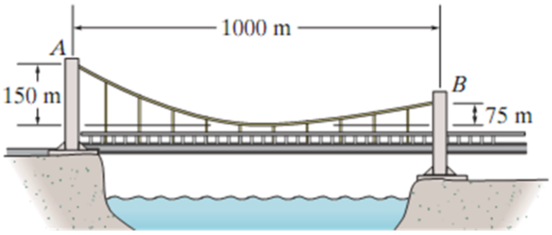
Hibbeler, Engineering Mechanics: Statics. 12th Edition

⊞— Utils

⊟— Problems

•7–105. If each of the two side cables that support the bridge deck can sustain a maximum tension of 50 MN, determine the allowable uniform distributed load w_0 caused by the weight of the bridge deck.



$h_A := 150\ \text{m}$ $\quad h_B := 75\ \text{m}$ $\quad d := 1000\ \text{m}$ $\quad T_M := 50\ \text{MN}$

$$\left[\begin{array}{l} y''(x) = \dfrac{wo}{2 \cdot F_H} \\ y(0) = h_A \qquad y'(0) = \tan(\theta_A) \end{array}\right.$$

$\text{RK}(wo, F_H, \theta_A) := \text{Adams}(y(x), d, 200)$

$$eq(u) := \left| \begin{array}{l} RK := RK(u_1, u_2, u_3) \\ \left[\begin{array}{c} RKI(RK, 3, u_4) - 0 \\ RKI(RK, 2, u_4) - 0 \\ RKI(RK, 2, d) - \dfrac{h_B}{\text{m}} \\ \dfrac{T_M \cdot \cos(u_3) - u_2}{\text{N}} \end{array}\right] \end{array}\right.$$

$$u = \begin{bmatrix} wo & F_H & \theta_A & x_o \end{bmatrix} \qquad \left[\begin{array}{c} y'(x_o) = 0 \\ y(x_o) = 0 \\ y(d) = h_B \\ F_H = T_M \cdot \cos(\theta_A) \end{array}\right]$$

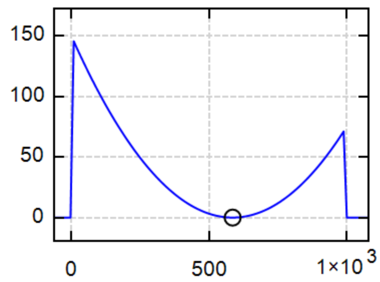
$$\left| \begin{array}{l} \begin{bmatrix} wo \\ F_H \\ \theta_A \\ x_o \end{bmatrix} := nNR\left(\text{"eq"}, \begin{bmatrix} 100\ \dfrac{\text{kN}}{\text{m}} \\ 5\ \text{kN} \\ -30\ \text{deg} \\ 100\ \text{m} \end{bmatrix}\right) \\ RK := RK(wo, F_H, \theta_A) \\ y(x) := RKI(RK, 2, x)\ \text{m} \\ y'(x) := RKI(RK, 3, x) \end{array}\right.$$

$$\boxed{wo = 77.82\ \frac{\text{kN}}{\text{m}}}$$

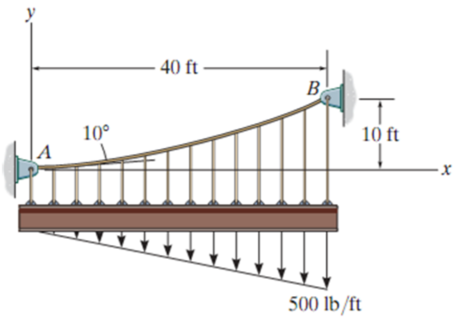
$F_H = 44503.2\ \text{kN}$

$\theta_A = -27.12\ \text{deg}$

$x_o = 585.79\ \text{m}$



7–106. If the slope of the cable at support A is 10°, determine the deflection curve $y = f(x)$ of the cable and the maximum tension developed in the cable.



$\theta_A := 10\ \text{deg}$ $\quad h_B := 10\ \text{ft}$ $\quad d := 40\ \text{ft}$ $\quad wo := 500\ \dfrac{\text{lbf}}{\text{ft}}$

$w(x) := \dfrac{wo}{d} \cdot x$ $\qquad \text{Clear}(F_H) = 1$

$$\left[\begin{array}{l} y''(x) = \dfrac{w(x)}{F_H} \\ y(0) = 0 \qquad y'(0) = \tan(\theta_A) \end{array}\right.$$

$\text{RK}(F_H) := \text{rkfixed}(y(x), d, 200)$

$$eq(u) := \left| \begin{array}{l} RK := RK(u_1) \\ \left[RKI(RK, 2, d) - \dfrac{h_B}{\text{m}} \right] \end{array}\right. \qquad u = \begin{bmatrix} F_H \end{bmatrix} \qquad \begin{bmatrix} y(d) = h_B \end{bmatrix}$$

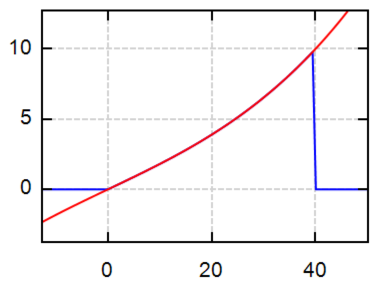
Symbolic solution $\quad f(x) := \dfrac{wo}{6 \cdot d \cdot F_H} \cdot x^3 + \tan(\theta_A) \cdot x$

$$\left| \begin{array}{l} \begin{bmatrix} F_H \end{bmatrix} := nNR(\text{"eq"}, [50\ \text{kip}]) \\ RK := RK(F_H) \\ y(x) := RKI(RK, 2, x)\ \text{m} \\ y'(x) := RKI(RK, 3, x) \end{array}\right.$$

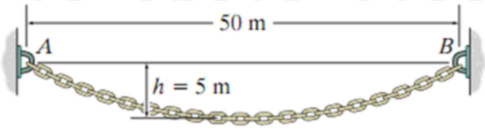
$F_H = 45.24\ \text{kip}$

$\theta_B := \text{atan}(y'(d)) = 21.67\ \text{deg}$

$$\boxed{T_M := \frac{F_H}{\cos(\theta_B)} = 48.69\ \text{kip}}$$



7–107. If $h = 5$ m, determine the maximum tension developed in the chain and its length. The chain has a mass per unit length of 8 kg/m.



$d := 25\ \mathrm{m}$ $\quad h := 5\ \mathrm{m}$ $\quad wo := 8\ \frac{\mathrm{kgf}}{\mathrm{m}}$

$$\begin{bmatrix} y''(x) = \frac{wo}{F_H} \cdot \sqrt{1 + y'(x)^2} \\ y(-d) = h \quad y'(-d) = \tan(\theta_M) \end{bmatrix}$$

$$eq(u) := \left| \begin{array}{l} RK := RK(u_1, u_2) \\ \begin{bmatrix} RKI(RK, 2, 0) - 0 \\ RKI(RK, 3, 0) - 0 \end{bmatrix} \end{array} \right. \qquad u = \begin{bmatrix} F_H & \theta_M \end{bmatrix} \qquad \begin{bmatrix} y(0) = 0 \\ y'(0) = 0 \end{bmatrix}$$

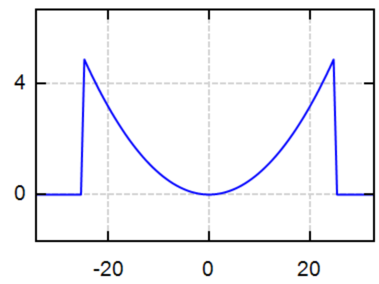
$RK(F_H, \theta_M) := \mathrm{rkfixed}(y(x), d, 200)$

$$\left| \begin{array}{l} \begin{bmatrix} F_H \\ \theta_M \end{bmatrix} := nNR\left("eq", \begin{bmatrix} 5\ \mathrm{kN} \\ -30\ \mathrm{deg} \end{bmatrix}\right) \\ RK := RK(F_H, \theta_M) \\ y(x) := RKI(RK, 2, x)\ \mathrm{m} \end{array} \right.$$

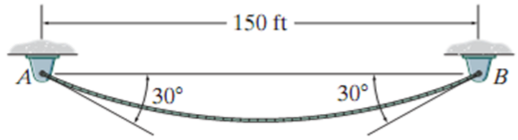
$F_H = 4.97\ \mathrm{kN}$

$\theta_M = -22.06\ \mathrm{deg}$

$$T_M := \frac{F_H}{\cos(\theta_M)} = 5.36\ \mathrm{kN}$$



***7–108.** A cable having a weight per unit length of 5 lb/ft is suspended between supports A and B. Determine the equation of the catenary curve of the cable and the cable's length.



$d := 75\ \mathrm{ft}$ $\quad \theta_M := -30\ \mathrm{deg}$ $\quad wo := 5\ \frac{\mathrm{lbf}}{\mathrm{ft}}$ $\quad \delta := \frac{d}{\mathrm{m}}$

$$\begin{bmatrix} y''(x) = \frac{wo}{F_H} \cdot \sqrt{1 + y'(x)^2} \\ y(-d) = h \quad y'(-d) = \tan(\theta_M) \end{bmatrix}$$

$$eq(u) := \left| \begin{array}{l} RK := RK(u_1, u_2) \\ \begin{bmatrix} RKI(RK, 2, 0) - 0 \\ RKI(RK, 3, 0) - 0 \end{bmatrix} \end{array} \right. \qquad u = \begin{bmatrix} F_H & h \end{bmatrix} \qquad \begin{bmatrix} y(0) = 0 \\ y'(0) = 0 \end{bmatrix}$$

$RK(F_H, h) := \mathrm{rkfixed}(y(x), d, 200)$

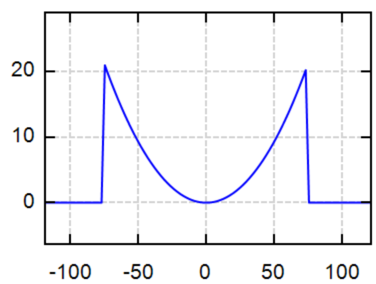
$$\left| \begin{array}{l} \begin{bmatrix} F_H \\ h \end{bmatrix} := nNR\left("eq", \begin{bmatrix} 500\ \mathrm{lbf} \\ 50\ \mathrm{ft} \end{bmatrix}\right) \\ RK := RK(F_H, h) \\ y(x) := RKI(RK, 2, x)\ \mathrm{m} \\ y'(x) := RKI(RK, 3, x) \end{array} \right.$$

$F_H = 682.68\ \mathrm{lbf}$

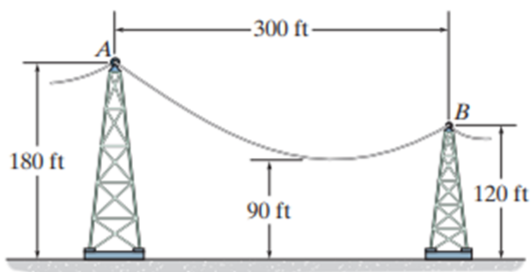
$h = 21.12\ \mathrm{ft}$

$$L := \int_{-\delta}^{\delta} \sqrt{1 + (y'(x\ \mathrm{m}))^2}\ \mathrm{d}x\ \mathrm{m}$$

$$L = 157.66\ \mathrm{ft}$$



***7–112.** The power transmission cable has a weight per unit length of 15 lb/ft. If the lowest point of the cable must be at least 90 ft above the ground, determine the maximum tension developed in the cable and the cable's length between A and B.



$h_A := 180\ \mathrm{ft}$ $\quad h_B := 120\ \mathrm{ft}$ $\quad h_o := 90\ \mathrm{ft}$ $\quad d := 300\ \mathrm{ft}$

$wo := 15\ \frac{\mathrm{lbf}}{\mathrm{ft}}$ $\quad \delta := \frac{d}{\mathrm{m}}$

$$\left[\begin{array}{l} y''(x) = \frac{wo}{F_H} \cdot \sqrt{1 + y'(x)^2} \\ y(0) = h_A \qquad y'(0) = \tan(\theta_A) \end{array}\right.$$

$$RK(F_H, \theta_A) := rkfixed(y(x), d, 200)$$

$$eq(u) := \left| \begin{array}{l} RK := RK(u_1, u_2) \\ \begin{bmatrix} RKI(RK, 3, u_3) - 0 \\ RKI(RK, 2, u_3) - \frac{h_o}{m} \\ RKI(RK, 2, d) - \frac{h_B}{m} \end{bmatrix} \end{array} \right.$$

$$u = \begin{bmatrix} F_H & \theta_A & x_o \end{bmatrix}$$

$$\begin{bmatrix} y'(x_o) = 0 \\ y(x_o) = h_o \\ y(d) = h_B \end{bmatrix}$$

$$\left| \begin{array}{l} \begin{bmatrix} F_H \\ \theta_A \\ x_o \end{bmatrix} := nNR\left(\text{"eq"}, \begin{bmatrix} 5000 \text{ lbf} \\ -30 \text{ deg} \\ 100 \text{ ft} \end{bmatrix} \right) \\ RK := RK(F_H, \theta_A) \\ y(x) := RKI(RK, 2, x) \text{ m} \\ y'(x) := RKI(RK, 3, x) \end{array} \right.$$

$$F_H = 3169.53 \text{ lbf}$$

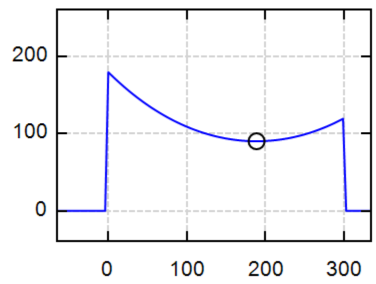
$$\theta_A = -45.47 \text{ deg}$$

$$x_o = 188.69 \text{ ft}$$

$$L := \int_0^{\delta} \sqrt{1 + y'(x \text{ m})^2} \, dx \text{ m}$$

$$L = 331.32 \text{ ft}$$

$$T_M := \frac{F_H}{\cos(\theta_A)} = 4.52 \text{ kip}$$



Alvaro

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