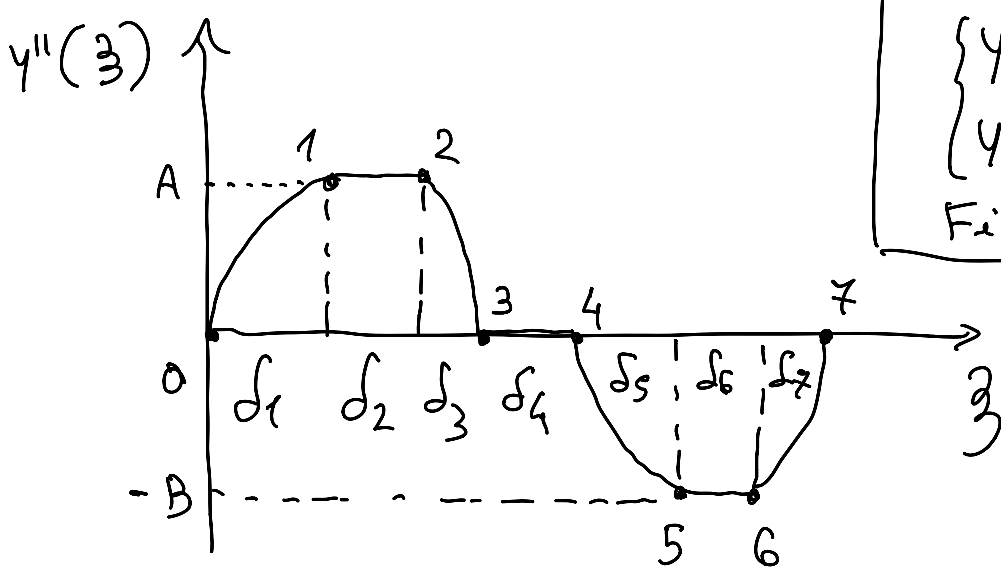
① MOTION LAW - RISE

α	x
$0°$	0 mm
$100°$	160 mm
$130°$	180 mm

1) Purpose:

0 —> 180 mm
crossing (100°, 160 mm)
without stopping
(due to problem discontinuity second cam trajectory)

2) Motion law chosen:



STANDARD PROCEDURE

Initial conditions:

$$\begin{cases} y_0 = 0 \\ y'_0 = 0 \end{cases} \rightarrow C_1, C_2$$

Final conditions:

$$\begin{cases} y_7 = 1 \\ y'_7 = 0 \end{cases} \rightarrow A, B$$

NEW PROCEDURE

$$Y_{01}''(z) = A \sin\left(\frac{z\pi}{2\delta_1}\right)$$

$$Y_{01}'(z) = -A \cos\left(\frac{z\pi}{2\delta_1}\right) \cdot \frac{2\delta_1}{\pi} + c_1$$

$$Y_{01}(z) = -A \sin\left(\frac{z\pi}{2\delta_1}\right)\left(\frac{2\delta_1}{\pi}\right)^2 + c_1 z + c_2$$

Initial conditions:

$$\begin{cases} Y_0 = 0 \\ Y_0' = 0 \end{cases} \longrightarrow \boxed{c_1, c_2}$$

Perform same procedure for other segments enforcing continuity in boundaries and obtain:

$$\tilde{Y} = \begin{bmatrix} Y_1 \\ Y_1' \\ Y_2 \\ Y_2' \\ \vdots \\ Y_7 \\ Y_7' \end{bmatrix} = f(A, B, \delta_1, \delta_2, \delta_3, \delta_4, \delta_5, \delta_6, \delta_7)$$

We need to enforce 4 additional conditions

$$\begin{cases} y_7 = 1 \\ y_7' = 0 \\ z_5 = 100/130 \\ y_5 = 160/180 \end{cases} \longrightarrow \boxed{\begin{array}{l} z_5 = \delta_1 + \delta_2 + \delta_3 + \delta_4 + \delta_5 \\ \sum_{i=1}^{7} \delta_i = 1 \end{array}}$$

$$\Downarrow$$

$$\delta_6 + \delta_7 = 1 - \frac{100}{130} = \frac{30}{130}$$

We can write

$$\tilde{Y} = f(A, B, \delta_6, \delta_7)^{\circledast} \quad \text{so that:}$$

$$\begin{cases} y_7 = 1 \\ y_7' = 0 \\ \delta_6 + \delta_7 = 30/130 \\ y_5 = 160/180 \end{cases} \longrightarrow \text{find } A, B, \delta_6, \delta_7$$

$\circledast$ $\delta_1, \delta_2, \delta_3, \delta_4, \delta_5$ are chosen so that:

$$\sum_{i=1}^{5} \delta_i = 1 - \frac{30}{130}$$

(∞^4 solutions)

THIS IS ONE OF THE POSSIBLE DESIGNS!

MOTION LAW - FALL

α	x
$170°$	180 mm
$200°$	160 mm
$360°$	0 mm

I take $\alpha = 300°$
$x = 0\,mm$

Same purpose as before but now the intermediate condition is crossing point $(30°, 20\,mm)$

$$\tilde{Y} = f(A, B, \delta_1, \delta_2)$$

$$\begin{cases} Y_7 = 1 \\ Y_7' = 0 \\ \delta_1 + \delta_2 = 30/130 \\ Y_2 = 20/180 \end{cases} \longrightarrow \text{find } A, B, \delta_1, \delta_2$$

$\delta_3, \delta_4, \delta_5, \delta_6, \delta_7$ chosen so that $\sum_{i=1}^{7} \delta_i = 1$

② BASE RADIUS DETERMINATION (WITHOUT ECCENTRICITY)

Pressure angle

$$\vartheta = \arctan\left(\frac{y'}{R_{bo} + y}\right)$$

We assume :

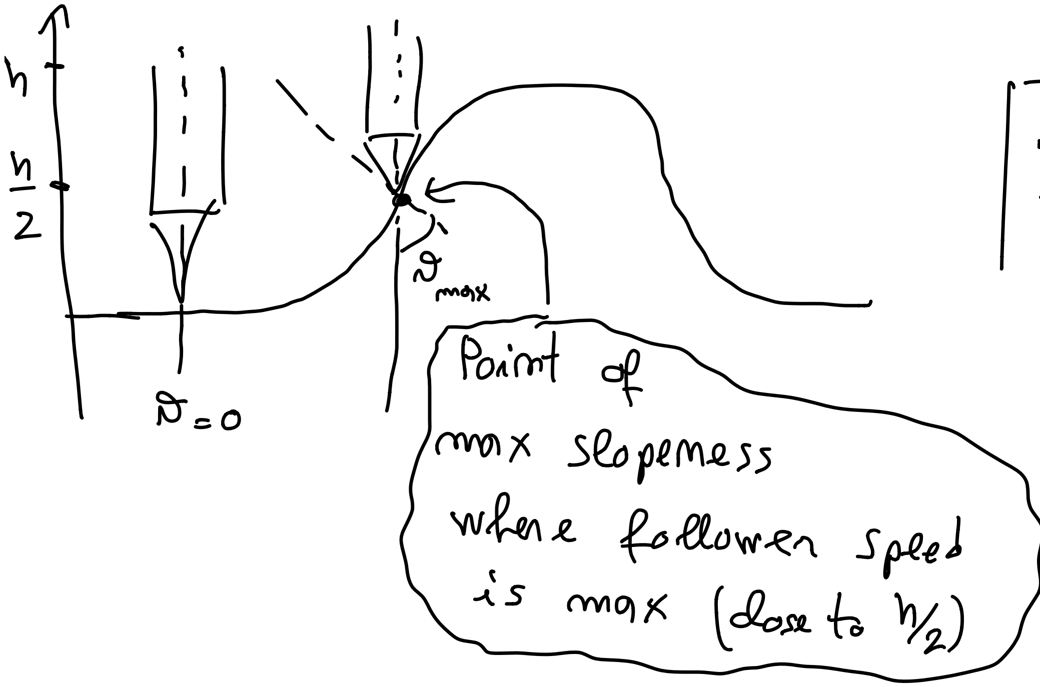
$$\begin{cases} \vartheta_{max} = \arctan\left(\dfrac{y'_{max}}{\underbrace{R_{bo} + h/2}_{= R}}\right) \\ y'_{max} = \dfrac{C_v h}{\vartheta_{RISE}} \end{cases}$$

$$\boxed{R \geq \frac{C_v h}{\vartheta_{RISE} \tan\vartheta_{max}}} \rightarrow \text{find } R$$

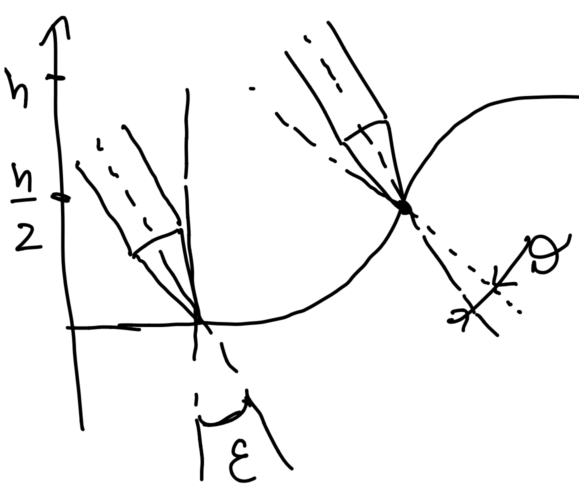
$$\boxed{R_{bo} = R - \frac{h}{2}}$$

Size Index $= \dfrac{R}{h}$ if $\dfrac{R}{h} > 5 \rightarrow$ big cam

BASE RADIUS DETERMINATION (WITH ECCENTRICITY)



No eccentricity



eccentricity

$\vartheta_{RISE\ max} = 30°$

$\vartheta_{FALL\ max} = 40° - 50°$

Eccentricity reduces ϑ in rise where the limit is more strict

At the end since you can have a smaller ϑ $\rightarrow$ R_{bo} can be smaller:

$$R \geq \frac{C_v\, h}{\alpha_s \cos\varepsilon\,(\tan\vartheta_{max} + \tan\varepsilon)} \rightarrow \text{find } R$$

$$R_{bo} = R - h/2$$

$$e = R \sin\varepsilon$$

3 $\rightarrow$ Select R_{bo} and e desired $\rightarrow$ draw cam (formulas with eccentricity)