



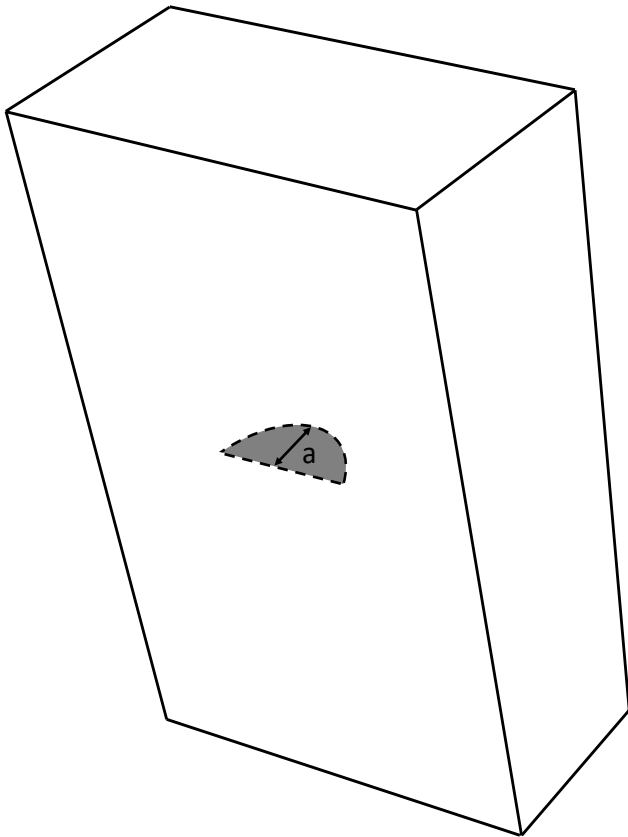
Fatigue & Fracture

Worked Example 2 – Fracture

Worked Example 2

Thumbnail Crack in Plate

A large high carbon steel plate with a thumbnail crack, as shown below, for which $K = 1.2\sigma\sqrt{\pi a}$, has a fracture toughness of $150 \text{ MPa}\sqrt{\text{m}}$ and yield stress, σ_y , of 230 MPa.



Problem

If plate is loaded in tension with an applied stress, $\sigma = \frac{2}{3}\sigma_y$, determine the critical initial crack size assuming linear elastic material.

Solution

Expression for Stress Intensity Factor for this geometry is:

$$K = 1.2\sigma\sqrt{\pi a}$$

Assuming the crack length, a , is at the critical length for causing fracture of the sample, a_{cr} , this expression can be rewritten as:

$$K_{\text{cr}} = 1.2\sigma\sqrt{\pi a_{\text{cr}}}$$

Substituting $\sigma = \frac{2}{3}\sigma_y$ into this:

$$K_{\text{cr}} = \frac{4}{5}\sigma_y\sqrt{\pi a_{\text{cr}}}$$

Re-arranging for a_{cr} and substituting in values for K_{cr} and σ_y :

$$a_{\text{cr}} = \frac{1}{\pi} \left(\frac{K_{\text{cr}}}{\frac{4}{5}\sigma_y} \right)^2 = \frac{1}{\pi} \left(\frac{150}{\frac{4}{5} \times 230} \right)^2 = 0.305 \text{ m} = 305 \text{ mm}$$