Longest Roll

\[ I = \frac{1}{12} (L)^2 \left( L - (2 \times 0.0747) \right)^2 \]

\[ I = 0.356 \]

\[ S_{\text{max}} = \frac{-FL^3}{48EI} = \frac{(-200)(86)}{48(29 \times 10^6)(0.356)} = 0.26 \text{ in} \]

Drive System Support

\[ \Sigma F_y = R_a - R_b - W_{\text{motor}} \]

\[ \Sigma M_a = L_a W_{\text{motor}} - L_b R_b \]

\( W_{\text{motor}} = 60 \text{ lb} \)

\( L_a = 78.75 \text{ lb} \)

\( L_b = 18.75 \text{ lb} \)

\[ \sigma = \frac{M}{S} = \frac{12}{E} \]

\[ I = \frac{1}{12} (L)^2 \left( L - (2 \times 0.083) \right)^2 \]

\[ I = 0.043 \]

\[ S = \frac{0.85}{0.5} = 1.7 \]

\[ \sigma = \frac{900}{1.7} = 529 \text{ psi} \]

\[ < S_{\text{UT}} \]
Wheel Arm

\( L_{AB} = 6.65 \text{ in} \)
\( L_{Bo} = 27 \text{ in} \)
\( E = 29 \times 10^6 \text{ psi} \)
\( G = 11.2 \times 10^4 \text{ psi} \)

\[ \frac{d}{dx} x \]

\[ O = Z \text{ in} \]
\[ d = Z - (2x - 188) = 1.625 \text{ in} \]

\[ I_X = I_Y = \frac{E}{6G} \left( D^3 - d^3 \right) \]
\[ = \frac{29}{6} \left( 2.57 \times 1.625 \right) \]
\[ = 0.444 \]

\[ J_0 = I_X + I_Y = 0.888 \]

\[ S_{Ay} = \frac{FL_{AB}^3}{2EI} + \frac{FL_{AB} L_{BO}}{LJ} \]

\[ S_{Ay} = \frac{50 (5.65)^3}{2 (29 \times 10^6) (0.444)} + \frac{50 (5.65)^2 (27)}{(11.2 \times 10^4) (0.888)} = 0.0047 \text{ in} \]
**Shaft**

\[ d = 0.75 \text{ in} \]

\[ S_{or} = 94800 \text{ psi} \]

\[ S_c = 42400 \text{ psi} \quad \text{(approx. 1/2 S_{or})} \]

\[ T_m + T_a = 175 \text{ psi} \quad \text{(max motor torque)} \]

\[ M_m + M_a = 314 \text{ psi} \quad \text{(Belt breaking estimate)} \]

\[ k_f k_{fs} = 1.5 \quad \text{(over estimate)} \]

D.E.:

\[
\frac{1}{n} = \frac{16}{\pi d^3} \left[ \frac{\sqrt{4 (k_f M_a)^2 + 3 (k_{fs} T_a)^2}}{S_c} \right. \\
+ \left. \frac{\sqrt{4 (k_f M_m)^2 + 3 (k_{fs} T_m)^2}}{S_{or}} \right]
\]

\[ n = 2.2 \]
Loads on Pivots supports (bearings)

\[ \text{Forward propulsion force} \]

\[ 5015 \text{ in-lb} \]

\[ \frac{1350 \text{ in-lb}}{5.5 \text{ in}} = 245 \text{ lb} \]

\[ R_1 = 245 - 18.75 = 226.25 \text{ lb} \]

\[ R_2 = -245 - 18.75 = -263.75 \text{ lb} \]

\[ R_3 = 245 + 78.75 = 323.75 \text{ lb} \]

\[ R_4 = -245 + 78.75 = -166.25 \text{ lb} \]

Uneven bearing loads may impede forward motion of drive system. Following wheel in water test plan, counter weights may be needed to allow for smooth forward motion. Most effective fender designs may require more counter weight to allow forward motion. Additional weight could then be used as a measure of improvement in fender performance.

Torque in XY plane will be counteracted by the tensioned cable attached to the load cell and in-line with the drive wheel.

\( \times \) Total bearing load must not exceed 700 lb