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(a) An AISI steel plate has width $W = 30$ cm and a central crack with size of 3 mm. The plate is under a uniform stress. Find the maximum value of the stress is $K_{Ic} = 50$ MPa m^{1/2}.

(b) If the part has to operate at a stress of 1,500 MPa, compute the maximum crack size that the plate can have.

Solutions:

$$W = 30\text{cm} = 0.3\text{m}$$

$$2a = 3\text{mm} \Rightarrow a = 1.5\text{mm} = 0.0015\text{m}$$

$$K_{Ic} = 50\text{MPa} \cdot \text{m}^{1/2} = 50 \cdot 10^6 \text{Pa} \cdot \text{m}^{1/2}$$

(a) use $K_{Ic} = Y\sigma\sqrt{\pi a}$ use $Y=1$ since $W \gg a$

$$\sigma = \frac{K_{Ic}}{Y\sqrt{\pi a}} = \frac{50 \cdot 10^6 \text{Pa} \cdot \text{m}^{1/2}}{1 \cdot \sqrt{\pi(0.0015)}} = 728\text{MPa}$$

(b) If

$$\sigma = 1,500\text{MPa}$$

$$K_{Ic} = Y\sigma\sqrt{\pi a}$$

$$a = \frac{1}{\pi} \left(\frac{K_{Ic}}{Y\sigma} \right)^2 = \frac{1}{\pi} \left(\frac{50 \cdot 10^6 \text{Pa} \cdot \text{m}^{1/2}}{1 \cdot 1500 \cdot 10^6 \text{Pa}} \right)^2 = 3.5 \cdot 10^{-4} \text{m}$$

$$\text{cracksize} = 2 \cdot a = 2 \cdot 3.5 \cdot 10^{-4} = 7.0 \cdot 10^{-4}$$

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