

Cyclic Stresses (Fatigue)

The S-N Curve

8.14 (a) Given the values of σ_m (70 MPa) and σ_a (210 MPa) we are asked to compute σ_{\max} and σ_{\min} .
From Equation 8.14

$$\sigma_m = \frac{\sigma_{\max} + \sigma_{\min}}{2} = 70 \text{ MPa}$$

Or,

$$\sigma_{\max} + \sigma_{\min} = 140 \text{ MPa}$$

Furthermore, utilization of Equation 8.16 yields

$$\sigma_a = \frac{\sigma_{\max} - \sigma_{\min}}{2} = 210 \text{ MPa}$$

Or,

$$\sigma_{\max} - \sigma_{\min} = 420 \text{ MPa}$$

Simultaneously solving these two expressions leads to

$$\begin{aligned}\sigma_{\max} &= 280 \text{ MPa} \quad (40,000 \text{ psi}) \\ \sigma_{\min} &= -140 \text{ MPa} \quad (-20,000 \text{ psi})\end{aligned}$$

(b) Using Equation 8.17 the stress ratio R is determined as follows:

$$R = \frac{\sigma_{\min}}{\sigma_{\max}} = \frac{-140 \text{ MPa}}{280 \text{ MPa}} = -0.50$$

(c) The magnitude of the stress range σ_r is determined using Equation 8.15 as

$$\sigma_r = \sigma_{\max} - \sigma_{\min} = 280 \text{ MPa} - (-140 \text{ MPa}) = 420 \text{ MPa} \quad (60,000 \text{ psi})$$