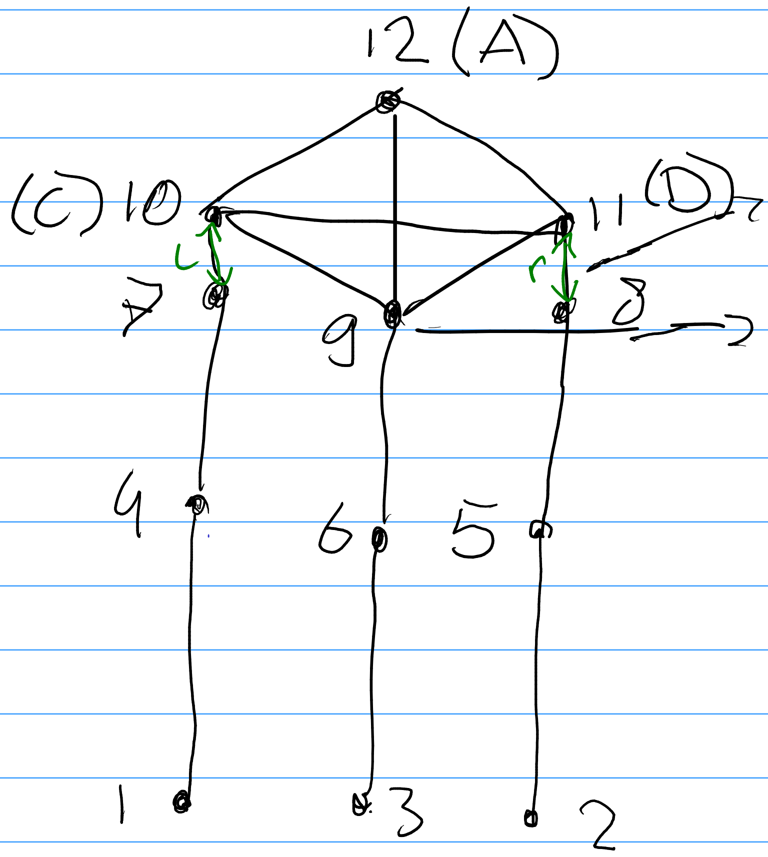
points with 2 segments per line

points: $3 \cdot seg + 4$



directly change pos

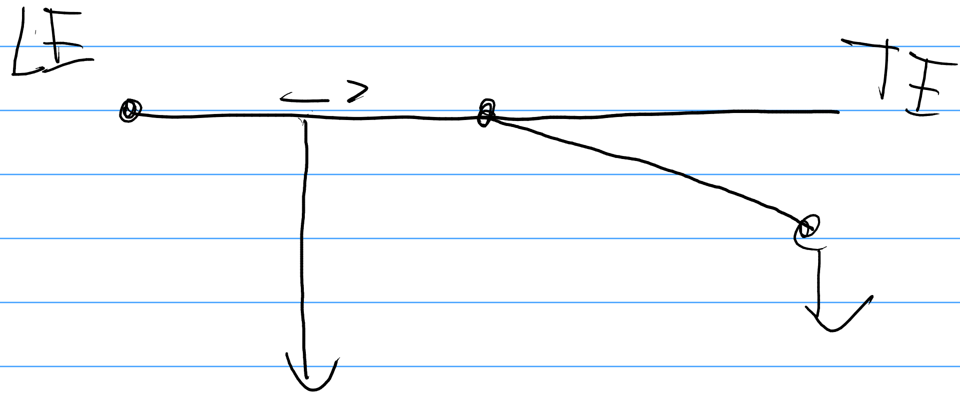
Length so that $F_{tether} = k \cdot F_{Lift}$

segments $\cdot 3 + 3$

$pos[5] = pos[8] - e_z \cdot L$

$vel[5] = vel[8]$

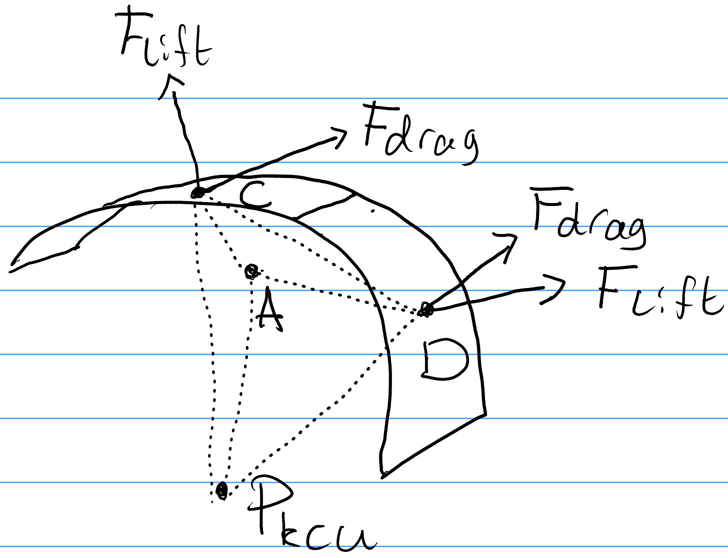
$acc[5] = acc[8]$

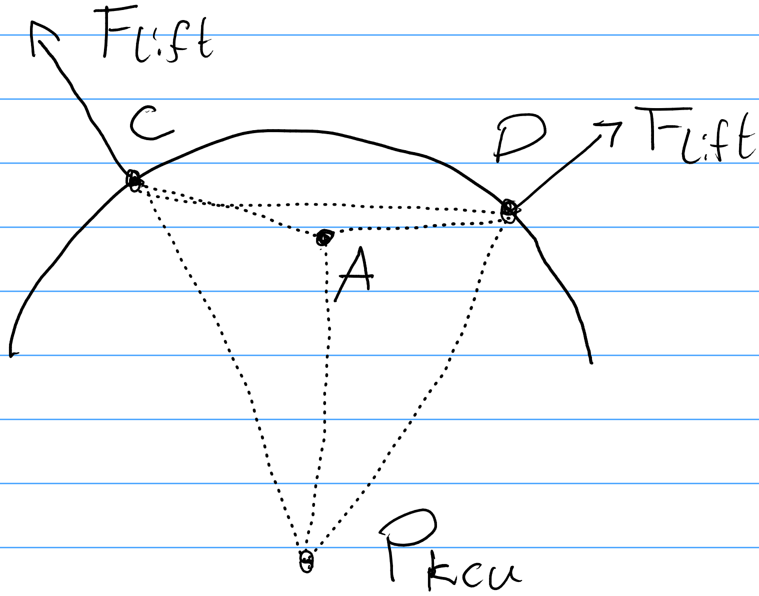


$k = 0{,}1$?

TE force should be small, k gets bigger with higher flap angle?

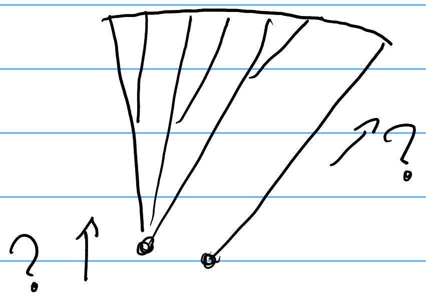
remove point B

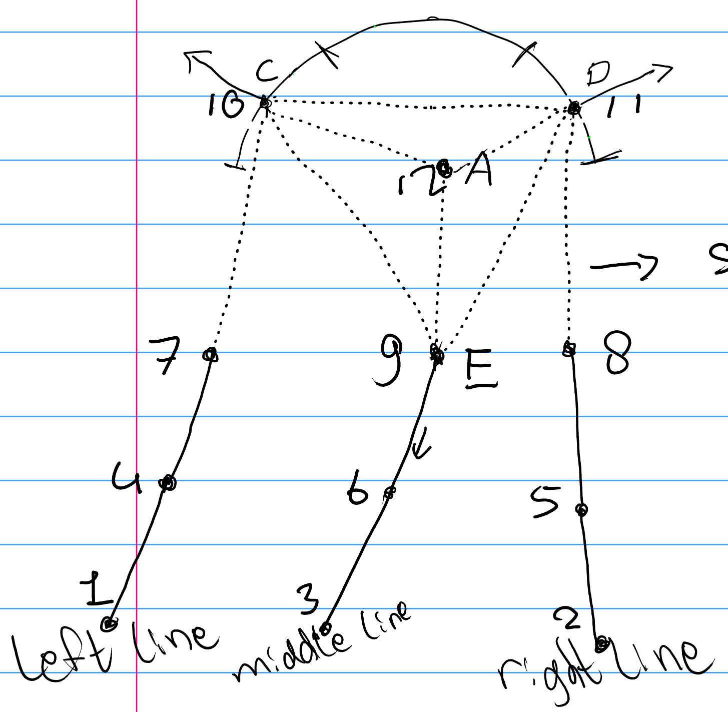




force on left
wire is difficult
to model

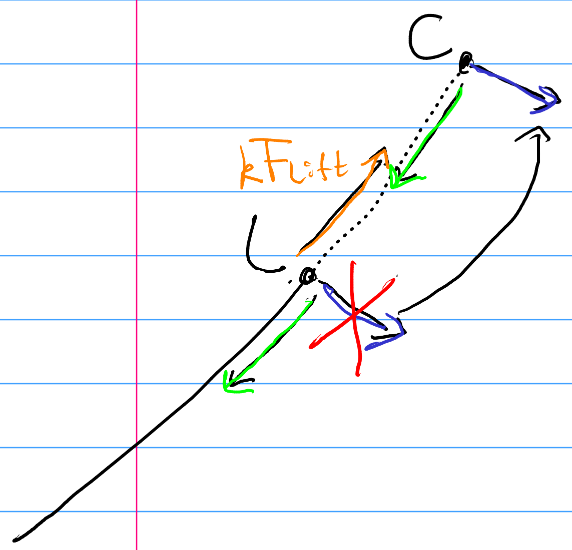
can assume
Lift is divided
between
power
and steering
Lines
with a
constant





→ steering tether connection

steering tether connection



$$F_L = F_g + F_d + F_{tether} + k \cdot F_{Lift,-z}$$

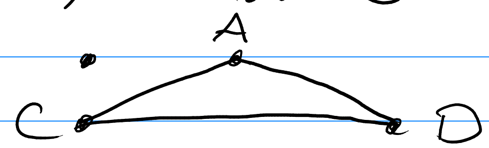
$$F_c = F_L - F_L$$

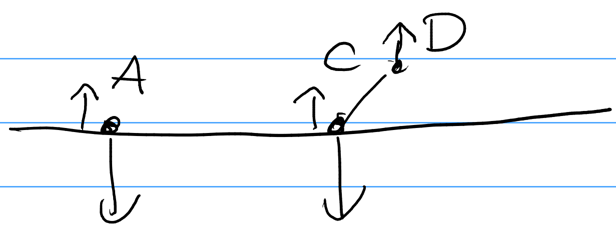
$$res1 = norm(v_c - v_L)$$

$\Rightarrow$ L should never move relative to C

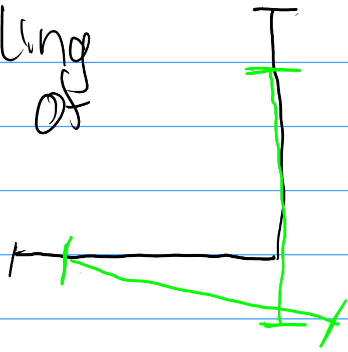
$$res2 = norm(a_c - a_L)$$

improvement: divide F_{tether} over A, C and D



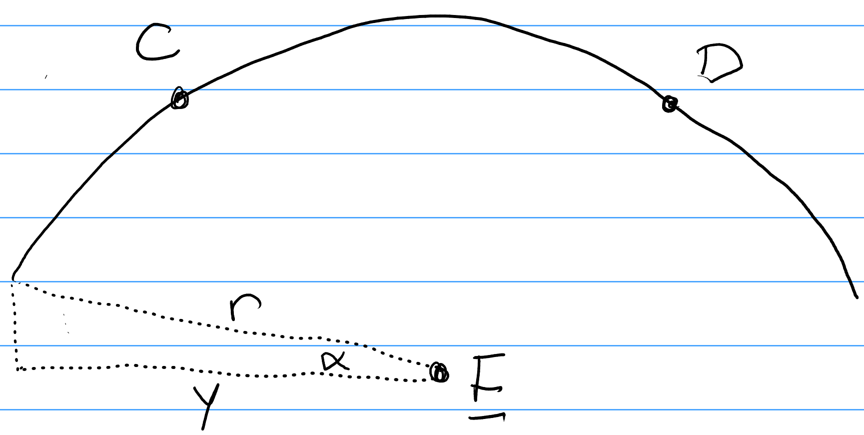


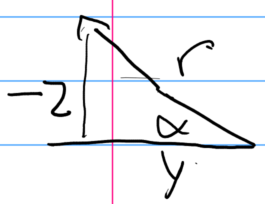
movement of trailing edge ≈ movement of L or r

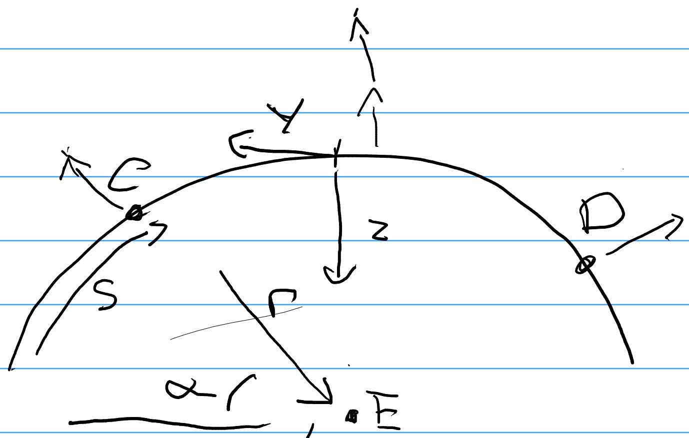


want to have Lift dependent of this distance, not angle

to find drag coefficients:
1 test kite and measure angles
2 manually change coefficients until they are right in sim





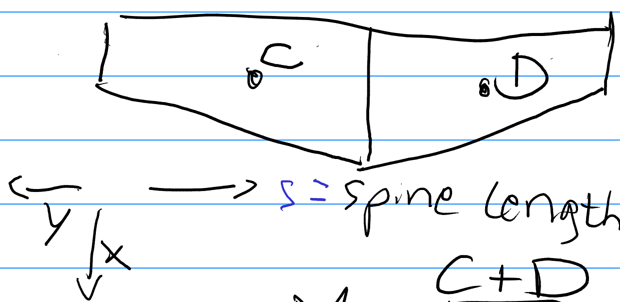


l_{line} = Lift on a line with length m

$$L_{c,x} = \int_0^{\frac{1}{2}w} L_{Lines} \cdot ds$$

$$L_c = \begin{bmatrix} L_{c,z} \\ L_{c,y} \end{bmatrix}$$

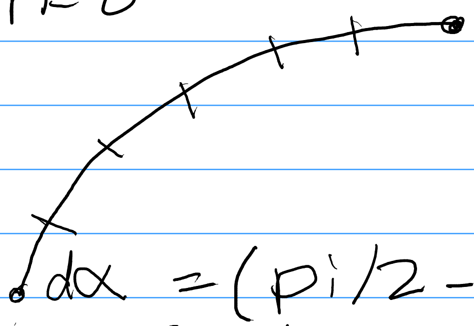
$$L_{line} = \frac{1}{2}\rho v$$



s = spine length

$$M = \frac{C+D}{2}$$

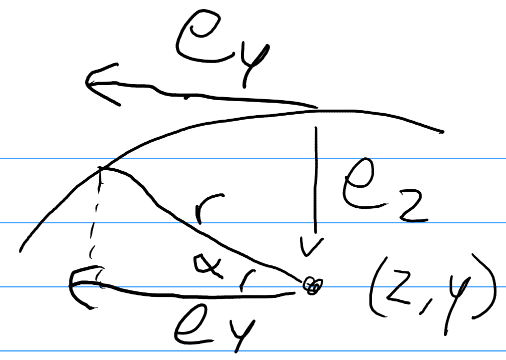
n=6



$$d\alpha = (pi/2 - \alpha_0)/n$$

$$L = \sum_{i=0}^{n} \frac{dL}{d\alpha}(d\alpha/2 + d\alpha \cdot i + \alpha_0) \cdot d\alpha$$

$$L_c = \int_{\alpha_0}^{\frac{1}{2}\pi} \frac{dL}{d\alpha}\, d\alpha$$



$$L = \frac{1}{2}\rho V_{a,xr}^2 A\, C_L(\alpha_c)\cdot e_r$$

$$e_r = \frac{E-F}{\|E-C\|}$$

$$F = E + e_y \cos\alpha\, r - e_z \sin\alpha\, r$$

F is any point on the kite

$$V_a = V_{wind} - V_{kite}(\alpha)$$

$$V_{kite}(\alpha) = \begin{bmatrix} V_{ex} \\ V_{ey} \\ V_{ez} \end{bmatrix}' \cdot [e_x\ e_y\ e_z]$$

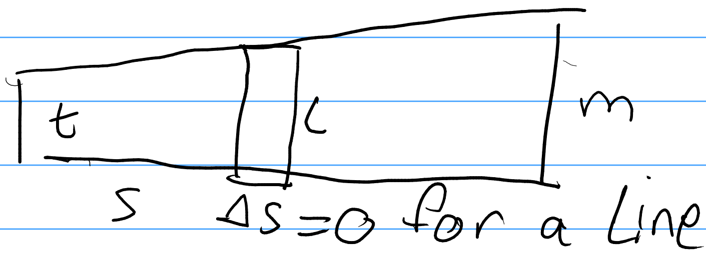
$$= \begin{bmatrix} \frac{V_{cx} - V_{Dx}}{y_c - y_D}\cdot(y - y_D) + V_{Dx} \\ V_{Ey} \\ V_{Ez} \end{bmatrix}' [e_x\, e_y\, e_z]$$

$$V_{ex} = V_c \cdot e_x$$

$$y = \cos\alpha\ r$$
$$z = \sin\alpha\ r$$

$$= \begin{bmatrix} \frac{V_{cx} - V_{Dx}}{y_c - y_D}(\cos\alpha\ r - y_D) + V_D \\ V_{Ey} \\ V_{Ez} \end{bmatrix}' [e_x\, e_y\, e_z]$$

$$l = \left(t + \frac{m-t}{0{,}5w}\ s\right)$$



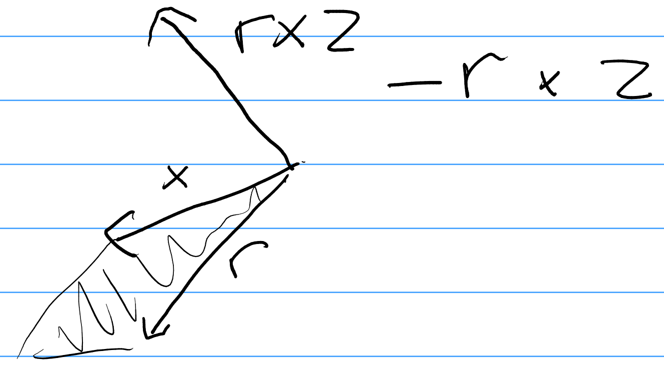
$$L(\alpha) = \frac{1}{2}\rho V_{a,xr}^2\, s\left(t + \frac{m-t}{0{,}5w}\ s\right) C_L(\alpha)\, e_r$$

$$s = \alpha\ r$$

$$dL(\alpha) = \frac{1}{2}\rho V_{a,xr_1}^2 \left(t + \frac{m-t}{0{,}5w}\ \alpha r\right) C_L(\alpha)\cdot e_r \quad d\alpha\ r$$

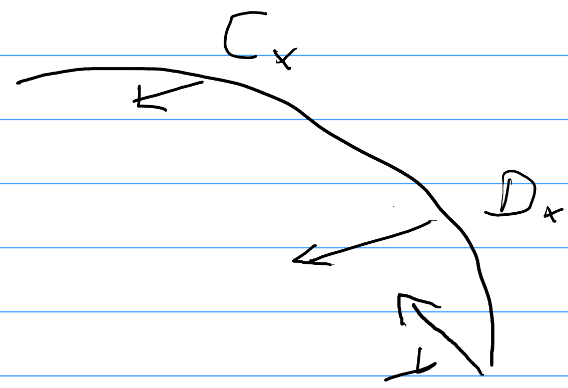
$$\frac{dL}{d\alpha} = \frac{1}{2}\rho V_{a,xr}^2\ r \left(t + \frac{m-t}{0{,}5w}\ \alpha r\right) C_L(\alpha)\cdot e_r$$

$$V_{a,xr} = V_a - (V_a \cdot (e_r \times e_x))(e_r \times e_x)$$



$$V_a = V_{wind} - V_{kite}$$

$$V_{Cx} = (V_c \cdot e_x) e_x$$



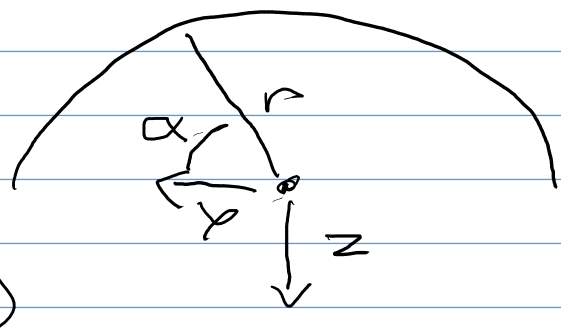
$$V_{kite}(\alpha) = V_x + V_y + V_z$$

Local: $y_L = \cos\alpha \; r$

$z_L = \sin\alpha \; r$

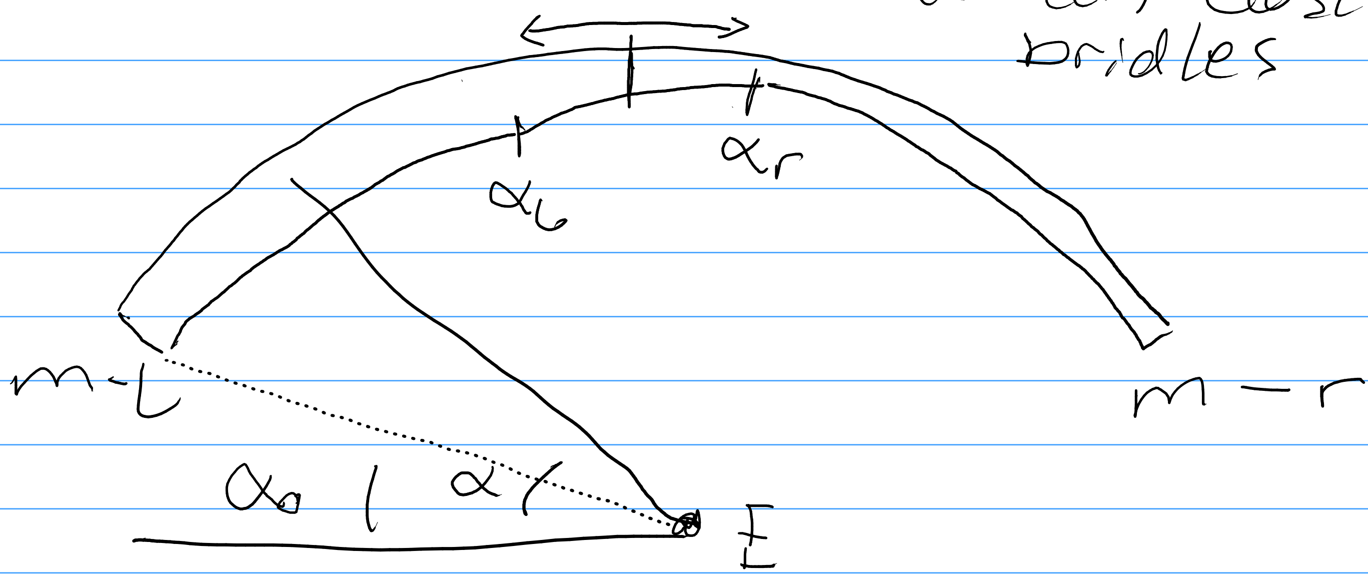
$$y_{L,C} = norm(C-P)$$

$$y_{L,D} = norm(D-P)$$



$$V_{kite}(\alpha) = \frac{V_{Cx} - V_{Dx}}{y_{LC} - y_{LD}}(y_L - y_{LD}) + V_{Dx} + V_{Iy} + V_{Iz}$$

d_s = distance between closest steering bridles



c_l is dependent of trailing edge displacement d

m, l, r middle left right line length

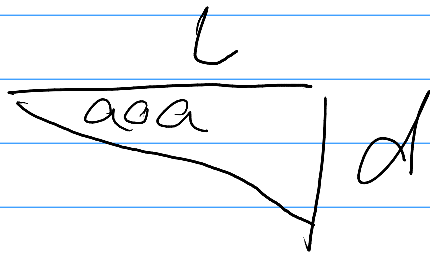
$$\alpha_0 = (\pi - w/r)/2$$

$$d(\alpha) = \begin{cases} m-l & \text{if } \alpha < \alpha_l \\ m-r & \text{if } \alpha > \alpha_r \\ \dfrac{(m-r)-(m-l)}{\alpha_r - \alpha_l}(\alpha - \alpha_l) + (m-l) & \text{if } \alpha_l < \alpha < \alpha_r \end{cases}$$

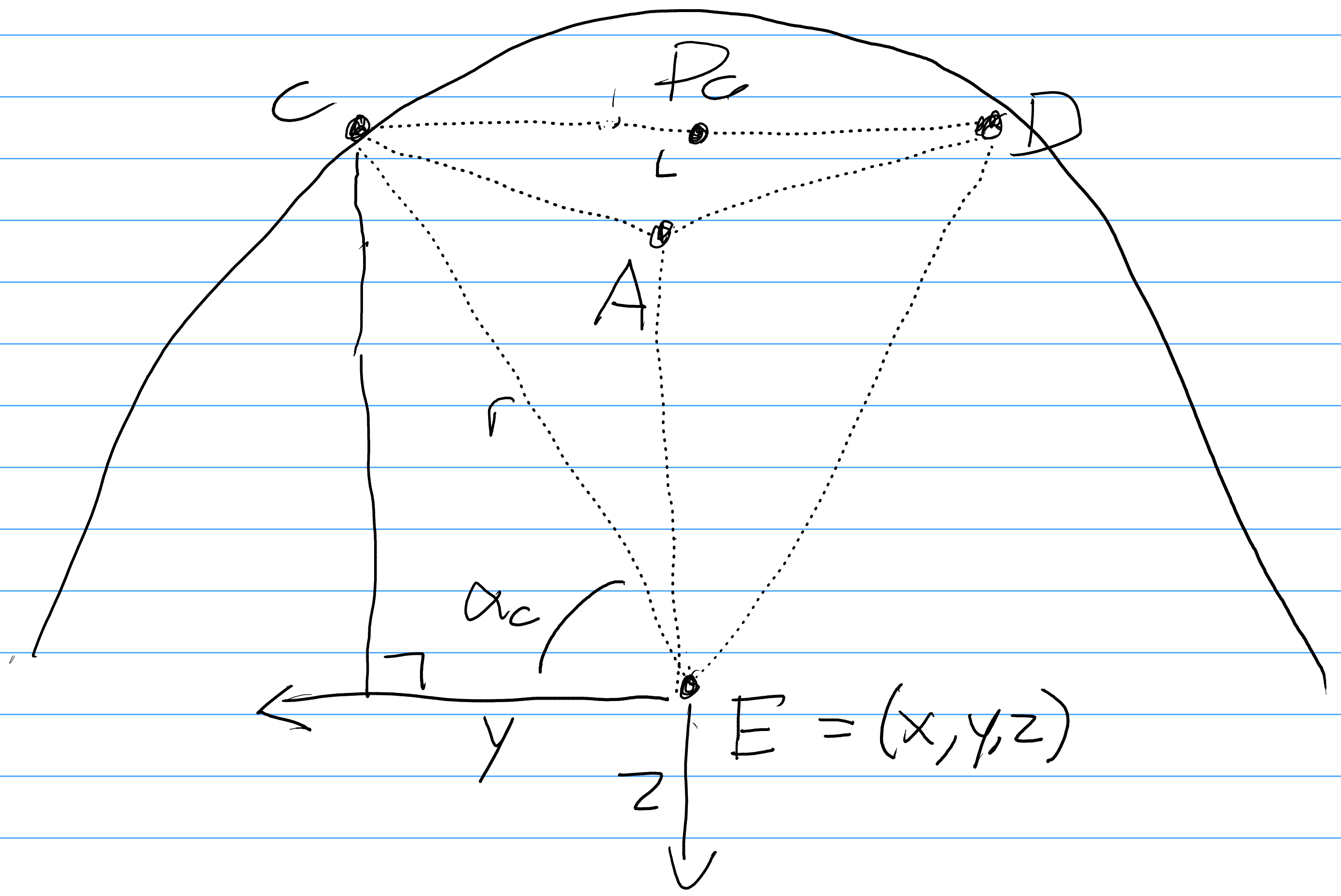
$$\alpha_l = \tfrac{1}{2}\pi - d_s/(2r)$$
$$\alpha_r = \tfrac{1}{2}\pi + d_s/(2r)$$

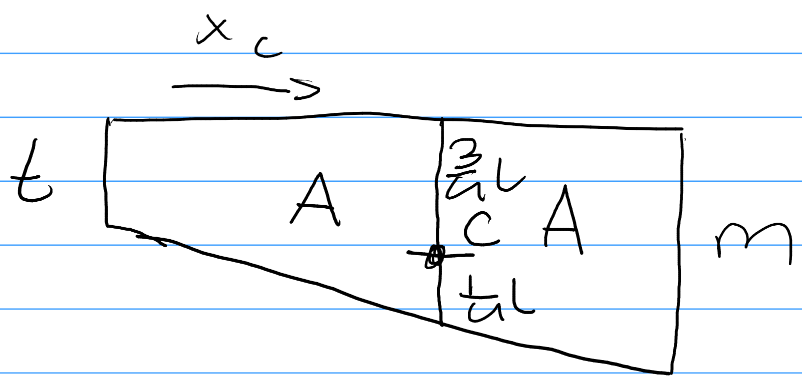
$c_l(aoa)$ where aoa is the angle of attack

$$aoa(d) = \tan^{-1}\left(\frac{d}{l}\right)$$



$$aoa(v_{xr}) = \pi - \operatorname{acos}(\operatorname{normalize}(va, xr) \cdot x)$$





$A = A$ (areas are equal)

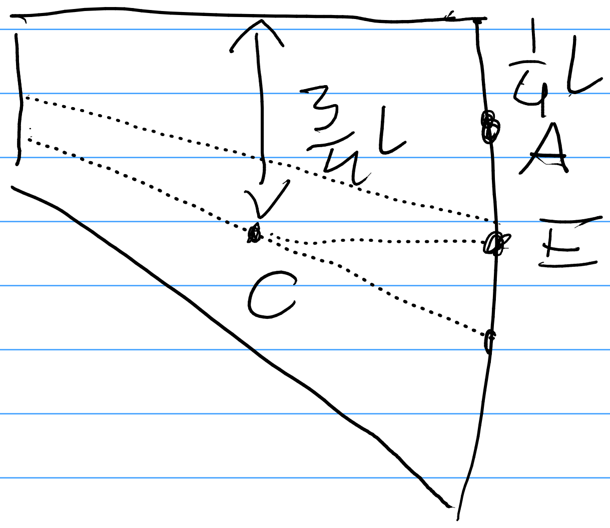
$$\frac{(L(\alpha_0) + L(\alpha_c))}{2}(\alpha_c - \alpha_0) =$$

$$\frac{(L(\alpha_c) + \frac{1}{2}\pi)}{2}(\frac{1}{2}\pi - \alpha_c)$$

$$x_c = \frac{w(-2t + \sqrt{2m^2 + 2t^2})}{4(m-t)}$$

hvis $m = t \Rightarrow x_c = w/4$

$$\alpha_c = \alpha_0 + x_c \cdot r$$



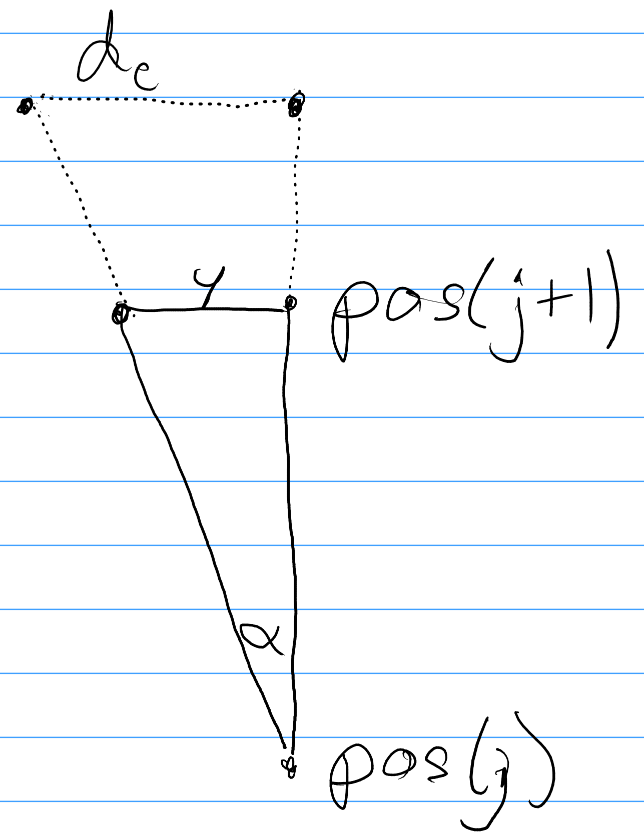
if area $= k \cdot$ mass
we want A at $\frac{1}{4}$ length, C at $\frac{3}{4}L$ (cop)
and E at the same e_x as C

$m_a = \frac{1}{2}\ m_{kite}$

$m_c = \frac{1}{4}\ m_{kite}$

$m_d = \frac{1}{4}\ m_{kite}$

$m_e =$ tether weight


d_c
y
pos(j+1)
α
pos(j)