MSE C212/ME C225
Deformation and Fracture of Engineering Materials
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Homework No. 2 Solutions

Prob. 1

$\frac{a}{W} = 0.5$, as desired

$B = W/2$, " " $P_{max} < 1.1\, P_Q$

$$K_Q = \frac{P_Q}{B\sqrt{W}} \cdot Y \;, \quad Y = f\left(\frac{a}{W}\right) \qquad \frac{a}{W} = 0.5,\ Y = 9.605$$

$$= \frac{100}{.05\sqrt{.10}} \cdot 9.605 = 60{,}747 \ \text{kPa}\sqrt{\text{m}}$$

$$= \underline{60.75 \ \text{MPa}\sqrt{\text{m}}}.$$

$2.5\left(\frac{K_Q}{\sigma_y}\right)^2 =$ 1.9 cm for $\sigma_y = 700$ MPa — valid

$=$ 7.5 cm for $\sigma_y = 350$ MPa — not valid.

Prob. 2

Again calculate 2.5 D:

Mat'l	ρ	σ_y, ksi	K_{Ic}	2.5 D	Plane strain?	a_c // $\left(\frac{K_{Ic}}{\frac{1}{3}\sigma_y}\right)^2 \frac{1}{\pi}$
A357	.100 lb/in³	45	11	0.15"	yes	0.17"
7075	.101	66.5	20	0.23"	yes	0.26"
6-4	.160	120	70	0.85	no	0.97"
4340	.283	180	100	0.77	no	0.88"

Under failure conditions, then, the aluminum alloys are in plane strain and are undesirable. Other two materials are better.

Prob. 2

- design stress is not used in K_{Ic} calculation but is used in a_c calculation.

- Recommend 4340 for cost. (~10 times cheaper) only go to 6-4 for higher toughness, corros. resistance
- Can would be lighter w/ 6-4
- corrosion, fabricability + COST

- could reduce thickness with 4340 to reduce weight but toughness could then be critical
- other criteria for materials can also be brought in