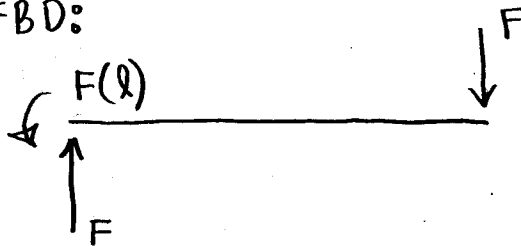


FBD:



CRITICAL POINT ON TOP OF BEAM WHERE IT MEETS THE WALL

ONLY BENDING STRESS IS PRESENT AT THE CRITICAL POINT

$$\sigma_b = \frac{Mc}{I}$$

$$\sigma_a' = \frac{Flc}{I} \left( \frac{1 - \frac{1}{2}}{2} \right) = \frac{Flc}{4I}$$

$$\sigma_{b,max} = \frac{Flc}{I} = \sigma'_{max}$$

$$\sigma_m' = \frac{Flc}{I} \left( \frac{1 + \frac{1}{2}}{2} \right) = \frac{3Flc}{4I}$$

$$\sigma_{b,min} = \frac{Flc}{2I} = \sigma'_{min}$$

(FROM VON MISES)

THE ABOVE ASSUMES NO STRESS CONCENTRATIONS

ASSUMPTIONS ARE REQUIRED TO FIND  $S_{ut}$  (MATERIAL SPECIFICATION)

FROM THE ENDURANCE LIMIT.

① ASSUME MACHINED SURFACE

② ASSUME RECTANGULAR CROSS SECTION

(CANNOT BE ROUND SINCE  $c$  &  $I$  ARE GIVEN AND  $I \neq \frac{\pi(2c)^4}{64}$ )

③ ASSUME ROOM TEMPERATURE

④ ASSUME 50% RELIABILITY

$$S_F = S_F' C_{LOAD} C_{SIZE} C_{SURF} C_{TEMP} C_{RELIAB}$$

EQN 6-6

$$C_{LOAD} = 1 \quad \text{EQN 6-7a}$$

$$C_{SIZE} = 1.189 \left( \sqrt{\frac{0.05bh}{0.0766}} \right)^{-0.097}$$

EQN 6-7b  
\*

$$C_{SURF} = 4.51 (S_{ut})^{-0.265}$$

EQN 6-7d

EQN 6-7e

$$C_{TEMP} = 1$$

EQN 6-7f

$$C_{RELIAB} = 1$$

TABLE 6-4

$$S_F' = \begin{cases} 0.5 S_{ut} & \text{STEEL} \\ 0.4 S_{ut} & \text{ALUMINUM} \end{cases} @ 5 \times 10^8 \text{ CYCLES}$$

$$N_f = \frac{S_f S_{ut}}{\sigma'_a S_{ut} + \sigma'_m S_f} \left( \rightarrow S_{ut} \text{ USING EQN 6-6} \right) \quad \text{EQN 6-18e}$$

HAND CALCULATIONS FOR ROW a:

$$\sigma'_a = \frac{Flc}{4I} = \frac{500N(1m)0.02m}{4(2.85 \times 10^{-8} m^4)} = 87.7 \text{ MPa}$$

$$\sigma'_m = \frac{3Flc}{4I} = \quad \text{MPa}$$

$$I = \frac{bh^3}{12} \quad \& \quad h = 2c \rightarrow b = \frac{12I}{(2c)^3} = \frac{12(2.85 \times 10^{-8} m^4)}{[2(0.02m)]^3} = 5.343 \times 10^{-3} m$$

$$C_{LOAD} = 1$$

$$C_{SIZE} = 1.189 \left( \sqrt{\frac{0.05(5.34)40^3}{0.0766}} \right)^{-0.097} = 0.936$$

$$C_{SURF} = 4.51(750)^{-0.265} = 0.78 \quad (\text{GUESS } 750 \text{ MPa})$$

$$C_{TEMP} = 1$$

$$C_{RELIAB} = 1$$

$$S_f = 0.5 S_{ut} (1) 0.936 (0.78) 1 (1) = 0.365 S_{ut}$$

$$N_f = 1.5 = \frac{S_f S_{ut}}{\sigma'_a S_{ut} + \sigma'_m S_f} = \frac{0.365 S_{ut}}{(\sigma'_a + 0.365 \sigma'_m)}$$

$$S_{ut} = \frac{1.5(\sigma'_a + 0.365 \sigma'_m)}{0.365} = \frac{1.5(87.7 + 0.365(263))}{0.365} = 755 \text{ MPa}$$

VALIDATES GUESS

TABLE PG-5 PLUS

| Row | $R(m)$ | $F(N)$ | $I(m^4)$ | $C(m)$ | $\sigma_a(MPa)$ | $\sigma_m(MPa)$ | $b(m)$ | $C_{SIZE}$ | $C_{SURF}$ | $S_F/S_{UT}$ | $S_{UT}(MPa)$ |
|-----|--------|--------|----------|--------|-----------------|-----------------|--------|------------|------------|--------------|---------------|
| a   | 1.00   | 500    | 2.85E-8  | 0.0200 | 87.7            | 263             | 0.0053 | 0.936      | 0.780      | 0.365        | 755           |
| b   | 0.70   | 850    | 1.70E-8  | 0.0100 | 87.5            | 263             | 0.0255 | 0.897      | 0.775      | 0.347        | 771           |
| c   | 0.30   | 450    | 4.70E-9  | 0.0125 | 89.8            | 269             | 0.0036 | 0.976      | 0.778      | 0.380        | 759           |
| d   | 0.80   | 250    | 4.90E-9  | 0.0110 | 112             | 336             | 0.0055 | 0.962      | 0.725      | 0.349        | 988           |
| e   | 0.85   | 750    | 1.80E-8  | 0.0090 | 79.7            | 239             | 0.0370 | 0.886      | 0.795      | 0.352        | 698           |
| f   | 0.50   | 950    | 1.17E-8  | 0.0100 | 101             | 305             | 0.0176 | 0.914      | 0.742      | 0.339        | 906           |
| g   | 0.60   | 250    | 3.20E-9  | 0.0075 | 87.9            | 264             | 0.0114 | 0.946      | 0.780      | 0.369        | 753           |
| h   | 0.20   | 500    | 4.00E-9  | 0.0050 | 31.3            | 93.8            | 0.0480 | 0.900      | 1          | 0.450        | 291           |
| i   | 0.40   | 200    | 2.75E-9  | 0.0050 | 36.4            | 109             | 0.0330 | 0.916      | 1          | 0.458        | 312           |
| j   | 0.20   | 80     | 6.50E-10 | 0.0055 | 33.8            | 102             | 0.0059 | 0.992      | 1          | 0.446        | 280           |
| k   | 0.40   | 880    | 4.30E-8  | 0.0145 | 29.7            | 89.0            | 0.0212 | 0.889      | 1          | 0.445        | 259           |
| l   | 0.90   | 600    | 4.20E-8  | 0.0075 | 24.1            | 72.3            | 0.1493 | 0.835      | 1          | 0.417        | 217           |
| m   | 0.70   | 500    | 2.10E-8  | 0.0065 | 27.1            | 81.3            | 0.1147 | 0.852      | 1          | 0.426        | 241           |
| n   | 0.85   | 120    | 7.90E-9  | 0.0100 | 32.3            | 96.8            | 0.0119 | 0.931      | 1          | 0.466        | 275           |