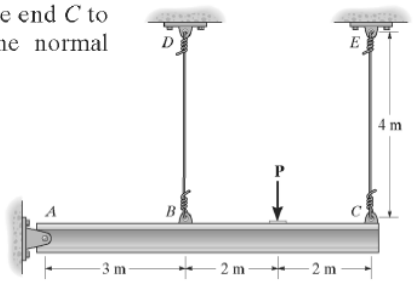
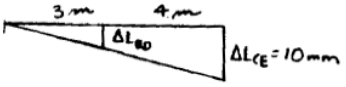
HW 15 SOLUTIONS

2–3. The rigid beam is supported by a pin at A and wires BD and CE. If the load **P** on the beam causes the end C to be displaced 10 mm downward, determine the normal strain developed in wires CE and BD.



$$\frac{\Delta L_{BD}}{3} = \frac{\Delta L_{CE}}{7}$$

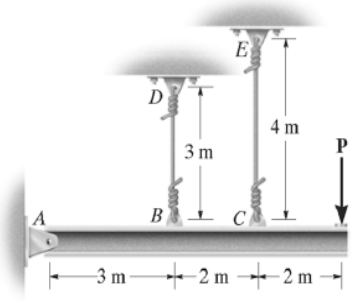
$$\Delta L_{BD} = \frac{3\,(10)}{7} = 4.286\ \text{mm}$$



$$\varepsilon_{CE} = \frac{\Delta L_{CE}}{L} = \frac{10}{4000} = 0.00250\ \text{mm/mm} \quad \textbf{Ans}$$

$$\varepsilon_{BD} = \frac{\Delta L_{BD}}{L} = \frac{4.286}{4000} = 0.00107\ \text{mm/mm} \quad \textbf{Ans}$$

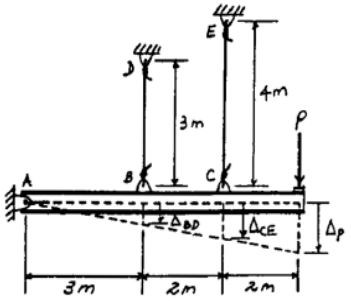
2–5. The rigid beam is supported by a pin at A and wires BD and CE. If the load **P** on the beam is displaced 10 mm downward, determine the normal strain developed in wires CE and BD.



Geometry :

$$\frac{\Delta_{BD}}{3} = \frac{\Delta_{CE}}{5} = \frac{10}{7}$$

$$\Delta_{BD} = 4.2857\ \text{mm} \qquad \Delta_{CE} = 7.1429\ \text{mm}$$

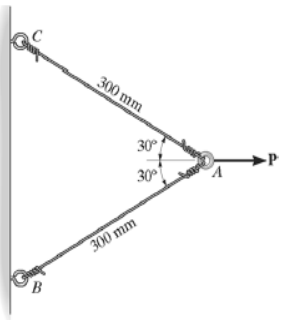


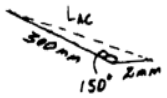
Average Normal Strain :

$$(\varepsilon_{CE})_{avg} = \frac{\Delta_{CE}}{L_{CE}} = \frac{7.1429}{4000} = 1.79\left(10^{-3}\right)\ \text{mm/mm} \quad \textbf{Ans}$$

$$(\varepsilon_{BD})_{avg} = \frac{\Delta_{BD}}{L_{BD}} = \frac{4.2857}{3000} = 1.43\left(10^{-3}\right)\ \text{mm/mm} \quad \textbf{Ans}$$

2–7. The two wires are connected together at A. If the force **P** causes point A to be displaced horizontally 2 mm, determine the normal strain developed in each wire.

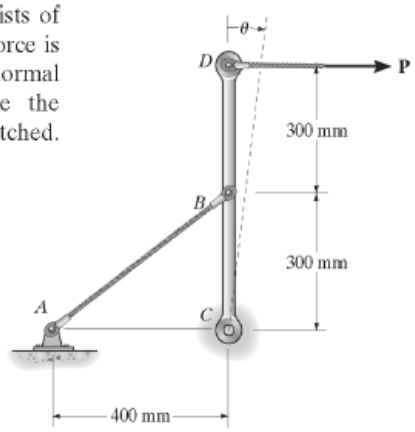




$$L'_{AC} = \sqrt{300^2 + 2^2 - 2(300)(2)\cos 150^\circ} = 301.734 \text{ mm}$$

$$\varepsilon_{AC} = \varepsilon_{AB} = \frac{L'_{AC} - L_{AC}}{L_{AC}} = \frac{301.734 - 300}{300} = 0.00578 \text{ mm/mm} \quad \textbf{Ans}$$

2–9. Part of a control linkage for an airplane consists of a rigid member CBD and a flexible cable AB. If a force is applied to the end D of the member and causes a normal strain in the cable of 0.0035 mm/mm, determine the displacement of point D. Originally the cable is unstretched.



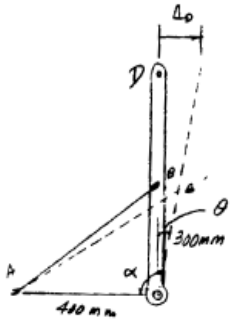
$$AB = \sqrt{300^2 + 400^2} = 500 \text{ mm}$$

$$AB' = AB + \varepsilon_{AB}AB$$
$$= 500 + 0.0035(500) = 501.75 \text{ mm}$$

$$501.75^2 = 300^2 + 400^2 - 2(300)(400)\cos\alpha$$

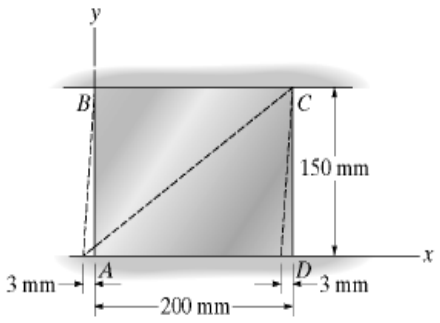
$$\alpha = 90.4185^\circ$$

$$\theta = 90.4185^\circ - 90^\circ = 0.4185^\circ = \frac{\pi}{180^\circ}(0.4185) \text{ rad}$$



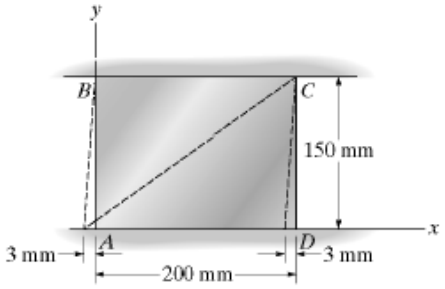
$$\Delta_D = 600(\theta) = 600\left(\frac{\pi}{180^\circ}\right)(0.4185) = 4.38 \text{ mm} \quad \textbf{Ans}$$

2–23. The rectangular plate is subjected to the deformation shown by the dashed lines. Determine the average shear strain γ_{xy} of the plate.



$$\gamma_{xy} \approx \tan \gamma_{xy} = \frac{3}{150} = 0.02 \text{ rad}$$ **Ans**

*2–24. The rectangular plate is subjected to the deformation shown by the dashed lines. Determine the average normal strains along the diagonal AC and side AB.

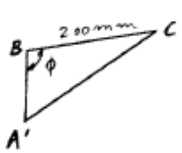


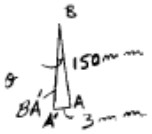
For AC :

$$\theta = \tan^{-1}\left(\frac{3}{150}\right)$$

$$\theta = 1.1458°$$

$$\phi = 90° + 1.1458° = 91.1458°$$





$$BA' = \sqrt{(150)^2 + (3)^2} = 150.0300 \text{ mm}$$

$$A'C' = \sqrt{(150.0300)^2 + (200)^2 - 2(150.0300)(200)\cos 91.1458°}$$

$$A'C' = 252.4064 \text{ mm}$$

$$AC = \sqrt{(200)^2 + (150)^2} = 250 \text{ mm}$$

$$\varepsilon_{AC} = \frac{252.4064 - 250}{250} = 0.00963 \text{ mm/mm} \qquad \textbf{Ans}$$

For AB :

$$\varepsilon_{AB} = \frac{150.0300 - 150}{150} = 0.000200 \text{ mm/mm} \qquad \textbf{Ans}$$