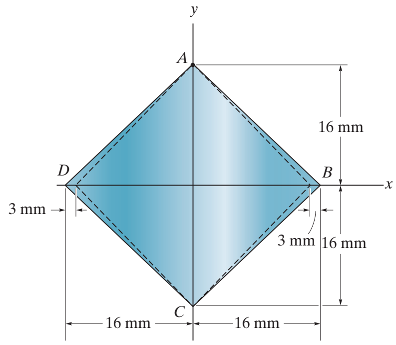
2–11. The corners B and D of the square plate are given the displacements indicated. Determine the average normal strains along side AB and diagonal DB.



Referring to Fig. a,

$L_{AB} = \sqrt{16^2 + 16^2} = \sqrt{512}$ mm

$L_{AB'} = \sqrt{16^2 + 13^2} = \sqrt{425}$ mm

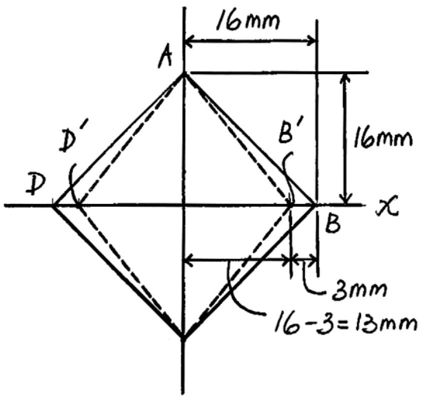
$L_{BD} = 16 + 16 = 32$ mm

$L_{B'D'} = 13 + 13 = 26$ mm

Thus,

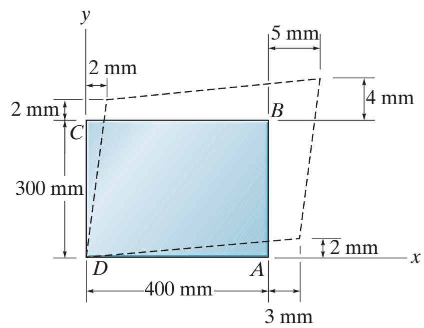
$$\left(\varepsilon_{\text{avg}}\right)_{AB} = \frac{L_{AB'} - L_{AB}}{L_{AB}} = \frac{\sqrt{425} - \sqrt{512}}{\sqrt{512}} = -0.0889 \text{ mm/mm}$$ **Ans.**

$$\left(\varepsilon_{\text{avg}}\right)_{BD} = \frac{L_{B'D'} - L_{BD}}{L_{BD}} = \frac{26 - 32}{32} = -0.1875 \text{ mm/mm}$$ **Ans.**



(a)

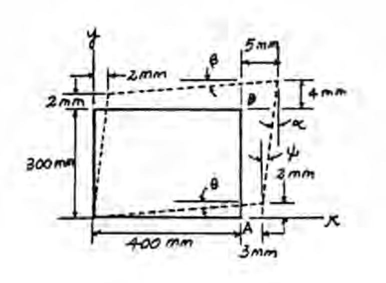
2–18. The piece of plastic is originally rectangular. Determine the shear strain γ_{xy} at corners A and B if the plastic distorts as shown by the dashed lines.



Geometry: For small angles,

$$\alpha = \psi = \frac{2}{302} = 0.00662252 \text{ rad}$$

$$\beta = \theta = \frac{2}{403} = 0.00496278 \text{ rad}$$



Shear Strain:

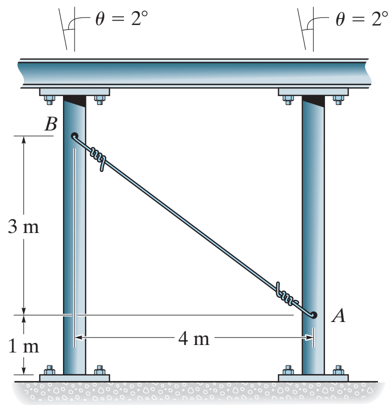
$$(\gamma_B)_{xy} = \alpha + \beta$$

$$= 0.0116 \text{ rad} = 11.6\left(10^{-3}\right) \text{ rad} \qquad \textbf{Ans.}$$

$$(\gamma_A)_{xy} = -(\theta + \psi)$$

$$= -0.0116 \text{ rad} = -11.6\left(10^{-3}\right) \text{ rad} \qquad \textbf{Ans.}$$

•**2–25.** The guy wire AB of a building frame is originally unstretched. Due to an earthquake, the two columns of the frame tilt $\theta = 2°$. Determine the approximate normal strain in the wire when the frame is in this position. Assume the columns are rigid and rotate about their lower supports.



Geometry: The vertical displacement is negligible

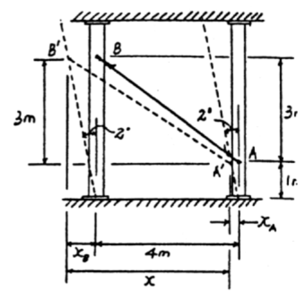
$$x_A = (1)\left(\frac{2°}{180°}\right)\pi = 0.03491 \text{ m}$$

$$x_B = (4)\left(\frac{2°}{180°}\right)\pi = 0.13963 \text{ m}$$

$$x = 4 + x_B - x_A = 4.10472 \text{ m}$$

$$A'B' = \sqrt{3^2 + 4.10472^2} = 5.08416 \text{ m}$$

$$AB = \sqrt{3^2 + 4^2} = 5.00 \text{ m}$$

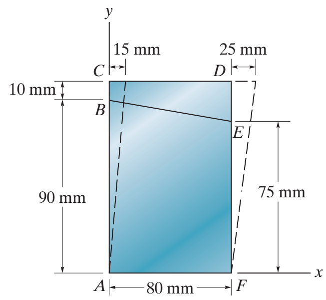


Average Normal Strain:

$$\varepsilon_{AB} = \frac{A'B' - AB}{AB}$$

$$= \frac{5.08416 - 5}{5} = 16.8\left(10^{-3}\right) \text{ m/m} \qquad \textbf{Ans.}$$

2–26. The material distorts into the dashed position shown. Determine (a) the average normal strains along sides AC and CD and the shear strain γ_{xy} at F, and (b) the average normal strain along line BE.



Referring to Fig. a,

$$L_{BE} = \sqrt{(90 - 75)^2 + 80^2} = \sqrt{6625} \text{ mm}$$

$$L_{AC'} = \sqrt{100^2 + 15^2} = \sqrt{10225} \text{ mm}$$

$$L_{C'D'} = 80 - 15 + 25 = 90 \text{ mm}$$

$$\phi = \tan^{-1}\left(\frac{25}{100}\right) = 14.04°\left(\frac{\pi \text{ rad}}{180°}\right) = 0.2450 \text{ rad.}$$

When the plate deforms, the vertical position of point B and E do not change.

$$\frac{L_{BB'}}{90} = \frac{15}{100}; \qquad L_{BB'} = 13.5 \text{ mm}$$

$$\frac{L_{EE'}}{75} = \frac{25}{100}; \qquad L_{EE'} = 18.75 \text{ mm}$$

$$L_{B'E'} = \sqrt{(90 - 75)^2 + (80 - 13.5 + 18.75)^2} = \sqrt{7492.5625} \text{ mm}$$

Thus,

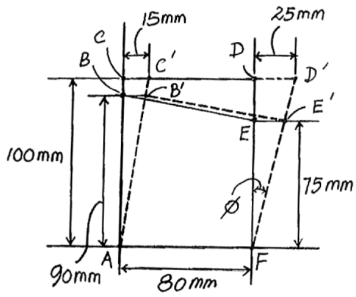
$$\left(\varepsilon_{\text{avg}}\right)_{AC} = \frac{L_{AC'} - L_{AC}}{L_{AC}} = \frac{\sqrt{10225} - 100}{100} = 0.0112 \text{ mm/mm} \qquad \textbf{Ans.}$$

$$\left(\varepsilon_{\text{avg}}\right)_{CD} = \frac{L_{C'D'} - L_{CD}}{L_{CD}} = \frac{90-80}{80} = 0.125 \text{ mm/mm} \qquad \textbf{Ans.}$$

$$\left(\varepsilon_{\text{avg}}\right)_{BE} = \frac{L_{B'E'} - L_{BE}}{L_{BE}} = \frac{\sqrt{7492.5625} - \sqrt{6625}}{\sqrt{6625}} = 0.0635 \text{ mm/mm} \qquad \textbf{Ans.}$$

Referring to Fig. a, the angle at corner F becomes larger than 90° after the plate deforms. Thus, the shear strain is negative.

0.245 rad **Ans.**



(a)