Swansea Metropolitan University
Prifysgol Fetropolitan Abertawe

Cornering and Steering Geometry

Basic Definitions

$$\text{Overall Steering Ratio} = \frac{\text{Steering Wheel Angle}}{\text{Road Wheel Angle}}$$

So

$$\text{Road Wheel Angle} = \frac{\text{Steering Wheel Angle}}{\text{Overall Steering Ratio}}$$

Neutral Steer

The SAE defines neutral steer as :

A vehicle is neutral steer at a given trim if the ratio of the steering wheel angle to the overall steering ratio [ie the actual steered wheel angle] equates to the Ackerman steering angle for a given radius of turn.

Ackerman Steering

Ackerman steering angle δ (*delta*) is the geometric steered wheel angle required for a car of wheelbase L to track round a turn of radius R at low speeds where the external forces due to accelerations are negligible so

$$\delta = L / R \text{ for small angles.}$$

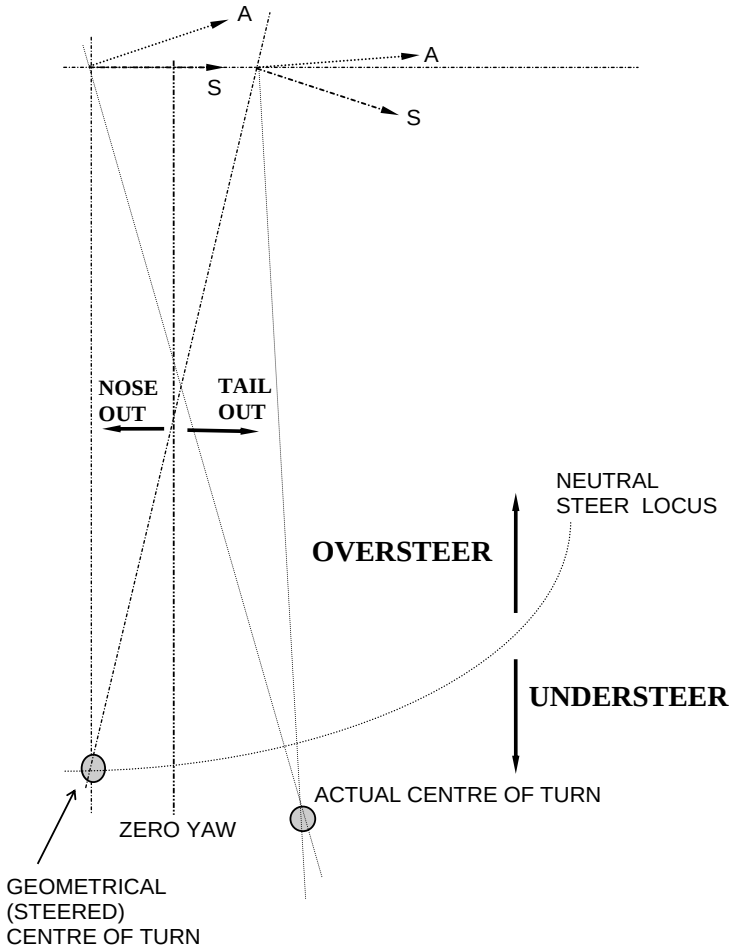
Understeer

A vehicle is understeer at a given trim if the ratio of the steering wheel angle to the overall steering ratio is greater than the Ackerman steering angle for a given radius of turn

Oversteer

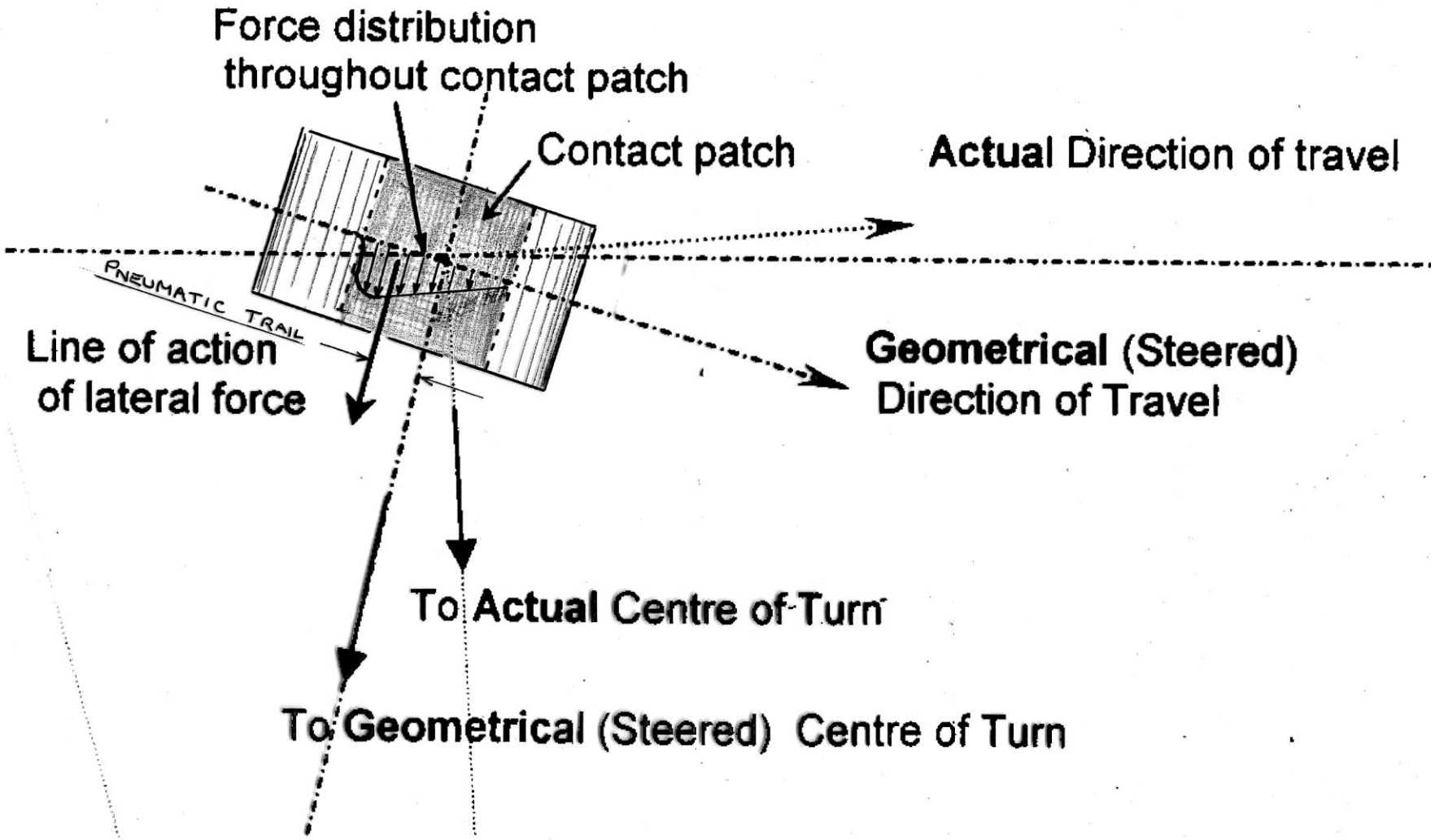
A vehicle is oversteer at a given trim if the ratio of the steering wheel angle to the overall steering ratio is less than the Ackerman steering angle for a given radius of turn

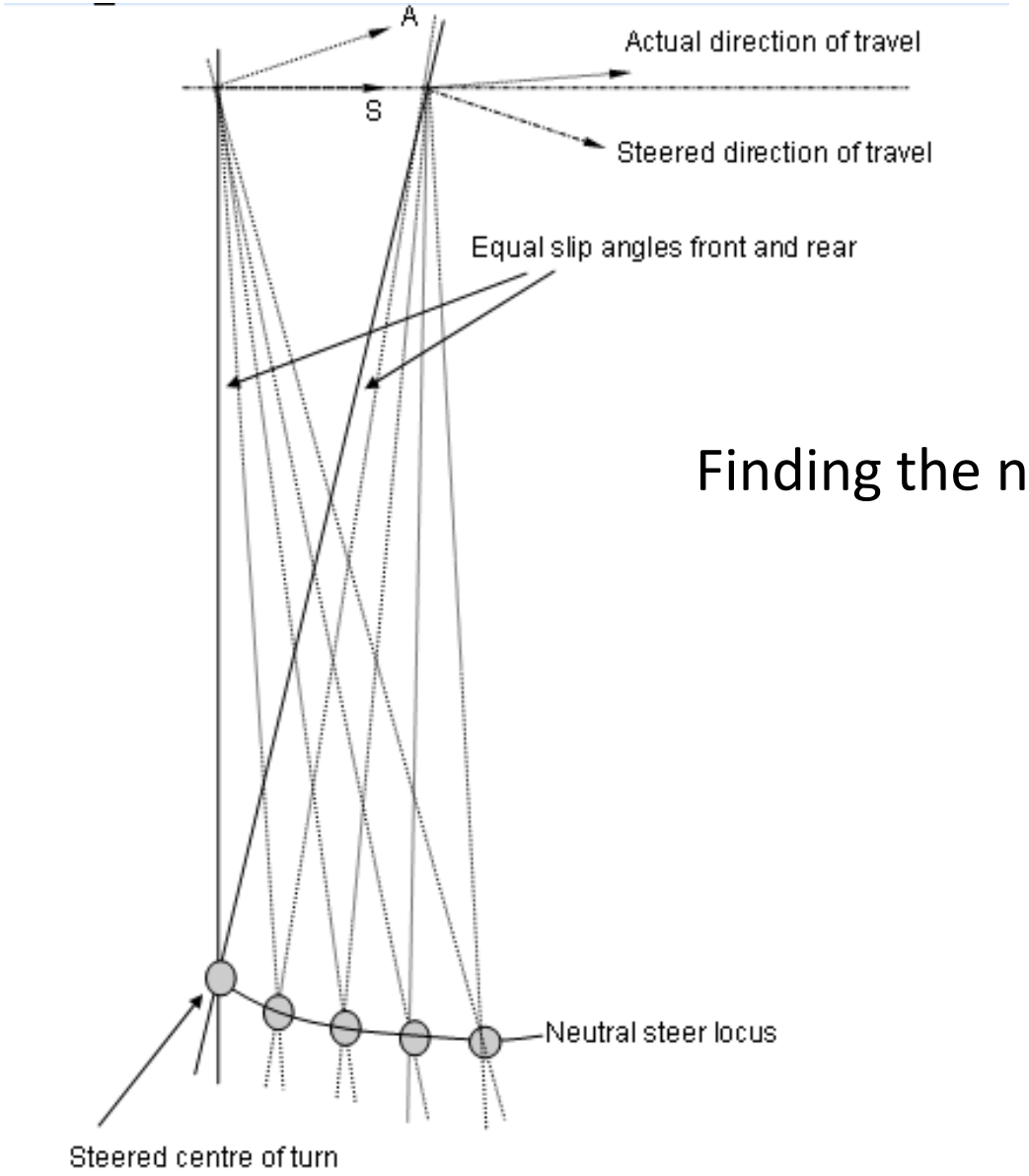
Geometrical method of demonstrating oversteer and understeer



If the centre of turn is closer to the car than the neutral steer locus the car will be oversteer and if it is beyond the locus it is understeer .

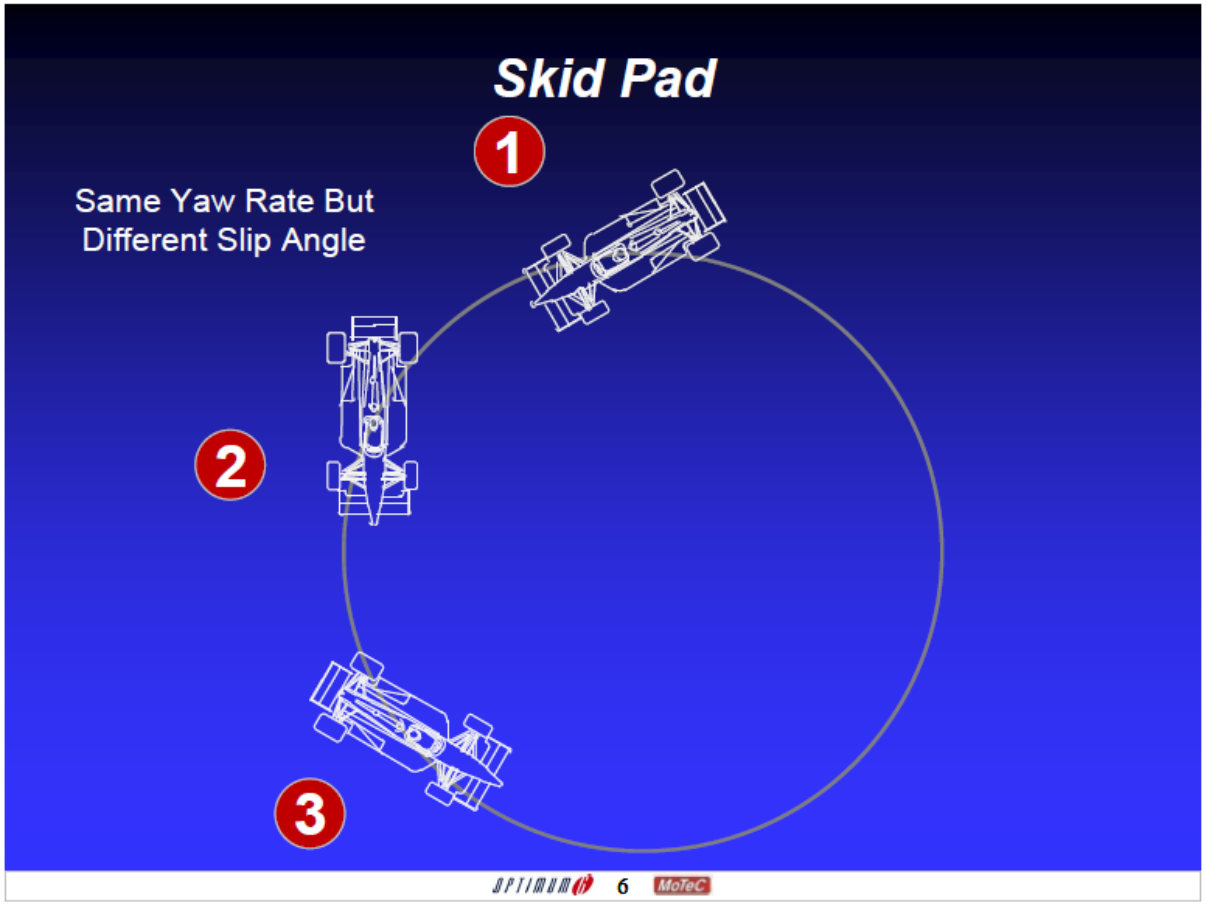
So the car shown is understeer with tail out attitude.


Force distribution
throughout contact patch
Contact patch
Actual Direction of travel
PNEUMATIC TRAIL
Line of action
of lateral force
Geometrical (Steered)
Direction of Travel
To Actual Centre of Turn
To Geometrical (Steered) Centre of Turn



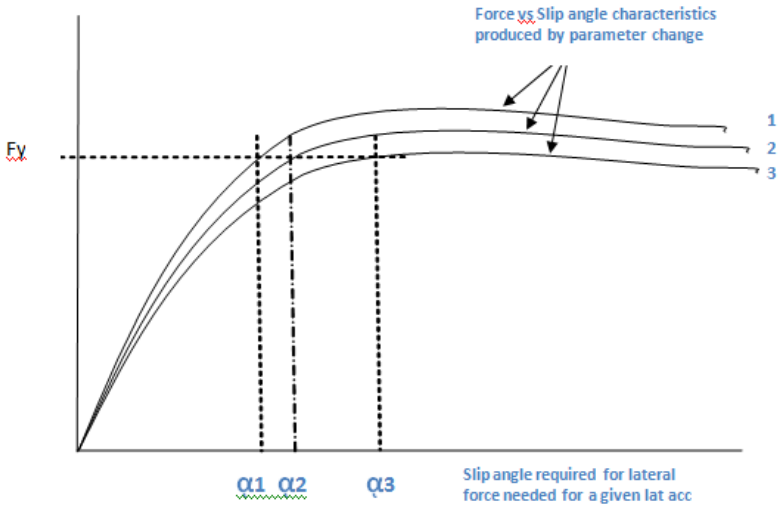
Finding the neutral steer locus

Tail out cornering on the skid pad

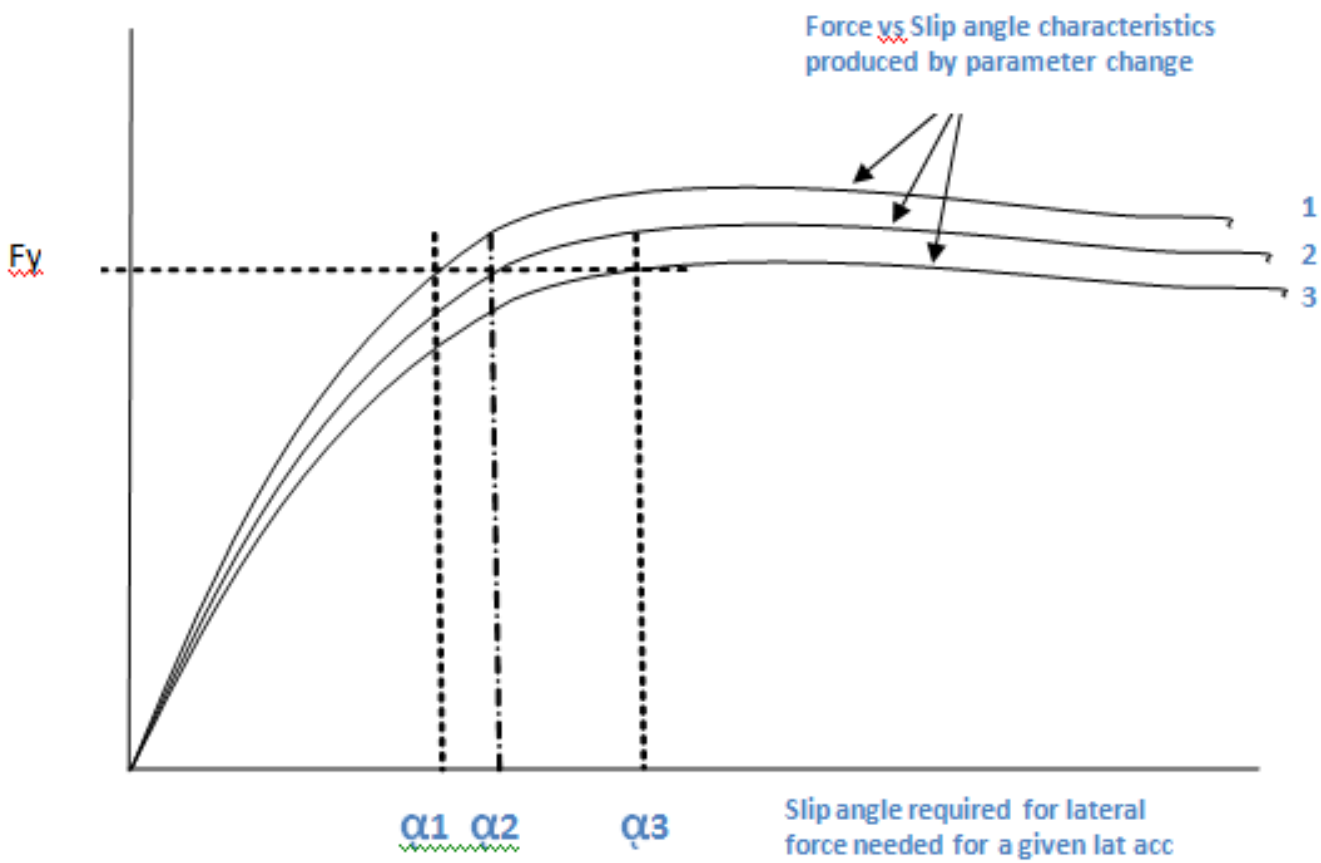


How steer angle can demonstrate changes in grip

If something is done to the front axle of a car that increases the grip characteristic from Level 3 to Level 1 the slip angle required to produce the force required for specific lateral acceleration will change from α_3 to α_2



Slip Angle vs lateral force characteristics for a range of parameter values



Ackerman Steering Geometry is <u>not</u> Ackerman Steering Angle

The **Ackerman Steering Geometry** is designed so that both inner and outer steered wheels have the correct steered angle so that they both drive round the same turn centre. In line with the rear axle with no slip angle.

The SAE effectively defines **Ackerman Steering Angle** as the angle of the road wheels that is required with zero front and rear slip angles for both front and rear wheels to track around the same centre.

Finding the Ackerman Steering Angle from track data

To create a radius of turn R channel in a data acquisition system then

$$a = v^2 / r \quad .$$

V and a will be known channels giving :

$$\text{Rad} = [\text{Speed}]^2 / [\text{Lat acc}]$$

This can be compared with actual road wheel angle to determine whether the car is oversteer or understeer