

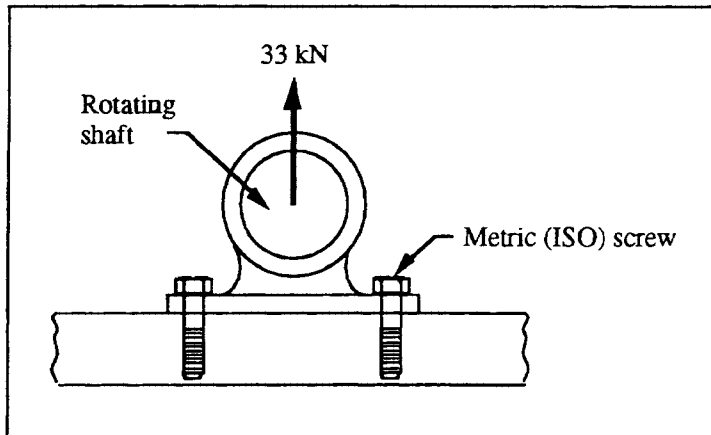
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**SOLUTION (10.29D)**

**Known:** A known static tensile load is applied to two metric (ISO) screws.

**Find:** Select appropriate screws and specify a tightening torque.

**Schematic and Given Data:**



### Assumptions/Decisions:

1. The load of 33 kN is shared equally by each screw.
2. No bending of the machine screws (bolts) takes place; i.e., the bolt is in axial tension.
3. Use a SF of 4.
4. A relatively inexpensive class 5.8 steel is chosen for the screw material.

### Analysis:

1. From Table 10.5, choose class 5.8 steel with proof strength of 380 MPa.

$$\text{Nominal load on each screw} = \frac{33 \text{ kN}}{2} = 16.5 \text{ kN}$$

$$\text{Using a safety factor of 4, design overload for each bolt} = 16.5 \text{ kN} \times 4 = 66 \text{ kN}$$

$$\sigma = \frac{P}{A} \Rightarrow 380 \text{ MPa} = \frac{66,000 \text{ N}}{A_t} \Rightarrow A_t = 173.7 \text{ mm}^2$$

From Table 10.2, use screw size M18  $\times$  2.5 (coarse threads) with  $A_t = 192 \text{ mm}^2$  ■

2. From Eq. (10.11a),  $F_i = 0.9 A_t S_p = 0.9(192)(380) = 65.7 \text{ kN}$   
From Eq. (10.12),  $T = 0.2 F_i d = 0.2(65.7)(18) = 236.5 \text{ N}\cdot\text{m}$  ■

### Comments:

1. In the analysis, step 1, the solution for area  $A_t$  is independent of the stiffness ratio,  $k_c/k_b$  and also independent of the initial tension  $F_i$ . Regardless of these quantities, static failure of the bolts will occur only when the overload is sufficient to yield the entire bolt cross section, with the pillow block pulled away from the mating fixed surface (i.e.,  $F_c = 0$ ). The optimal initial tension would be the highest value that does not yield the bolts enough to damage them after taking them out and reinstalling them many times.
  2. The procedure to obtain  $A_t = 173.7 \text{ mm}^2$  was based on slight yielding of the entire bolt cross section when the design overload is reached. With the M18  $\times$  2.5 screws ( $A_t = 192 \text{ mm}^2$ ), a design overload of 73 kN would cause slight yielding. A small additional overload would distort the bolts so that they would not be reusable. However, a substantially higher overload would be needed to bring the material to its ultimate strength and fracture the bolts (ratio  $S_u/S_p = 520/380 = 1.37$ ). In some situations the design overload might be based on using the ultimate strength of the bolt material rather than its proof or yield strength.
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