from the above. Suppose that the material is subjected to an applied load P. The actual stress is then given by $\sigma = P/A$ while the nominal stress is given by $\sigma_{nom} = P/A_o$. Therefore, substituting in Eq. (i) for A/A_o

$$\varepsilon = \frac{\sigma}{\sigma_{nom}} - 1$$

Then

$$\sigma_{nom}(1 + \varepsilon) = \sigma = C\varepsilon^n$$

or

$$\sigma_{nom} = \frac{C\varepsilon^n}{1 + \varepsilon} \tag{ii}$$

Differentiating Eq. (ii) with respect to ε and equating to zero gives

$$\frac{d\sigma_{nom}}{d\varepsilon} = \frac{nC(1 + \varepsilon)\varepsilon^{n-1} - C\varepsilon^n}{(1 + \varepsilon)^2} = 0$$

i.e.

$$n(1 + \varepsilon)\varepsilon^{n-1} - \varepsilon^n = 0$$

Rearranging gives

$$\varepsilon = \frac{n}{(1 - n)}.$$

S.11.4

Substituting in Eq. (11.1) from Table P.11.4

$$\frac{10^4}{5 \times 10^4} + \frac{10^5}{10^6} + \frac{10^6}{24 \times 10^7} + \frac{10^7}{12 \times 10^7} = 0.39 < 1$$

Therefore, fatigue failure is not probable.

Solutions to Chapter 12 Problems

S.12.3

From Example 12.1 and noting that there are two rivets/pitch in double shear

$$(b - 3) \times 2.5 \times 465 = 2 \times 2 \times \frac{\pi \times 3^2}{4} \times 370$$

from which

$$b = 12\,\text{mm}$$

From Eq. (12.5)

$$\eta = \frac{12-3}{12} \times 100 = 75\%$$

S.12.4

The loading is equivalent to a shear load of 15 kN acting through the centroid of the rivet group together with a clockwise moment of $15 \times 50 = 750$ kN mm.

The vertical shear load on each rivet is $15/9 = 1.67$ kN.

From Example 12.2 the maximum shear load due to the moment will occur at rivets 3 and 9. Also

$$r \text{ (rivets 1, 3, 7, 9)} = (25^2 + 25^2)^{1/2} = 35.4\,\text{mm}$$

$$r \text{ (rivets 2, 4, 6, 8)} = 25\,\text{mm}$$

$$r \text{ (rivet 5)} = 0$$

Then

$$\sum r^2 = 4 \times 35.4^2 + 4 \times 25^2 = 7500$$

From Eq. (12.6)

$$S_{\text{max}} = \frac{750}{7500} \times 35.4 = 3.54\,\text{kN}$$

Therefore, the total maximum shear force on rivets 3 and 9 is given by (see Example 12.2)

$$S_{\text{max}} \text{ (total)} = (1.67^2 + 3.54^2 + 2 \times 1.67 \times 3.54 \cos 45°)^{1/2}$$

i.e.

$$S_{\text{max}} \text{ (total)} = 4.4\,\text{kN}$$

Then

$$350 = \frac{4.4 \times 10^3}{\pi d^2/4}$$

which gives

$$d = 4.0\,\text{mm}$$

The plate thickness is given by

$$\frac{4.4 \times 10^3}{td} = 600$$

from which

$$t = 1.83\,\text{mm}$$