Calculation applies to
ADN8UP SADNUP upper radial connector rotating bending qualification test:
100862958; ET201009263

$$\rho := .25\cdot\frac{lb}{in^3}$$

$$A_a := 43\cdot in^2$$

$$A_b := 19.8\cdot in^2$$

$$E := 200\cdot GPa = 2.901\times 10^7\ psi$$

$$q_a := \rho\cdot A_a\cdot\frac{lbf}{lbm} = 10.75\cdot\frac{lbf}{in}$$

$$I_a := 190\cdot in^4$$

$$q_b := \rho\cdot A_b\cdot\frac{lbf}{lbm} = 4.95\cdot\frac{lbf}{in}$$

$$I_b := 50.6\cdot in^4$$

$$L_a := 62\cdot in$$

$$L_b := 99\cdot in$$

$$x_P := 206\cdot in \qquad P := 12900\cdot lbf$$

$$x_2 := x_P + 40\cdot in = 246\cdot in$$

$$x_D := 202\cdot in$$

$$x_{end} := 263\cdot in$$

$$SumR := P + q_a\cdot L_a + q_b\cdot L_b + q_a\cdot\left(x_{end} - L_a - L_b\right) = 1.515\times 10^4\cdot lbf$$

$$R_2 := \left[P\cdot x_P + q_a\cdot L_a\cdot\frac{L_a}{2} + q_b\cdot L_b\cdot\left(L_a + \frac{L_b}{2}\right) \ldots + q_a\cdot\left(x_{end} - L_a - L_b\right)\cdot\left(L_a + L_b + \frac{x_{end} - L_a - L_b}{2}\right)\right]\cdot\frac{1}{x_2} = 12.053\cdot kip$$

$$R_1 := SumR - R_2 = 3.1\cdot kip$$

$$q(x) := -q_a\cdot\left(1 - \Phi\left(x - L_a\right)\right) - q_b\cdot\left(\Phi\left(x - L_a\right) - \Phi\left(x - L_a - L_b\right)\right) - q_a\cdot\Phi\left(x - L_a - L_b\right)$$

$$V_i(x) := \int_0^x q(x)\,dx + R_1 - P\cdot\left(x > x_P\right) + R_2\cdot\left(x > x_2\right)$$

$$M_i(x) := \int_0^x V_i(x)\,dx$$

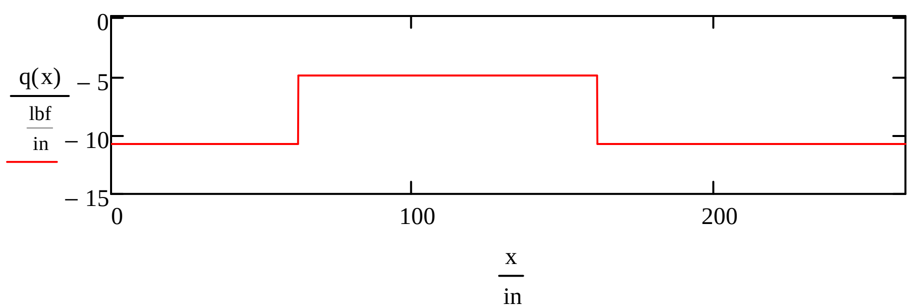
$M_i(250\cdot in) =$

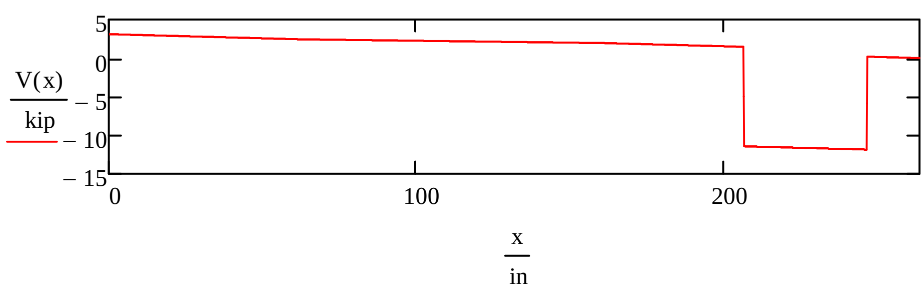
$$V(x) := -q_a\cdot\left[x - (x - L_a)\cdot\Phi(x - L_a)\right] - q_b\cdot\left[(x - L_a)\cdot\Phi(x - L_a) - (x - L_a - L_b)\cdot\Phi(x - L_a - L_b)\right] \ldots$$
$$+ -q_a\cdot(x - L_a - L_b)\cdot\Phi(x - L_a - L_b) + R_1 - P\cdot\Phi(x - x_P) + R_2\cdot\Phi(x - x_2)$$

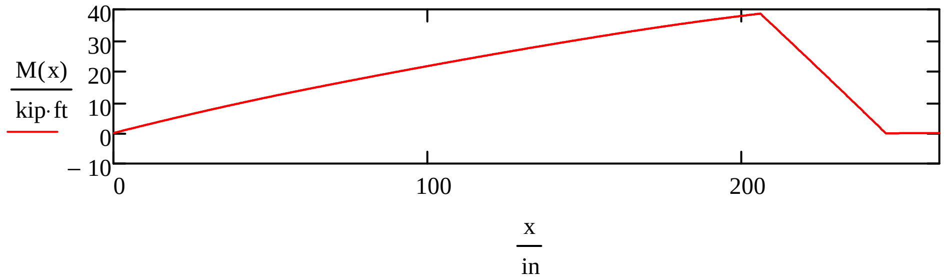
$$M(x) := -q_a\cdot\left[\frac{1}{2}x^2 - \frac{1}{2}(x - L_a)^2\cdot\Phi(x - L_a)\right] \ldots$$
$$+ -q_b\cdot\left[\frac{1}{2}(x - L_a)^2\cdot\Phi(x - L_a) - \frac{1}{2}(x - L_a - L_b)^2\cdot\Phi(x - L_a - L_b)\right] \ldots$$
$$+ -q_a\cdot\frac{1}{2}(x - L_a - L_b)^2\cdot\Phi(x - L_a - L_b) \ldots$$
$$+ R_1\cdot x - P\cdot(x - x_P)\cdot\Phi(x - x_P) + R_2\cdot(x - x_2)\cdot\Phi(x - x_2)$$

$M(x_D) = 38.229\,kip\cdot ft$

$x := 0, 0.1\cdot in .. x_{end}$

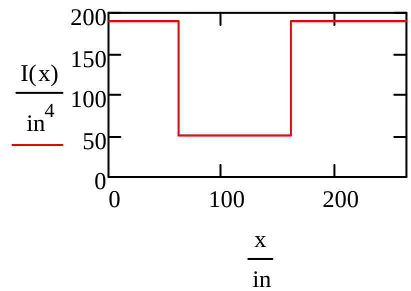




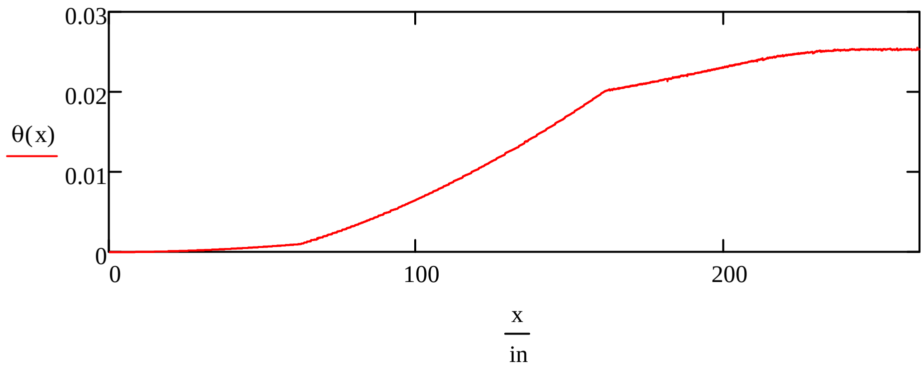


$$I(x) := \text{if}\left(L_a < x < L_a + L_b , I_b , I_a\right)$$

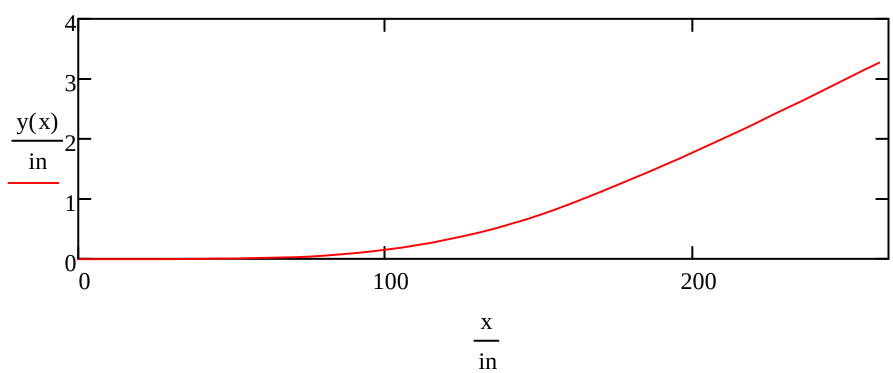
$$\theta(x) := \int_0^x \frac{1}{E \cdot I(x)} M(x)\, dx$$



$$y(x) := \int_0^x \theta(x)\, dx$$



$$x := 0 , 5 \cdot in .. x_{end}$$



To simplify setup, let the drive bearing and far-end support the roll assembly offset from the floor. Apply load using the bending deflector and measure the displacement at the bending deflector.

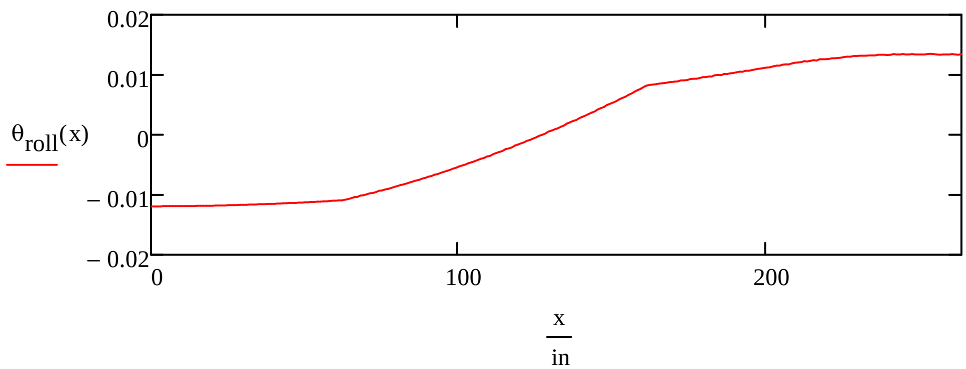
$$\theta_0 := \frac{y(x_2)}{x_2} = 0.012$$

$$\theta_{roll}(x) := \theta(x) - \theta_0$$

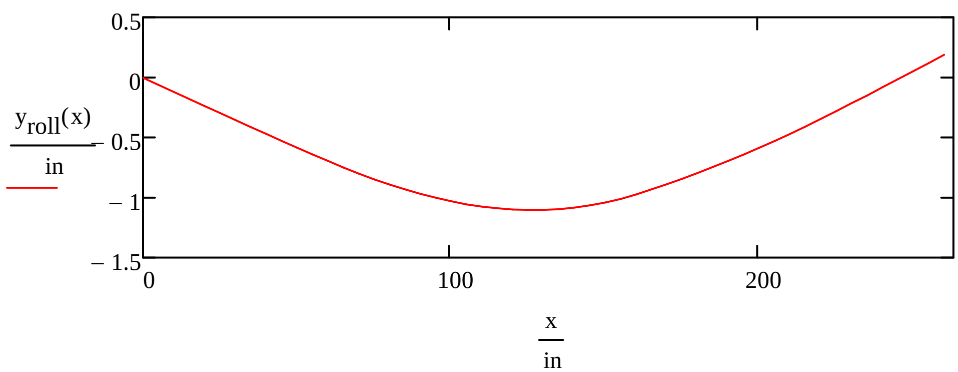
$$y_{roll}(x) := y(x) - x \cdot \theta_0$$

$$\min(y_{roll}(x), x, 0, x_{end}) =$$

$$x := 0, 1 \cdot in .. x_{end}$$



$$x := 0, 5 \cdot in .. x_{end}$$



$$y_{roll}(x_D) = -0.561\,in$$

$$y_{roll}(125 \cdot in) = -1.101\,in$$