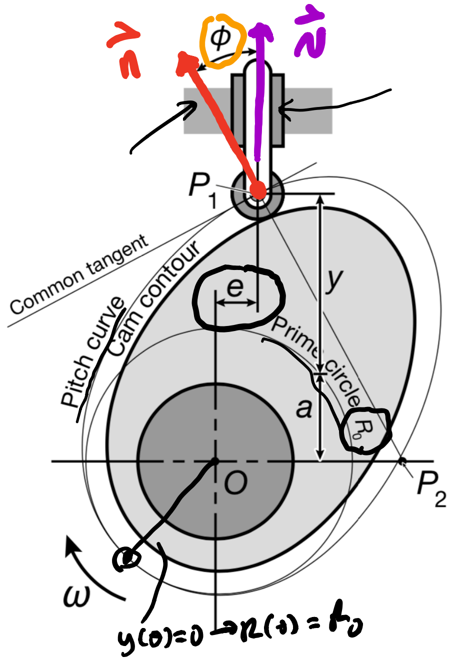
Today:

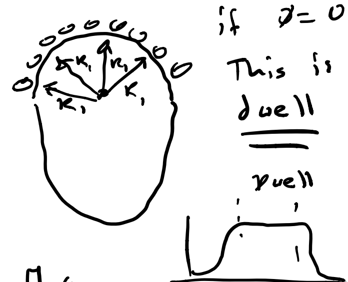
- ~~HW 3 discussion~~ → ~~Offset curve~~ ~~Derivs numerically~~

- Cam pressure angle

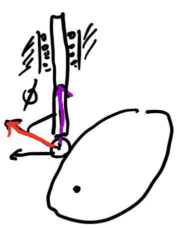
- Cam radius of curvature

- mobility equations



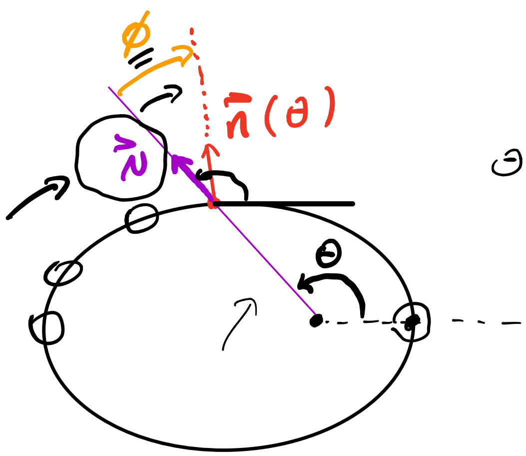


if $\phi = 0$
This is a dwell



large ϕ
are problematic
increase wear
of the cam.

$\phi < 30^\circ$



$\theta = \omega t$

$R(\theta)$

$x = R\cos\theta$

$y = R\sin\theta$

$x' = R'\cos\theta - R\sin\theta$

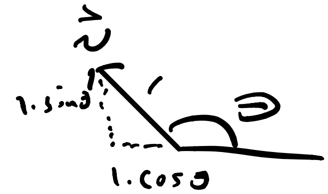
$y' = R'\sin\theta + R\cos\theta$

$$R(\theta) = y(\theta) + R_0$$

$$\vec{n}(\theta) = \frac{1}{\sqrt{x'^2 + y'^2}}\left[-y', x'\right]$$

$$\vec{n}(\theta) = \frac{1}{\sqrt{R'^2 + R^2}}\left[-R'\sin\theta - R\cos\theta,\; R'\cos\theta - R\sin\theta\right]$$

$\vec{n}\cdot\vec{n} = ? \rightarrow \underline{\vec{n}\cdot\vec{n} = 1}$



$\vec{v} = [\cos(\theta), \sin(\theta)]$

$\underline{\vec{v}\cdot\vec{n}} = \overset{1}{\cancel{|\vec{v}|}}\,\overset{1}{\cancel{|\vec{n}|}}\cos(\phi)$

pressure angle

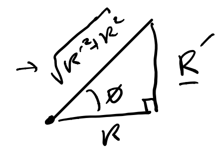
$\cos\phi = \frac{1}{\sqrt{R'^2+R^2}}\left[-R'\sin\theta - R\cos\theta,\ R'\cos\theta - R\sin\theta\right]\cdot\left[\cos(\theta),\ \sin(\theta)\right]$

$= \frac{1}{\sqrt{R'^2+R^2}}\left[\cancel{-R'\sin\theta\cos\theta} - R\cos^2\theta + \cancel{R'\cos\theta\sin\theta} - R\sin^2\theta\right]$

$$\boxed{\cos\phi = \frac{-R}{\sqrt{R'^2+R^2}}}$$

fine & Done ✓

→ but look for $\tan\phi$



$\tan\phi = \frac{R'}{R}$

$b^2 = R'^2 + \cancel{R^2} - \cancel{R^2}$

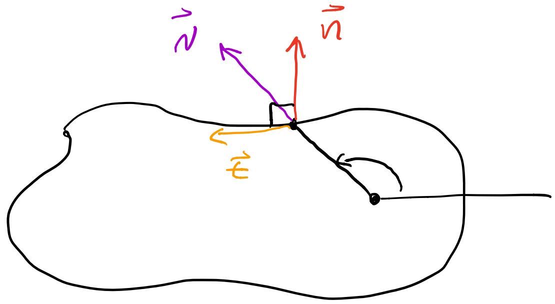
$b^2 = R'^2$

$$\tan\phi = \frac{y' - \cancel{e}}{\sqrt{R_0^2 - \cancel{e^2}} + y} = \frac{y'}{R_0 + y} = \boxed{\frac{R'}{R}}$$

$R(\theta) = R_0 + y$

$R'(\theta) = y'$

Radius of curvature:



$|\vec{n}| = 1$

$|\vec{t}| = 1$

$\vec{n} \cdot \vec{n} = 1$

$\vec{t} \cdot t = 1$

units 1/length   length

$$\vec{t}' = \kappa(\theta)\, v(\theta)\, \vec{n}$$

Curvature

$v(\theta) = \sqrt{x'^2 + y'^2}$

$$\frac{\partial}{\partial \theta}(\vec{t} \cdot \vec{t}) = 0$$

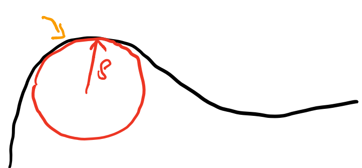
$$\vec{t}' \cdot \vec{t} = 0$$

$\vec{t}'$ is $\perp$ $\vec{t}$

$$\kappa(\theta) = \frac{1}{\rho(\theta)}$$

Radius of curvat.

$$\vec{n} = \frac{1}{\sqrt{\cancel{x'^2+y'^2}}}[\cancel{-y'}, \cancel{x'}]$$



$\kappa(\theta) >> 1$

$\rho(\theta) << 1$

$\kappa(\theta) << 1$

$\rho(\theta) >> 1$

$(\vec{n} \cdot \quad \vec{t}' = \vec{n}(\kappa(\partial)\, \underline{v(\partial)}\, \vec{n})$ $\qquad \vec{n} \cdot \vec{n} = 1$

$$\boxed{\frac{\vec{n} \cdot \vec{t}'}{v(\partial)} = \underline{\underline{\kappa(\partial)}}} \qquad \boxed{\frac{v(\partial)}{\vec{n} \cdot \vec{t}'} = \rho(\partial)}$$

Curvature relationships

$x(\theta) = R(\theta)\cos\theta$

$v = \sqrt{x'^2 + y'^2}$

$\vec{n} = \frac{1}{v}[-y', x']$ $\qquad \vec{t}' = ?$

$\vec{t} = \frac{1}{v}[x', y']$

$$\left[\frac{\partial}{\partial\partial}\frac{x'}{v}, \frac{\partial}{\partial\partial}\frac{y'}{v}\right]$$

$v(\partial)$

$$\frac{\partial}{\partial\partial}\frac{x'}{v} = \frac{x''v - v'x}{v^2}$$

$\vec{n} = \frac{1}{v}[\underline{-y'}, \underline{\underline{x'}}]$

$$\vec{t}' = \frac{1}{\underline{\underline{v^2}}}\left[x''\underline{v - v'}x, y''v - v'y\right]$$

$$\kappa(\partial) = \frac{\vec{n} \cdot \vec{t}'}{v} \qquad \left[-x''vy' + \cancel{y'v'x} + y''vx' - \cancel{x'v'y'}\right]$$

$$= \frac{1}{\cancel{v}}\frac{1}{v}\frac{1}{v^2}\left[-x''\cancel{v}y' + y''\cancel{v}x'\right]$$

$$\boxed{\kappa(\partial) = \frac{y''x' - x''y'}{v^3} \rightarrow \rho(\partial) = \frac{v^3}{\underline{\underline{y''x'}} - \underline{\underline{x''y'}}}}$$

$$x = R\cos\theta$$
$$y = R\sin\theta$$

$$\longrightarrow \quad v(\theta) = \sqrt{x'^2 + y'^2} = \sqrt{R'^2 + R^2}$$

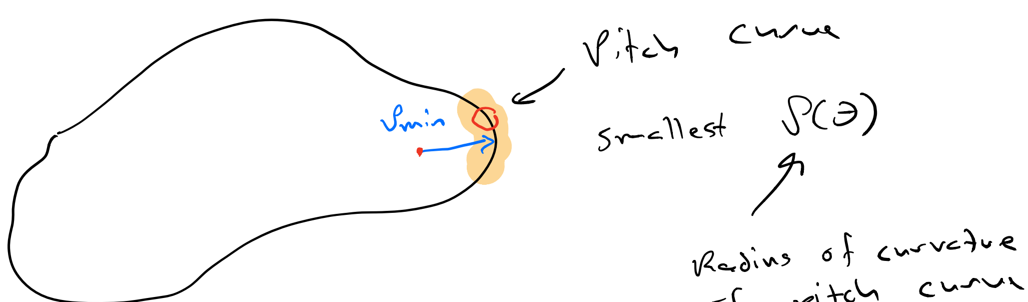
$$x' = R'\cos\theta - R\sin\theta$$
$$y' = R'\sin\theta + R\cos\theta$$

$$x' = R''\cos\theta - 2R'\sin\theta - R\cos\theta$$
$$y'' = R''\sin\theta + 2R'\cos\theta - R\sin\theta$$

$$y''x' - x''y' \longrightarrow R^2 + 2R'^2 - RR'$$

$$R(\theta) = R_p + y(\theta)$$

$$\boxed{\rho(\theta) = \frac{(R'^2 + R^2)^{3/2}}{R^2 + 2R'^2 - RR'}}$$



$$R_F < \rho_{min}$$