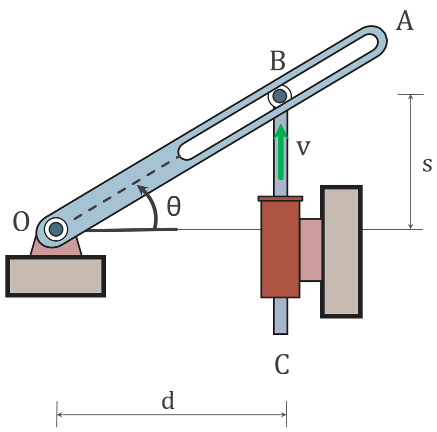
Hydraulic Cylinder induces Angular Velocity



A fixed hydraulic cylinder C exerts a constant upward velocity v to the collar B, which slips freely on rod OA. Determine the resulting angular velocity ω_{OA} as a function of the velocity v, the displacement s of point B, and the fixed distance d.

Using known expressions:

$$\boldsymbol{v_{B/O}} = \boldsymbol{v_O} + \boldsymbol{\omega} \times \boldsymbol{r_{B/O}} \tag{1}$$

Given:
Velocity C: v
Vertical displacement of B: s
Horizontal displacement of B: d
Constant velocity of point C $\Rightarrow$ constant angular velocity of rod OA.

Figure 1 shows the kinematic diagram of the situation. The angular velocity can be determined using the relative velocity $v_{B/O}$ and the distance L_{OB} with the relation from Equation 1. Since $v_O = 0$, this results in:

$$\left|v_{B/O}\right| = |\omega| \cdot \left|r_{B/O}\right| \tag{2}$$

Where $\left|r_{B/O}\right| = \sqrt{d^2 + s^2}$.

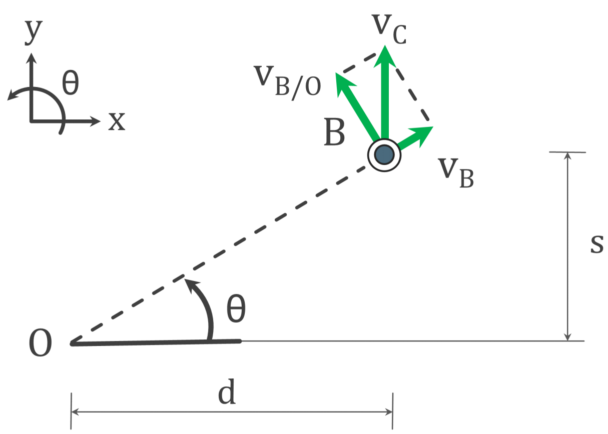


Figure 1: Kinematic diagram of the roller and the slotted guide.

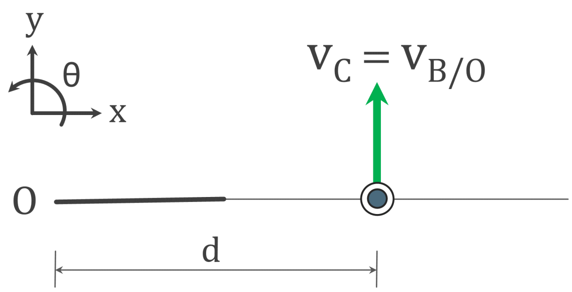


Figure 2: Kinematic diagram of the roller and the slotted guide for $\theta = 0°$.

For the time instant that $\theta = 0°$, this results in a vertical velocity that must be equal to $v_C = v$. Figure 2 shows this exact time instant which results in the following equation.

$$v_C = \omega \cdot d = v \tag{3}$$

Since the velocity of point C is constant and thus the angular velocity is constant. These two equations can be manipulated to get an equation for ω. To do that first a relation to write $v_{B/O}$ in terms of v_C must be found. From the geometry of Figure 1 it follows:

$$v_C = \frac{\sqrt{d^2 + s^2}}{d} \cdot v_{B/O} \tag{4}$$

Inserting Equation 2 into Equation 4 gives:

$$v_C = \frac{\sqrt{d^2 + s^2}}{d} \cdot v_{B/O} = \frac{\sqrt{d^2 + s^2}}{d} \cdot \sqrt{d^2 + s^2} \cdot \omega = \frac{d^2 + s^2}{d} \cdot \omega = v \tag{5}$$

Rewriting give the following relation for ω:

$$\omega = \frac{v \cdot d}{d^2 + s^2} \tag{6}$$