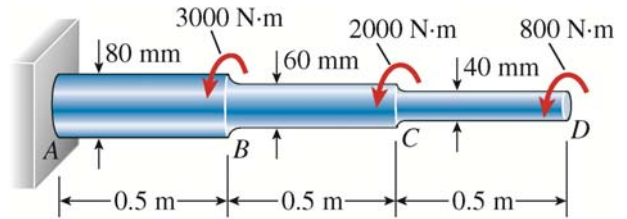


### 四造二甲材料力學 HW9

**3.4-3** A stepped shaft  $ABCD$  consisting of solid circular segments is subjected to three torques, as shown in the figure. The torques have magnitudes  $3000\text{ N}\cdot\text{m}$ ,  $2000\text{ N}\cdot\text{m}$ , and  $800\text{ N}\cdot\text{m}$ . The length of each segment is  $0.5\text{ m}$  and the diameters of the segments are  $80\text{ mm}$ ,  $60\text{ mm}$ , and  $40\text{ mm}$ . The material is steel with shear modulus of elasticity  $G = 80\text{ GPa}$

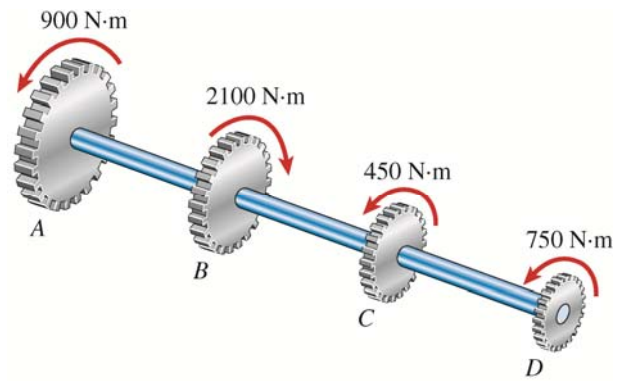


- Calculate the maximum shear stress  $\tau_{\max}$  in the shaft.
- Calculate the angle of twist  $\phi_D$  (in degrees) at end  $D$ .

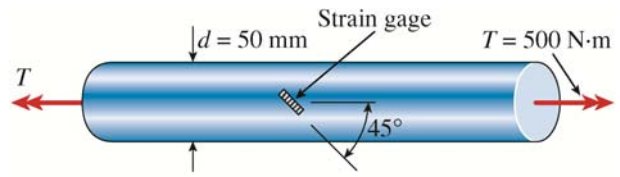
**3.4-7** Four gears are attached to a circular shaft and transmit the torques shown in the figure. The allowable shear stress in the shaft is 70 MPa.

(a) What is the required diameter  $d$  of the shaft if it has a solid cross section?

(b) What is the required outside diameter  $d$  if the shaft is hollow with an inside diameter of 40 mm?



**3.5-4** A solid circular bar of diameter  $d = 50$  mm (see figure) is twisted in a testing machine until the applied torque reaches the value  $T = 500$  N·m. At this value of torque, a strain gage oriented at  $45^\circ$  to the axis of the bar gives a reading  $\epsilon = 339 \times 10^{-6}$ . What is the shear modulus  $G$  of the material?



**3.5-8** An aluminium tube has inside diameter  $d_1 = 50$  mm, shear modulus of elasticity  $G = 27$  GPa, and torque  $T = 4.0$  kN·m.

The allowable shear stress in the aluminum is 50 MPa and the allowable normal strain is  $900 \times 10^{-6}$ .

Determine the required outside diameter  $d_2$ .