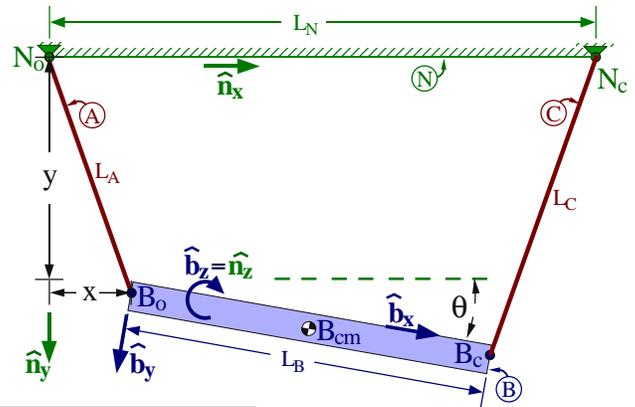


7.15 Kinematics of a swinging beam - with constant length cables. (Section 8.1)

Consider the swinging beam (construction hoist) system shown right and described in Homework 4.13.

Cables A and C are modeled as straight and inextensible (**constant length**).

Points N_o , N_C , B_o , B_C are all in the same vertical plane and the uniform rigid beam B 's motion is restricted to that plane (which is perpendicular to $\hat{n}_z = \hat{b}_z$).



Description	Symbol	Type	Value
Distance between N_o and N_C	L_N	Constant	6 m
Distance between B_o and B_C	L_B	Constant	4 m
Length of cable A	L_A	Constant	2.7 m
Length of cable C	L_C	Constant	3.7 m
\hat{n}_x measure of B_o 's position vector from N_o	x	Variable	varies
\hat{n}_y measure of B_o 's position vector from N_o	y	Variable	varies
Angle from \hat{n}_x to \hat{b}_x with $+\hat{n}_z$ sense	θ	Variable	varies

- (a) **Efficiently** express the following quantities in terms of \hat{n}_x , \hat{n}_y , \hat{n}_z and/or \hat{b}_x , \hat{b}_y , \hat{b}_z .

B 's angular velocity in N	${}^N\vec{\omega}^B =$ <input type="text"/>
B 's angular acceleration in N	${}^N\vec{\alpha}^B =$ <input type="text"/>
B_{cm} 's position vector from N_o	$\vec{r}^{B_{cm}/N_o} =$ <input type="text"/> \hat{n}_x + <input type="text"/> \hat{n}_y + 0.5 <input type="text"/> \hat{b}_x
B_{cm} 's velocity in N	${}^N\vec{v}^{B_{cm}} =$ <input type="text"/> \hat{n}_x + <input type="text"/> \hat{n}_y + <input type="text"/> \hat{b}_y
B_{cm} 's acceleration in N	${}^N\vec{a}^{B_{cm}} =$ <input type="text"/> \hat{n}_x + <input type="text"/> \hat{n}_y + <input type="text"/> \hat{b}_y - <input type="text"/> \hat{b}_x

- (b) Aerodynamic damping is modeled as depending on the square of ${}^N\vec{v}^{B_{cm}}$, denoted here as \vec{v}^2 . **Efficiently** calculate \vec{v}^2 in terms of symbols in the table and their time-derivatives.

Result: $\vec{v}^2 =$

- (c) As shown in Homework 4.13, there are geometrical (kinematical) relationships between x , y , and θ . Given numerical values for L_N , L_B , L_A , L_C , and x , and an understanding of how construction hoists on cables work on Earth, it's possible to uniquely determine y and θ using:

Just mathematics/Math and physical intuition/Neither (circle one of the choices)

- (d) † **Optional:** Calculate \vec{v}^2 (2^+ significant digits) when $x = 1$ m and $\dot{x} = 0.4$ $\frac{m}{s}$.

Result: $\vec{v}^2 = 0.134$ $\frac{m^2}{s^2}$

Hint: Intermediate results are $y = 2.508$ m, $\theta = 0.2565$ rad = 14.7° , $\dot{y} = -0.1595$ $\frac{m}{s}$, $\dot{\theta} = 0.06863$ $\frac{rad}{sec}$.

Hint: Refer to Homework 4.13. Consider using a computational tool, e.g., MotionGenesis.

Stumped? Student/instructor scripts at www.MotionGenesis.com \Rightarrow [Textbooks](#) \Rightarrow [Resources](#) \Rightarrow [Swinging beam](#).