding and keeping it from reverse action.

At the same time, practice shows that the clamping force of the foot affects the tension of the roving in the winding. Let's identify the reasons for the change in this tension.

The relative deformation of the product with the precision method can be represented as:

$$\varepsilon = \frac{\Pi n_0 - V_{\text{в}} К_{\text{у}}}{V_{\text{в}} К_{\text{у}}} = \frac{\Pi n_0}{V_{\text{в}} К_{\text{у}}} - 1 \qquad (5)$$

Where: P - the perimeter of the wound coil;

n_0 is the number of turns, stacked per unit of time;

V_v - the speed of release of the sliver by the exhaust device;

K_u = 0.98 - roving twist coefficient.

The angle of ascent of the turns is not taken into account due to its smallness.

From (5) it can be seen that the tension of the product (rovings) on the package is determined by the kinematics of its release and winding at a constant release rate Vw and constant P and n_0- when winding this layer. But in this case, the perimeter of the winding turn can be violated due to the change in the winding radius from the influence of the flyer foot, as for the case of friction winding, noted in the work / 2 /.

Above we focused on the consideration of the 22-33 turns of the laid roving. The segment of the turn, limited by sections 33-44, is very short, and we will consider it transitional and not requiring special attention.

Let's move on to the segment of the turn, limited by sections 44-55, i.e. a segment already laid on the winding surface and in equilibrium due to the action of its own tension and the reaction of the base.

When solving the problem, we make the following assumptions:

the solution is carried out in the elastic zone of the roving and the winding body;

we do not take into account the relaxation process in the loop;

the problem is considered in statics.

First, consider a simpler problem when laying a turn with a flyer without a foot. In this case, the coil is laid with tension on an elastic base and creates a radial load.

The base reaction will be q_0. Equality of pressures will be written as:

$$q_{\text{в}} - q_0 = 0 \qquad (6)$$

Roving tension is determined

$$T_3 = E_p F_p \varepsilon \qquad (7)$$

Where ε is the relative deformation of the roving, determined by (5)

E_p - the modulus of elasticity of the roving; Fr is the cross-sectional area of the roving.

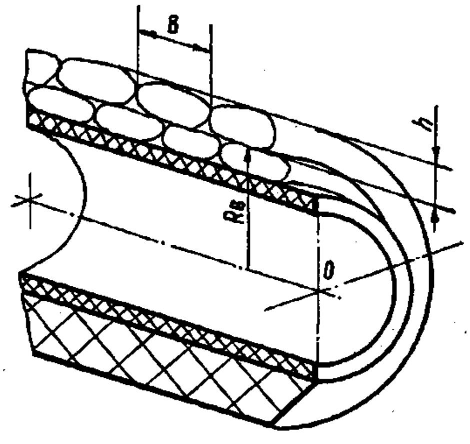

Fig. 2. Sectional diagram of turns on the winding body

$$F_p = bh\frac{\pi}{4} \qquad (8)$$

Where b.h- respectively the dimensions of the elliptical section of the roving along the axis of the package and along the radius, determined by / 2 / Fig. 2

Loop pressure transmitted per unit surface of the winding body / 3 /.

$$q_{\text{в}} = \frac{T_3}{R_{\text{в}} b} \qquad (9)$$

This pressure, according to the conclusions of Sorkin A.P., Paigin Yu.F., Babadzhanov S.X / 3 /, causes a radial deformation of the surface.

$$\varepsilon_n = \frac{E_p h \varepsilon_p}{E_{\text{п}} R} = \frac{R_H - R_{\text{в}}}{R_H} \qquad (10)$$

Where: $E_{\text{п}}$ - the radial modulus of elasticity of the package;

R_w is the restored winding radius after the flyer foot leaves the surface of the laid roving layer.

ε_p is the relative deformation of the roving.

In this case, the deformation of the surface ε_p causes the transition of the turn from the winding radius Rn to another, smaller radius R_w and, accordingly, a decrease in its tension

$$\Delta T_4 = E_p F_p \varepsilon_p \qquad (11)$$

The winding layer compressed due to the clamping of the foot after its withdrawal tends to be restored to the previous size $R_{\text{Н}}$, but the winding body will not be able to fully restore its size due to the resistance of the roving turn. See fig. 3.

In this case, equilibrium is established when the winding body partially restores its size to the value of R_w, and the laid roving turn goes from R_c to R_w and receives additional deformation $\acute{\varepsilon}_p$ and, consequently, additional tension ΔT. The power balance of the roving turn on the restored radius $R_{\text{В}}$ will be represented as the sum of radial pressures

$$q_{\text{в}} - q_0 = 0$$

The base reaction to the turn will be $q_0 = E_{\text{п}} \varepsilon_{\text{p}}$ (12)

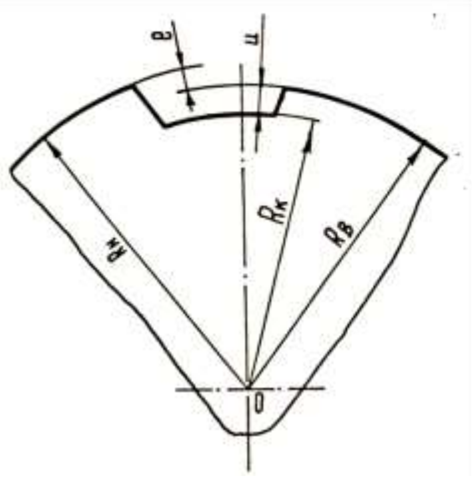

Figure: 3. Scheme of restoration of the contact radius of winding

The coil tension on the package will be

$$T_4 = T_3 + \Delta T \qquad (13)$$

Thus, the determining factor of the mechanical stress in the winding body is the tension of the winding roving T4, which in the general case is a constant value during the running time of the package. But in real conditions, the winding tension controlled during the seme production on the winding body is significantly different and apparently leads to the manifestation of breakage on machines at certain winding diameters.

As can be seen from equation 6, in determining the flexibility of the package, the parameter of the elastic modulus is taken for the winding body, and in real conditions when winding the first layers of roving, it fits on a rigid base, on an empty cartridge, which is very different from the conditions for winding roving, the value of the elastic modulus of the cartridge is much higher than the modulus the elasticity of the winding, which leads to a violation of the roving winding process. In this case, the balance of the coil on the surface of the cartridge will be written as: $E_p h \varepsilon_p = E_{\text{пат}} R \varepsilon_{\text{пат}}$ (14) and the reduced modulus of elasticity is calculated from the equilibrium conditions of the turn on the surface of the cartridge.

$$E_{\text{пр}} = \frac{E_{\text{п}} E_{r\text{в}}}{E_{\text{п}} + E_{r\text{в}}} \qquad (15)$$

3. Conclusion

Analyzing the obtained equations of equilibrium of the turn, it can be judged that the tension of the roving on the surface of the empty cartridge significantly depends on the elastic properties of the roving itself, since, when winding the roving, due to the specific pressure created by the roving turn, the cartridge does not have the ability to deform. The strength characteristics of the chuck and the material from which it is made lead to a redistribution of stresses in the winding body and roving, which is caused by an increase in roving breakage during the formation of roving packages at the initial stage of winding.

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