METHOD OF SELECTING AND CALCULATING TENSIONING.

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Annotatsiya

Taranglikli va parchinlangan birikmalarni hisoblash uslubiyoti, masala yechish namunalari va masalalar to‘plami.Taranglikli va parchinlangan birikmalarga doir masalani yechish namunasi

Kalit so‘zlar

Murakkab yig'ish usuli, po’lat, Cho'yan, Alyuminiy va magniy qotishmalari, Plastmassa, aylanish momenti, eksenel kuch, birikma diametri, silindrsimon, tahlil

Аннотация

Методика расчета напряженных и заклепочных соединений, примеры решения задач и наборы задач. Пример решения задачи о напряженных и заклепочных соединениях

Ключевые слова

Метод сборки соединения, сталь, чугун, алюминиевые и магниевые сплавы, пластик, крутящий момент, осевая сила, диаметр соединения, цилиндрический, анализ

Annotation

Methodology for calculating tensioned and riveted joints, problem solving examples and sets of problems. Example of solving a problem about tensioned and riveted joints

Key words

Method of collecting the compound, Steel, Cast iron, Aluminum and magnesium alloys, Brass, Plastic, rotational moment, axial force, diameter of the joint, cylindrical, analysis

RESULTS: The selection of dressings is carried out in the following order.

1) average contact pressure (MPa)

$$P = 2 \cdot 10^3 \cdot K \cdot F_\Sigma /(\pi \cdot d \cdot l \cdot f),$$

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where K is the coefficient of the joint reserve; f is the coefficient of friction.

When the bending moment M_I acts on the joint, the required pressure is determined by the following expression: $P = \frac{K \cdot 12 \cdot M_И}{\pi \cdot d \cdot l^2}$.

To prevent a decrease in bearing capacity due to the instability of the friction coefficient and contact corrosion (in particular, failure of the bearing surface due to microslip under the influence of variable stresses, difficult loads during start-up and shutdown) or to reduce its effect on tension joints, a certain friction reserve K is assumed, taken as K = 2.0…4.5.

To determine the quantitative values of the friction coefficient f, the data of Table 1 can be used. It gives the values of the friction coefficient for the case of a joint with a shaft made of steel.

Table 1

Method collecting e mpound	Steel	Cast iron	Aluminum d magnesium oys	Brass	Plastic
Mechan	0,06…0,13	0,07… 0,12	0,02… 0,06	0,05… 0,10	0,6… 0,5
Heat	0,14… 0,16	0,07… 0,09	0,05… 0,06	0,05… 0,14	-

2) *Calculation theoretical tension (µm):* $\delta = 10^3 \cdot P \cdot d \cdot (C_1/E_1 + C_2/E_2)$,

where C_1, C_2 are the stiffness coefficients: $C_1 = \frac{1+\left(\frac{d_1}{d}\right)^2}{1-\left(\frac{d_1}{d}\right)^2} - \mu$;

$$C_2 = \frac{1+\left(\frac{d}{d_2}\right)^2}{1-\left(\frac{d}{d_2}\right)^2} - \mu_2,$$

where E is the modulus of elasticity, MPa: for steel - $2.1 \cdot 10^5$; cast iron - $0.9 \cdot 10^5$; for bronze - $0.8 \cdot 10^5$; for bronze and brass - 105; - Poisson's ratio: for steel - 0.3; for cast iron - 0.25; for bronze, brass - 0.35.

DISCUSSION: Initial data: T - rotational moment on the roller, N·m; Fa - axial force, N; d - diameter of the joint, mm; d_1 - diameter of the hollow shaft hole, mm; d_2 - conditional outer diameter of the bushing (outer diameter of the roller bearing, band, etc.), mm; l - joint length, mm; materials of the parts being joined and surface roughness. When the joint is simultaneously loaded with a rotational moment T and an axial force Fa, the calculation is conditionally carried out for the equally acting force F_Σ. It consists of the rotational force T and the axial force Fa.

$$F_\Sigma = \sqrt{\left(\frac{2T}{d}\right)^2 + F_a^2}\ .$$

The axial force acting on the coupling is not taken into account: the analysis shows that after the forces and are reduced to the diameter d of the coupling, the effect of the axial force becomes negligible (when the force is taken into account, the pressure increases by a factor of 1.005 for a cylindrical and worm gear, and by a factor of 1.02 for a bevel gear with a rotating gear).

The index "1" is for the part to be covered (shaft), the index "2" is for the part to be covered (sleeve).

In the questions about the installation of a rolling bearing, it is necessary to determine the diameters d_1 and d_2 according to the following relations.

The diameter along the bottom of the groove (d_2)

$d_0 = 0{,}5 \cdot (D + d) - d_w$,

Board diameter (d_1)

$d_2 = d_0 + 2 \cdot 0{,}2 \cdot d_w$,

the corresponding dimensions of the bearing are given in the table.

3) Adjustment of microuniformities (μm)

$u = 5{,}5 \cdot (Ra_1 + Ra_2)$, where Ra_1 and Ra_2 are the arithmetic mean deviations of the surface profile. The values of Ra, μm, are taken in accordance with the detail drawing or Table1, which gives the recommended values of the roughness parameters Ra for the mating surfaces of holes and shafts.

Table 1

Size ranges, mm	Hole			Shaft		
	Квалитет					
	6,7	8	9	6, 7	8	9
	Ra, мкм					
From 18 to 50	0,8	1,6	3,2	0,8	0,8	1,6
From 50 to 120	1,6		3,2	0,8	1,6	
From 120 to 500	1,6	3,2		1,6	3,2	

4) Correction for temperature deformation (μm). When choosing to wear a gear flange of a worm wheel, which heats up at a relatively high temperature in transmission work, the temperature deformation of the wheel center and flange, which weakens the tension, is taken into account:

$$\delta_t = 10^3 \cdot d \cdot \left[\left(t_2 - 20^0\right) \cdot \alpha_2 - \left(t_1 - 20^0\right) \cdot \alpha_1\right].$$

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Here t_1 and t_2 are the average bulk temperatures of the center pulley and the wheel hub, respectively. The values of the coefficients , 1/°C: for steel - $12{\cdot}10^{-6}$; cast iron - $10{\cdot}10^{-6}$; bronze, brass - $19{\cdot}10^{-6}$.

5) The minimum tension required to transmit torque (μm),

$$[N]_{\min} \geq \delta + u + \delta_t .$$

6) The maximum tension (μm) in the permissible strength of the covering details (bump, flange, etc.), $[N]_{\max} \leq [\delta]_{\max} + u$.

7) The maximum deformation (μm) in the permissible strength of the covering details, $[\delta]_{\max} = \delta \cdot [P]_{\max} / P$,

here

$$[P]_{\max} = 0{,}5 \cdot \sigma_T \cdot \left[1 - \left(\frac{d}{d_2}\right)^2\right];$$

Maximum pressure in the permissible strength of the covering details (σ_{T2} – yield strength of covering detail material, MPa).

8) *Choosing to wear.* $[N]_{\min}$ and $[N]_{\max}$ is selected from the table by values.

the minimum of the possible tension given in the table $N_{\min}$ and maximum $N_{\max}$ The values are calculated according to a formula that takes into account the dispersion of shaft and hole dimensions and, as a consequence, the dispersion of the tension value.

9) The clamping force or the heating temperature of the part for the selected fitting is determined.

Clamping force, *H*

$$F_{\Pi} = \pi \cdot d \cdot l \cdot P_{\max} \cdot f_{\Pi},$$

Here $P_{\max} = N_{\max} - u \cdot P / \delta$, MPa

P_{max} – of selected wear $N_{\max}$ tension pressure;

f_{Π} – coefficient of adhesion (friction) in pressing (Table 2).

Table 2

Composite detail material	Steel – steel	Steel – cast iron	Steel - bronze, brass	Cast iron - bronze, brass
f_{Π}	0,20	0,14	0,10	0,08

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10) The heating temperature of the covering part to ensure the gap in the assembly, °C:

$$t = 20^0 + \frac{N_{max} + Z_{сб}}{10^3 \cdot d \cdot \alpha_2}$$

here $Z_{сб}$ – clearance for ease of assembly, μm; this clearance is taken depending on the shaft diameter d according to Table 3:

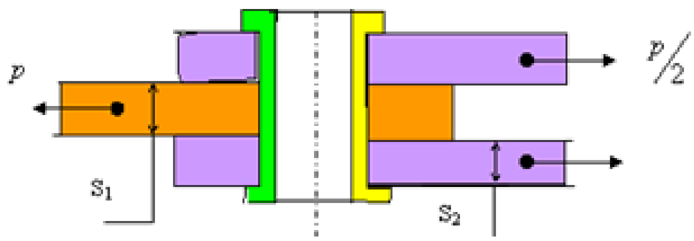
Table 3

d, мм	From 30 to 80	From 80 to 180	From 180 to 400
$Z_{сб}$, μm	10	15	20

The heating temperature should be such that no structural changes occur in the material. For steel [t] = 230… 240°C, for bronze [t] = 150… 200°C.

CONCLUSION: Problem 1: Determine the outer diameter of the rivet according to the shear strength condition and test the rivet for crushing. Initial data: S1=S2=8 mm, inner diameter of the rivet d=15 mm, [σ]cm=120 MPa, [τ]sr=70 MPa. The value of the force P is given in the table. The problem is solved according to one of the options specified by the teacher.

P, кН	10,5	11	11,5	12	12,5	13	13,5	14	14,5	15



Solving

1. We determine the required outer diameter of the rivets according to the shear resistance condition:

2. We get the diameter value from the standard line:

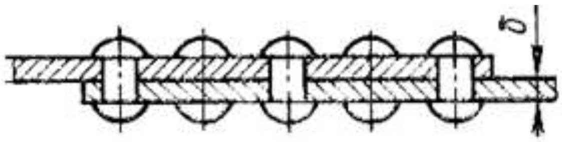
1 line {1;1,25;1,5;2;2,5;3;4;5;6;8;10;12;16;20} – preferred;

2 rows {1.75;2.25;2.75;3.5; 4,5;5,5;7;9;11;14;18}- is allowed.

3. We check the resistance to crushing:

4. If the condition is not met, we increase the outer diameter of the rivet.

Problem 2: Two steel sheets are connected by rivets. If the allowable shear stress [τ] = 80 MPa, the rivet diameter d = 8.0 mm, and the shear force Q = 35 kN, determine the number of rivets. Check the crush resistance of the rivets, where the sheet thickness is δ = 7.0 mm, [σ]cm = 160 MPa.



Solving

1. We determine the total surface of the shear according to the shear resistance condition:

$\tau = Q/S_{сум} \leq [\tau]$, from this: $S_{сум} = Q/[\tau]$

2. We calculate the required number of rivets:

$n = 4 \cdot \frac{S_{сум}}{\pi \cdot d^2}$, We round up to a large integer.

3. We check the crush resistance of the rivet: $\sigma_{см} = Q/n \cdot \delta \cdot d \leq [\sigma]_{см}$

Methodology for calculating riveted joints. Calculation sequence. Calculation of solid riveted joints.

1) The diameter of the rivets d0 and the weld parameters are determined: the pitch of multi-row welds p and the distance from the rivet axis to the edge e according to the recommendations given in the text of the reports.

2) permissible stress. In practice, when calculating solid riveted joints, a simpler calculation based on the conditional shear stress is used, without taking into account the friction force[τ_{CP}]. For rivets made of steels St 0, St 2, St 3 in holes drilled in the sheets to be joined, [τ_{CP}] = 140 МПа, [σ_{CM}] = 280… 320. For rivets made of steels St 0, St 2, St 3 in holes drilled in the sheets to be joined, [τ_{CP}] = 140 МПа, [σ_{CM}] = 280… 320 MPa are taken; when the holes are prepared by pressure or cold riveting, the allowable stress is reduced by 20… 30%.

REFERENCES:

1. Abdullayev.A.N (2024). Use of measuring instruments. v international bulletin of engineering and technology (113–119). https://doi.org/10.5281/zenodo.10726900

2. Abdullayev.A.N (2024). A study of enclosed cylindrical and bevel gear reducers. Nauka i innovatsiya, 2(6), 148–154.https://inacademy.uz/index.php/si/article/view/28348

3. Abdullayev.A.N (2023). Methodology of problem solving in technical mechanics classes. Scientific electronic magazine "Science and Education". Volume 4 Issue 4 https://drive.google.com/file/d/1GJzuiTGK_lTj7HReL8Pl6_yMqytgpgj1/view?usp=share_link . ISSN 2181-0842 . APRIL 2023 . 684-688

4. A.N.Abdullayev. "Innovations in the field of pedagogical technologies of teaching in technical higher education institutions" Republic-wide scientific and

technical conference on "Modern research, innovations, current problems and development trends of techniques and technologies" April 8-9, 2022, pp. 336- 339 Jizzakh polytechnic institute

5. A.N. Abdullayev. "Universal stand for laboratory and practical classes in electrical engineering". Collection of materials of the scientific-practical conference on the topic "The role of young scientists of higher and secondary special, vocational educational institutions in the innovative development of agriculture". TashDAU, Tashkent-2016, 382-386

6. A.N.Abdullayev. "Development of production serving farms" problems and solutions to increase the export potential of the agricultural sector, to organize multi-sectoral farms, to develop the production and market infrastructure serving them, April 27 2019 TDAU

7. Abdullayev, A. (2023). METHODS OF PROBLEM SOLVING IN THEORETICAL MECHANICS COURSES. *International Bulletin of Applied Science and Technology*, *3*(9), 282-287.

8. Nigmatovich, A. A. (2023). THE IMPORTANCE OF SPECIAL SUBJECTS TRAINING IN THE PROFESSIONAL EDUCATION SYSTEM. ONLINE SCIENTIFIC JOURNAL OF EDUCATION AND DEVELOPMENT ANALYSIS, 3(5), 145-147.

9. Abdullayev, A. N. (2023). Problem-solving methodology in machine parts training. Science and Education, 4(5), 666-670.

10. Abdullaev, A. N., & Borotov, A. N. (2017). RESEARCH OF MATERIALS FOR EXPERIMENTAL MEASUREMENT OF HOISTING DRILLS, ASSEMBLY OF MACHINES WITH HORIZONTAL-SPINDLE APPARATUS (HSA). Vestnik Prikaspiya, (2), 36-39.

11. Abdullaev, A. N. (2017). A REVIEW OF RESEARCH ON THE DEVELOPMENT OF MODELS FOR ASSESSING WEED INFECTION IN MACHINE-HARVESTED COTTON. Vestnik Prikaspiyya, (2), 48-51.

12. Abdullaev, A. N. (2017). ANALYSIS OF OPERATING CONDITIONS OF HORIZONTAL SPINDLE COTTON PICKING MACHINES (HSC). Vestnik Prikaspiyya, (2), 27-31.