

Using track data to determine CG Height

Using measured roll angle from a track test to determine the centre of gravity height above roll axis

When calculating the lateral weight transfer of the cornering vehicle the height of the CG above the roll axis is the hardest value to determine accurately.

Using track data the CG height can be found as an alternative to workshop measurement

Finding the CG height above the roll axis

Data required (live axle rear, independent front)

M_s	Sprung Mass
b	CG to front axle form 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

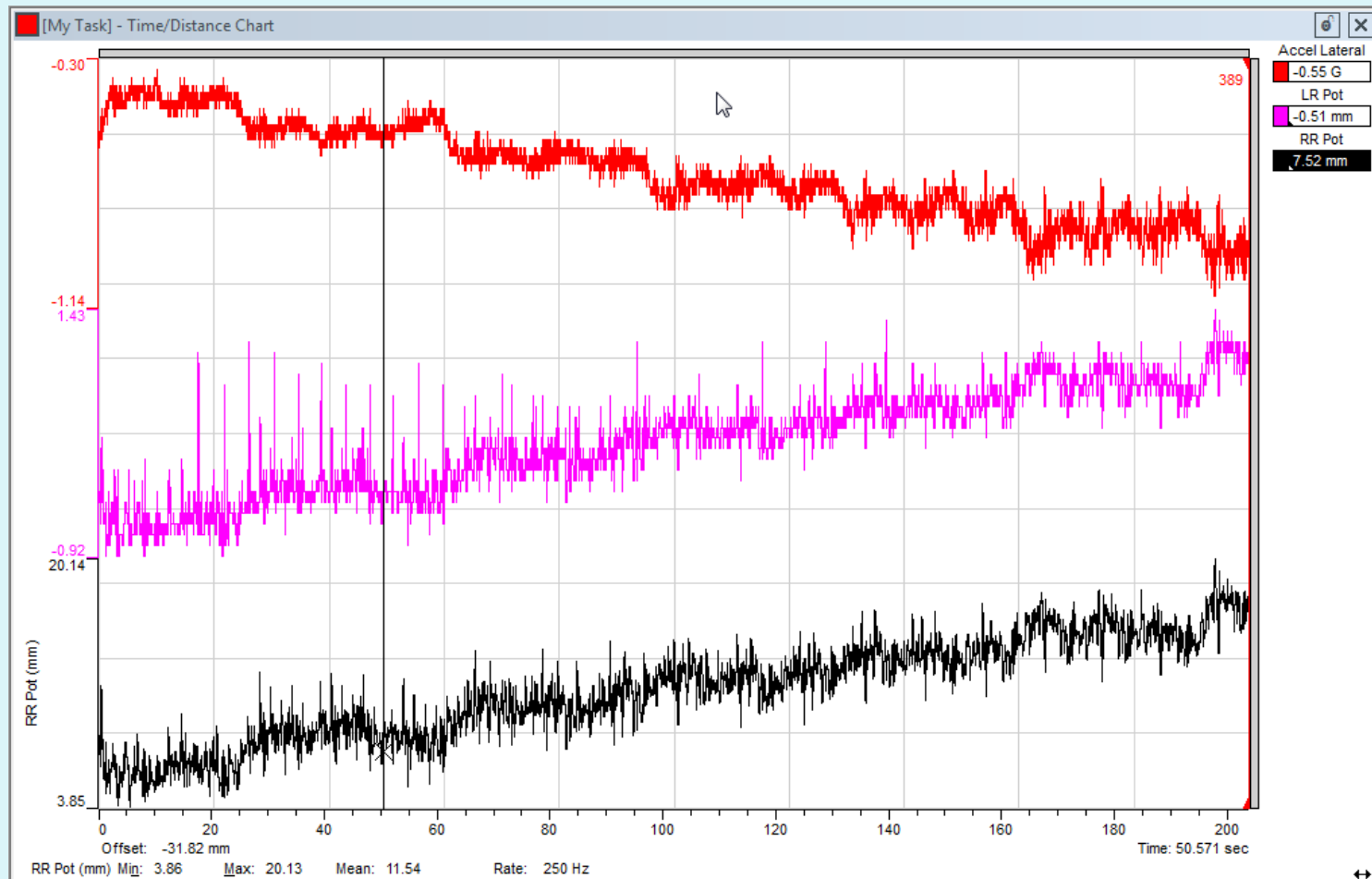
Vehicle Data

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'	CG height above ground	H' m
H	CG height above Roll axis	H m
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	29,772.1 N/m
K_{wf}	Front wheel rate	15893.35 N/m
L_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		

Finding the Actual Roll Angle

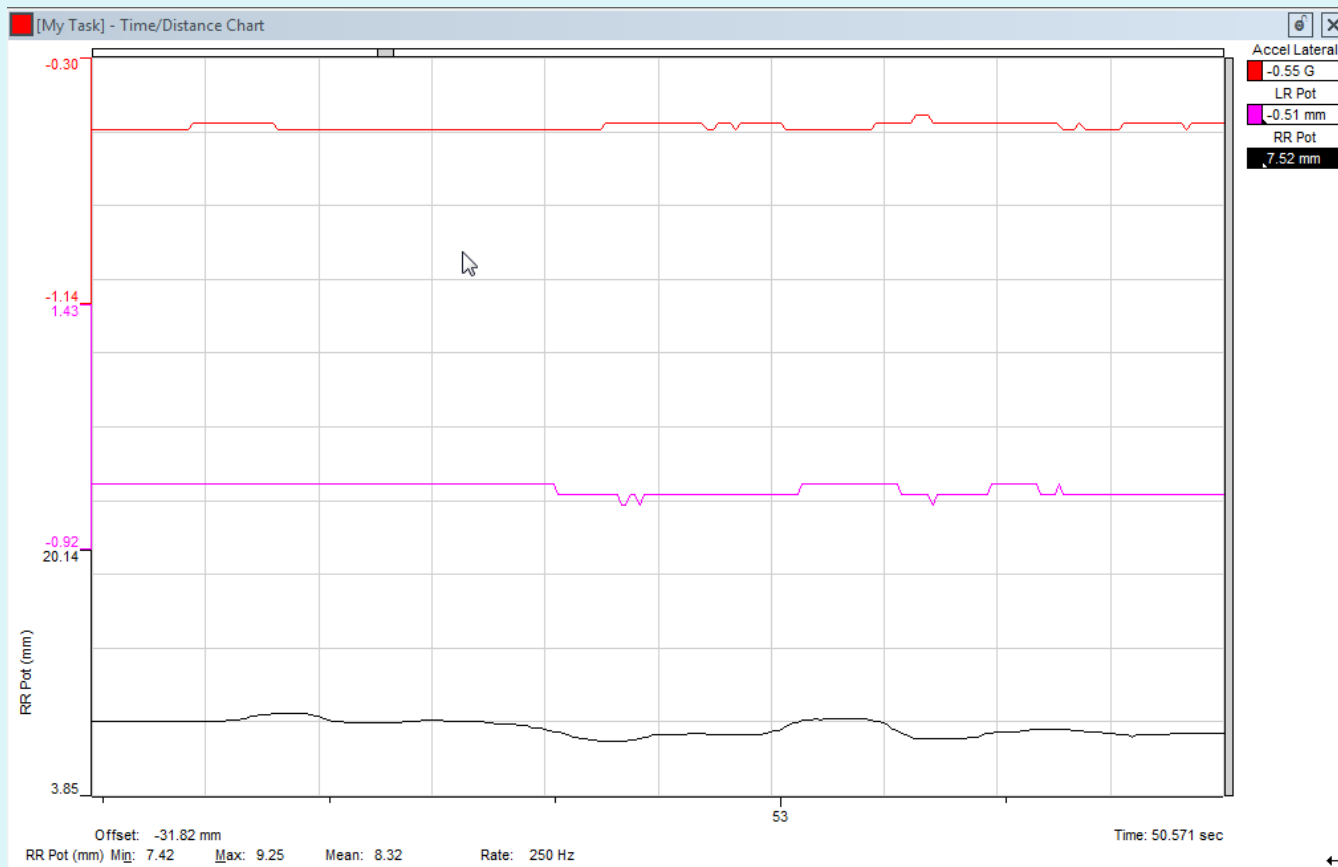
- To find H , the actual roll angle needs to be found at a consistent, steady state lateral acceleration. This can then be equated to the roll angle calculated using the same lateral acceleration to find H .
- The simplest method to find the roll angle is to measure the displacement of the damper pots at one end of the car at a given lateral acceleration in this example the rear axle is used.
- 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

$$\begin{aligned}\text{Roll angle} &= 8.67 / 960 \\ &= \mathbf{0.00903} \text{ Rad}\end{aligned}$$

at

$$\text{Lateral acceleration} = 5.297\text{m/s}^2$$

Roll angle calculation

The theoretical roll angle is now calculated as normal but leaving H as an unknown

Wheel rate

$$K_{wf} = 15893.35 \text{ N/m}$$

$$K_{wr} = 29772.1 \text{ N/m}$$

$$K_{\phi f}$$

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

$$= \frac{1.27^2 \times 15893.35}{2}$$

$$= 12817.19 \text{ Nm/rad}$$

$$K_{\phi r}$$

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

$$= \frac{0.96^2 \times 29772.1}{2}$$

$$= 13718.98 \text{ Nm/Rad}$$

Total Roll Stiffness

$$K_{\varphi t} = 12817.19 + 13718.98$$

$$K_{\varphi t} = 12817.19 + 13718.98$$

$$= 26536.17 \text{ Nm/rad}$$

Overturning Moment

$$M_{ot} = M_a H$$

$$= 517 * 5.297 * H$$

$$= 2738.549 * H \text{ Nm}$$

Calculated Roll Angle

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

$$\Theta = 2738.549 * H / 26536.17$$

$$= 0.1032 * H \text{ rad}$$

NB There is only one roll angle !!

Finding Roll Centre Height Above Roll Axis

Actual roll angle was found to be **0.00903** Rad
from track data

Actual Roll Angle = Calculated Roll Angle

$$0.00903 = 0.1032 * H \text{ rad}$$

$$H = 0.0875 \text{ m}$$

$$= 87.5 \text{ mm}$$

Is it right?

Possible errors could come from:

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