AMERICAN Journal of Engineering, Mechanics and Architecture
Volume 01, Issue 10, 2023 ISSN (E): 2993-2637

Theoretical Calculation of Couplings

Tovashov Rustam Xo'jaxmat o'g'li
Doctor of Philosophy in technical Sciences, docent, Karshi engineering-economic institute

Abstract: This article presents the types of couplings used to connect parts together, their uses, and their theoretical calculation.

Keywords: mechanical, force, coupling, attachment, detail, torque, bushing, fixed, movable.

Introduction. Couplings are tools used to connect the ends of shafts, axles, rods, pipes and similar parts. Couplings can be mechanical, electromagnetic, hydraulic or pneumatic. Mechanical couplings that connect the ends of shafts or parts mounted on shafts to each other and transmit torque are studied in machine parts.

Research method. Permanently attached couplings can be fixed or movable. Fixed couplings connect the shafts so that they do not slide relative to each other. Movable couplings connect the shafts in a way that allows them to move in different directions.

The simplest of fixed couplings are bushings (Figure 1) and flanged couplings (Figure 2).

Research results and discussions. These couplings are selected based on the diameter of the shaft and the torque being transmitted:

$$T_{x} = k\,T \leq [\,T\,]$$

where k is the coefficient that takes into account the operating conditions of the coupling.

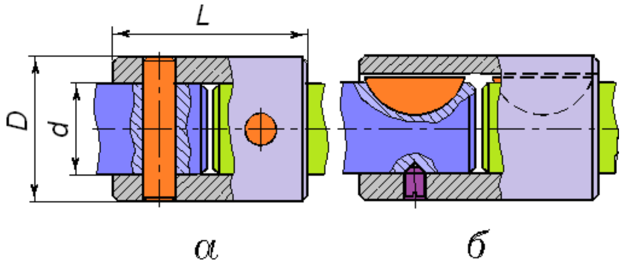

Figure 1. Bushing couplings.

In bushing couplings, the bushing is inserted into the end of the connecting shafts and is fixed immovably by means of a pin (Fig. 1 a), a key (Fig. 1 b) or slots.

These couplings are simple in design and relatively small in size, but require axial movement of the shaft to accommodate the bushing.

The bushing is made of structural steel material and its dimensions are:

$$d \leq 70, \quad D = (1{,}5\ldots1{,}8)\,d,$$

$$L = (2{,}5\ldots4)\,d.$$

The strength of couplings is determined by the strength of keyed, pin or slotted joints and the strength of the bushing.

Flanged couplings (Fig. 2) consist of two semi-circular couplings 1 and 2 mounted on the ends of the shafts, which are fastened with bolts. In one type of this coupling (Fig. 2 a), the bolts are installed with a slot, and the torque is transmitted due to the frictional force generated on the separation surfaces of the two halves of the coupling.

These couplings are made of 40, 35 L steel materials. The dimensions are as follows:

Diameter **D= (3....3,5) d**

total length **L= (2,5...4)d**

Number of bolts **Z= 4= 6**

The coupling is standardized on the basis of GOST 20716-80, the diameter of the shaft is 12...220 mm, the torque that can be transmitted is up to 45000 N*m.

Alignment of the shafts is ensured by the placement of the centering ring A of the left half-coupling in the hole of the right-hand half-coupling. To ensure technical safety, B closes.

In the second type of flanged coupling (Fig. 2 b), the half-couplings are centered at the expense of the bolts, which are installed without a gap, and the torque is transmitted mainly at the expense of the bolt rods working in shear and bending. In this case, safety is provided by the wrapping tool - 3.

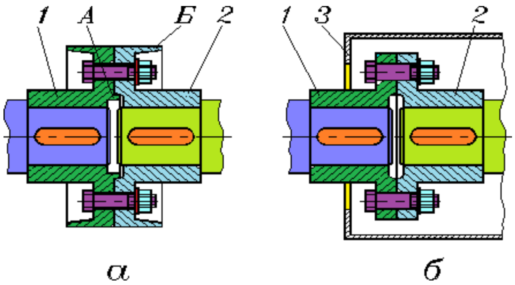

Figure 2. Flanged couplings.

The value of the force required to fasten the bolt in these couplings is determined as follows:

$$T = F \cdot f \cdot D_0 \cdot z /(2 S)$$

ago

$$F=2T \cdot S/(f \cdot D_0 \cdot z)$$

where F is the value of the force required to fasten the bolt; S= 1.2...1.5 - safety factor; D_0-bolt mounting circle diameter; z - number of bolts; f = 0.15...0.2 - friction coefficient.

The structure of the above-mentioned couplings requires that the shafts are precisely aligned.

Movable compensating couplings are used to prevent shaft bending under the influence of external force. These couplings come in different forms, and compensating elements can be rigid or elastic.

The compensating element of the gear coupling is solid (Fig. 3) and consists of 1 and 2 semi-couplings, consisting of equivalent external teeth and a separating ring-3 and two rows of internal teeth.

In order to compensate for the misalignment of the shafts, the coupling should have an interaxial groove - d and a radial and lateral groove in the coupling. In addition, the flanges of the semi-coupling teeth are not cylindrical, but spherical, and the teeth are barrel-shaped.

Calculation of strength of such coupling teeth is performed according to contact stress. However, it is somewhat difficult to determine the actual contact stress, because the value, direction and location of the forces acting on the teeth vary depending on the conditions. Therefore, this is replaced by a conditional method of calculating couplings. In this case, the consistency condition is as follows:

$$T \cdot K = \sigma_{ez}\, bhzD/2$$

where: T-transmitted torque; k-dynamic loading coefficient; b-tooth length; z-number of teeth; Dividing diameter of D-teeth.

$D = m \cdot z$, if $h = 1{,}8\, m$ tooth height:

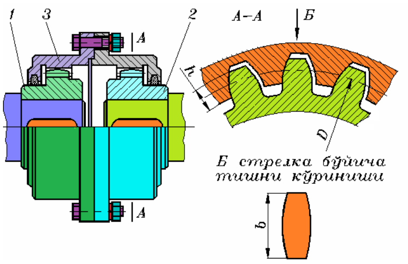

Figure 3. Gear coupling.

$$\sigma_{ez} = T \cdot k / (0{,}9\, D_2 \cdot b) \leq [\sigma_{ez}]\ .$$

Details of gear couplings are made of structural and alloy steels. $[\sigma_{ez}]$ = (12 ... 15) MPa is accepted.

The design of hinged-hinged couplings is based on a cardan hinge (Hook's hinge) (Fig. 4). Unlike couplings compensating for assembly defects, these couplings are used in transport and technological machines to connect shafts that do not correspond to the angular axis $30\text{-}40^0$ taken into account in the structure of the machine.

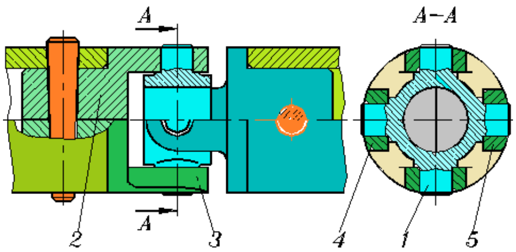

Figure 4. Butsimon-hinge coupling.

Idol-shaped circuit-1 is hinged with a semi-coupling in a mutually perpendicular (vertical) plane. The connection with half-couplings with an idol circuit consists of two half-pieces of half-couplings - 2, 3 and 4, 5 - half-couplings are attached to the shaft with the help of pins.

The compensating Oldgem clutch is a disc clutch. The coupling consists of two semi-circular couplings 1 and 2 and an intermediate disc 3.

The space d between the disk and half-couplings located in a perpendicular plane leads to axial, radial and angular displacement of the shafts, as a result of which these displacements are smoothed using the coupling. Generally, the radial displacement of non-aligned shafts should be limited to D*r* £ 0,04*d*, and the angular displacement should be limited to Da £ 0°30¢. These couplings are calculated for compressive stress:

$$\sigma_{EZ} = 6\, k \cdot T \cdot D / [\, h\, (D^3 - d_1^{\,3})] \leq [\sigma_{ez}]$$

here *k* – speaker coefficient; *h* – the height of the disk output; *D/d*= (2,5….3) is taken. $[\sigma_{ez}]$ = (15…20) MPa.

Couplings with an elastic compensating element are called elastic couplings. They correct (compensate) inaccuracies, regardless of whether or not the alignment of the shafts is fixed. Elastic couplings with their elements also perform the function of a joint with low stiffness in operation, ensure that the machines do not work in resonance conditions as much as possible, prevent vibration. These couplings are divided into metallic and non-metallic types according to the material of the elastic element.

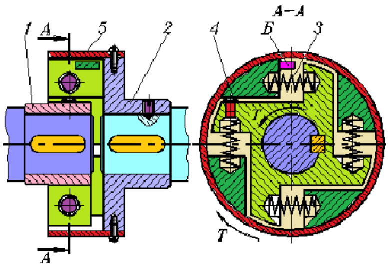

Figure 5. Elastic coupling with cylindrical spring.

The elastic coupling with a cylindrical spring (Fig. 5) consists of the leading 1 and leading 2 semi-couplings, the elastic element of which is a metal spring and is fixed to the shaft with the help of a key. Compression springs - 3 are placed in special holes of half couplings.

The initial position of the half-coupling located at an angle is determined by limiter 4. After the spring is deformed, the possibility of relative turning of the half-coupling is determined by the limiter-B installed on the half-coupling 2. The coupling is closed from the outside with a retainer 5. Until the spring is loaded with a torque T_1 under the influence of the initial compressive force F_1, this coupling works like compensating couplings with sufficient uniformity.

$$T_1 = F_1 R z$$

where: R is the radius of the hole where the spring is located; z is the number of springs.

If the transmitted torque T is greater than the torque T_1, then the coupling acts like an elastic coupling at a constant rate. The coils of the spring are twisted, and at the same time, the longitudinal force on the shoulder of the spring corresponds to the torque equal to half the diameter of the spring, therefore, the strength condition of the spring is expressed as follows:

$$FD/2 = \tau W_p / k_V$$

where: F is the longitudinal force compressing the spring:

$$F = T_{max} / R$$

where: T_{max}-torque transmitted through the coupling; D-spring middle diameter; τ-twisting tension in spring coils; W_P is the cross-sectional resistance moment of the spring winding.

The following formula for checking the spring comes from the above formulas:

$$\tau = (8DT_{max}k_V) / (\pi d^3 Rz) \leq [\tau]$$

The spring is made of special spring steels (steel 65G). Permissible stress $[\tau]$ = (500...900) MPa is obtained depending on their type.

Examples of non-metallic couplings with an elastic element are bush-finger, star-shaped and spherical couplings with an elastic element.

Bushing - finger coupling due to its simplicity of preparation and ease of replacement of rubber elements, it is often used to connect the drive shaft with the shaft of the electric motor. It is intended for transmission of small and medium torques.

Several rubber rings with a trapezoidal cross-section - 4 are placed on the finger - 3 and fixed on the half-coupling - 2. These rings are inserted into the half-coupling-1 hole. Such couplings serve as a low-uniformity joint of the drive and compensate for shafts that are not aligned with each other in the following range: displacement along the axis $\Delta\alpha$ £ 18, torsion Δa= (145) mm, Δr = (0,3 …. 0,6).

Checking the strength of the selected couplings is the bending of the rubber ring on the surface touching the finger.

Conclusion. Worm gears are used in many areas of production. When using extensions, it is necessary to pay serious attention to working conditions, prepared materials and the forces applied to the extension. For this reason, it is important to theoretically justify the geometric parameters of the transmission and calculate its kinematic parameters accordingly.

References

1. Mamatov F. et al. Machine for cultivation and sowing of cereal seeds on sloping fields //AIP Conference Proceedings. – AIP Publishing, 2023. – Т. 2612. – №. 1.
2. Mahamov K. T., Tovashov R. K., Ochilov S. U. Part of the soil surface with minimal tillage analysis of lateral suction techniques and technologies //Academicia: An International Multidisciplinary Research Journal-Kurukshetra. – 2020. – №. 10 (4). – С. 706.
3. Товашов Р. Х. и др. НИШАБЛИКЛАРГА ИШЛОВ БЕРИШ ВА ЭКИШ СЕЯЛКАСИ АРИҚ ОЧГИЧНИНГ ТАЖРИБАВИЙ ТАДҚИҚОТЛАРИ НАТИЖАЛАРИ //Инновацион технологиялар. – 2021. – №. Спецвыпуск 1. – С. 105-108.
4. Kh T. R. Theoretical basis of the crushing angle of the loosening working body blades of the combined machine //Инновационная наука. – 2020. – №. 10. – С. 23-25.
5. Tovashov R. K. Theoretical basis of the installation corner in relation to the direction of movement of the furrow opener working body of the combined machine //РАЗВИТИЕ НАУКИ И ТЕХНИКИ: МЕХАНИЗМ ВЫБОРА И РЕАЛИЗАЦИИ ПРИОРИТЕТОВ. – 2020. – С. 26.
6. Mamatov F. et al. Working body of the machine for sowing cereals on slopes //AIP Conference Proceedings. – AIP Publishing, 2023. – Т. 2612. – №. 1.
7. Mamatov F. et al. Ridge forming machine for sowing cereals on sloping fields //E3S Web of Conferences. – EDP Sciences, 2023. – Т. 401. – С. 04051.
8. Маматов Ф. М., Махамов Х. Т., Товашов Р. Х. Нишаб ерларга ишлов берадиган машина юмшаткичининг тажрибавий тадқиқотлари натижалари //Инновацион технологиялар. – 2021. – №. 1 (41). – С. 27-30.
9. Maxamov XT T. R. X. Tavashov Sh. X., Safarov FS Theoretical basis of the parameters of the base of antique chairs //International Journal of Trend in Scientific Research and Development (IJTSRD), India. – 2022. – Т. 6. – №. 2. – С. 1213-1217.
10. Tovashov R. Нишаб ерларга ишлов берадиган машина корпусининг тажрибавий тадқиқотлари натижалари //Science and innovation. – 2022. – Т. 1. – №. A6. – С. 411-415.
11. Товашов Р. Х., Товашов Б. Р. Результаты экспериментальных исследований рыхлителя сеялки //ИНТЕЛЛЕКТУАЛЬНЫЙ ПОТЕНЦИАЛ ОБЩЕСТВА КАК ДРАЙВЕР ИННОВАЦИОННОГО РАЗВИТИЯ НАУКИ. – 2021. – С. 27-31.
12. Tovashov R. X., Safarov F. S., Maxamov A. U. Theoretical justification of parameters of backrest of antique chair. – 2022.
13. Mirzaev B. et al. Combined machine for preparing soil for cropping of melons and gourds IOP Conference Series: Earth and Environmental Science, 403 DOI: 10.1088. – 1755-1315/403/1, 2019. – Т. 12158.
14. Алдошин Н.В., Маматов Ф.М., Исмаилов И.И., Тавашов Р.., Васильев А.С. Обработка почвы и посев зерновых культур на склоновых полях. *Агроинженерия*. 2023;25(3):30-34. https://doi.org/10.26897/2687-1149-2023-3-30-34
15. Xo‘jaxmat o‘g‘li, T. R. . (2023). Nishabli Dalalarga Ishlov Beradigan Va Don Ekadigan Mashinaning O‘Rkach Hosil Qilgichining Harakat Yo‘Nalishiga Nisbatan O‘Rnatilish Burchagini Asoslash. *Journal of Innovation, Creativity and Art, 2*(2), 27–31.

16. Rustam Xoʻjaxmat oʻg T. et al. KOMBINATSIYALASHGAN MASHINANING ARIQOCHKICH ISHCHI ORGANINING HARAKAT YO ʻNALISHIGA NISBATAN O ʻRNATILISH BURCHAGINI NAZARIY ASOSLASH //JOURNAL OF INNOVATIONS IN SCIENTIFIC AND EDUCATIONAL RESEARCH. – 2023. – Т. 6. – №. 1. – С. 147-151.
17. Rustam Xoʻjaxmat oʻg T. et al. THEORETICAL JUSTIFICATION OF BELT TRANSMISSION PARAMETERS //American Journal of Science on Integration and Human Development (2993-2750). – 2023. – Т. 1. – №. 9. – С. 208-212.
18. Rustam Xoʻjaxmat oʻg T. et al. Calculation Of The Strength Of Welded Joints //American Journal of Engineering, Mechanics and Architecture (2993-2637). – 2023. – Т. 1. – №. 9. – С. 10-13.
19. Tovashov R. et al. Combination machine for soil cultivation and sowing grain //E3S Web of conferences. – EDP Sciences, 2021. – Т. 264. – С. 04049.
20. Irgashev D. B., AR R. X. T., Sadikov O. T. Mamadiyorov. Technical Analysis of Plug Software When Working Between Gardens //International Journal of Advanced Research in Science, Engineering and Technology. – 2022. – Т. 9. – №. 5.
21. Mirzaev B. et al. Combined machine for preparing soil for cropping of melons and gourds //IOP Conference Series: Earth and Environmental Science. – IOP Publishing, 2019. – Т. 403. – №. 1. – С. 012158.
22. Fayzullayev K. et al. The quality of loosening the soil with subsoilers of the combined machine //IOP Conference Series: Materials Science and Engineering. – IOP Publishing, 2021. – Т. 1030. – №. 1. – С. 012171.
23. Kh T. R. Makhamov Kh. T. Analysis of combined machines for minimal tillage of soil //International Journal of Advanced Research in Engineering and Technology. – 2020. – Т. 11. – №. 8. – С. 609-616.
24. Kh T. R. Makhamov Kh. T., Tovashov BR Justification of Parameters of the Loosening Working Body //International Journal of Advanced Research in Science, Engineering and Technology. – 2020. – Т. 7. – №. 7. – С. 14336-14339.
25. Kh M. et al. IOP Conf. Series //Materials Science and Engineering. – 2020. – Т. 883. – С. 012179.
26. Товашов Р. Х., Ашуров Б. Analysis of the working bodies of the ridger //Просвещение и познание. – 2022. – №. 5 (12). – С. 9-15.
27. Товашов Р. Х., Ашуров Б. Analysis of bodies for plowing soil crest //Просвещение и познание. – 2022. – №. 5 (12). – С. 3-8.