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Static Analysis of Multifunctional Machine Working Shaft

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ABSTRACT: A machine for mechanical processing of semi-finished leather raw materials was developed by us . Currently, the theoretical and practical definition of the parameters of the multi-machine machine is being carried out..

KEY WORDS: Roller pair, leather semi-finished product, base plate, feed mechanism, vertical feed, water squeezing.

I. INTRODUCTION

This multifunctional machine performs several technological processes in the mechanical processing of leather (fig 1). Consider the case of this multifunctional machine working body (non-porous cylindrical core) affected by external forces.

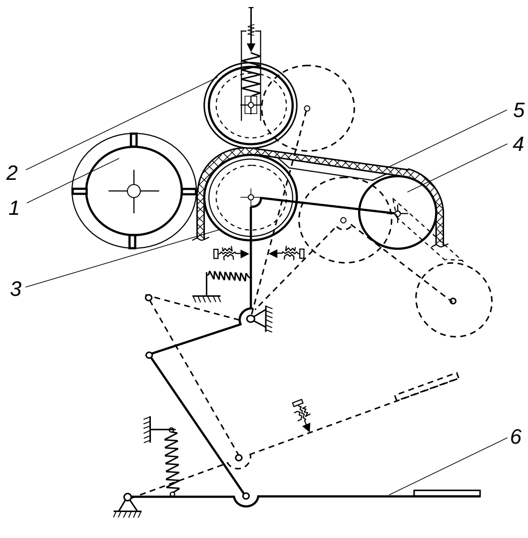

Figure 1. Multipurpose machine schema
1 working shaft, 2 transport valve, 3 compressor shaft, 4 auxiliary shafts, 5 processed leather raw material, 6-pin

II. LITERATURE SURVEY

In [2], the process of pressing a fibrous material in a roller device was studied; it was considered as a dynamic oscillatory system "roller pair - fibrous material - fluid". The author has developed a mathematical model of the transition state of the process of mass transfer during the squeezing of fibrous material in the roller device; it allowed getting a scientifically based forecast of the parameters of the technological process. A technique has been developed for determining the stable operation of a roller device in the mode of dynamic loading. The development

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of the process of leather dehydration and the study to improve the properties of fur semi-finished product are given in [4].

In [5], a method was developed where the processed raw material was fed into the clearance between the driven roller and the fixed cheek. The authors of this method state that the energy consumed per unit of product when using a single-roll crusher is two times less as compared to a two-roll crusher due to the torsional strains and shear stresses acting on the material being processed. The processed leather semi-finished product due to the bending in the base plate, forms two separate pieces, each of which is in contact with a separate working shaft and a fixed rigid base plate. So, it can be assumed that in that case, in total counting it will be possible to achieve about 4 times saving of energy, due to the simultaneous processing of the two halves of the leather half-finished product.

III. METHODOLOGY

We will direct the reaction forces of the hardened parts of the shaft axis and the gravity forces of the shaft as shown in Figure 2.

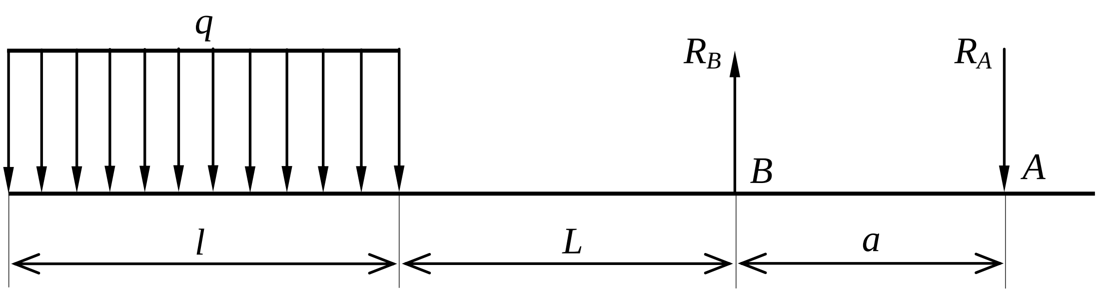

Figure 2. Scheme of forces acting on non-porous cylinder core shaft

In this, q unevenly distributed force, l uneven spreading force, L given distance between the spindle shaft and base, The above system must be in a state of equilibrium. From the equilibrium state of a system we can determine the reaction forces in it

$$\sum F_{kx} = 0 \ ; \ -ql + R_B - R_A = 0 \tag{1}$$

$$\sum M_i = 0 \ ; \ ql[L + \frac{l}{2}] - R_A a = 0 \tag{2}$$

From equation (2) we define: R_A

$$R_A = \frac{ql[L + \frac{l}{2}]}{a} \tag{3}$$

We can find (3) by putting Equation (1) into:

$$R_B = \frac{ql[L + \frac{l}{2}]}{a} + ql \tag{4}$$

We will now determine the internal tension forces. To do this, we cut off the non-porous cylinder core shaft section. We plot the internal tension force (Q_1) and the bending moment (M_1) generated at the cut-off point as in Fig. 3.

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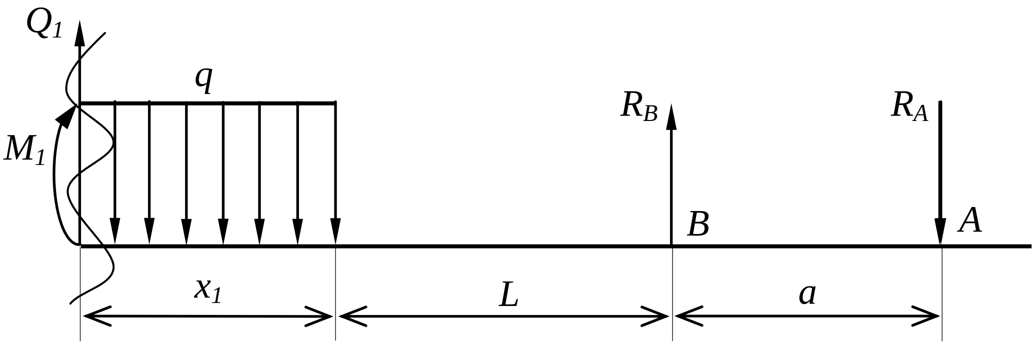

Figure 3.

For the above system to be in equilibrium

$$\sum F_{kx} = 0;$$

the equation must be appropriate. According to the equation above, the sum of the projections of the forces on the vertical axis is as follows.

$$-Q_1 + qx - R_B + R_A = 0, \quad Q_1 = [R_A - R_B + qx], \; a + L \le x \le a + L + l$$

We can R_B and R_A replace equations (3) and (4) in this equation. We also determine the tensile strength of the plot.

$$Q_1 = -ql + qx$$

$$Q_1(a + l + L) = -ql + q(a + L + l) = q(a + L) \tag{5}$$

$$Q_1(a + L) = -ql + q(a + L) = q(a + L - l) \tag{6}$$

L plot the internal tensile strength (Q_2) and the tensile moment (M_2) as in Fig. 4.

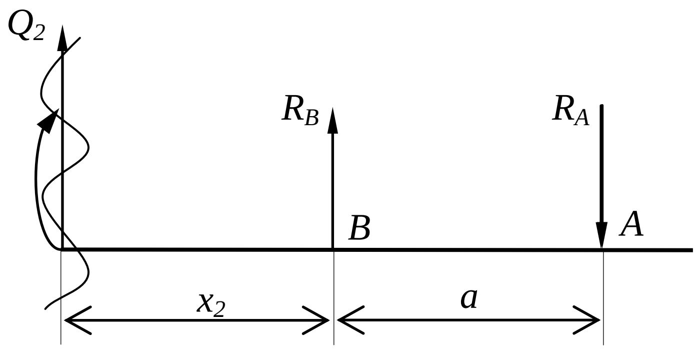

Figure 4.

According to the equation of statistics:

$$\sum F_{kx} = 0;$$

$$Q_2 - R_B + R_A = 0 \; Q_2 = R_B - R_A$$

: Using equations (3) and (4):

$$Q_2 = ql \tag{7}$$

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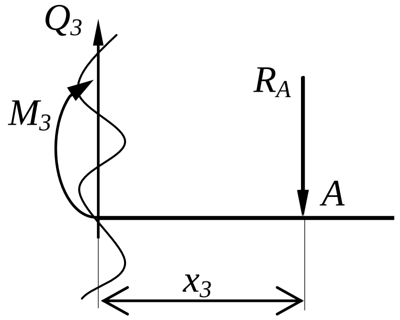

Figure-5

a plot the internal tension force (Q_3) and tensile torque (M_3) at the cut.

$$\sum F_{kx} = 0$$

$$Q_3 = R_A = \frac{ql[L+\frac{l}{2}]}{a} \tag{8}$$

Using the equations (5), (6), (7) and (8), we construct an epicure of internal tension:

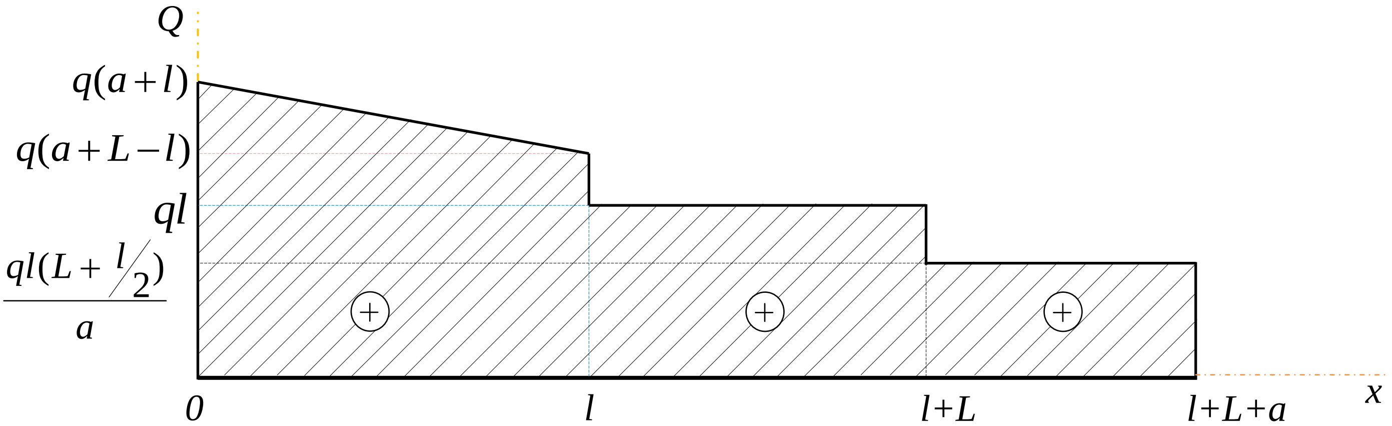

Figure-6.

Now, we calculate the value of the momentum. We use these in Figures (3), (4) and (5) above. $\sum M_i = 0$,

$$M_1 - \frac{qx_1^{\ 2}}{2} + R_B(L+x_1) - R_A(L+a+x_1) = 0$$

$$M_1 = \frac{qx_1^{\ 2}}{2} + (R_B - R_A)(L+x_1) - R_a a \quad a+L \le x_1 \le a+L+l$$

$$M_1(a+L+l) = \frac{q(a+L+l)^2}{2} + (R_B - R_A)(a+2L+l) - R_A a$$

$$M_1(a+L+l) = \frac{q(a+L+l)^2}{2} + ql(a+2L+l) - ql(L+\frac{l}{2})$$

$$M_1(a+L+l) = \frac{q(a+L+l)^2}{2} + ql(a+L+\frac{l}{2})$$

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$$M_1(a+L)=\frac{q(L+a)^2}{2}+ql(a+2L)-ql(L+\frac{l}{2})=\frac{q(l+a)^2}{2}+ql(a+L-\frac{l}{2})$$

Now, we calculate the curvature moment in section 2:

$$-M_2+R_Bx_2-R_A(a+x_2)=0$$

Let's find out M_2

$$M_2=(R_B-R_A)x_2-R_Aa$$

here $a\le x_2\le a+L$

Let us calculate the upper and lower values of x_2

$$M_2(a+L)=ql(a+L)-ql(L+\frac{l}{2})=ql(a-\frac{l}{2})$$

$$M_2(a)=qla-ql(L+\frac{l}{2})=ql(a-L-\frac{l}{2})$$

Calculate the momentum for plot 3:

$$M_3-R_Ax_3=0$$

$$M_3=R_Ax_3 \qquad 0\le x_3\le a$$

$$M_3(a)=\frac{ql(L+\frac{l}{2})}{a}a=ql(L+\frac{l}{2})$$

$$M_3(0)=0$$

From the top it was clear that the maximum value of the bending moment was in the 1st plot.

$$M_э^{мax}=\frac{q(a+L+l)^2}{2}+ql(a+L+\frac{l}{2})$$

We also find the turning point:

$$M_б=0$$

Determine the diameter of the shaft axis by using the following theories (joint condition of bending and torsion)

1. The theory of the maximum normal voltages

According to this theory, the computational moment of a system is expressed by twisting and bending angles as follows:

$$M_{1,хuc}\ \frac{1}{2}[M_э+\sqrt{M_б^{\ 2}+M_э^{\ 2}}]$$

If the rotation torque is zero:

$$M_{1,хuc}=M_э^{мax}$$

$$M_{1,хuc}=\frac{q(a+L+l)^2}{2}+ql(a+L+\frac{l}{2})$$

$$\frac{M_{1,хuc}}{W}\le[\sigma],$$

$$W=\frac{\pi d^3}{32}$$

According to the equations above

$$\frac{32M_{1,хuc}}{\pi d^3}\le[\sigma]$$

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This will determine the diameter

$$d^3 \geq \frac{32 M_{1,хис}}{\pi[\sigma]}$$

$$d \geq \sqrt[3]{\frac{32}{\pi[\sigma]}[\frac{q(a+L+l)^2}{2} + ql(a+L+\frac{l}{2})]}$$

: 2. On the theory of energy
 According to this theory, the computational moment of a system is expressed by twisting and bending angles as follows:

$$M_{2,хис} = \sqrt{M_э{}^2 + \frac{3}{4}M_б{}^2}$$

Since the rotating moment is zero:

$$M_{2,хис} = M_э^{мах}$$

$$M_{2,хис} = \frac{q(a+L+l)^2}{2} + ql(a+L+\frac{l}{2})$$

$$d^3 \geq \frac{32}{\pi[\sigma]} M_{2,хис}$$

$$d \geq \sqrt[3]{\frac{32}{\pi[\sigma]}(\frac{q(a+L+l)^2}{2} + ql(a+L+\frac{l}{2}))}$$

IV. RESULTS

According to both theories above, the diameter of the non-porous cylindrical shaft is expressed by the same equation. Given the parameter that a and q must be chosen in this equation, we find the diameter of the core shaft graphically.

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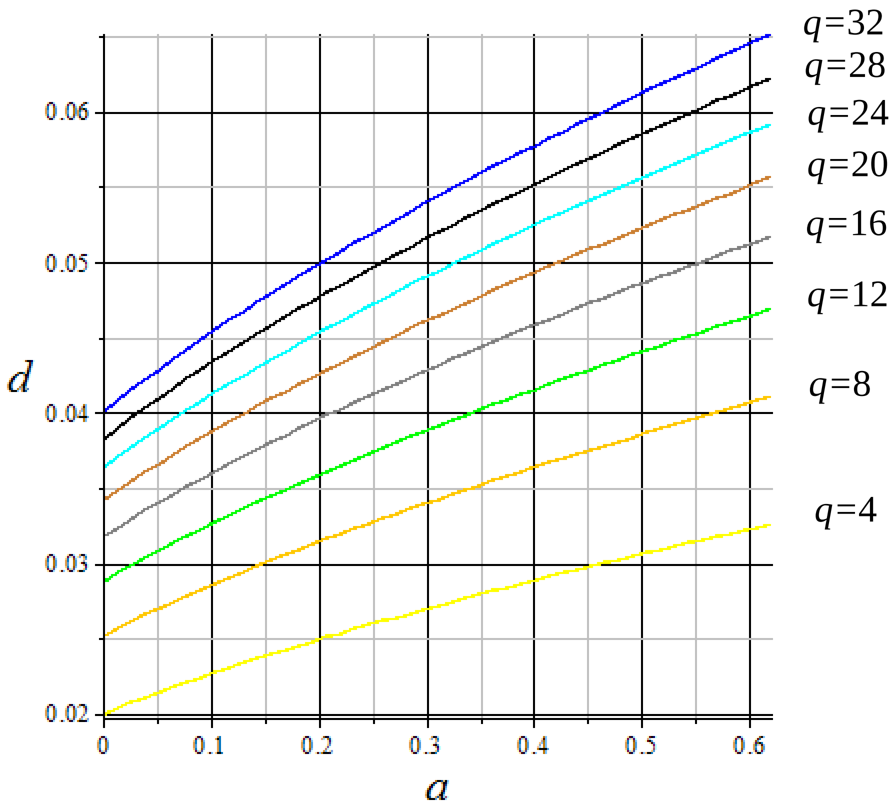

Figure 7

The diagram above shows the diameter of the non-porous cylinder shaft Properly proportional to the distance between the force and base spreads. That is, for me to choose the smaller the diameter of the shaft, the smaller the distance between the supports and the evenly distributed force is to choose smaller.

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