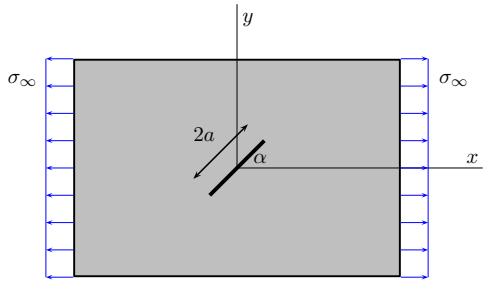
RAK-33060 Fracture mechanics and fatigue

3. Exercise

1. A large plate has a crack inclined by an angle α w.r.t. the horizontal line. The length of the crack is $2a$. The plate is loaded by a horizontal tensile stress $\sigma_x = \sigma_\infty$. Determine the stress intensity factors at the crack tip. At the end of this paper there is a table of stress intensity factors for basic loading cases.

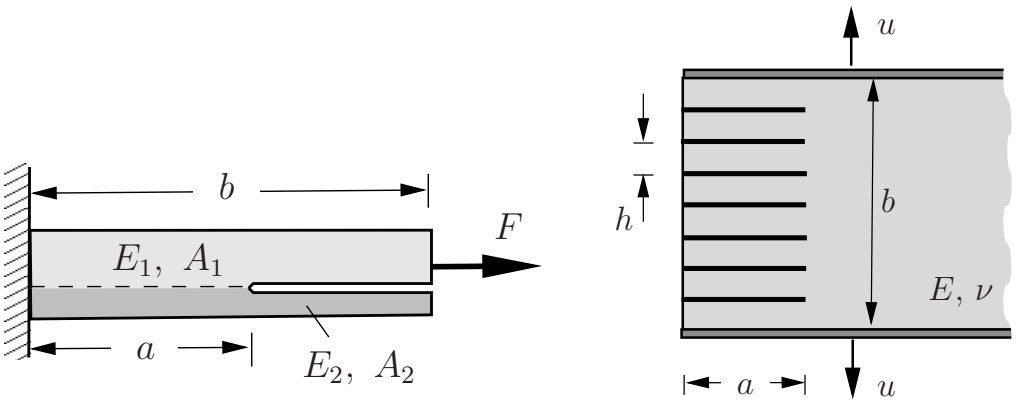


2. Investigate the previous structure. Assume that the fracture occurs if

$$\left(\frac{K_\mathrm{I}}{K_\mathrm{Ic}}\right)^2 + \left(\frac{K_\mathrm{II}}{K_\mathrm{IIc}}\right)^2 = 1,$$

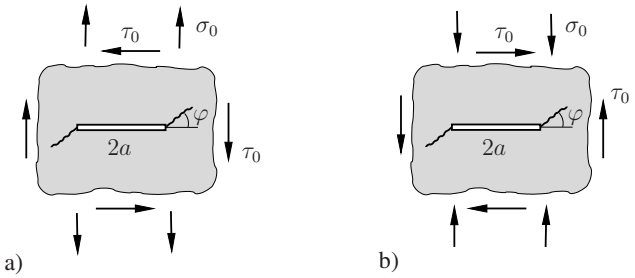
where $K_\mathrm{Ic} \neq K_\mathrm{IIc}$. Investigate which angles α are the most dangerous as a function of the ratio $K_\mathrm{Ic}/K_\mathrm{IIc}$.

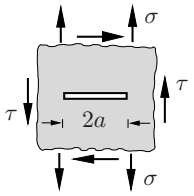
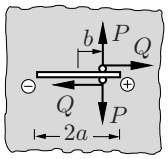
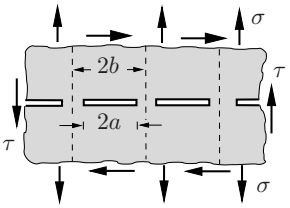
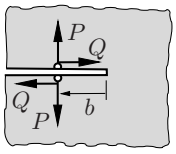
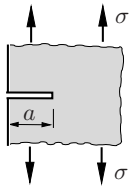
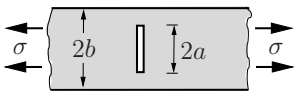
3. A crack grows along the interface in a bi-material bar of width B under a tensile force F (figure below on the LHS).
   (a) Determine the crack driving force $\mathcal{G}$ using simple bar model.
   (b) Determine K_II for the case $E_1 = E_2$ under the assumption that pue mode II and plane stress is present.



4. Calculate the crack driving force $\mathcal{G}$ and the stress intensity factor K_I for the structure shown above on the right hand side. Assume the state of plane strain and that $h \ll a$.

5. Calculate the crack deflection angle φ for the two configurations shown below. Use the criterion of maximum circumferential stress and assume $\tau_0 = \sigma_0/2$.



1		$\left\{ \begin{matrix} K_I \\ K_{II} \end{matrix} \right\} = \left\{ \begin{matrix} \sigma \\ \tau \end{matrix} \right\} \sqrt{\pi a}$
2		$\left\{ \begin{matrix} K_I^{\pm} \\ K_{II}^{\pm} \end{matrix} \right\} = \left\{ \begin{matrix} P \\ Q \end{matrix} \right\} \frac{1}{\sqrt{\pi a}} \sqrt{\frac{a \pm b}{a \mp b}}$
3		$\left\{ \begin{matrix} K_I \\ K_{II} \end{matrix} \right\} = \left\{ \begin{matrix} \sigma \\ \tau \end{matrix} \right\} \sqrt{2b \tan \frac{\pi a}{2b}}$
4		$\left\{ \begin{matrix} K_I \\ K_{II} \end{matrix} \right\} = \left\{ \begin{matrix} P \\ Q \end{matrix} \right\} \frac{2}{\sqrt{2\pi b}}$
5		$K_I = 1.1215\, \sigma \sqrt{\pi a}$
6		$K_I = \sigma \sqrt{\pi a}\, F_I(a/b)$ $F_I = \frac{1 - 0.025(a/b)^2 + 0.06(a/b)^4}{\sqrt{\cos(\pi a/2b)}}$