TBeam

Input properties for average shear strength and applied shear force

\[ \text{Avg. shear strength} \]
\[ \sigma_{vc} := 0.398 \sqrt{3500} \text{ psi} = 23.5 \text{ psi} \]

\[ \text{Avg. applied shear force} \]
\[ \text{AvgV} := 55 \text{ kip} \]

\[ \sigma_v := 11 \text{ kip} \]

Part a)

Area required = Applied shear force / shear strength

\[ \text{CSF} := 1.3 \quad \text{Central Safety Factor} \]

\[ A := \frac{\text{CSF} \cdot \text{AvgV}}{\text{Avgvc}} = 869.5 \text{ in}^2 \quad \text{Required Area} \]

Part b)

Area required = Applied shear force / shear strength

\[ \text{ProbV} := \frac{1}{1000} = 0.001 \]

\[ \alpha_D := -\text{qnorm(ProbV, 0, 1)} = 3.09 \quad \text{How many standard deviations is the probability from the mean?} \]

\[ \text{VD} := \text{AvgV} + \alpha_D \cdot \sigma_v = 89 \text{ kip} \quad \text{Design shear force} \]

Part c)

\[ \gamma := \frac{\text{VD}}{\text{AvgV}} = 1.62 \quad \text{Load Factor} \]
Part d)\
\[ Probc := \frac{1}{100} = 0.01 \]
\[ \alpha_{DS} := -\text{qnorm} (Probc, 0, 1) = 2.326 \]
\[ vD := Avgc - \alpha_{DS} \cdot \sigma_{vc} = 27.5 \text{ psi} \]
Design shear resistance

Part e)\
\[ \phi := \frac{vD}{Avgc} = 0.33 \]
Capacity Reduction Factor

Part f)\
\[ A_{req} := \frac{\gamma \cdot AvgV}{\phi \cdot Avgc} = 3241.1 \text{ in}^2 \]
Resistance Factor

Part g)\
\[ A_a := A \]
If area is set in Part a
\[ AvgF := Avgc - \frac{AvgV}{A_a} = 19 \text{ psi} \]
Define factor F = Resistance-Load Effect
\[ \sigma_F := \sqrt{\frac{\sigma_{vc}^2}{A_a^2} + \frac{\sigma_V^2}{A_a^2}} = 26.7 \text{ psi} \]
\[ \beta := \frac{AvgF}{\sigma_F} = 0.71 \]
\[ ProbF := \text{pnorm} (-\beta, 0, 1) = 0.239 \quad 23.9\% \text{ Prob. of Failure} \]

Part h)\
\[ A_f := A_{req} \]
If area is set in Part f
\[ \bar{V} := \frac{AvgV}{A} \]
Average shear force
\[
\text{Avg} F := \frac{\text{Avg} v_c \cdot \text{Avg} V}{A_f} = 65.3 \text{ psi}
\]

Define factor F = Resistance-Load Effect

\[
\sigma_F := \sqrt{\frac{\sigma_{vc}^2}{A_f^2} + \frac{\sigma_V^2}{A_f^2}} = 23.8 \text{ psi}
\]

\[
\beta := \frac{\text{Avg} F}{\sigma_F} = 2.743
\]

\[
\text{Prob} F := \text{pnorm}(-\beta, 0, 1) = 0.003 \quad \text{0.3\% Prob. of Failure}
\]