材料力學　作業 1

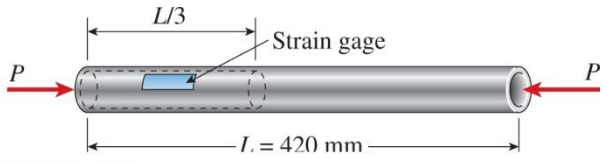
學號：＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿姓名：＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿

1.3-4 A circular aluminum tube with a length of *L*=420mm is loaded in compression by forces *P* (see figure). The hollow segment of length *L*/3 has outside and inside diameters of 60 mm and 35 mm, respectively. The solid segment of length 2*L*/3 has diameter of 60 mm. A strain gage is placed on the outside of the hollow segment of the bar to measure normal strains in the longitudinal direction.

(a) If the measured strain in the hollow segment is $\varepsilon_h = 470 \times 10^{-6}$, what is the strain ε_s in the solid part? (*Hint*: The strain in the solid segment is equal to that in the hollow segment multiplied by the ratio of the area of the hollow to that of the solid segment).

(b) What is the overall shortening δ of the bar?

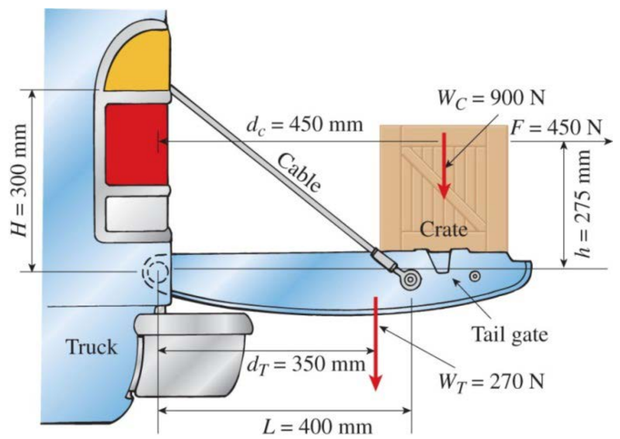
(c) If the compressive stress in the bar cannot exceed 48 MPa, what is the maximum permissible value of load *P*?



Problem 1.3-9 A pickup truck tailgate supports a crate ($W_C = 900N$), as shown in the figure. The tailgate weighs $W_T = 270N$ and is supported by two cables (only one is shown in the figure). Each cable has an effective cross-sectional area $A_e = 11mm^2$.

(a) Find the tensile force *T* and normal stress σ in each cable.

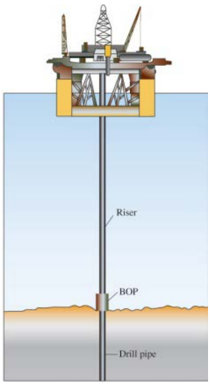
(b) If each cable elongates $\delta = 0.42$mm due to the weight of both the crate and the tailgate, what is the average strain in the cable?



1.4-2 Steel riser pipe hangs from a drill rig located offshore in deep water (see figure).

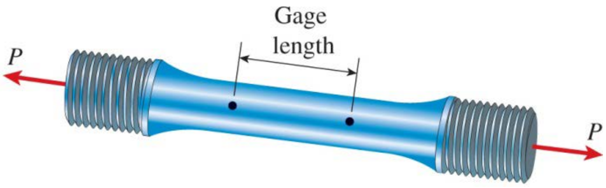
(a) What is the greatest length (meters) it can have without breaking if the pipe is suspended in air and the ultimate strength (or breaking strength) is 550 MPa?

(b) If the same riser pipe hangs from a drill rig at sea, what is the greatest length? (Obtain the weight densities of steel and sea water from Table H-1, Appendix H. Neglect the effect of buoyant foam casings on the pipe.)



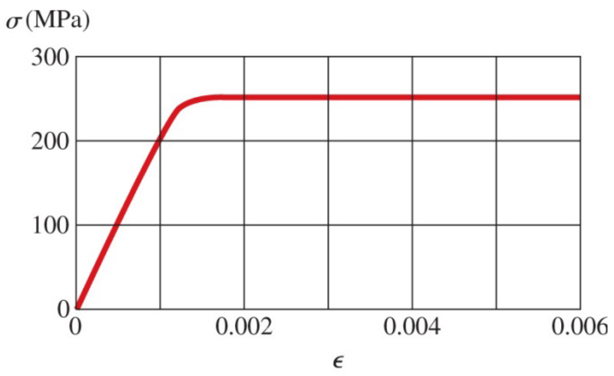
1.4-3 Three different materials, designated *A*, *B*, and *C*, are tested in tension using test specimens having diameters of 12 mm and gage lengths of 50 mm (see figure). At failure, the distances between the gage marks are found to be 54.5 mm, 63.2 mm, and 69.4 mm, respectively. Also, at the failure cross sections the diameters are found to be 11.46, 9.48, and 6.06 mm, respectively.

Determine the percent elongation and percent reduction in area of each specimen, and then, using your own judgment, classify each material as brittle or ductile.



1.5-2 A bar of length 2.0 m is made of a structural steel having the stress-strain diagram shown in the figure. The yield stress of the steel is 250 MPa and the slope of the initial linear part of the stress-strain curve (modulus of elasticity) is 200 GPa. The bar is loaded axially until it elongates 6.5 mm, and then the load is removed.

How does the final length of the bar compare with its original length? (Hint: Use the concepts illustrated in Fig. 1-36b.)



1.5-5 A wire of length $L = 2.5\text{m}$ and diameter d=1.6mm is stretched by tensile forces $P = 600\text{N}$. The wire is made of a copper alloy having a stress-strain relationship that may be described mathematically by the following equation:

$$\sigma = \frac{124{,}020\varepsilon}{1+300\varepsilon} \qquad 0 \le \varepsilon \le 0.03 \qquad (\sigma = MPa)$$

in which ε is nondimensional and σ has units of MPa.

(a) Construct a stress-strain diagram for the material.

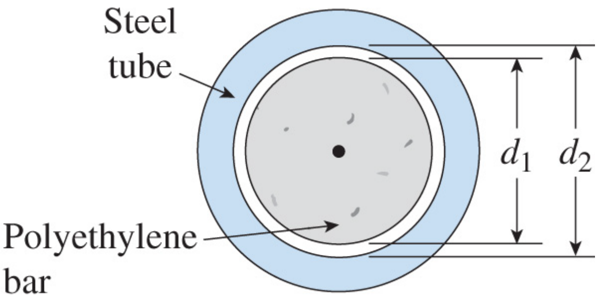
(b) Determine the elongation of the wire due to the forces P.

(c) If the forces are removed, what is the permanent set of the bar?

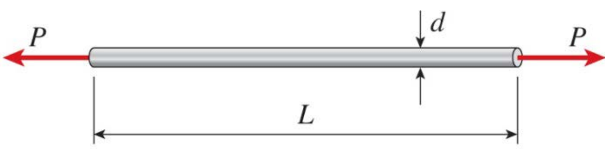
(d) If the forces are applied again, what is the proportional limit?

1.6-3 A polyethylene bar having diameter $d_1 = 70mm$ is placed inside a steel tube having inner diameter $d_2 = 70.2mm$ (see figure). The polyethylene bar is then compressed by an axial force P.

At what value of the force P will the space between the polyethylene bar and the steel tube be closed? (For polyethylene, assume $E = 1.4\text{GPa}$ and $v = 0.4$.)



1.6-5 A bar of monel metal as in the figure (length $= 230\text{mm}$, diameter $d = 6\text{mm}$) is loaded axially by a tensile force P. If the bar elongates by 0.5 mm, what is the decrease in diameter d? What is the magnitude of the load P? Use the data in Table H-2, Appendix H.

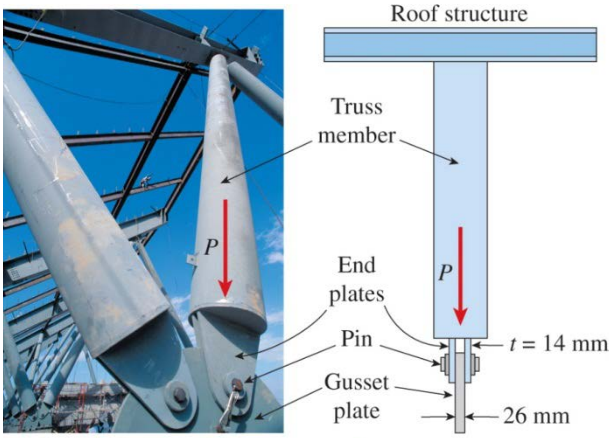


1.7-2 Truss members supporting a roof are connected to a 26-mm-thick gusset plate by a 22-mm diameter pin as shown in the figure and photo. The two end plates on the truss members are each 14 mm thick.

(a) If the load $P = 80\text{kN}$, what is the largest bearing stress acting on the pin?

(b) If the ultimate shear stress for the pin is 190 MPa, what force P_{ult} is required to cause the pin to fail in shear?

(Disregard friction between the plates.)



Truss members supporting a roof (Vince Streano/Getty Images)

1.7-10 A flexible connection consisting of rubber pads (thickness $t = 9\text{mm}$) bonded to steel plates is shown in the figure. The pads are 160 mm long and 80 mm wide.

(a) Find the average shear strain γ_{aver} in the rubber if the force $P = 16\text{kN}$ and the shear modulus for the rubber is $G = 1250\text{kPa}$.

(b) Find the relative horizontal displacement δ between the interior plate and the outer plates.

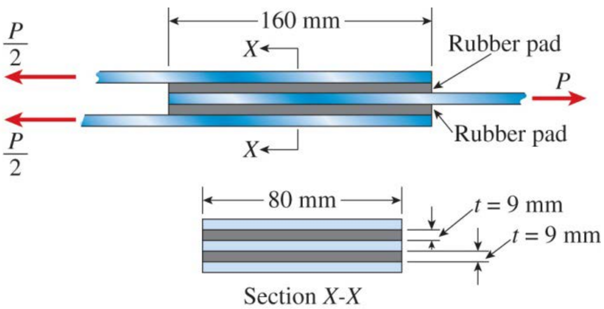


Fig. 1-36

Stress-strain diagrams illustrating (a) elastic behavior, and (b) partially elastic behavior

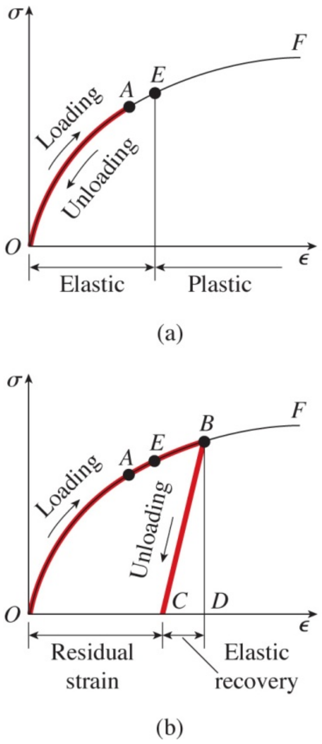


Table H-1

Weights and Mass Densities

Material	Weight density γ kN/m³	Mass density ρ kg/m³
Aluminum alloys 2014-T6, 7075-T6 6061-T6	26–28 28 26	2,600–2,800 2,800 2,700
Brass	82–85	8,400–8,600
Bronze	80–86	8,200–8,800
Cast iron	68–72	7,000–7,400
Concrete Plain Reinforced Lightweight	 23 24 11–18	 2,300 2,400 1,100–1,800
Copper	87	8,900
Glass	24–28	2,400–2,800
Magnesium alloys	17–18	1,760–1,830
Monel (67% Ni, 30% Cu)	87	8,800
Nickel	87	8,800
Plastics Nylon Polyethylene	 8.6–11 9.4–14	 880–1,100 960–1,400
Rock Granite, marble, quartz Limestone, sandstone	 26–28 20–28	 2,600–2,900 2,000–2,900
Rubber	9–13	960–1,300
Sand, soil, gravel	12–21	1,200–2,200
Steel	77.0	7,850
Titanium	44	4,500
Tungsten	190	1,900
Water, fresh sea	9.81 10.0	1,000 1,020
Wood (air dry) Douglas fir Oak Southern pine	 4.7–5.5 6.3–7.1 5.5–6.3	 480–560 640–720 560–640

Table H-2

Moduli of Elasticity and Poisson's Ratios

Material	Modulus of elasticity E GPa	Shear modulus of elasticity G GPa	Poisson's ratio ν
Aluminum alloys	70–79	26–30	0.33
2014-T6	73	28	0.33
6061-T6	70	26	0.33
7075-T6	72	27	0.33
Brass	96–110	36–41	0.34
Bronze	96–120	36–44	0.34
Cast iron	83–170	32–69	0.2–0.3
Concrete (compression)	17–31		0.1–0.2
Copper and copper alloys	110–120	40–47	0.33–0.36
Glass	48–83	19–35	0.17–0.27
Magnesium alloys	41–45	15–17	0.35
Monel (67% Ni, 30% Cu)	170	66	0.32
Nickel	210	80	0.31
Plastics			
Nylon	2.1–3.4		0.4
Polyethylene	0.7–1.4		0.4
Rock (compression)			
Granite, marble, quartz	40–100		0.2–0.3
Limestone, sandstone	20–70		0.2–0.3
Rubber	0.0007–0.004	0.0002–0.001	0.45–0.50
Steel	190–210	75–80	0.27–0.30
Titanium alloys	100–120	39–44	0.33
Tungsten	340–380	140–160	0.2
Wood (bending)			
Douglas fir	11–13		
Oak	11–12		
Southern pine	11–14		