

A photograph of a motorcycle racer in a red and yellow suit leaning into a turn. The racer is wearing a helmet with a star pattern. The motorcycle is black and red, and there are flames visible from the engine area. The background is a dark, textured surface, likely a racetrack.

Motorcycle Dynamics

Rake and Trail

Introduction

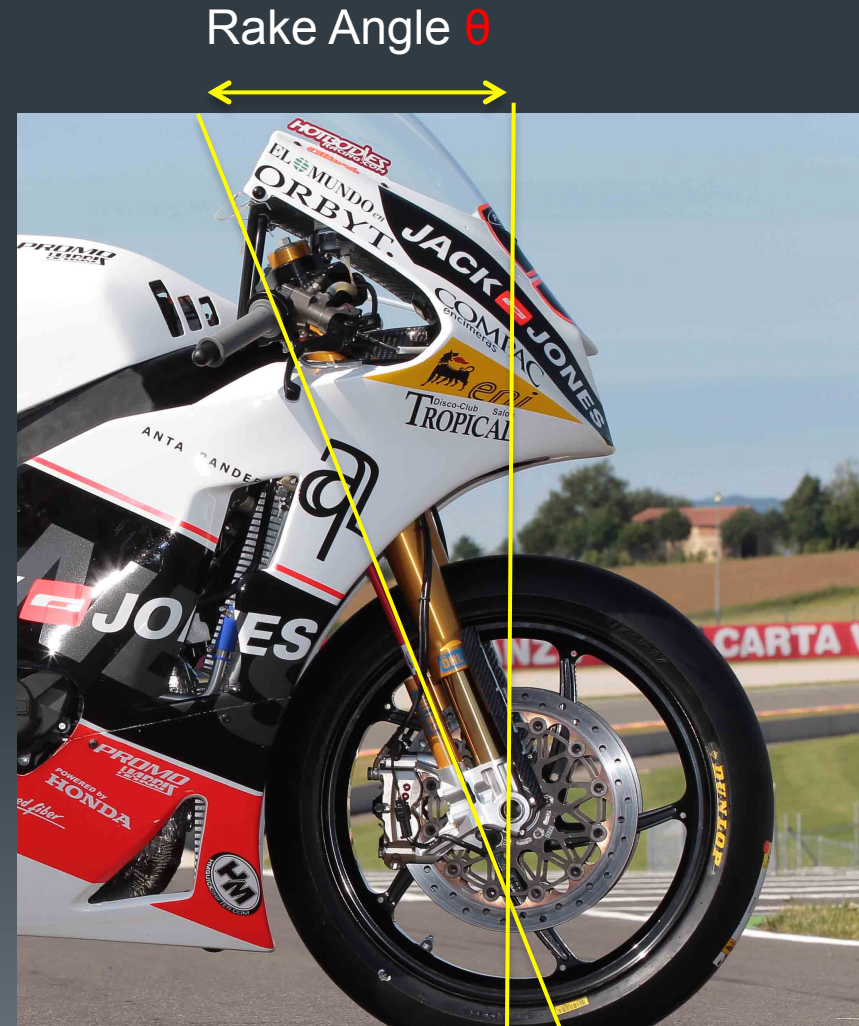


How you need the motorcycle to handle depends on its application, for now we will focus on a motorcycle for circuit racing. There are many factors that determine how a motorcycle handles such as the overall mass of the motorcycle, the mass of the wheels, the suspension setup, the weight and skill level of the rider, and the geometry of the motorcycle. When talking about the geometry of the motorcycle there are 2 vital factors to consider, these have the biggest influence on how a motorcycle will handle –

- Rake
- Trail

Rake

On the right we can see how the Rake angle is measured. The Rake is the angle of the steering head when measured against a vertical axis.



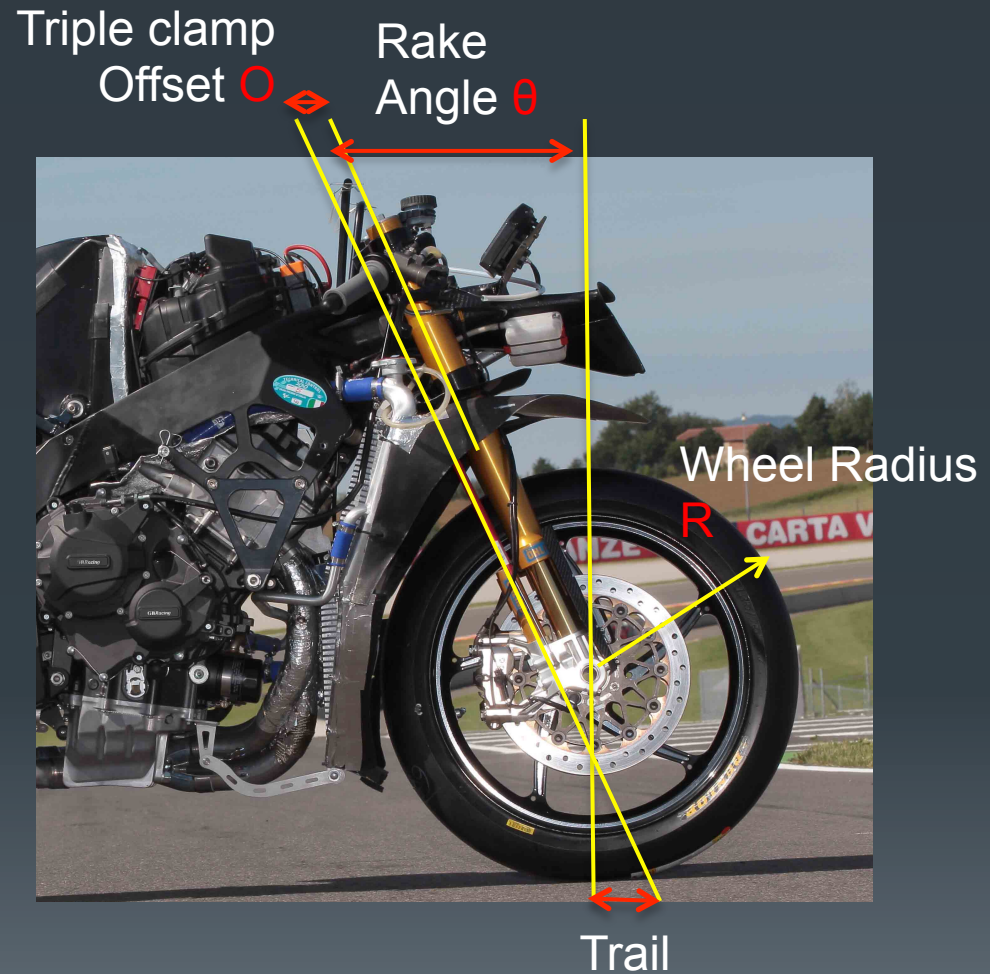
Rake



- The Rake on most production motorcycles is determined by the manufacturer and has no real adjustment.
- On production bikes the Rake only really changes as a result of changing the fork height or the rear ride height.
- On most prototype motorcycles however this can be adjusted to a greater effect, usually with different inserts into the headstock.
- With prototype motorcycles the Rake angle is considered to be a parameter of its own due to the extra adjustability, not just a result of other changes.

Trail

The Trail is the horizontal measurement from where the line through the front axle meets the ground to where the line drawn through the steering head meets the ground.



- $\text{Trail} = (R \times \sin\theta - O) / \cos\theta$

Trail

- Worked Example

$$\text{Trail} = (R \times \sin\theta - O) / \cos\theta$$

$$\text{Trail} = (302.99 \times \sin(23) - 27) / \cos(23)$$

$$\text{Trail} = (118.39 - 27) / 0.92$$

$$\text{Trail} = 91.39 / 0.92$$

$$\text{Trail} = 99.34\text{mm}$$

- Trail gives a self centering effect due to the front wheel being behind (trailing) the steering axis.
- Too little – self centering is decreased to the point of instability.
- Too much – steering becomes too heavy.

Trail



Some parameters that can be used to affect Trail on a production motorcycle are –

- Fork height
- Rear ride height (Shock length)
- Front and rear sag
- Swing arm length

Most prototype motorcycles have a few other parameters available to change –

- Rake angle (e.g. by changing bearing inserts)
- Triple clamp offset