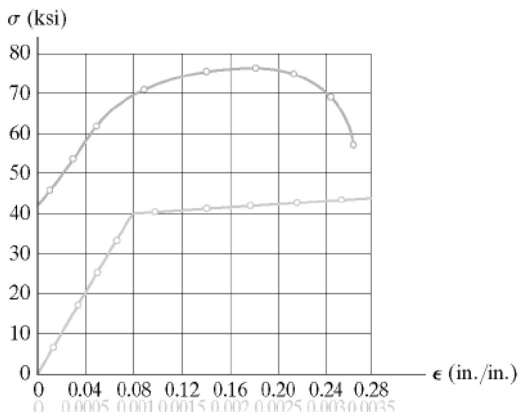
HW 16 SOUTIONS

3–6. The stress–strain diagram for a steel alloy having an original diameter of 0.5 in. and a gauge length of 2 in. is given in the figure. If the specimen is loaded until it is stressed to 70 ksi, determine the approximate amount of elastic recovery and the increase in the gauge length after it is unloaded.



Modulus of Elasticity : From the stress – strain diagram, $\sigma = 40$ ksi when $\varepsilon = 0.001$ in./in.

$$E = \frac{40-0}{0.001-0} = 40.0(10^3) \text{ ksi}$$

Elastic Recovery :

$$\text{Elastic recovery} = \frac{\sigma}{E} = \frac{70}{40.0(10^3)} = 0.00175 \text{ in./in.}$$

Thus,

The amount of Elastic Recovery = 0.00175(2) = 0.00350 in. **Ans**

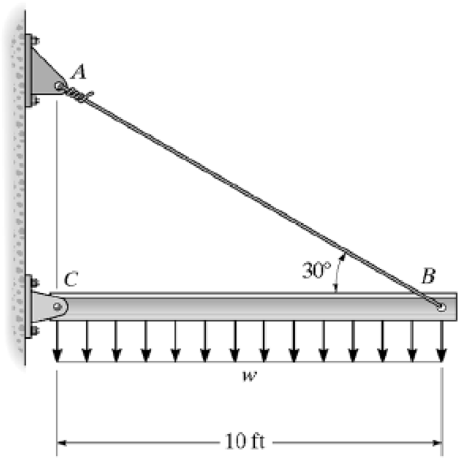
Permanent Set :

Permanent set = 0.08 − 0.00175 = 0.07825 in./in.

Thus,

Permanent elongation = 0.07825(2) = 0.1565 in. **Ans**

3–23. The beam is supported by a pin at C and an A-36 steel guy wire AB. If the wire has a diameter of 0.2 in., determine how much it stretches when a distributed load of $w = 100$ lb/ft acts on the pipe. The material remains elastic.



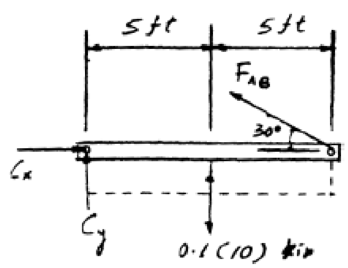
$+\Sigma M_C = 0; \quad F_{AB} \sin 30°(10) - 0.1(10)(5) = 0;$

$F_{AB} = 1.0 \text{ kip}$

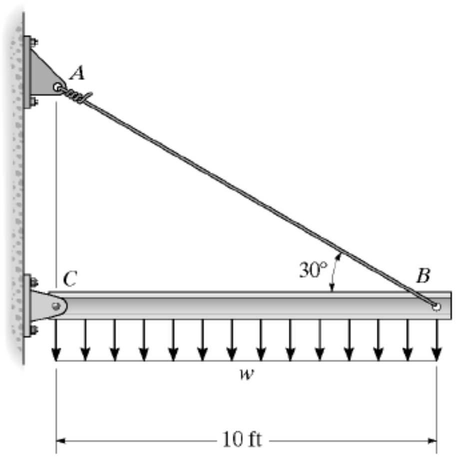
$\sigma_{AB} = \frac{F_{AB}}{A_{AB}} = \frac{1.0}{\frac{\pi}{4}(0.2)^2} = 31.83 \text{ ksi}$

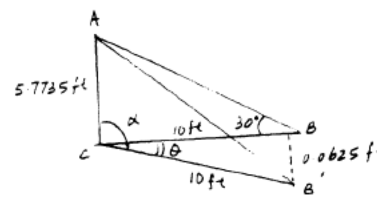
$\sigma = E\,\varepsilon; \quad 31.83 = 29(10^3)\,\varepsilon_{AB}; \quad \varepsilon_{AB} = 0.0010981 \text{ in./in.}$

$\delta_{AB} = \varepsilon_{AB} L_{AB} = 0.0010981\left(\frac{120}{\cos 30°}\right) = 0.152 \text{ in.}$ **Ans**



***3–24.** The beam is supported by a pin at C and an A-36 steel guy wire AB. If the wire has a diameter of 0.2 in., determine the distributed load w if the end B is displaced 0.75 in. downward.





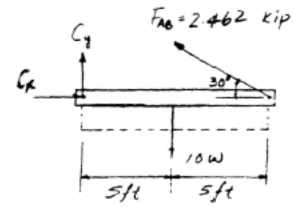
$$\sin\theta = \frac{0.0625}{10}; \qquad \theta = 0.3581°$$

$$\alpha = 90 + 0.3581° = 90.3581°$$

$$AB = \frac{10}{\cos 30°} = 11.5470 \text{ ft}$$

$$AB' = \sqrt{10^2 + 5.7735^2 - 2(10)(5.7735)\cos 90.3581°}$$
$$= 11.5782 \text{ ft}$$

$$\varepsilon_{AB} = \frac{AB' - AB}{AB} = \frac{11.5782 - 11.5470}{11.5470} = 0.002703 \text{ in./in.}$$



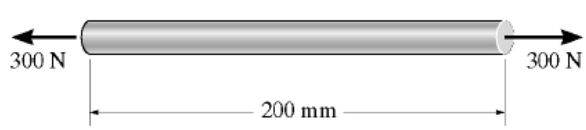
$$\sigma_{AB} = E\,\varepsilon_{AB} = 29(10^3)(0.002703) = 78.38 \text{ ksi}$$

$$F_{AB} = \sigma_{AB} A_{AB} = 78.38\left(\frac{\pi}{4}\right)(0.2)^2 = 2.462 \text{ kip}$$

$$+\Sigma M_C = 0; \qquad 2.462 \sin 30°(10) - 10w(5) = 0;$$

$w = 0.246$ kip/ft **Ans**

3–26. The acrylic plastic rod is 200 mm long and 15 mm in diameter. If an axial load of 300 N is applied to it, determine the change in its length and the change in its diameter. $E_p = 2.70$ GPa, $\nu_p = 0.4$.



$$\sigma = \frac{P}{A} = \frac{300}{\frac{\pi}{4}(0.015)^2} = 1.697 \text{ MPa}$$

$$\varepsilon_{long} = \frac{\sigma}{E} = \frac{1.697(10^6)}{2.70(10^9)} = 0.0006288$$

$\delta = \varepsilon_{long} L = 0.0006288(200) = 0.126$ mm **Ans**

$$\varepsilon_{lat} = -\nu\,\varepsilon_{long} = -0.4(0.0006288) = -0.0002515$$

$\Delta d = \varepsilon_{lat} d = -0.0002515(15) = -0.00377$ mm **Ans**

***3–28.** A short cylindrical block of bronze C86100, having an original diameter of 1.5 in. and a length of 3 in., is placed in a compression machine and squeezed until its length becomes 2.98 in. Determine the new diameter of the block.

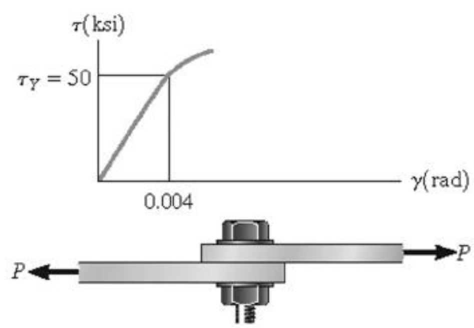
$$\varepsilon_{long} = \frac{-0.02}{3} = -0.0066667 \text{ in./in.}$$

$$\varepsilon_{lat} = -\nu\varepsilon_{long} = -0.34(-0.0066667) = 0.0022667 \text{ in./in.}$$

$$\Delta d = \varepsilon_{lat} d = 0.0022667(1.5) = 0.0034 \text{ in.}$$

$$d' = d + \Delta d = 1.5 + 0.0034 = 1.5034 \text{ in.}$$ **Ans**

3–31. The shear stress–strain diagram for a steel alloy is shown in the figure. If a bolt having a diameter of 0.25 in. is made of this material and used in the lap joint, determine the modulus of elasticity E and the force P required to cause the material to yield. Take $\nu = 0.3$.



Modulus of Rigidity : From the stress – strain diagram,

$$G = \frac{50}{0.004} = 12.5(10^3) \text{ ksi}$$

Modulus of Elasticity :

$$G = \frac{E}{2(1+\nu)}$$

$$12.5(10^3) = \frac{E}{2(1+0.3)}$$

$$E = 32.5(10^3) \text{ ksi}$$ **Ans**

Yielding Shear : The bolt is subjected to a yielding shear of $V_Y = P$. From the stress – strain diagram, $\tau_Y = 50$ ksi

$$\tau_Y = \frac{V_Y}{A}$$

$$50 = \frac{P}{\frac{\pi}{4}(0.25^2)}$$

$$P = 2.45 \text{ kip}$$ **Ans**