

2. State of strain

$$\epsilon_x = -500 \times 10^{-6} \quad (\text{ie } -500 \text{ microstrain})$$

$$\epsilon_y = 140 \times 10^{-6}$$

$$\gamma_{xy} = 360 \times 10^{-6}$$

To find the principal planes (on which extensional strain ϵ_θ is a maximum and a minimum, and shear strain γ_θ is zero)

$$\tan 2\theta = \frac{\gamma_{xy}}{\epsilon_x - \epsilon_y} = \frac{360}{-500 - 140}$$

$$= -0.5625$$

$$2\theta = -29.4^\circ \text{ and } 150.6^\circ$$

$$\therefore \theta = -14.7^\circ \text{ and } 75.3^\circ$$

To obtain the principal strains, substitute these two values of θ into the strain transformation eqnⁿ.

$$\epsilon_\theta = \frac{1}{2}(\epsilon_x + \epsilon_y) + \frac{1}{2}(\epsilon_x - \epsilon_y) \cos 2\theta + \frac{1}{2}\gamma_{xy} \sin 2\theta$$

$$\text{ie } \epsilon_{-14.7} = \frac{1}{2}(-500 + 140) + \frac{1}{2}(-500 - 140) \cos(-29.4^\circ) \\ + \frac{1}{2} \cdot 360 \sin(-29.4^\circ)$$

$$= -180 - 278.8 - 88.4$$

$$= \underline{\underline{-547 \text{ microstrain}}} \quad (\epsilon_2)$$