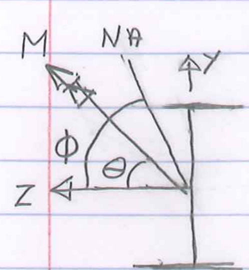
ME 35 c HW #5 Solution

4.134 S6×12.5 $\quad I_z = 22.1\ in^4,\ S_z = 7.37\ in^3$

$I_y = 1.82\ in^4,\ S_y = 1.09\ in^3$

$M = 15\ in\text{-}k,\quad M_z = M \cdot \sin 20° = 5.130\ in\text{-}k$

$M_y = M \cdot \cos 20° = 14.095\ in\text{-}k$



$\theta = 70° \qquad \phi = \tan^{-1}\left(\frac{I_z}{I_y}\tan\theta\right) = 88.28°$

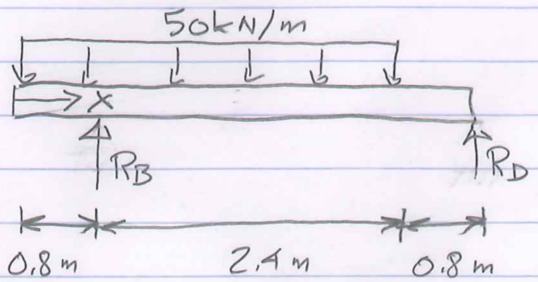
angle above horizontal on book figure

$= \phi - 70° = \boxed{18.28°}$

σ_{max} occurs at D

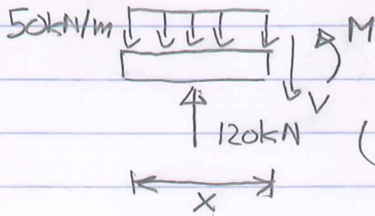
$= M_z/S_z + M_y/S_y = \boxed{13.6\ ksi}$

5.73



$\Sigma M_D = 0 = 50\ kN/m \cdot 3.2m \cdot 2.4m - R_B \cdot 3.2m \Rightarrow R_B = 120\ kN$

$\Sigma M_B = 0 = -50\ kN/m \cdot 3.2m \cdot 0.8m + R_D \cdot 3.2m \Rightarrow R_D = 40\ kN$



$X \le 0.8m:\ M = -\frac{1}{2} \cdot 50\ kN/m \cdot X^2$

$0.8m < X \le 3.2m:\ M = -\frac{1}{2} \cdot 50\ kN/m \cdot X^2 + 120\ kN\ (X - 0.8m)$

$\frac{dM}{dx} = -50\ kN/m \cdot X + 120\ kN = 0$ at $X = 2.4m$

max negative moment occurs at $X = 0.8\ m$ $= -16\ kN\text{-}m$

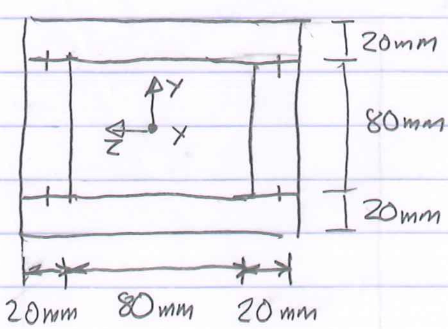
max positive moment occurs at $X = 2.4m$ $= 48\ kN \cdot m = M_{max}$

$\sigma_{allow} = 160 \times 10^6\ N/m^2$

$S_{required} = M_{max}/\sigma_{allow} = 3 \times 10^{-4}\ m^3 = 3 \times 10^5\ mm^3$

choose $\boxed{W\,250 \times 28.4}$ with $S_x = 3.08 \times 10^5\ mm^3$

6.2



$I_z = \frac{1}{12}(120mm)^4 - \frac{1}{12}(80mm)^4$

$= 13.867 \times 10^6\ mm^4$

$V = 1200\ N$

$s = 30\ mm$ (nail spacing)

(a) find shear stress at upper joint ($Y = 40\,mm$)

$Q = 20mm \cdot 120mm \cdot 50mm = 120{,}000\ mm^3$

$t = 40mm$

$\tau = VQ/I_z t = 0.2596\ N/mm^2$

$q = \tau \cdot 20mm = 5{,}192\ N/mm$ (each side)

force per nail $= q \cdot s = \boxed{156\ N}$

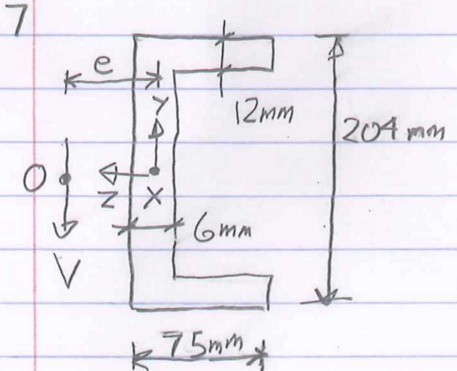
(b) max shear stress occurs at $Y = 0$

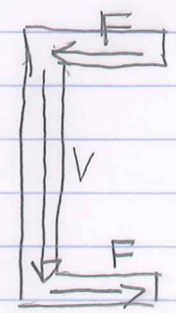
$Q = 120{,}000\ mm^3 + 40mm \cdot 40mm \cdot 20mm = 152{,}000\ mm^3$

$t = 40mm$

$\tau_{max} = VQ/I_z t = .329\ N/mm^2 = \boxed{329\ kPa}$

6.67





$t_f = 12mm$ $V = 110kN$

$t_w = 6mm$

$h = 204\ mm$

$b = 75\ mm$

$I_z = \frac{1}{12} \cdot 75mm \cdot (204mm)^3 - \frac{1}{12} \cdot 69mm \cdot (180mm)^3 = 19.5264 \times 10^6\ mm^4$

$F = \frac{1}{4} \frac{V}{I_z} (h - t_f)(b - \frac{t_w}{2})^2 t_f = 16.821\ kN$

$\Sigma M_o = 0 = F \cdot (h - t_f) - V \cdot e \Rightarrow \boxed{e = 29.36\ mm}$

max shear stress occurs at $Y = 0$

$Q = 75mm \cdot 12mm \cdot 96mm + 90mm \cdot 6mm \cdot 45mm$

$= 110{,}700\ mm^3$

$\tau_{max} = VQ/I_z t_w = \boxed{103.9\ MPa}$