ENCE353 Introduction to Structural Analysis Fall 2022

Homework 3 (Due: Friday, November 4th,2022 @ 11:59pm)

Question 1: 10 points. The three-pin parabolic arch shown in Figure 1 has a profile shape,

$$y(x) = \left[\frac{4f}{l^2}\right] x\,(l - x)\,. \tag{1}$$

where f = 4m and l = 16m.

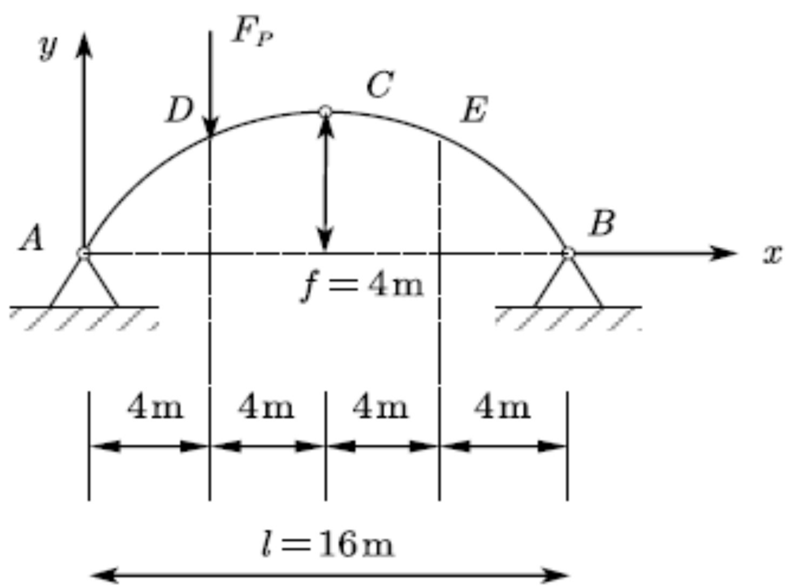


Figure 1: Elevation view of a parabolic three-pin arch.

Questions:

[1a] Calculate the horizontal and vertical components of reaction force at A and B.

[1b] Calculate the internal forces (i.e., shear, moment and axial forces) at point E.

[1c] Draw the bending moment diagram.

Question 2: 10 points

Figure 2 shows an elevation view of a pre-fabricated steel building frame that is subject to a variety of snow and wind loadings.

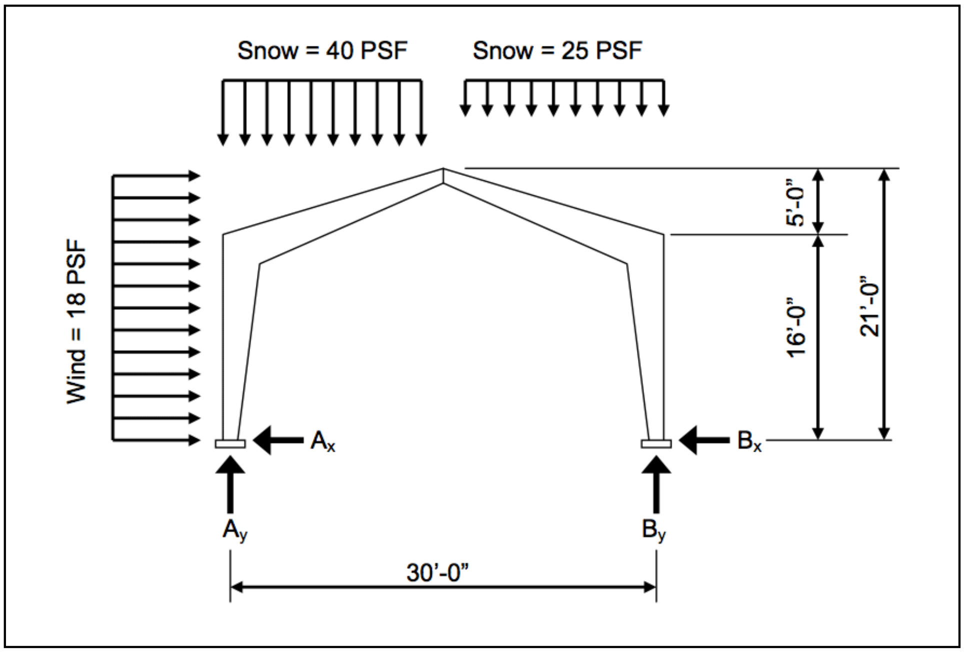


Figure 2: Elevation view of pre-fabricated steel building frame subject to snow and wind loadings.

Assuming that the frames are spaced at 20 ft centers, and that the foundation-level supports and roof apex are pinned (i.e., the frame can be modeled as a three-pinned arch), compute the vertical and horizontal reactions at the base supports.

Question 3: 10 points

The cable structure shown in Figure 3 carries a uniform load w_o N/m along its entire length.

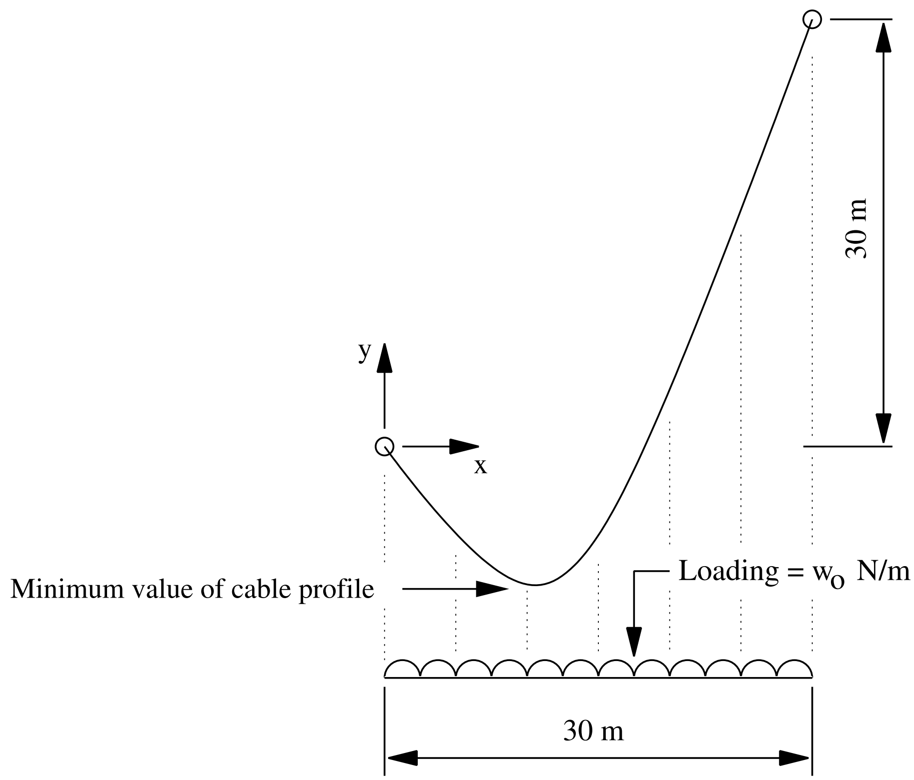


Figure 3: Elevation view of a pedestrian swing bridge.

[3a] Starting from first principles (i.e., the differential equation), show that cable profile is given by the equation

$$y(x) = \frac{w_o x^2}{2H} + \left(1 - \frac{15 w_o}{H}\right) x. \tag{2}$$

Now let us assume that the minumum value of the cable profile occurs at x = 10.

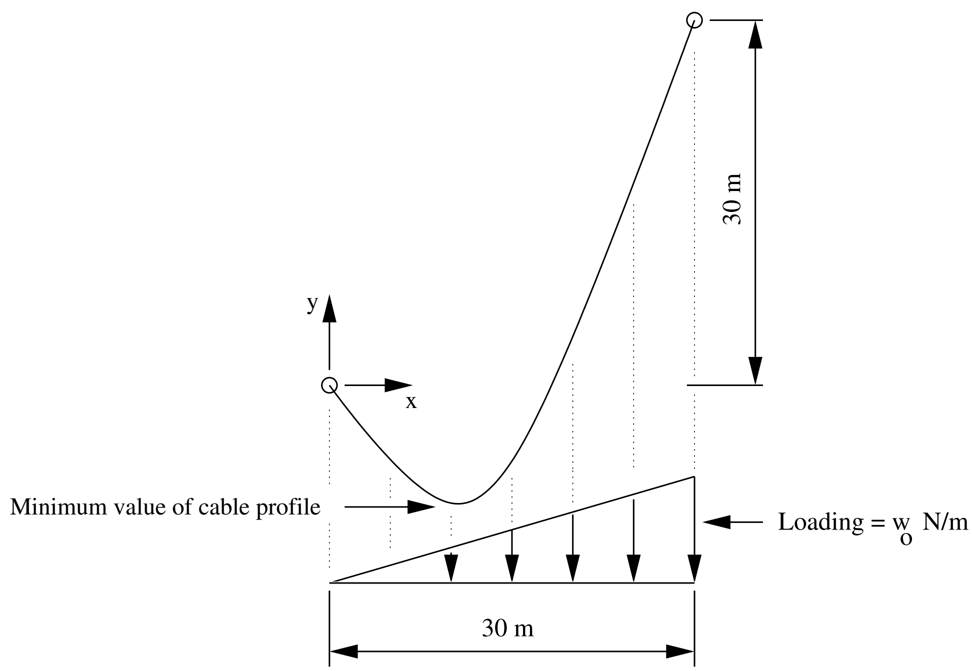
[3b] Show that the horizontal cable force is:

$$H = 5 w_o. \tag{3}$$

[3c] Derive a simple expression for the maximum tensile force in the cable.

Question 4: 10 points

The cable structure shown in Figure carries a triangular load that is zero at the left-hand support and increases to w_o N/m at the right-hand support.



[4a] Starting from first principles (i.e., the differential equation), show that cable profile is given by the equation

$$y(x) = \frac{w_o x^3}{180H} + \left(1 - \frac{5w_o}{H}\right) x. \tag{4}$$

Now let us assume that the minumum value of the cable profile occurs at x = 10.

[4b] Show that the horizontal cable force is:

$$H = \frac{20w_o}{6}. \tag{5}$$

[4c] Draw and label a diagram showing the horizontal and vertical components of reaction force at the left- and right-hand cable supports.

Question 5: 10 points

An inclined pedestrian walkway is supported by two identical cables and a system of closely space hangers. The cable towers are 40 m apart with one 4 m higher than the other. One end of the walkway is 5 m below the cables at the high tower and 3 m below the cables at the low tower.

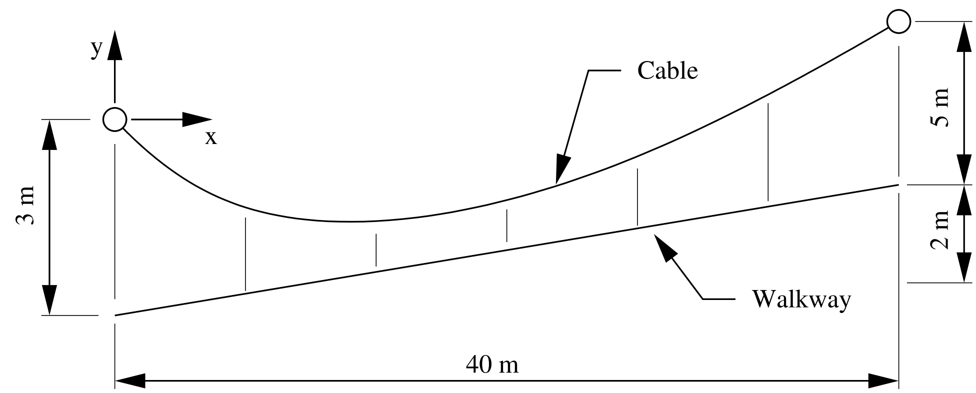


Figure 4: Schematic of walkway dimension (not to scale).

If the smallest possible hanger is 1 m long, and the walkway weighs 5 kN/m, determine:

[5a] H, the horizontal component of force in the cable?

[5b] The maximum force in the cable?

[5c] The length of the cable?