Cables Pre.pptx

Thursday, April 27, 2017 8:14 PM

Chapter 7, Section 4: Cables

Page 2

Thursday, April 27, 2017 8:14 PM

Cables

discrete, concentrated loads

distributed load

Cables carry/support loads
— always do so in tension

Assume:

- Weight is negligible — loads >> cable's weight ⟹ cable will have straight (uncurved) sections
- Perfectly flexible — exhibits no resistance to bending ($M(x) = 0$)
- Inextensible — No change in the total length of the cable before/during/after loading

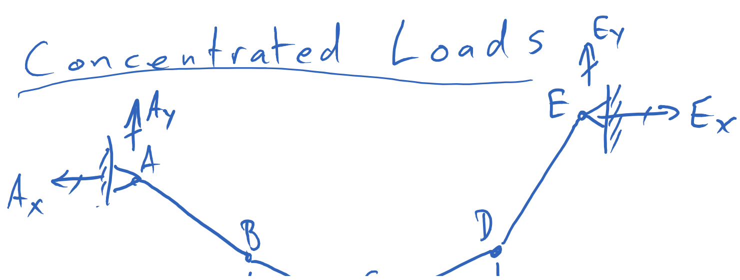
(in truth, there is "some" elongation, but insignificant compared to total length of the cable)

$e \ll L$

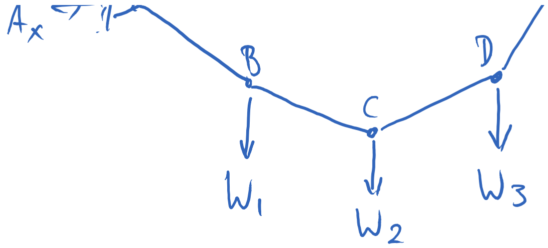
e ← elongation; L ← cable length

In general, 3 cable problems

1. <u>Concentrated Loads</u>



Straight segments between

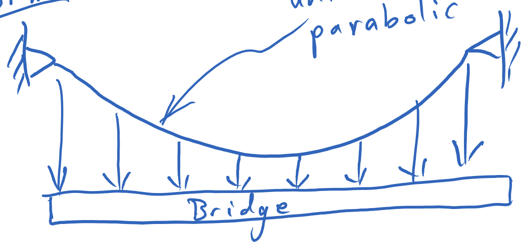


segments between loads

2. Distributed Loads

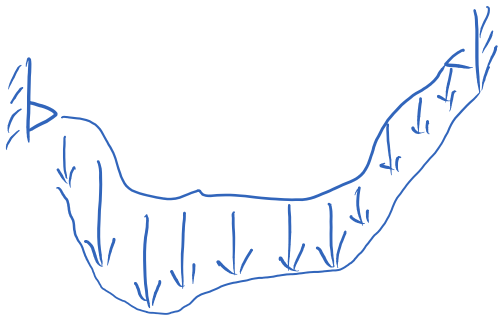
uniform

uniform load, parabolic



If distributed load is uniform, the cable curve $y(x)$ will be parabolic

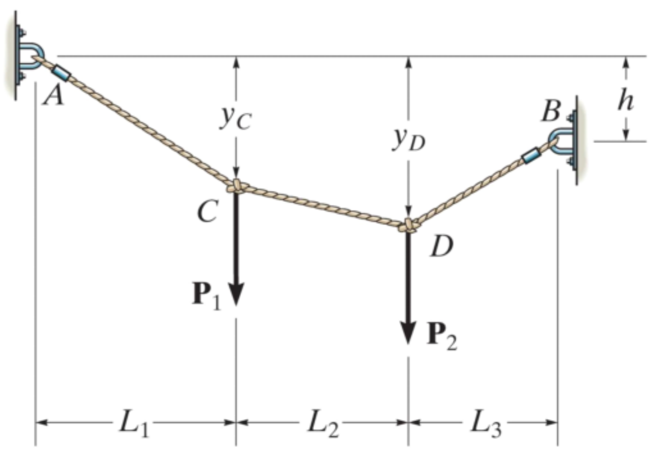
non-uniform



Cable subjected to it own weight alone

not parabolic "catenary curve"

Cable subjected to concentrated loads



Givens (knowns)

$h, P_1, P_2, L_1, L_2, L_3$

unknowns: T_{AC}, T_{CD}, T_{DB}

tension in each segment

A_x, A_y, B_x, B_y

sag at c & D

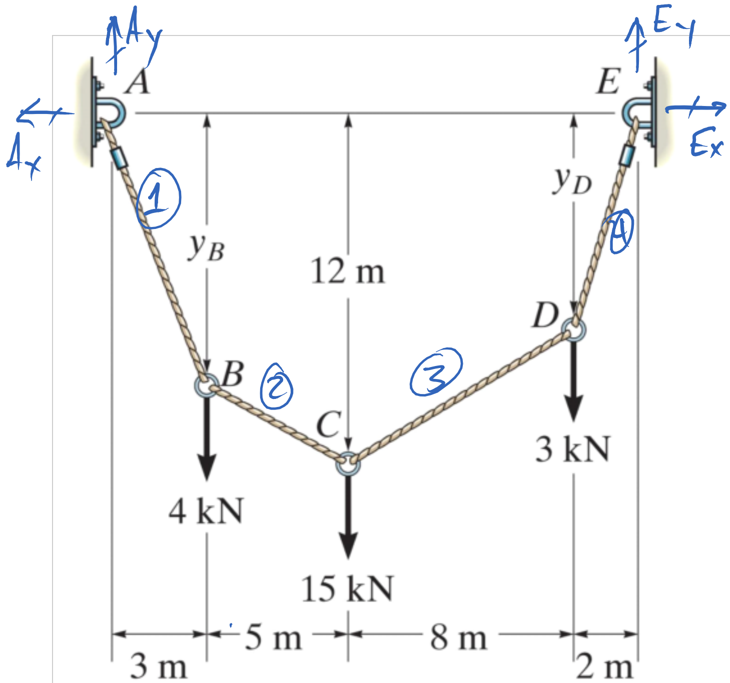
y_c & y_D

9 unknowns

Take $\Sigma F_x = 0$, $\Sigma F_y = 0$ at each joint

A, B, C, D $\Rightarrow$ 8 equations

If we know initial cable length, we can use pythagorean theorem to get a 9^{th} equation. $\Rightarrow$ problem will be hard to solve



Determine the tension in each segment of the cable shown.

If one sag is given, things become easier

unknowns

$A_x \; A_y \; E_x \; E_y$
$T_1 \; T_2 \; T_3 \; T_4$
$y_B \; y_D$

$\Big\}$ 10

$$\Sigma F_x = 0 \Rightarrow A_x = E_x$$

$$\Sigma F_y = 0 \Rightarrow A_y + E_y = 4\,kN + 15\,kN + 3\,kN$$

$$A_y + E_y = 22\,kN$$

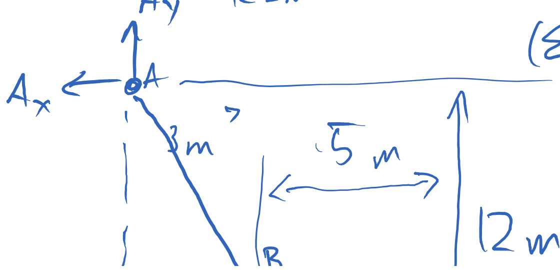
$$(\Sigma M)_E = 0$$

$$\Rightarrow (3kN)(2m) + (15kN)(10m) + (4kN)(15m) - A_y \cdot (18m) = 0$$

$$\Rightarrow \boxed{A_y = 12\,kN}$$

$$\boxed{E_y = 10\,kN}$$

Cut segment 2:



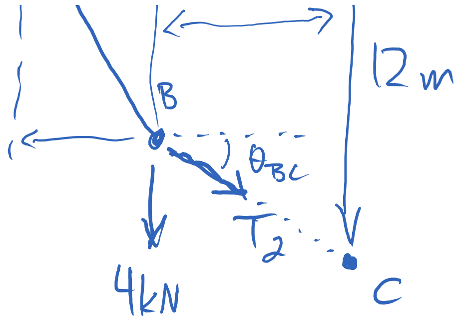
$$(\Sigma M)_C = 0$$

$$(12m)A_x - (8m)A_y + (5m)(4kN) = 0$$

12kN

$$\boxed{A_x = 6.33\,kN} \quad \boxed{E_x = 6.33\,kN}$$

$\boxed{A_x = 6.33\,kN}$ $\boxed{E_x = 6.33\,kN}$



$$\Sigma F_x = 0 \Rightarrow T_2 \cdot \cos\theta_{BC} = 6.33\,kN$$
$$\Sigma F_y = 0 \Rightarrow 12kN - 4kN - T_2 \cdot \sin\theta_{BC} = 0$$

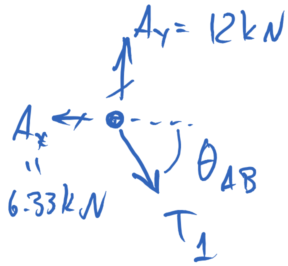
2 eqns
2 unknowns

solve: $\boxed{T_2 = 10.2\,kN}$

$\theta_{BC} = 51.6°$

Equilibrium of A, C, & E

Equil. @ A:

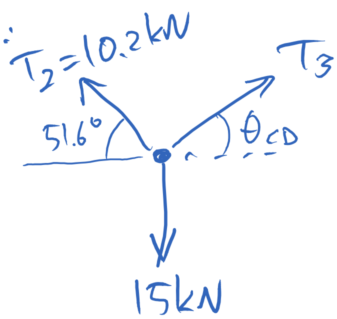


$$\Sigma F_x = 0 \Rightarrow T_1 \cdot \cos\theta_{AB} = 6.33\,kN$$
$$\Sigma F_y = 0 \Rightarrow T_1 \sin\theta_{AB} = 12\,kN$$

solve: $\boxed{T_1 = 13.6\,kN}$

$\theta_{AB} = 62.2°$

Equil. @ C:



$\Sigma F_x = 0$

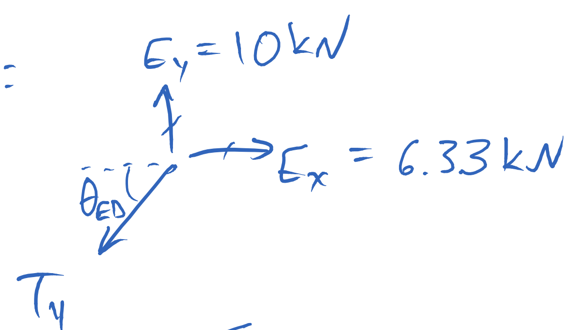
$$\Rightarrow \underbrace{T_2 \cdot \cos 51.6°}_{6.33kN} = T_3 \cdot \cos\theta_{CD}$$

$$\Sigma F_y = 0 \Rightarrow T_2 \sin\theta_{BC} + T_3 \sin\theta_{CD} = 15\,kN$$

solve: $\boxed{T_3 = 9.44\,kN}$

$\theta_{CD} = 47.9°$

Equil. @ E:



$\Sigma F_x = 0$

$$\Rightarrow \quad T_4 \cos\theta_{ED} = 6.33\,kN$$

$$\Sigma F_y = 0$$

$$\Rightarrow \quad T_4 \sin\theta_{ED} = 10\,kN$$

$$\boxed{T_4 = 11.8\,kN}$$

$$\theta_{ED} = 57.7^\circ$$

we can now solve for y_c & y_D

Summary

Rank

1	$T_1 = 13.6\,kN$	$\theta_{AB} = 62.2^\circ$	1
3	$T_2 = 10.2\,kN$	$\theta_{BC} = 51.6^\circ$	3
4	$T_3 = 9.44\,kN$	$\theta_{CD} = 47.9^\circ$	4
2	$T_4 = 11.8\,kN$	$\theta_{DE} = 57.7^\circ$	2

Tension rank = slope rank

The horiz. component of tension is same for all.