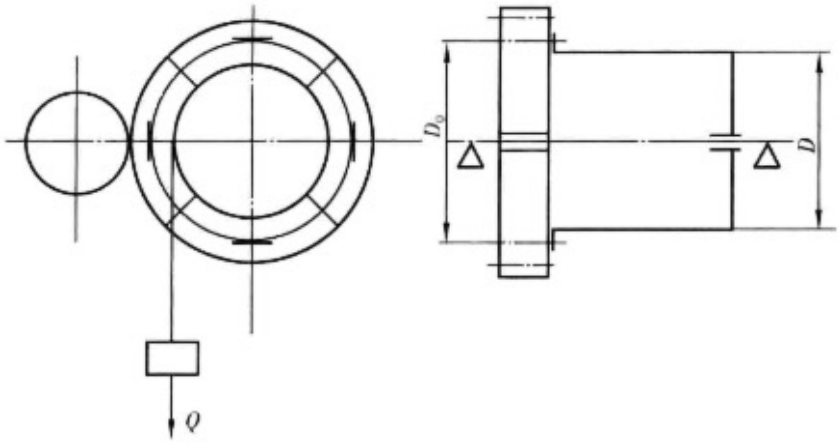
HW06
第05章 连接及连接件
作业

南方科技大学

HW 06.1

起重卷筒与大齿轮用8个普通螺栓连接在一起，如图所示。已知卷筒直径$D = 400\,mm$，螺栓分布圆$D_0 = 500\,mm$，接合面间摩擦系数$f = 0.12$，可靠性系数$K_f = 1.2$，起重钢索拉力$Q = 50000\,N$，螺栓材料的许用拉伸应力$[\sigma] = 100\,MPa$。试设计该螺栓组的螺栓直径。

A lifting reel is connected to a large gear with 8 ordinary bolts as shown in the figure. It is known that the diameter of the reel D = 400 mm, the bolt distribution circle D_0= 500 mm, the coefficient of friction between the joint surfaces f = 0.12, the reliability coefficient K_f= 1.2, lifting cable tension Q = 50,000 N, and permissible tensile stress of the bolt material $[\sigma]$ = 100 $M\ Pa$. try to design the bolt diameter of this bolt group.



HW 06.1

解题要点：

1. 计算旋转力矩 T Calculation of rotational moments T

$$T = Q \cdot \frac{D}{2} = 50000 \times \frac{400}{2}\ \text{N} \cdot \text{mm} = 10^7\ \text{N} \cdot \text{mm}$$

2. 计算螺栓所需要的预紧力 F' Calculate the required preload force F' for the bolt.

由 $$zfF' \cdot \frac{D_0}{2} = K_f T$$

得 $$F' = \frac{2K_f T}{zfD_0}$$

将已知数值代入上式，可得 Bringing the known values into the above equation gives:

$$F' = \frac{2K_f T}{zfD_0} = \frac{2 \times 1.2 \times 10^7}{8 \times 0.12 \times 500}\ \text{N} \cdot \text{mm} = 50000\ \text{N} \cdot \text{mm}$$

3. 确定螺栓直径 Determine the bolt diameter.

$$d_1 \geqslant \sqrt{\frac{4 \times 1.3F'}{\pi[\sigma]}} = \sqrt{\frac{4 \times 1.3 \times 50000}{\pi \times 100}}\ \text{mm} = 28.768\ \text{mm}$$

取 M36($d_1 = 31.670$ mm > 28.768 mm)。

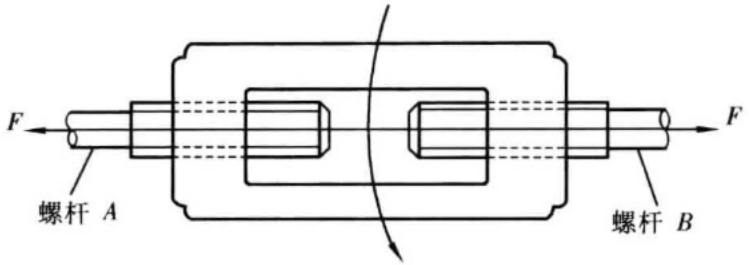
HW 06.2

如图所示为一螺旋拉紧装置，旋转中间零件，可使两端螺杆A和B向中央移近，从而将被拉两零件拉紧。已知: 螺杆A和B的螺纹为M16(d_1=13.835mm)，单线;其材料许用拉伸应力[σ]= 80MPa; 螺纹副间摩擦系数f=0.15。试计算允许施加于中间零件上的 最大转矩T_{max}，并计算旋紧时螺旋的效率η。

M16螺纹的相关参数： 大径$d = 16\,mm$； 中径$d_2 = 14.701\,mm$； 螺距$p = 2\,mm$；

A screw tensioning device is shown in the figure, rotating the middle part can make the two ends of the screw A and B move closer to the center, so as to tighten the two parts being pulled. It is known that the threads of screws A and B are M16 (d_1 = 13.835 mm), single thread; their material allowable tensile stress [σ] = 80 MPa; and the coefficient of friction between the threaded pairs, f = 0.15. Calculate the maximum torque, T_{max}, allowed to be applied to the intermediate parts, and calculate the efficiency of the screws during tightening. Calculate the maximum permissible torque T_{max} on the intermediate part and calculate the efficiency of the screw during tightening.

Parameters related to M16 thread : large diameter $d = 16\,mm$; medium diameter $d_2 = 14.701\,mm$; pitch $p = 2\,mm$;



HW 06.2

解题要点：

(1) 计算螺杆所能承受的最大轴向拉力 F_{max}。

Calculate the maximum axial tension F_{max} that the screw can withstand.

由 $$\sigma_e = \frac{1.3F}{\pi d_1^2/4} \leqslant [\sigma]$$

得 $$F \leqslant \frac{\pi d_1^2}{4\times 1.3}[\sigma]$$

所以 $$F_{max} = \frac{\pi d_1^2}{4\times 1.3}[\sigma] = \frac{\pi \times 13.835^2}{4\times 1.3}\times 80\ \text{N} = 9251\ \text{N}$$

(2) 计算螺纹副间的摩擦力矩 T_{1max}。

Calculate the friction torque T_{max} between the threaded pairs.

查 M16 螺纹的参数如下：

大径 $d=16$ mm；中径 $d_2=14.701$ mm；螺距 $p=2$ mm；单线，即线数 $n=1$，所以，螺旋升角为

Parameters related to M16 thread : large diameter d = 16 mm; medium diameter d_2 = 14.701 mm; pitch p = 2 mm; single thread, that is, the number of threads n = 1, so that the helical lift angle is:

$$\lambda = \arctan\frac{np}{\pi d_2} = \arctan\frac{1\times 2}{\pi\times 14.701} = 2.480^\circ = 2^\circ 28' 47''$$

而当量摩擦角为

The equivalent friction angle is:

$$\rho_v = \arctan f_v = \arctan\frac{f}{\cos\beta}$$

已知 $$f=0.15,\quad \beta=\frac{\alpha}{2}=30^\circ$$

所以 $$\rho_v = \arctan\frac{0.15}{\cos 30^\circ} = 9.826^\circ = 9^\circ 49' 35''$$

螺纹副间的最大摩擦力矩为

The maximum friction torque between the threaded pairs is:

$$T_{1max} = F_{max}\tan(\lambda+\rho_v)\frac{d_2}{2}$$

$$= 9251\times\tan(2.480^\circ+9.826^\circ)\times\frac{14.701}{2}\ \text{N}\cdot\text{mm} = 14834\ \text{N}\cdot\text{mm}$$

(3) 计算允许施加于中间零件上的最大转矩 T_{max}。

Calculate the maximum torque T_{max} allowed to be applied to the intermediate part.

因为施加于中间零件上的转矩要克服螺杆 A 和 B 的两种螺纹副间摩擦力矩，故有

$$T_{max} = 2T_{1max} = 2\times 14834\ \text{N}\cdot\text{mm} = 29668\ \text{N}\cdot\text{mm}$$

Since the torque applied to the intermediate parts has to overcome the frictional torque between the two threaded pairs of screws A and B, so:

HW 06.2

(4) 计算旋紧时螺旋的效率 η。

Calculate the efficiency η of the screw when screwed.

Because screwing the middle part for a week, do input work for $T_{max} \cdot 2\pi$, and at this time screw A and B each move 1 lead $l = np = 1{\times}2\ mm = 2\ mm$, do useful work for $2F_{max}l$, so at this time the screw to the efficiency of:

因为旋紧中间零件一周，做输入功为 $T_{max} \cdot 2\pi$，而此时螺杆 A 和 B 各移动 1 个导程 $l=np=1\times2$ mm$=2$ mm，做有用功为 $2F_{max}l$，故此时螺旋的效率为

$$\eta = \frac{2F_{max}l}{T_{max} \cdot 2\pi} = \frac{2\times9251\times2}{29668\times2\times\pi} \approx 0.199 = 19.9\%$$

或按公式

$$\eta = \frac{\tan\lambda}{\tan(\lambda+\rho_v)} = \frac{\tan 2.480^\circ}{\tan(2.480^\circ+9.826^\circ)} \approx 0.199 = 19.9\%$$

HW 06.3

某带式输送机传动系统中，已知电动机功率$P = 13.69\ kW, n = 136.4\ r/min$, 电动机轴的直径和减速器输入轴的直径均为42mm。请选择一种联轴器（固定刚性联轴器、可移式刚性联轴器、弹性套柱联轴器、弹性柱销联轴器、轮胎式联轴器）给出相应理由，并计算转矩。

工况系数$K_A = 1.5$

In a belt conveyor drive system, it is known that the motor power $P = 13.69\ kW$, $n = 136.4\ r/min$, and that the diameter of the motor shaft and the diameter of the gearbox input shaft are both 42 mm. Choose one type of coupling (fixed rigid coupling, removable rigid coupling, flexible sleeve-column coupling, flexible pin coupling, tire-type coupling) giving the appropriate justification and calculating the torque.

Working condition factor: $K_A = 1.5$

HW 06.3

解 (1) 类型选择。Type selection

由于机组功率不大，运转平稳，且结构简单，便于提高其制造和安装精度，使其轴线偏移量较小，故选用弹性柱销联轴器。

Due to the unit power is not large, smooth operation, and simple structure, easy to improve its manufacturing and installation accuracy, so that its axis offset is small, so the choice of flexible pin coupling.

(2) 计算转矩。Calculate torque

转矩为 Torque is

$$T=9\ 550\ \frac{P}{n}=9\ 550\times\frac{13.69}{136.4}\ \mathrm{N\cdot m}=958.5\ \mathrm{N\cdot m}$$

查教材表 15-1 得，工况系数 $K_A=1.5$，故计算转矩 Working condition factor is $K_A = 1.5$, so torque is:

$$T_c=K_A T=1.5\times 958.5\ \mathrm{N\cdot m}=1\ 437.8\ \mathrm{N\cdot m}$$

Deadline of this homework: Dec 05 @ **23:30**

Link to submission:
https://ancorasir.com/?page_id=3987

All homework MUST be hand-written.
No late submission is allowed!

Please refer to the above link for further details on how to make the submission and the detailed deadline for submission.

谢谢~

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