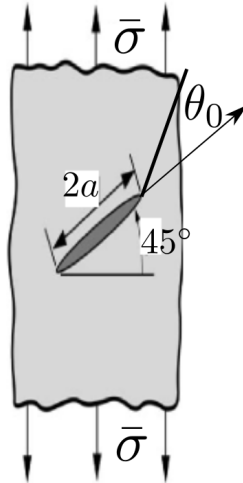


1. Anderson problem 12.2 (section 13.12). **(40 Points)**
2. Anderson problem 12.3 (section 13.12). **(40 Points)**
3. In figure below, a crack with initial angle of  $45^\circ$  is under uniaxial far field loading  $\sigma_0$  in a sufficiently large domain (*e.g.*, infinite domain SIF formula can be used).



- Using maximum circumferential tensile stress obtain the angle  $\theta_0$  (angle relative to original crack direction not the horizontal  $x$  axis) at which the crack would propagate. Hint: Refer to Saouma notes pages 160-161.
- For a given fracture toughness  $K_{Ic}$  we can express the maximum traction  $\bar{\sigma}_{\max}$  for which the crack would not propagate using maximum circumferential tensile stress criteria. You can express  $\bar{\sigma}_{\max} = \alpha_{\text{MCTS}} \frac{K_{Ic}}{\sqrt{a}}$  for a nondimensional value  $\alpha_{\text{MCTS}}$ .
- Compare  $\theta_0$  you obtained with figure 10.4 in Saouma notes (p. 165/446). How is this  $\theta_0$  compared with  $\theta_0$  obtained from maximum energy release rate and minimum strain energy density criteria shown in the same figure?
- Referring to figure 10.5 in Saouma notes (p.165/446) compare the traction  $\bar{\sigma}_{\max}$  that would initiate crack propagation in terms of nondimensional parameter  $\alpha = \frac{\bar{\sigma}_{\max} \sqrt{a}}{K_{Ic}}$  based on maximum energy release rate ( $\alpha_{\text{MERR}}$ ) and minimum strain energy density ( $\alpha_{\text{MSED}}$ ). Which one is the most conservative and which one is the least conservative?

**(60 Points)**

4. A crack growth at a rate  $(\frac{da}{dN})_1 = 8.84 \times 10^{-7} \frac{\text{m}}{\text{cycle}}$  when the stress intensity factor is  $(\Delta K)_1 = 50 \text{ MPa}\sqrt{\text{m}}$  and at a rate  $(\frac{da}{dN})_2 = 4.13 \times 10^{-5} \frac{\text{m}}{\text{cycle}}$  when  $(\Delta K)_2 = 150 \text{ MPa}\sqrt{\text{m}}$ . Determine the parameters  $C$  and  $m$  in Paris equation. **(60 Points)**