Turning For Lap Sim

$$SR = \frac{\Omega - \Omega_0}{\Omega_0} = \frac{\Omega}{\Omega_0} - 1$$ Fraction or percentage

$\Omega_0 = \frac{V}{R_e}$ R_e = effective radius

$$SR = \frac{\Omega R_e}{V} - 1 , a=0$$

$\frac{V^2}{R} = a_{lateral}$

- Area in contact with ground is print or footprint
- when cornering changes in slip angles create lateral forces

- when front wheels are steered, a slip angle is created which gives rise to a lateral force, this force then turns (yaws) the car.

- amount of lateral movement depends on sliding velocity and slip angle

$\mu = \frac{\text{Frictional force between two bodies}}{\text{Normal force between two bodies}}$

$\frac{\text{Lateral Force}}{\text{load on tire}}$ = Lateral Force Coefficient $= \frac{F_y}{F_z}$ ← higher for lighter loads

Ch 7 - lateral load transfer
Ch 5 - Stability of vehicle
ch 18 - estimating wheel loads

How $\left\|\frac{F_y}{F_z}\right\|$ varies with load is "Load Sensitivity"

Justin's Numbers:

proportion of mass on the front: .47
wheel base: 1.5367 m
CGH: .332486 m
yaw inertia: 100 $kg\,m^2$ ← not verified

CoF at 0 load: 1.6
load sens: .00040774471967 $\frac{1}{N}$

Scanned with CamScanner

Tire Forces

$$W_L = \frac{W}{2} + \frac{WA_yh}{t}$$

One axle

W_L = load on left tire

W = weight force (?)

A_y = lateral force

h = ground to CG

t = distance between tire patches

weight transfer

$$\Delta W = W_L - \frac{W}{2} = \frac{WA_yh}{t}$$

increase in left load and decrease right side

Fraction of total weight → $LLT = \frac{A_yh}{t}$

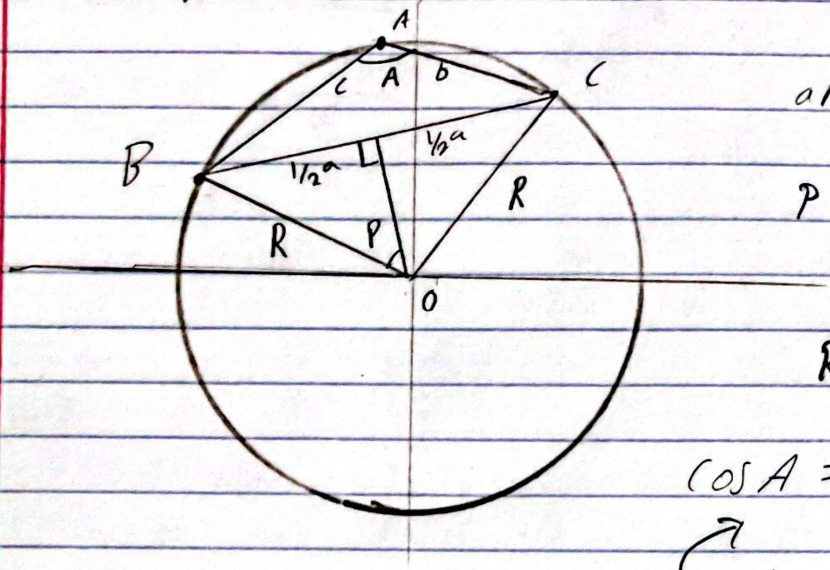
Roll Center Height? Ch. 17

Roll center

Neutral Roll axis

Roll Rate/Roll stiffness

Corner radius calc



angle BOC is 2X angle BAC

$$P = \frac{(360-2A)}{2} - 180 - A$$

$$R = \frac{a}{2\sin(180-A)}$$

$$\cos A = \frac{(b^2+c^2-a^2)}{2bc}$$

a, b, c are easy with coordinates

A is the effective radius at point A

Point A: Starting point of current sector

Point B: .... previous sector

Point C: .... next sector

Error in the beginning and end of corner

Max corner speed

Max force to tire => $F_f = \mu F_N$ (assuming not sliping)

- currently neglect all car dynamics that change F_N
- constant speed around corner

$\mu = 1.6$

$$F_{total} = \sqrt{F_c^2 + F_d^2} = \mu F_N$$

F_c = centripical

F_d = Trust to overcome drag

Need condition:

if F_{total} (on tire) $\geq F_f max$

reduce engine force

(by one step)

$$F_c = \frac{mv^2}{r} \quad r = A$$

$$F_t^2 = v^4\left(\left(\frac{m}{r^2}\right)^2 + \left(\frac{1}{4}\rho^2 A^2 Cd^2\right)\right)$$

$$v_{max} = \sqrt[4]{(\mu F_N)^2 / \left(\left(\frac{m}{r}\right)^2 + \left(\frac{1}{2}\rho A Cd\right)^2\right)}$$ ← No downforce

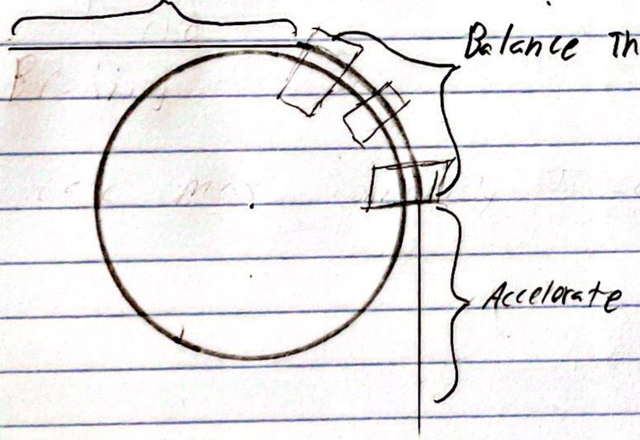
$F_N = F_N + \text{Down force}$

★ Also want to impliment % throttle for driver.
★ Need throttle position data?

All that ← assumes the car is one tire.
After suspension geometry and weight distribution is implimented, need to check each tire for slip to find max corner speed.

V_{max} will be the set speed for exit sectors

Find exit V with straight line accel eq.
↓
if $v_{exit} > v_{max}$ ← no braking, maybe for constant V around turn?
Brake $v_{exit} = v_{max}$



↳ if $v_{exit} > v_{max}(n+1)$
restart n sector with reduced F_{engine}

$$F_{total} = \sqrt{F_c^2 + (F_{engine} - F_d)^2} = \mu F_N$$

Apex → $V_{max_{max}}$
↳ go backwords and accel to entrance velocity