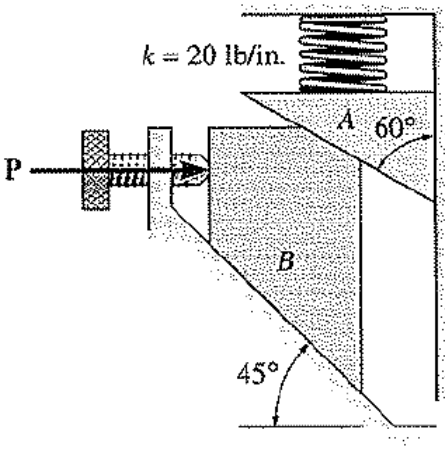
1. The two blocks used in a measuring device have negligible weight. If the spring is compressed 5 in. when in the position shown, determine the smallest axial force P that the adjustment screw must exert on B in order to start the movement of B downward. The end of the screw is smooth and the coefficient of static friction at all other points of contact is μ_s=0.3



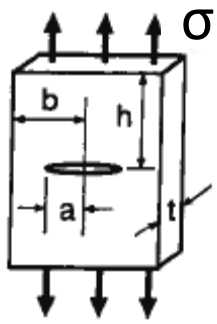
2. A center-cracked plate made of AISI 4340 steel has dimensions, as defined in the figure below, of b = 38 mm and t = 6 mm, and it contains an initial crack of half length a_i = 2 mm. The stress intensity factor, K, for this crack configuration can be approximated as:

$$K = \sigma\sqrt{\pi a}$$

where σ is the far-field stress. The plate is subjected to tension-to-tension cyclic loading between constant values of minimum and maximum far-field stress, σ_{min} = 0 and σ_{max} = 500 MPa.

(a) Determine the number of cycles that can be applied before failure occurs. List all your assumptions, and whenever possible, justify the validity of your equations.

(b) How would you solve question (a) if σ_{min} = 250 MPa instead of 0. You do not need to estimate the number of cycles for this question; instead highlight the main difference(s) with respect to question (a).



You know the following materials properties:

Yield stress, σ_0 = 1255 MPa

Plane strain Fracture toughness, K_{IC} = 130 MPa.m$^{1/2}$

Paris equation (for $R = \sigma_{min}/\sigma_{max} = 0$): $\frac{da}{dN}(mm/cycle) = 5.11\times10^{-10}\times\left(\Delta K(MPa\sqrt{m})\right)^{3.24}$

3. Consider a composite bar (1-D) with ends fixed on rigid walls as shown below. When the temperature is T_0, the interface between Al and Cu is at the middle $x = L/2$.

   (a) Please find the position of the interface when the temperature is raised to $T > T_0$. Assume the Young's moduli and the thermal expansion coefficients of Al and Cu are, respectively, E_a, E_c, α_a, and α_c, both materials remain elastic, and these properties do not change with temperature.

   (b) If it is assumed that Al has yield strength σ_{ya} and behaves elastic-perfectly plastic (to keep things relatively simple) while Cu has a higher yield strength, what is your answer?