

Track Test Investigation Week 1

Aims

The two aims of this non-assessed assignment will be to

1. Use the measured roll angle from a track test to determine the centre of gravity height of the Locost
2. To investigate the effect of wedge on the handling characteristics of the car when cornering both practically and theoretically

Step 1

Create an Excel Spreadsheet that calculates the height of the centre of gravity above the roll axis for a given Lateral Acceleration.

Finding CG Height Above Roll Axis

Data required:

M_s Sprung Mass

Mass distribution to give CG Position to work out H height of CG above roll axis

h_f RC height at front

h_r RC height at rear

a_y Lateral acceleration from Pi Data Acquisition

T_f Front track

T_r Rear track

T_s Rear Spring track

$K\phi_f$ Front roll stiffness

$K\phi_r$ Rear roll stiffness

Data

T_f	Front track	1.270 m
T_r	Rear track	1.335 m
T_s	Rear Spring track	0.96m
L	Wheel base	2.351 m
H_{tot}	CG height above ground	_____
H_s	Height of CG of sprung mass	_____
H_{sra}	CG height above Roll axis	_____
M_{sf}	Front sprung mass	234 kg
M_{sr}	Rear sprung mass	283 kg
M_{usf}	Front total unsprung mass	76 kg
M_{usr}	Rear total unsprung mass	88 kg
r	Rolling radius of tyre	0.275m
h_f	Front RC height	95 mm
h_r	Rear RC Height	238 mm
K_{wr}	Rear wheel rate	29,722.1 N/m
K_{wf}	Front wheel rate	14,572.7 N/m
SL_f	Front suspension leverage	1.97
a_y	Lateral acceleration	5.297 m/s ²
Front suspension - unequal length double wishbones		
Rear suspension - live axle		

Wheel rate

$$\begin{aligned}K_{wf} &= 325 * 175.13 / 1.97^2 \\ &= 14572.65 \text{ N/m}\end{aligned}$$

$$\begin{aligned}K_{wr} &= 170 * 175.13 \\ &= 29772.1 \text{ N/m}\end{aligned}$$

$$K_{\phi f}$$

$$K_{\phi f} = \frac{(T_f^2 \times K_{wf})}{2}$$

$$= \frac{1.27^2 \times 14572.65}{2}$$

$$= 11752.114 \text{ Nm/rad}$$

$$K_{\phi r}$$

$$K_{\phi r} = \frac{(T_s^2 \times K_{wr})}{2}$$

$$= \frac{0.96^2 \times 29155}{2}$$

$$= 13434.62 \text{ Nm/Rad}$$

Total Roll Stiffness

$$K_{\varphi t} = 12737.19 + 13718.98$$

$$K_{\varphi t} = 11752.19 + 13718.98$$

$$= 25471.094 \text{ Nm/rad}$$

Overturning Moment

$$M_{ot} = M a_y H_{sra}$$

$$= 517 * 5.297 * H_{sra}$$

$$= 2738.549 * H_{sra} \text{ Nm}$$

Calculated Roll Angle at 5.297 m/s²

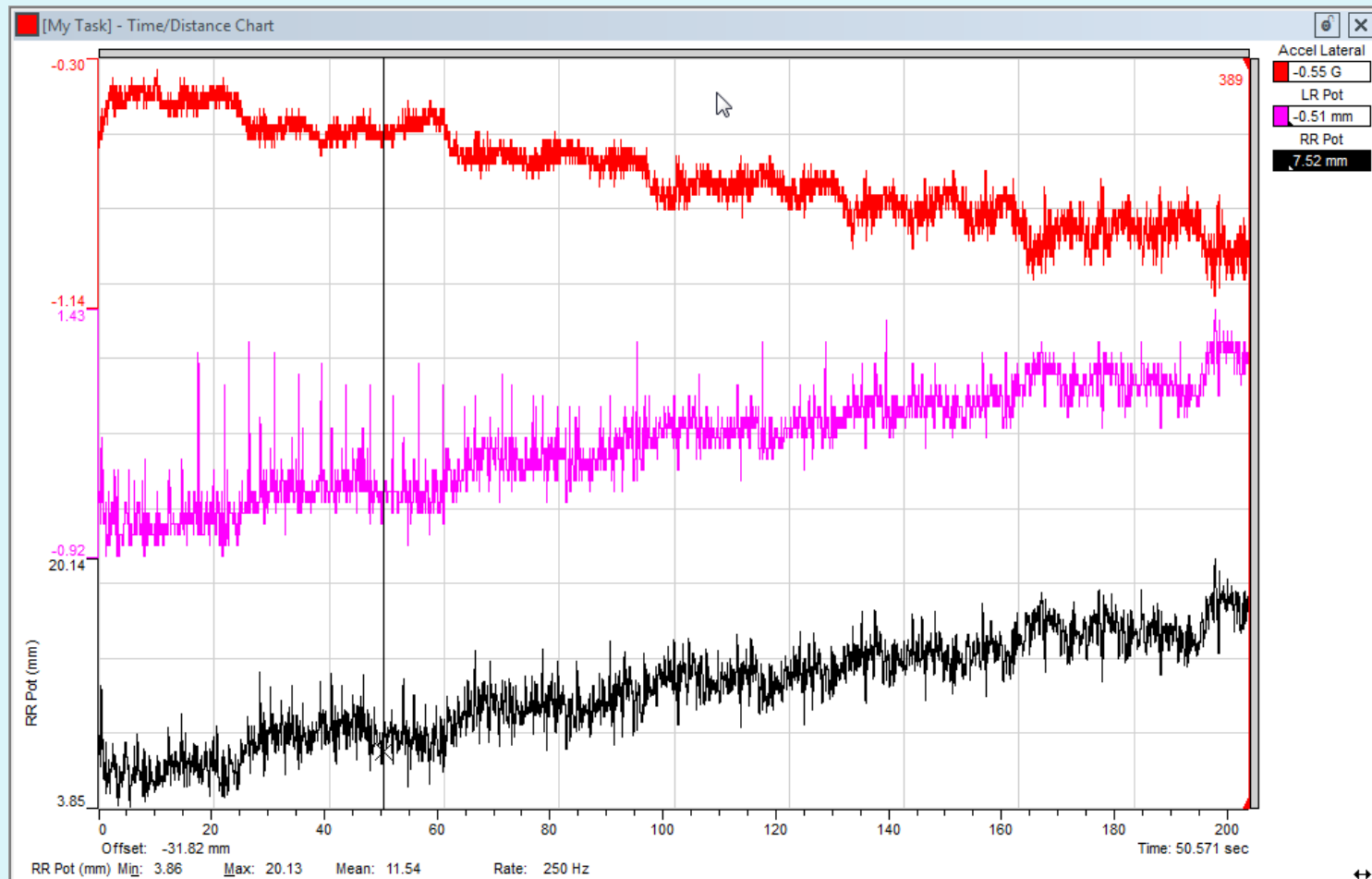
$$\Theta = M_{ot} / K_{\phi t}$$

$$\begin{aligned}\Theta &= 2738.549 * H_{sra} / 25471.094 \\ &= 0.107516 * H_{sra} \text{ rad} \\ &= 6.159 * H_{sra} \text{ deg}\end{aligned}$$

Finding the Actual Roll Angle

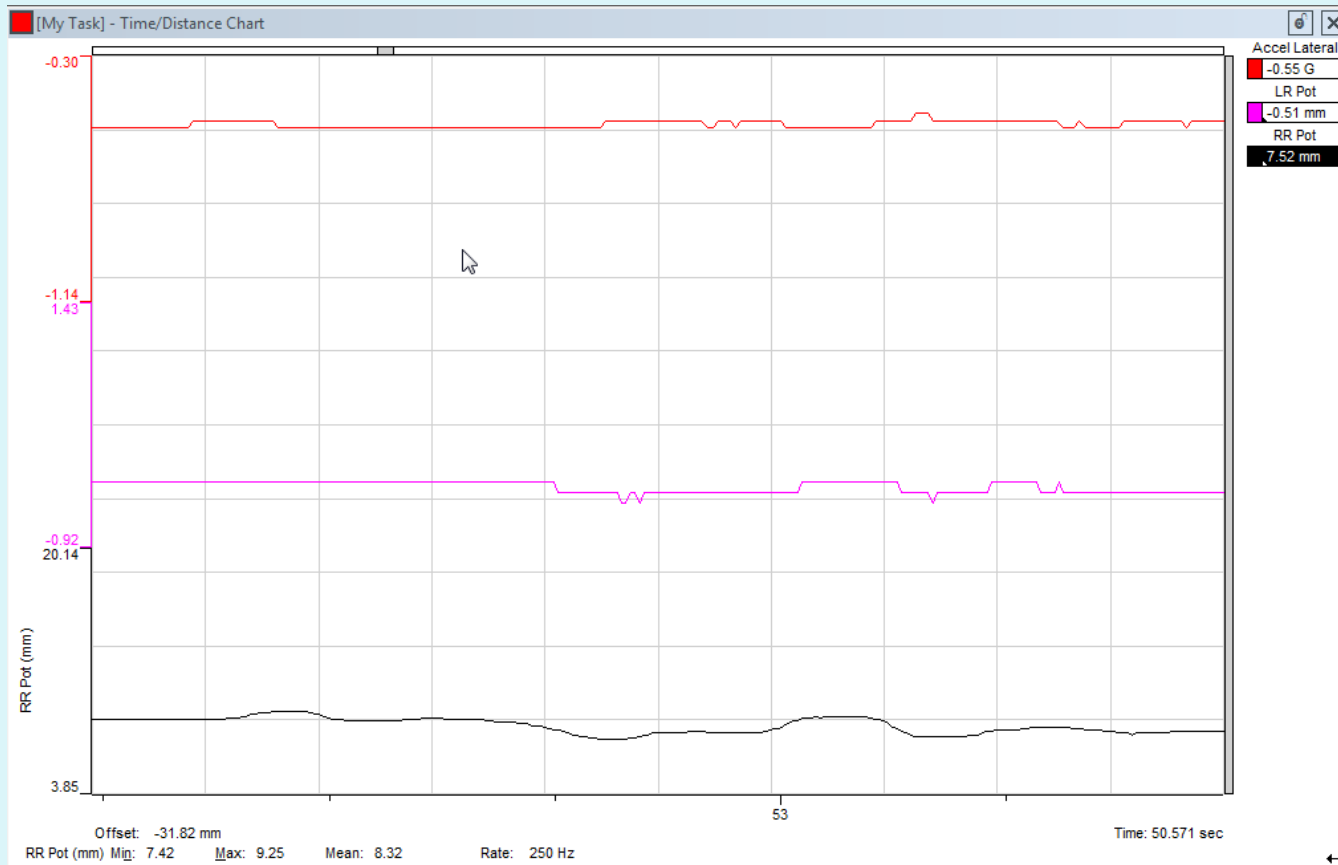
- To find H , the actual roll angle needs to be found at the specified lateral acceleration. This can then be equated to the calculated roll angle.
- The simplest method to find the roll angle is to measure the displacement of the damper pots at a given lateral acceleration.
- The roll angle can be calculated and then the centre of gravity height for the car determined

Select Data



Zero all channels when car is loaded and stationary

Focus in on a short period of steady state behaviour and collect mean values for each channel



Mean values

For this example the mean values are

RR Pot = 8.32mm

LR Pot = -0.35

Lat Acc = 0.54 g

This give displacement difference of

$8.32 + 0.35 = 8.67\text{mm}$

Calculating Roll Angle

$$\text{Roll angle} = 8.67 / 960$$

$$= 0.00903 \text{ Rad}$$

$$= 0.517^\circ \text{ at a lateral acceleration of } 5.297 \text{ m/s}^2$$

Finding Roll Centre Height Above Roll Axis

Actual Roll Angle = Calculated Roll Angle

$$0.517 \text{ deg} = 5.912 * H_{sra}$$

$$H_{sra} = 0.517 / 6.159$$

$$= 83.94 \text{ mm}$$

Is it right?

The CG height of 87.45 mm above the roll axis would put the height of the CG above the ground as:

$$70 + 87.45 + 95 = 252.45\text{mm}$$

Possible errors could come from

- the roll stiffness used
- using a single roll angle / lateral acceleration combination.

Possible Improvements

- Improve accuracy of roll stiffness
- Improve validity of roll angle / lateral acceleration used.
- ?
- ?
- ?
- ?