3.1) Assuming that the edge crack is much smaller than the width of the plate allows use of the stress intensity factor, \( K_I = F \sigma \sqrt{\pi a} \) where \( F = 1.12 \). For the critical condition \( K_I = K_{ic} = 45 \text{ ksi} \sqrt{\pi a} = \sigma \sqrt{\pi a} = 1.12 \times 40 \text{ ksi} \sqrt{\pi a_c} \). Solving for \( a_c \) gives, \( a_c = 0.321 \text{ in.} \)

3.4) In this case, the stress, critical crack length, and fracture toughness are known.....the question is, what is the required \( F(a/b) \)?

For the lower strength material, \( K_I = K_{ic} = 105 \text{ ksi} \sqrt{\pi a} = F \times (130/2) \text{ksi} \sqrt{\pi 0.2 \text{in}} \) Solving for \( F(a/b) \) gives \( F=2.0379 \). Solving for \( a/b \) in the equation for an edge cracked panel \( (F(a/b) = 1.12 - 0.231 (a/b) + 10.55 (a/b)^2 - 21.72 (a/b)^3 + 30.39 (a/b)^4) \) gives \( a/b=0.39 \) or \( b=0.512 \text{ in.} \)

Similarly for the higher strength material, \( F = 0.8412 \) which does not occur for the edge cracked panel. Thus for this combination of high stress, low fracture toughness and the specified critical crack size, the higher strength material cannot be used. The material change should not be approved with the maximum stress of 1/2 the yield strength.

If the stress is reduced for the higher strength material, a stress of 56.3 ksi is calculated for an \( F(a/b) \) of 1.12. This results in \( a/b = 0.025 \text{ or } b = 8 \text{ in.} \) Assuming a design load of 100 kips, for a maximum stress of 65 ksi and \( b = 0.512 \), then the thickness, \( t \), is 3.0 in for the lower strength material (cross sectional area of 1.53 \text{ in}^2). For a maximum stress of 56.3 ksi and \( b = 8 \), then the thickness, \( t \) is 0.22 in for the higher strength material (cross sectional area of 1.77 \text{ in}^2). Even with the lower design stress, there is no weight savings with the higher strength material and it is the change is not recommended.

3.11) For \( b = 5 \text{ in} \) and \( (F(a/b)=1.12 - 0.231 (a/b) + 10.55 (a/b)^2 - 21.72 (a/b)^3 + 30.39 (a/b)^4) \):
\[ a=0.01 \text{ in}, \ a/b=0.002, \ F(a/b)=1.1196 \]
\[ a=0.05 \text{ in}, \ a/b=0.01, \ F(a/b)=1.1187 \]
\[ a=0.1 \text{ in}, \ a/b=0.02, \ F(a/b)=1.1194 \]
\[ a=0.2 \text{ in}, \ a/b=0.04, \ F(a/b)=1.1263 \]

If we make some assumptions about \( C = 1 \times 10^{-5}, \ m=1, \Delta \sigma = 10 \text{ ksi} \) and calculate, \( N_f \) from \( a_i = 0.01 \text{ to } a_f = 0.2 \text{ in} \), then for the closed from solution \( (F(a/b)=\text{constant}) \), \( N_f = 3499 \text{ cycles} \) and \( N_f = 4193 \text{ cycles} \) if we use numerical integration and the actual \( F(a/b) \) at each crack length...This gives an under prediction of -16.5%.....Note that this percent difference is dependent on the value of \( m \) since \( F(a/b) \) is raised to the \(-m\) power.
Although it is not clear over what range of crack length the authors wish to run this scenario of $a_i=0.2$, the intent of the problem is to illustrate that the calculation of $N_i$ is much more sensitive to $a_i$ than it is to $a_f$ as shown in the figure. Note that assumptions of $a_i$ in the 0.01 in range can span several decades.

3.12) a) Direct plot of $a$ vs. $N$
b) Using the SIF relation for a surface crack, $K_i = 1.12\left(\frac{2\sigma\sqrt{\pi a}}{\pi}\right)$ and $\Delta\sigma = 250$ MPa, the plot of $da/dN$ vs. $\Delta K =$ is developed as shown. Note, we can assume that Walker equation can be used to find $C'$ from the data for the $R$ ratio = 0.1 such that $m' = m$ and $C = C'/(1-R)^{m(1-n)}$

c) From curve fit of $da/dN = C\Delta K^m$ to the data in Region 2, $C = 1.998x10^{-9}$ mm/cycle/(MPa√m)$^m$ and $m = 4.766$. Extracting the constants $C'$ and $m'$ gives $m' = 4.766$ and $C' = 3.83xx10^{-10}$ mm/cycle/(MPa√m)$^m$