Module 3 : Cables
Lecture 4 : Examples

Objectives

In this course you will learn the following

- Some examples of cable systems.

Example 3.1 A 35 *m* cable is supported at ends *A* and *B* which are at the same horizontal level and are 25 *m* apart. A vertical load of 25 *kN* is acting at point *C* which is at a distance of 9 *m* from *A* . Find the horizontal reaction at *A* and the dip at *C* **.**

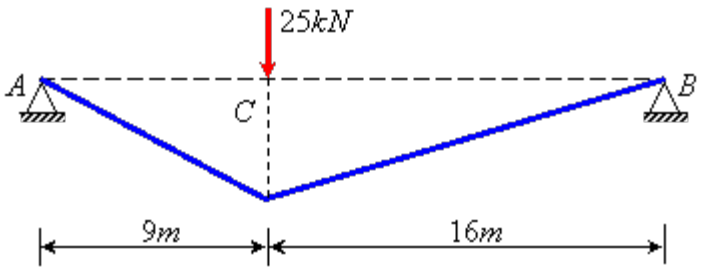
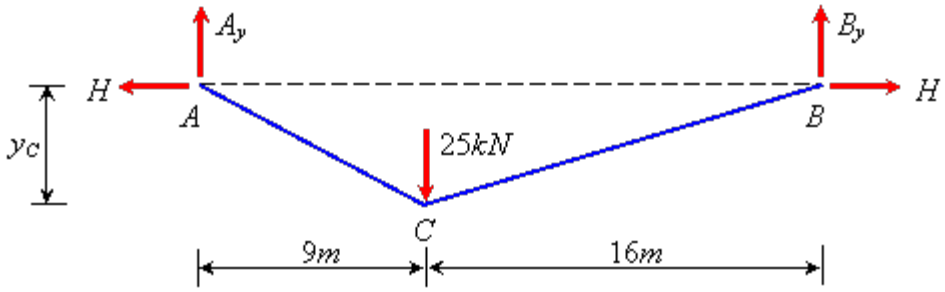


Figure E3.1

Solution:

Free body diagram of the cable:



If the dip at point *C* is y_C, then applying the general cable theorem, we get:

$$Hy_C = \left(\frac{9}{25}\right)\sum M_B - \sum M_C$$

Where $\sum M_B = 25 \times 16 = 400\ kNm$ and $\sum M_C = 0$

Therefore

$$Hy_C = \frac{9}{25} \times 400 = 144$$

$$\Rightarrow H = \frac{144}{y_C}$$

The other equation based on total length of the cable is

$$\left|\sqrt{9^2 + y_C^2}\right| + \left|\sqrt{16^2 + y_C^2}\right| = 35$$

$$\Rightarrow 9^2 + y_C^2 + 16^2 + y_C^2 + 2\sqrt{(9^2 + y_C^2)(16^2 + y_C^2)} = 35^2$$

$$\Rightarrow 4(9^2 + y_C^2)(16^2 + y_C^2) = (35^2 - 9^2 - 16^2 - 2y_C^2)^2$$

$$\Rightarrow 82944 + 1348\, y_C^2 + 4 y_C^4 = 788544 - 3552\, y_C^2 + 4 y_C^4$$

$$\Rightarrow 4900 y_C^2 = 705600$$

$$\Rightarrow y_C = 12m$$

$$\therefore H = \frac{144}{12} = 12kN$$

Note: Using the static equilibrium conditions we can find that:

$$A_y = 16kN$$

$$B_y = 9kN$$

$$T_{AC} = 12 \times \frac{15}{9} = 20kN \text{ (tension in } AC)$$

$$T_{BC} = 12 \times \frac{20}{16} = 15kN \text{ (tension in } BC)$$

Example 3.2 A light cable (that is, self weight of cable is negligible compared to external loads) is carrying uniformly distributed load of 30 *kN* / *m* . The span of the cable is 75 *m* and its length is 77 *m* , where the supports are at same horizontal level. What will be the percentage change in minimum tension if there is a rise of temperature by 35 ° C? Coefficient of thermal expansion of the cable material is (12× 10 -6 / ° C).

Solution: if y_m is the dip at mid point, then using equation 3.13

$$77 = 75 + \frac{8 y_m^2}{3 \times 75}$$

$$\Rightarrow y_m = 7.5m$$

Change in length due to temperature rise

$$\delta S = 77 \times (12 \times 10^{-6}) \times 35$$

$$= 0.03234\, m$$

Differentiating equation 3.13, we get:

$$\delta S = \frac{16 y_m\, \delta y_m}{3L}$$

$$\Rightarrow \delta y_m = \frac{3 \times 75 \times 0.03234}{16 \times 7.5}$$

$$= 0.0606375\, m$$

Differentiating equation 3.8

$$\delta H = -\frac{wL^2}{8 y_m^2} \times \delta y_m$$

$$\frac{\delta H}{H} = -\frac{\delta y_m}{y_m} = -0.008085$$

$$= 0.8085\ \% \text{ decrease}$$

This is the change in horizontal reaction, that is, in minimum tension in the cable.

Recap

In this course you have learnt the following

- Some examples of cable systems.