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**Machine Design – 2**


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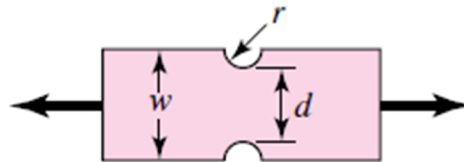
The double-edged notch specimen shown is machined from a 2024-T4 aluminum to study the effect of surface finish on the number of cycles to failure in a high-cycle fatigue study. The double-edge notch specimen is flat with thickness,  $t = 0.125$  in, a nominal width,  $w = 1.0$  in, a notch width,  $d = 0.5$  in and notch radius,  $r = 0.25$  in. The stress concentration factor at the double-notch is  $K_t = 1.86$ . The notch sensitivity factor for the 2024-T4 aluminum specimen is  $q = 0.774$ .

The specimen is machined from 2024-T4 aluminum with the following material properties:

- Elastic Modulus:  $E = 10.0(10)^3$  kpsi
- Yield Strength:  $S_y = 44.0$  kpsi
- Ultimate Tensile Strength:  $S_{ut} = 69.0$  kpsi
- Fatigue Strength Coefficient:  $A = 122.0$  kpsi
- Fatigue Strength Exponent:  $b = -0.102$

The unmodified stress-life curve (S-N curve) for the 2024-T4 aluminum is given by:  $S'_f = AN^b$ .

The specimen is tested in a load frame where it experiences the fluctuating axial loads,  $F_{max} = 2000$  lbf, and  $F_{min} = 200$  lbf.



Assume that the nominal mean and nominal alternating stress increase proportionally, that is

$$\frac{\Delta\sigma_{a \text{ nominal}}}{\Delta\sigma_{m \text{ nominal}}} = 1.0.$$

Determine:

- **(20 pts)** The mean and alternating stresses;  $\sigma_m$  and  $\sigma_a$ ,
- **(20 pts)** The unmodified fatigue strength at  $N = 400(10^3)$  cycles;  $S'_{f@N=400(10^3) \text{ cycles}}$ ,
- **(20 pts)** The modified fatigue strength at  $N = 400(10^3)$  cycles;  $S_{f@N=400(10^3) \text{ cycles}}$ ,
- **(15 pts)** The factor of safety at  $N = 400(10^3)$  cycles against fatigue fracture,  $n_{\text{FatigueFracture}}$ ,
- **(15 pts)** The factor of safety at  $N = 400(10^3)$  cycles against fatigue yield,  $n_{\text{FatigueYield}}$ ,
- **(10 pts)** Sketch and clearly label the Modified Goodman Diagram indicating:
  - the fatigue fracture line.
  - the fatigue yield line.
  - the design point.
  - the design load line.

## Problems

### Figure A-15-3

Notched rectangular bar in tension or simple compression.  $\sigma_0 = F/A$ , where  $A = dt$  and  $t$  is the thickness.

