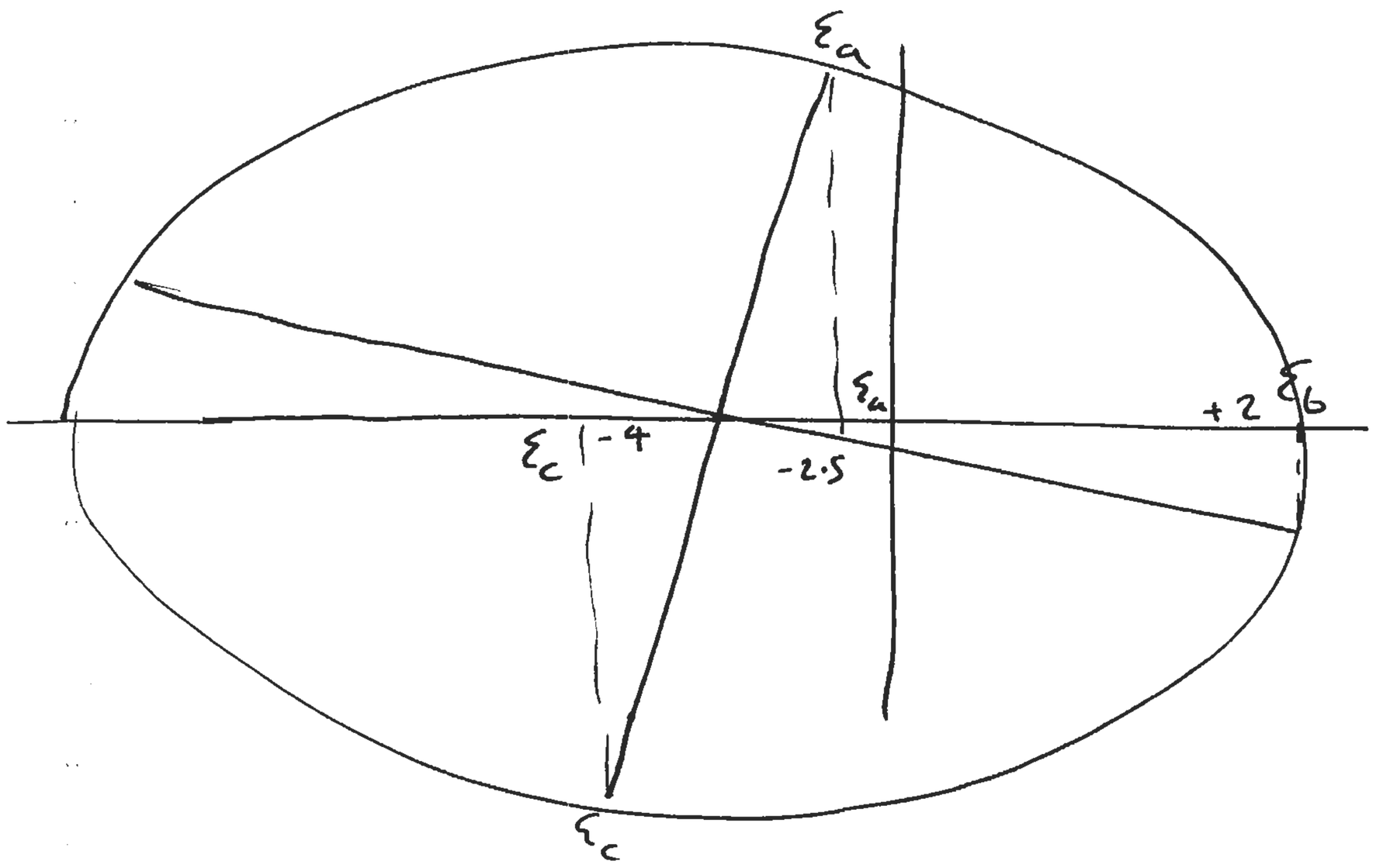
M20 45° Rosette $\varepsilon_a = -2.5\,m\varepsilon = 2500\,\mu\varepsilon$

$\varepsilon_b = +2.0\,m\varepsilon = 2000\,\mu\varepsilon$

$\varepsilon_c = -4.0\,m\varepsilon = 4000\,\mu\varepsilon$



Center of circle @ $-3.25\,m\varepsilon$

Radius $= \sqrt{(2-(-3.25))^2 + (3.25-2.5)^2} = 5.3\,m\varepsilon$

Principal Strains $= -3.25\,m\varepsilon \pm 5.3\,m\varepsilon$

$\varepsilon_I = +2053\,\mu\varepsilon \qquad \varepsilon_{II} = -8553\,\mu\varepsilon$

a) State of Strain

$\varepsilon_{11} = \varepsilon_a = -2500\,\mu\varepsilon$, $\varepsilon_{22} = -4000\,\mu\varepsilon$, $\varepsilon_{12} = \frac{1}{2}(20-(-32.5)) = 2625\,\mu\varepsilon$

$\varepsilon_{11} = \varepsilon_b = +2000\,\varepsilon$, $\varepsilon_{22} = -32.5-(52.5) = -8500\,\mu\varepsilon$, $\varepsilon_{12} = \frac{1}{2}(7.5) = 3750\,\mu\varepsilon$

From Elasticity — Plane Stress

$$\varepsilon_{11} = \frac{\sigma_{11}}{E} - \frac{\nu\sigma_{22}}{E} - \frac{\nu\sigma_{33}}{E} = 0 \quad (1)$$

$$\varepsilon_{22} = -\frac{\nu\sigma_{11}}{E} + \frac{\sigma_{22}}{E} - \frac{\nu\sigma_{33}}{E} = 0 \quad (2)$$

Multiply through by (1) by ν add to (2)

$$\nu\varepsilon_{11} + \varepsilon_{22} = \frac{\sigma_{22}}{E}(1-\nu^2)$$

$$\sigma_{22} = \frac{E(\nu\varepsilon_{11} + \varepsilon_{22})}{(1-\nu^2)} = \frac{70\times10^9(0.33\times(-2500)+(-4000))\times10^{-6}}{(1-(0.33)^2)}$$

$\sigma_E = \sigma_{22} = -380$ MPa

$\sigma_a = \sigma_{11} = -300$ MPa $\left(\frac{E(\nu\varepsilon_{22}+\varepsilon_{11})}{(1-\nu^2)}\right)$

Similarly for $\sigma_b = \sigma_{TT} = \frac{E(\nu\varepsilon_{22}+\varepsilon_{TT})}{(1-\nu^2)} = -63$ MPa

Principal stresses from principal strains

$$\sigma_I = \frac{E(\varepsilon_{II}+\nu\varepsilon_{II})}{(1-\nu^2)} = -60.4 \text{ MPa}$$

$$\sigma_{II} = \frac{E(\varepsilon_{II}+\nu\varepsilon_{I})}{(1-\nu^2)} = -618.7 \text{ MPa}$$

$\sigma_{III} = 0$