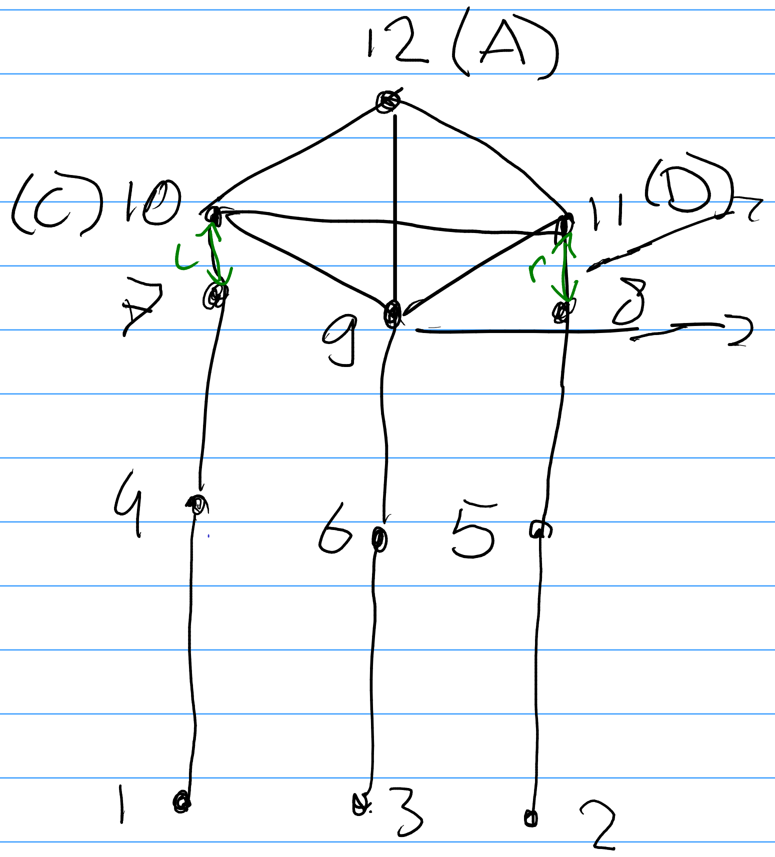
points with 2 segments per line

points: $3 \cdot seg + 4$



directly change pos

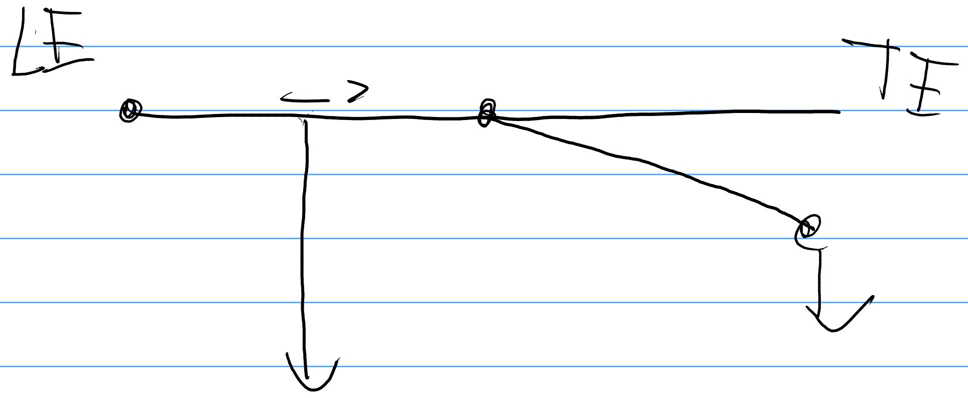
Length so that $F_{tether} = k \cdot F_{Lift}$

segments $\cdot 3 + 3$

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

$vel[5] = vel[8]$

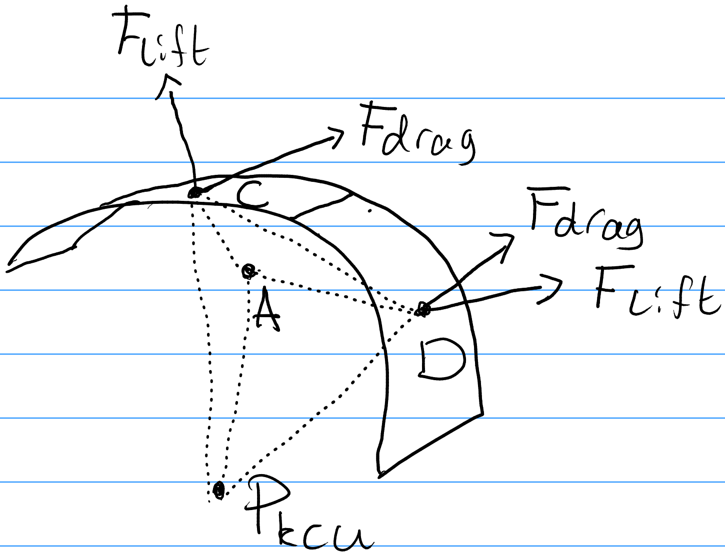
$acc[5] = acc[8]$

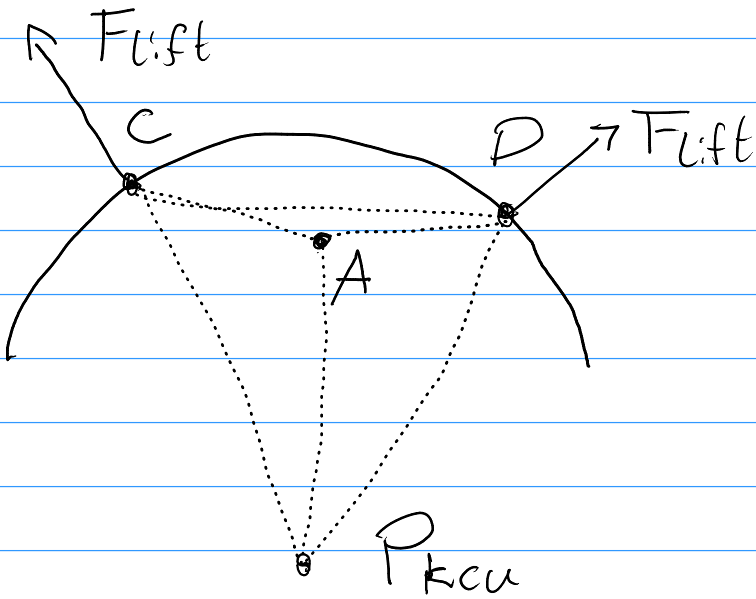


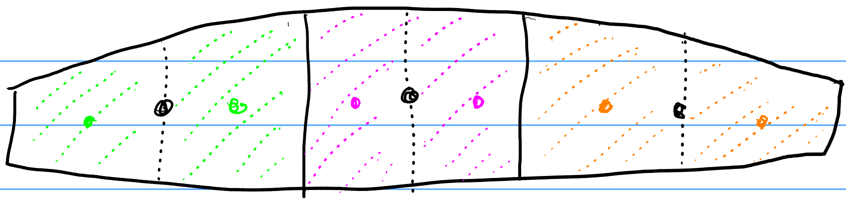
$k = 0{,}1$?

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

remove point B





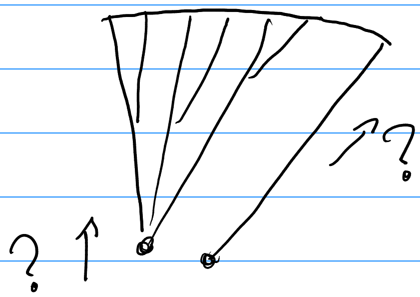


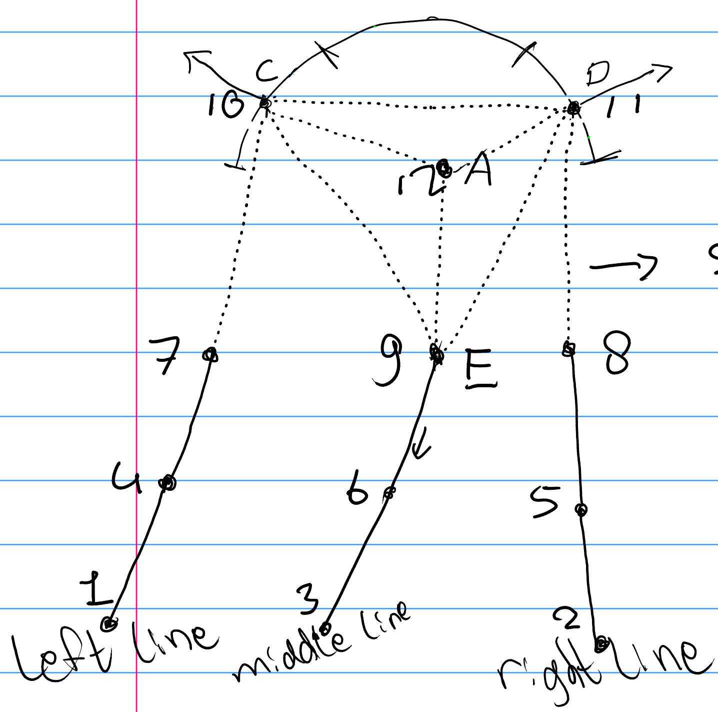
- mass
- force
- force on mass = Σ force

should work as long as the dyhedral is not accounted for?

force on left wire is difficult to model

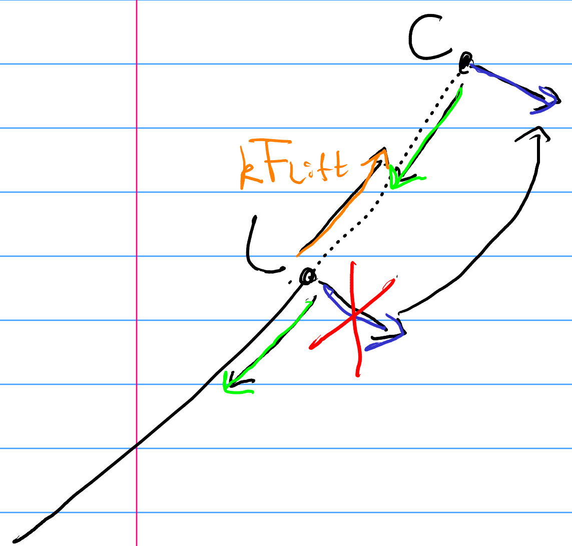
can assume Lift is divided between power and steering Lines with a constant





→ steering tether connection

steering tether connection



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

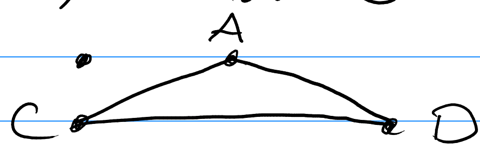
$$F_C = F_L - F_L$$

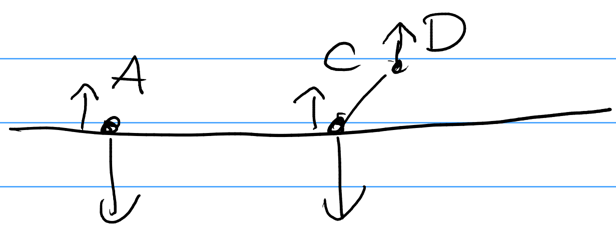
$$res1 = norm(V_C - V_L)$$

$\Rightarrow$ L should never move relative to C

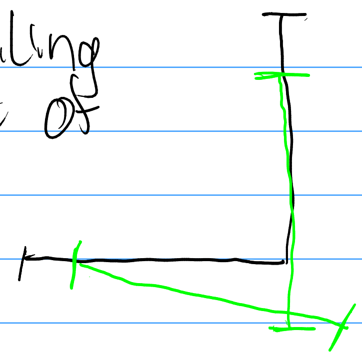
$$res2 = norm(a_C - a_L)$$

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



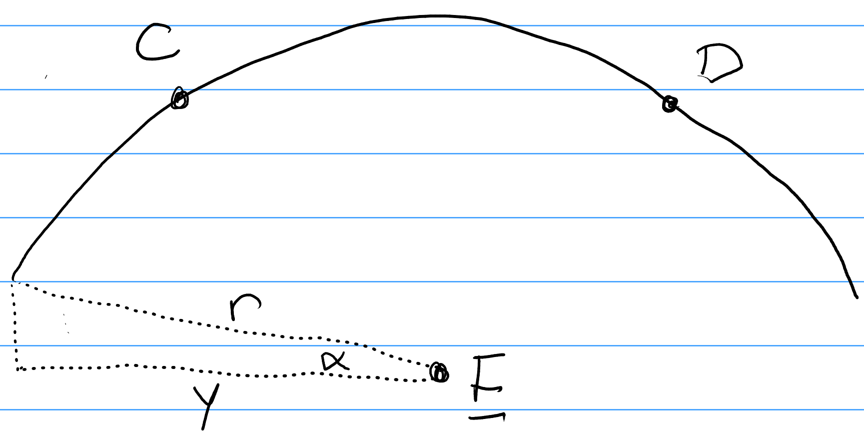


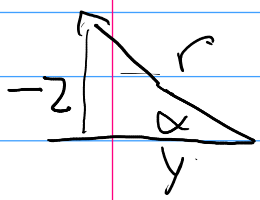
movement of trailing edge ≈ movement of L or r

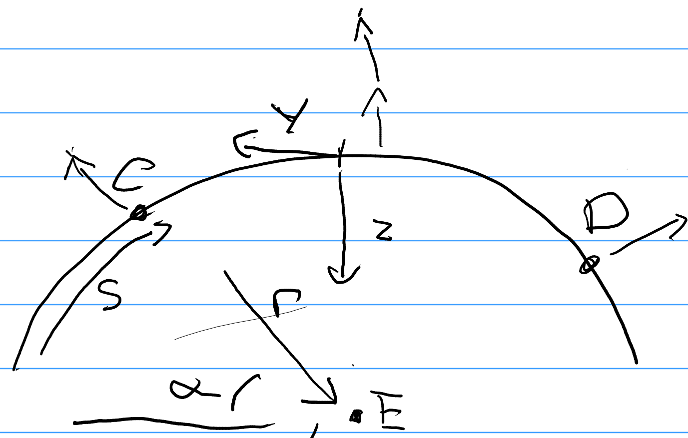


want to have lift dependent of this distance, not angle

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





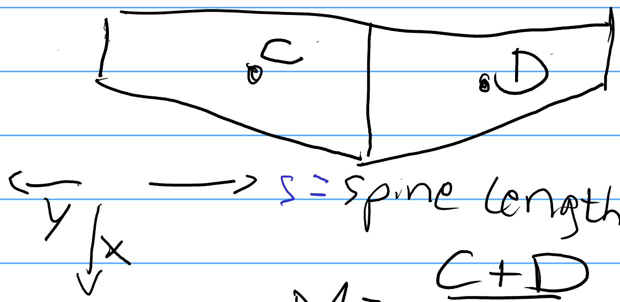


L_{line} = Lift on a line with length m

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

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

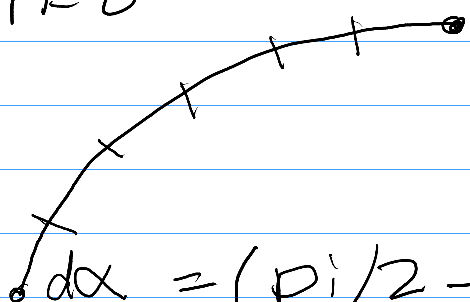
$$L_{Line} = \frac{1}{2} \rho v$$



s = spine length

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

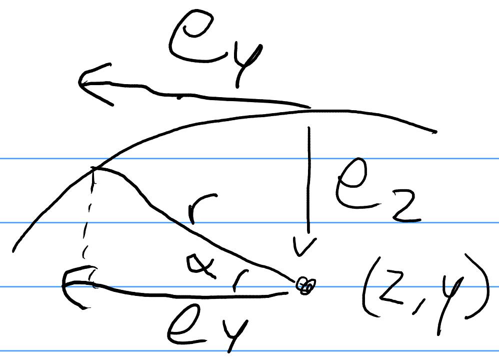
$n = 6$



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

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

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



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

$$e_r = \frac{E - F}{\lVert E - C \rVert} \qquad F = E + e_y \cos\alpha\, r - e_z \sin\alpha\, r$$

F is any point on the kite

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

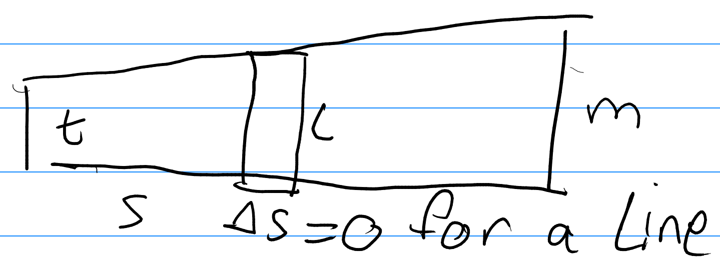
$$V_{kite}(\alpha) = \begin{bmatrix} V_{ex} \\ V_{ey} \\ V_{ez} \end{bmatrix}' \cdot [e_x\ e_y\ e_z]$$

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

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

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

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



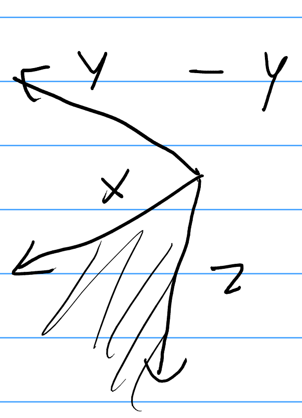
$$L(\alpha) = \frac{1}{2} \rho V_{a,xr}^2\, s \left(t + \frac{m-t}{0{,}5w}\, s\right) C_L(\alpha)\, e_r$$

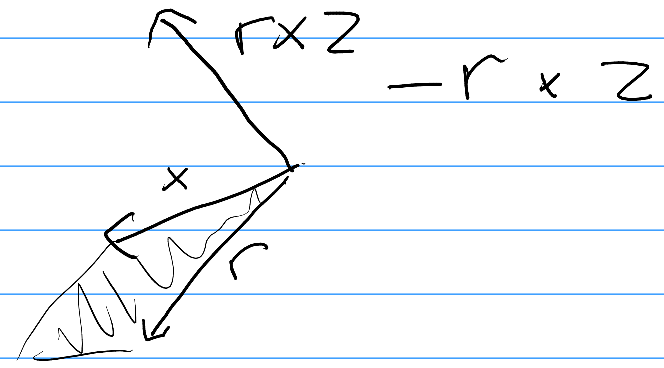
$$s = \alpha\, r$$

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

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

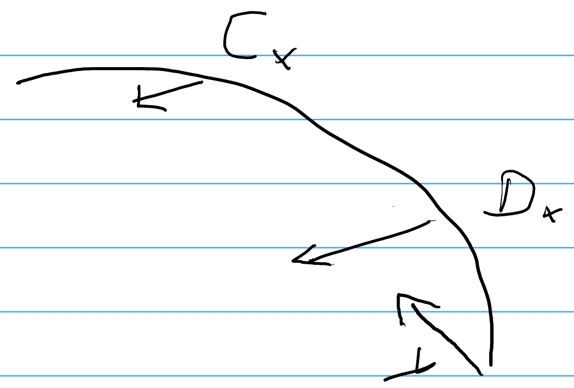
$$V_{a,xr} = V_a - (V_a \cdot (e_r \times e_x))(e_r \times e_x)$$





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

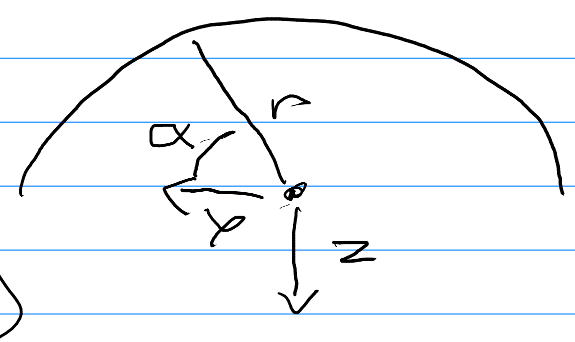
$$V_{Cx} = (V_C \cdot e_x)e_x$$



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

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

$z_L = \sin\alpha \; r$

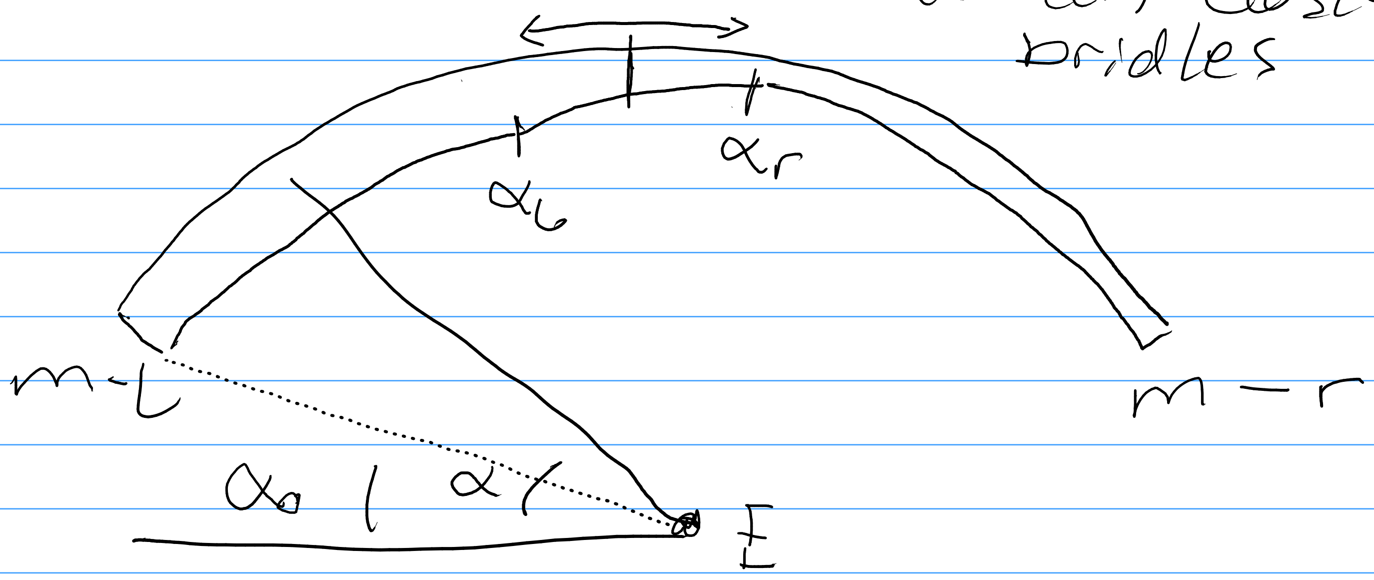


$$y_{L,C} = norm(C-P)$$

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

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

d_s = distance between closest steering bridles



c_l is dependent of trailing edge displacement d

m, l, r middle left right line length

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

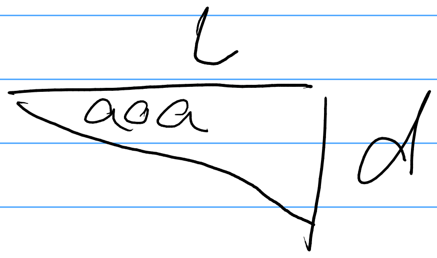
$$d(\alpha) = \begin{cases} m-l & \text{if } \alpha < \alpha_l \\ m-r & \text{if } \alpha > \alpha_r \\ \frac{(m-r)-(m-l)}{\alpha_r - \alpha_l}(\alpha-\alpha_l)+(m-l) & \text{if } \alpha_l < \alpha < \alpha_r \end{cases}$$

$$\alpha_l = \frac{1}{2}\pi - d_s/(2r)$$

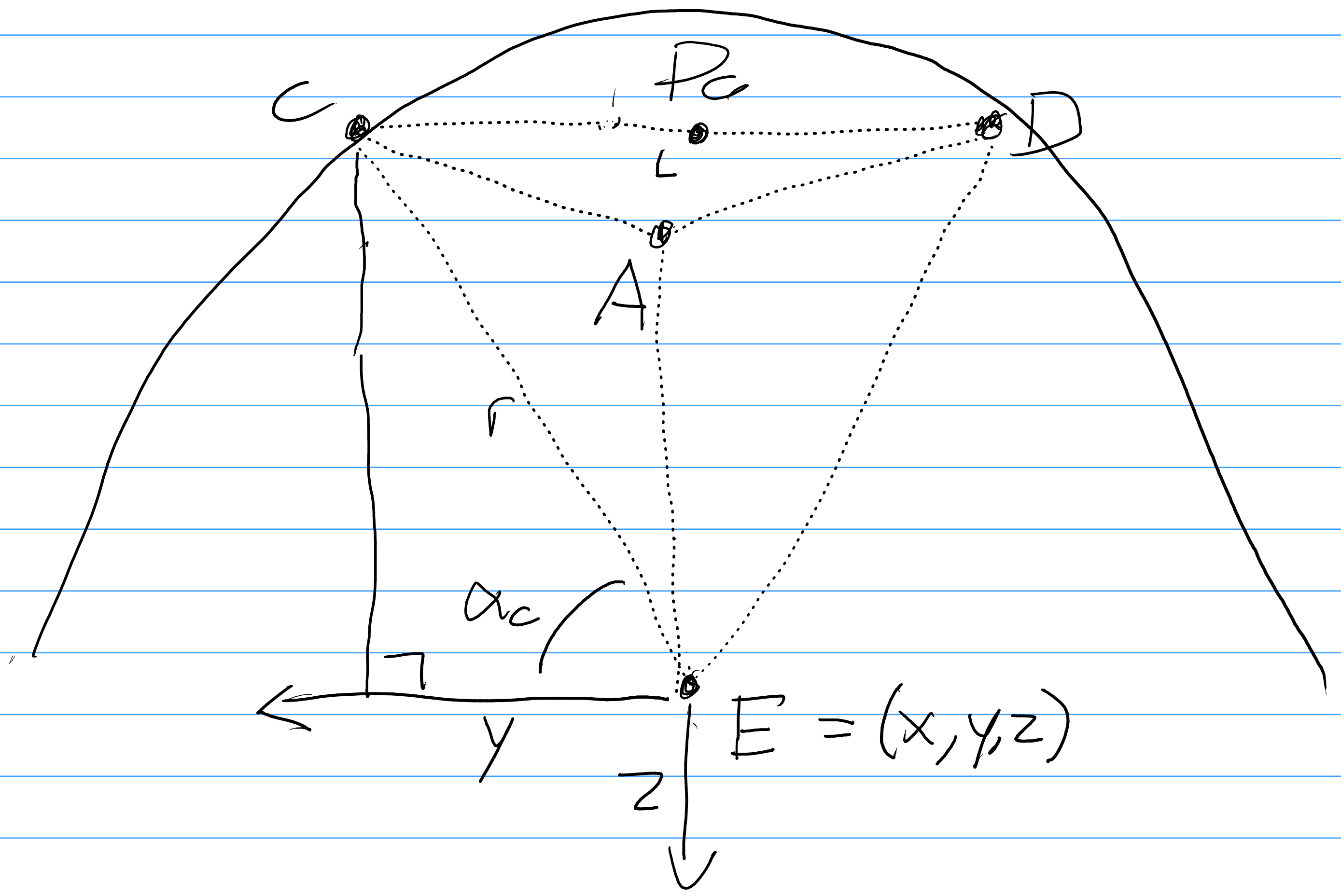
$$\alpha_r = \frac{1}{2}\pi + d_s/(2r)$$

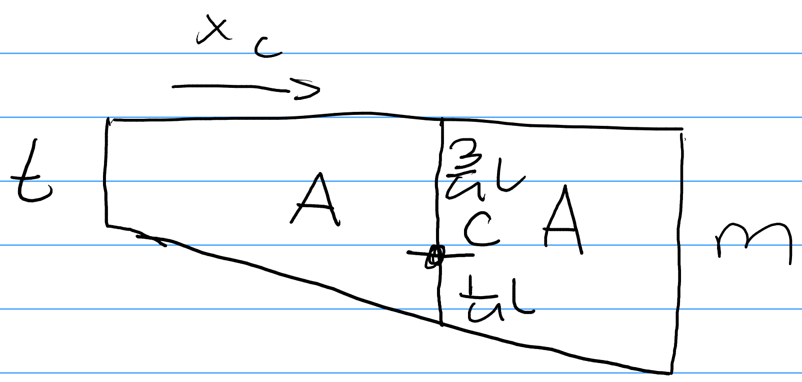
$c_l(aoa)$ where aoa is the angle of attack

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



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





A = A (areas are equal)

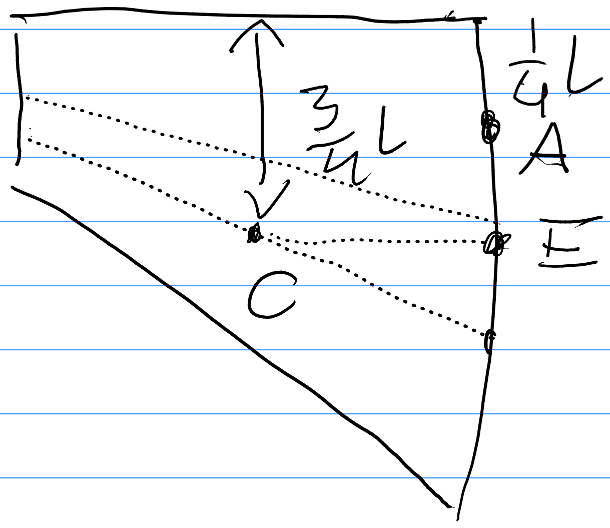
$$\frac{(L(\alpha_0) + L(\alpha_c))}{2}(\alpha_c - \alpha_0) =$$

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

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

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

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



if area = k · mass

we want A at $\frac{1}{4}$ · length, C at $\frac{3}{4}L$ (cop)

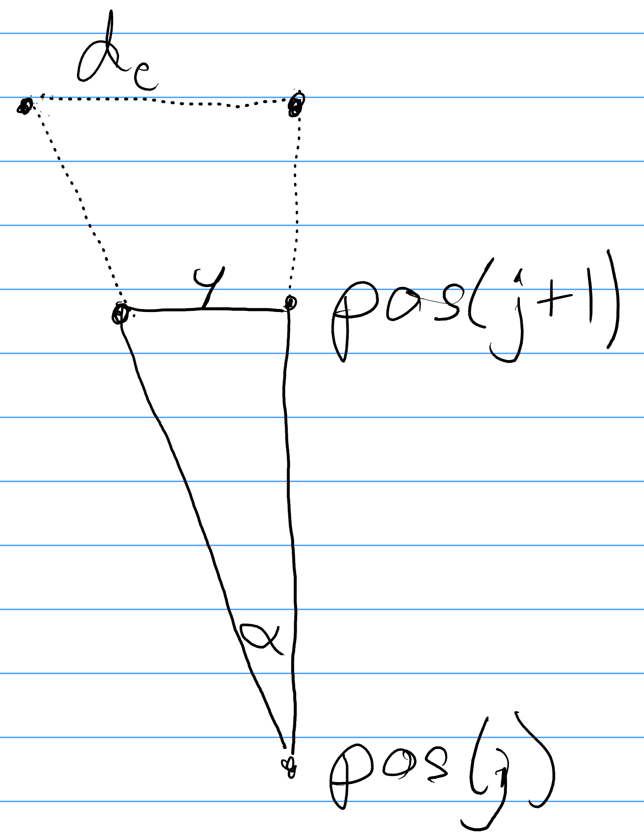
and E at the same e_x as C

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

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

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

m_e = tether weight


d_c
r
pos(j+1)
α
pos(j)