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DEVELOPING CREATIVE ABILITIES THROUGH INDEPENDENT SOLVING PROBLEMS IN CALCULATION AND GRAPHIC WORK ON CALCULATION OF CHAIN TRANSMISSIONS IN TECHNICAL MECHANICS

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Abstract: This article aims to improve students' skills in solving problems in the computational and graphical work on calculating chain transmissions from the machine details section of the discipline "Technical Mechanics".

Keywords: Technical mechanics, driving, driven, sprockets, transmission, shaft, loading, research, chain, speeds, gear, bushing, roller, center distance.

Introduction. Technical mechanics is an applied science that occupies a leading position in the development of science and technology. In the machine details section of technical mechanics, each theoretical law and concept has its own theoretical basis and proof. Solving problems in computational and graphical work on calculating chain transmissions from the machine parts section is one of the means of acquiring a system of scientific knowledge and concepts.

In the process of solving problems in the computational and graphical work on calculating chain transmissions in the subject of "Technical Mechanics", students develop their creative abilities by applying their theoretical knowledge about chain transmissions to solving practical problems.

Main part. A chain drive consists of two gears (sprockets) attached to two parallel shafts, the leading and driven, which are interconnected by an endless chain worn on these sprockets.

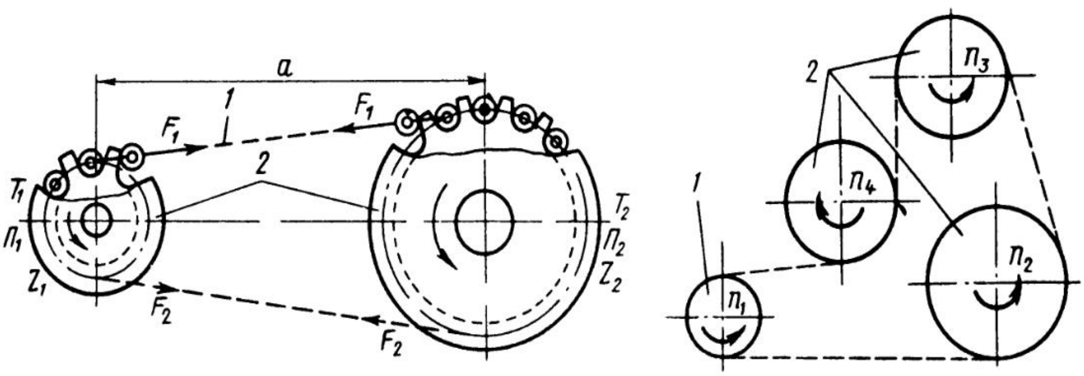

Figure 1

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Chains are bushing, roller, and sprocket. Both the roller chain and the sprockets are evenly spaced. At high speeds, it is better to use a sprocket chain. The distance traveled by the chain during one revolution of the sprocket is , then the speed of the chain is

$$V = \frac{tz_1\omega_1}{2\pi 1000} = \frac{tz_2\omega_2}{2\pi 1000}, \quad (1)$$

here: t - chain step

z_1; z_2 - the number of teeth of the driving and driven sprockets.

ω_1; ω_2 - angular velocity of the leading and trailing stars.

Number of rotations $$i = \frac{\omega_1}{\omega_2} = \frac{z_2}{z_1}; \quad i \quad 8 \quad (2)$$

Distance between axles A=(30…50)t (3)

Chain length $$L_t = \frac{2A}{t} + \frac{z_1 + z_2}{2} + \quad \frac{z_2 - z_1}{2\pi} \quad ^2 \frac{t}{A}$$

Once the chain pitch is selected, the distance between the axles is found as follows.

$$A = \frac{t}{4} \quad L_t - \frac{z_1 + z_2}{2} + \sqrt{\quad L_t - \frac{z_1 + z_2}{2} \quad ^2 - 8 \quad \frac{z_2 + z_1}{2\pi} \quad ^2} \quad (4)$$

Forces acting on chain links.

Rotational force $$P = \frac{2M}{d_{\partial 1}} \quad (5)$$

here: - the diameter of the star division.

The force generated when tensioning a chain. $S_0 = KfqA$ (6)

Here: **q** is the weight of the chain, **Kf** is the chain's sag coefficient.

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Stress due to centrifugal force. $S_v = \frac{q}{g} v^2$ (7)

where: g=9.81: v-chain speed.

The issue. Power $P_1 = 4{,}5\ kk$, rotation frequency $n_1 = 750 \min^{-1}$, number of transmissions Consider a roller chain transmission with u=5. The load acting on the transmission remains unchanged. The chain is periodically lubricated and tensioned.

Solution to the problem.

1. Number of teeth of the leading sprockets: $z_1 = 29 - 2u = 29 - 2\ \ 5 = 19$

2. Number of teeth of the driven sprocket: $z_2 = z_1\ \ u = 19\ \ 5 = 95$

3. The actual value of the transmission number: $u = \frac{z_2}{z_1} = \frac{95}{19} = 4{,}84$

4.Timing chain pitch $t = 2{,}8\sqrt[3]{\frac{T_1 K_e}{[p] z_1}}\,mm$ in this

$$T_1 = 9550 P_1 / n_1 = 9550 \frac{4{,}5}{750} = 57{,}3\ \text{N}\ \ \text{m},\ K_e = K_1 K_2 K_3 K_4 K_5 K_6 = 1\ \ 1\ \ 1\ \ 1{,}25\ \ 1{,}5\ \ 1 = 1{,}875$$

Speed of the transmission chain $\vartheta = 4 m/s$, permissible pressure value Let's take $[p] = 18 MPa$ and calculate the pitch of the transmission chain

$$t = 2{,}8\sqrt[3]{\frac{57{,}3\ \ 10^3\ \ 1{,}875}{18\ \ 19}} = 19{,}04 mm$$

5. Transmission chain speed

$$\vartheta = z_1 n_1 t = \frac{19\ \ 750\ \ 19{,}05}{60\ \ 10^3} = 4{,}524 m/s$$

6. Actual value of pressure in the joints of the transmission chain

$$P = (2{,}8)^3 \frac{T_1 K_e}{z_1 t^3} = (2{,}8)^3 \frac{53\ \ 10^3\ \ 1{,}875}{19(19{,}05)^3} = 17{,}995 MPa\ ,$$

So $P = 17{,}995 < [P] = 18 MPa$

7. Geometric dimensions of the transmission

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a) wheelbase $a = 40t = 40 \; 19{,}05 = 762mm$

b) the number of links in the chain

$$L_t = 2 \; a_t + 0{,}5 z_{um} + \Delta^2 / a_t , a_t = 40$$

$$z_{um} = z_1 + z_2 = 19 + 95 = 114 , \quad \Delta = \frac{(z_2 - z_1)}{2\pi} = \frac{95 - 19}{2 \; 3{,}14} = 12{,}1$$

$$L_t = 2 \; a_t + 0{,}5 z_{um} + \Delta^2 / a_t = 2 \; 40 + 0{,}5 \; 110 + \frac{(12{,}1)^2}{40} = 138{,}66$$

Chain length $L = L_t \; t = 138{,}66 \; 19{,}05 = 2641{,}5mm = 2{,}641m$

8. Frequency of impact of chain links on sprocket teeth

$$\omega = 4 z_1 n_1 / 60L \quad \frac{508}{t} \quad , \quad \omega = \frac{4 \; 19 \; 750}{60 \; 138{,}66} = 6{,}85 s^{-1} , \quad \frac{508}{t} = \frac{508}{19{,}05} = 26{,}6 s^{-1}$$

Safety factor for strength of the transmission chain

$$S = \frac{F_{uz}}{F_t K_t + F_m + F_f}; \qquad F_{uz} = 31{,}8kN$$

$$F_m = m\upsilon^2 = 1{,}9(4{,}524)^2 = 38{,}89, F_f = gK_f m \; a = 9{,}81 \; 1 \; 1{,}9 \; 0{,}762 = 14{,}2N ,$$

$$d_{b1} = \frac{z_1 t}{\pi} = \frac{19 \; 19{,}05}{3{,}14} = 115{,}27mm , \quad S = \frac{F_{uz}}{F_t K_t + F_m + F_f} = \frac{31{,}8 \; 10^3}{919{,}6 \; 1 + 38{,}89 + 14{,}2} = 32{,}7$$

$$F_t = \frac{2T_1}{d_{b1}} = \frac{2 \; 57{,}3 \; 10^0}{115{,}27} = 919{,}6N , \quad [S] = 10{,}8 , \quad S > [S] \quad , \quad 32{,}7 > 10{,}8$$

Variant number Given	0	1	2	3	4	5	6	7	8	9
Power on the driving pulley P_1(kW)	2,5	3	3,5	4	4,5	5	5,5	6	7	7,5
Rotation frequency	720	750	850	600	700	800	550	570	500	730

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$n_1 (min^{-1})$										
Speed $\vartheta_1 (m/s)$	4,5	4,2	5	3,8	4,3	3,5	4,2	4,1	4	5
Permissible pressure value $[p](MPa)$	20	21	24	22	23	22,5	23,5	24	22	23,5

Note: The student determines the option by taking the last number in the journal. For example, if the journal has 4 digits, the student takes the quantities given in 4 options, and if it has 24 digits, the student takes the quantities given in 4 options, performs the calculation and graphic work and submits it to the teacher conducting the practical exercise.

Conclusion. Solving problems in the computational and graphical work on calculating chain transmissions in the subject "Technical Mechanics" increases students' general mental development, logical thinking and reasoning skills, and further increases their interest in studying the machine details section in more depth.

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