Homework

(1) What is the difference between the strength calculation of a bolt group and the strength calculation of a single bolt? What is the difference between the connection design process for bolt groups subjected to lateral working loads and the connection design process for bolt groups subjected to axial working loads?

The strength calculation difference

For a single bolt:
the strength calculation typically involves determining the strength of the bolt itself based on its material properties and geometry, as well as the loading conditions and environmental factors that the bolt will be subjected to. This calculation typically takes into account the ultimate tensile strength and yield strength of the bolt, as well as factors such as the thread engagement length, bolt diameter, and whether the bolt is subjected to shear or tension forces.

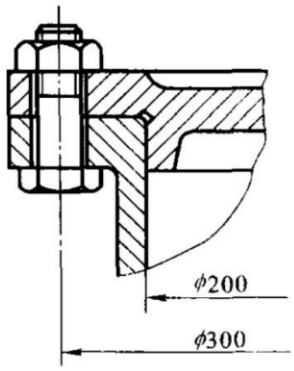
For a bolt group:
the strength calculation is more complex because it involves multiple bolts working together to resist external loads. The strength of a bolt group is typically calculated based on the number and arrangement of the bolts in the group, the strength and stiffness of the connected materials, and the loading conditions that the bolt group will be subjected to. The calculation may also take into account factors such as the spacing between bolts, the size and shape of the connection plates, and the type of connection being used.

The difference of connection design process for bolt groups

For axial working loads:
Calculate the connection for tension and compression stresses. The design should ensure that the connection can resist the applied axial load without excessive deformation or failure. The bolt strength and stiffness, as well as the strength and stiffness of the connected members, are some of the factors that may need to be considered in the design process.

For lateral working loads:
Calculate the shearing and extruding strength accordingly. The design should ensure that the connection can resist the applied lateral load without excessive deformation or failure. The number and spacing of bolts, the bolt diameter, and the thickness and stiffness of the connected members are some of the factors that may need to be considered in the design process.

(2) The cylinder head connection is shown in the figure. The pressure in the cylinder is between 0 - 1 MPa. The arc distance (弧度距离) between bolts shall not exceed160 mm. Please determine the number *z* and corresponding diameter d_1 of bolts.



Hint:
1. *When determining the number of bolts, please select the minimum value that meets the requirements of the question.*
2. *Select F"=1.65F*
3. *The tables that may be used are shown at the end of the slides.*

Calculate the minimum value of the number of bolts that meets the requirement:
Select:

Arc distance=160mm ⟶ number $z=\frac{\pi\times300}{160}=5.89\approx6$

Now calculate the corresponding diameter d_1:
Pressure $p=1\text{MPa}$

Total axial load $F_Q=\frac{\pi}{4}D^2p=\frac{\pi}{4}\times(200\times10^{-3})^2\times1\times10^6=31415.93N$

Single axial load $F=\frac{F_Q}{z}=5236N$

$$F_0=F''+F=1.65F+F=2.65F=13875.4N$$

$$d_1\geq\sqrt{\frac{4\times1.3F_0}{\pi[\sigma]}}=\sqrt{\frac{4\times1.3\times13875.4}{\pi[\sigma]}}$$

由教材:"求螺纹直径时要用到许用应力$[\sigma]$，而$[\sigma]$又与螺纹直径有关，所以常需采用试算法"

选取螺栓材料性能等级为 4.8 级,查表得: $\sigma_b=400MPa$, $\sigma_s=\frac{8}{10}\sigma_b=320MPa$

装配时不要求严格控制预紧力，暂取安全系数 $S=3$

$$[\sigma]=\frac{\sigma_s}{S}=107MPa$$

计算螺纹小径:

$$d_1\geq\sqrt{\frac{4\times1.3F_0}{\pi[\sigma]}}=\sqrt{\frac{4\times1.3\times13875.4}{\pi\times107\times10^6}}=0.014651m=14.651mm$$

由教材表 10-1，取 M18 螺栓（小径d_1=15.294mm），按照表 10-8 可知，所取安全系数$S=3$是正确的。