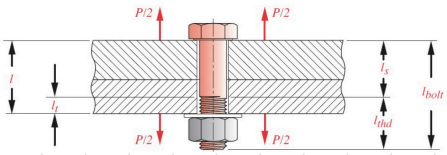
Ex6) Stiffness of Bolt and Member

A $5/8-11\ \text{UNC} \times 2\frac{1}{4}$ (grade 5) steel screw is used to clamp two 1 inch steel plates. Find k_b and k_m. Use $E_b = E_m = 30$ Mpsi, and the effective washer diameter $D_w = 1.2$ in.



$E_b = E_m = 30 \times 10^6$ psi

$l_{bolt} = 2.25$ in, $l_{thd} = 2d + \frac{1}{4} = 1.5$ in

The grip has $l = 2$ in. $l_s = l_{bolt} - l_{thd} = 2.25 - 1.5 = 0.75$ in

$l_t = l - l_s = 2 - 0.75 = 1.25$ in, $A_b = \frac{\pi d^2}{4} = 0.3068$, $A_t = 0.226$

$$k_b = \frac{A_t A_b}{A_b l_t + A_t l_s} E_b = \frac{0.226 \times 0.3068 \times 30 \times 10^6}{0.3068 \times 1.25 + 0.226 \times 0.75} = 3.7615 \text{ M lbf/in}$$

$$A_m = \frac{\pi D_w^2}{4} - \frac{\pi d^2}{4} = 0.8242 \Rightarrow k_m = \frac{A_m E_b}{l} = \frac{0.8242 \cdot 30 \times 10^6}{2}$$

$$= 12.36 \text{ M lbf/in}$$