



PRIFYSGOL CYMRU

Y Drindod Dewi Sant

UNIVERSITY OF WALES

Trinity Saint David

SWANSEA - ABERTAWE

Swansea's Metropolitan University

Prifysgol Metropolitan Abertawe

School of Engineering

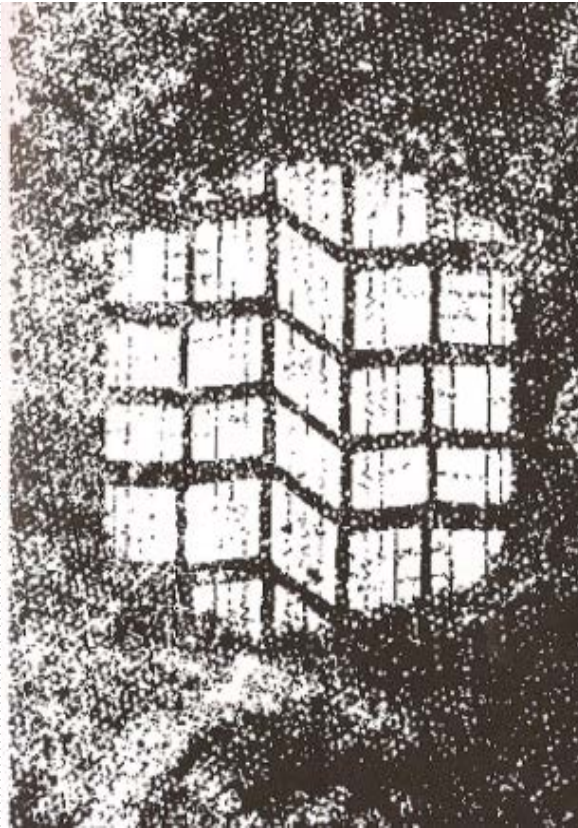
Introduction to Vehicle Tyres

Mark Sandford

Why tyres are important

- Whatever you do to improve the vehicle performance the forces go through the tyres
 - Acceleration
 - Braking
 - Cornering
 - Tyre selection is critical
 - Performance verses wear
 - Handling feel - feedback
 - Comfort – ride and noise
 - Economy – fuel consumption
 - Tyre properties and dynamics are an important area of study
-

The Contact Patch



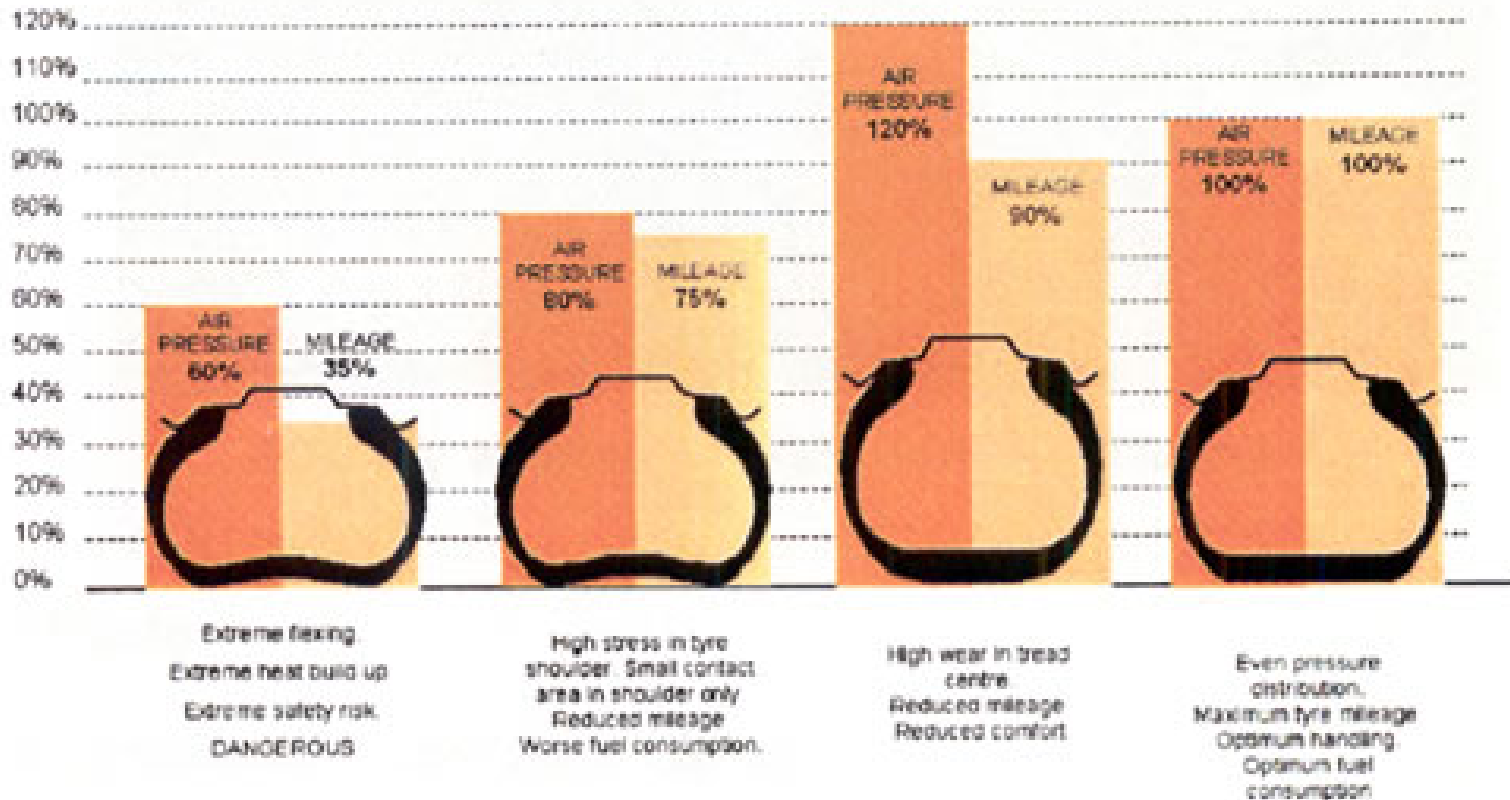
The Contact Patch

- The area of the tyre in physical contact with the ground
 - The contact patch changes shape and size depending on various factors, such as
 - Tyre dimensions
 - Pressure – internal air (gas) pressure.
 - Vertical loading
 - Tractive effort
 - Lateral loading
 - Wheel attitude
-

Basic tyre forces - Pressure

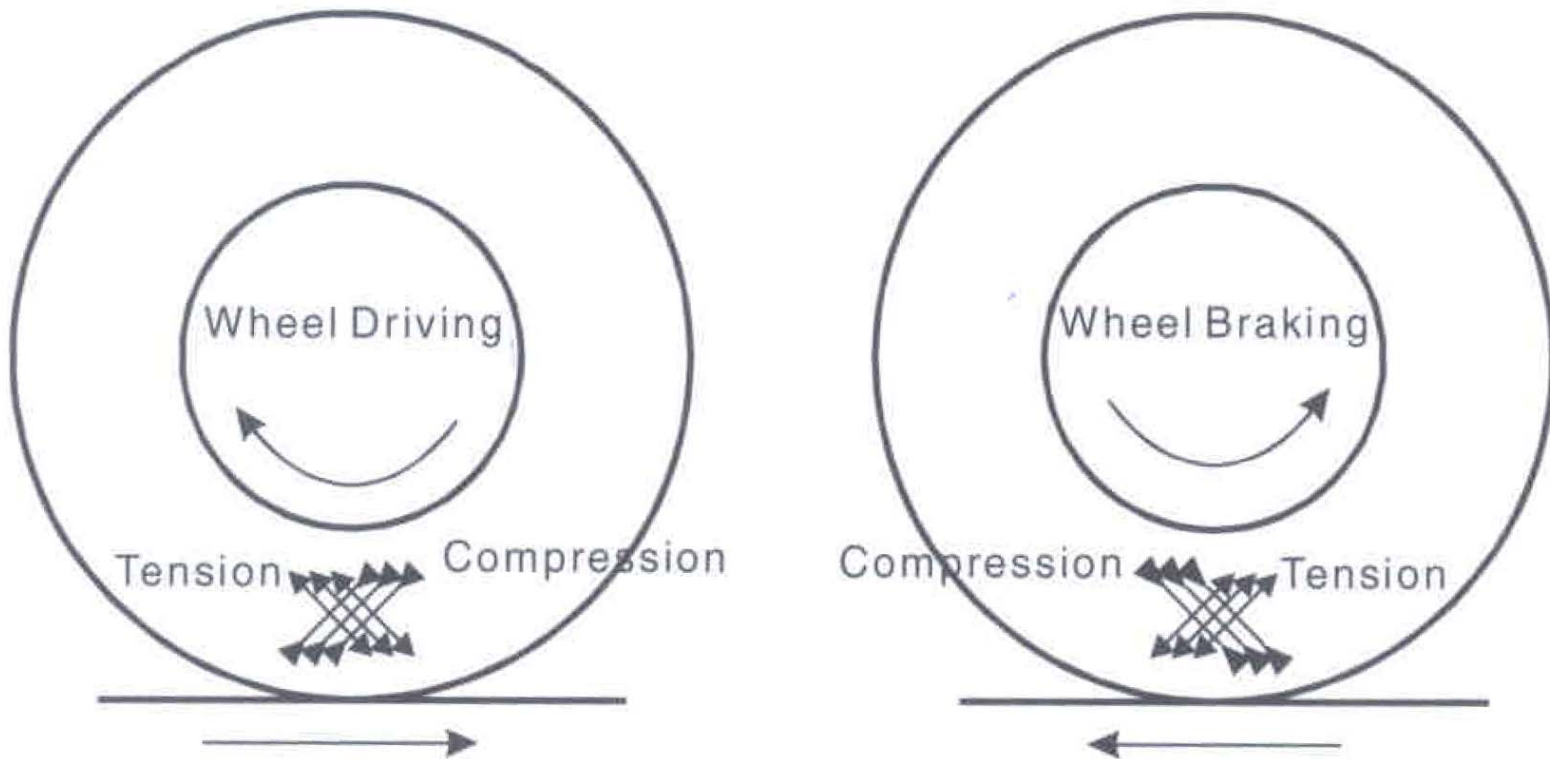
Air Pressure Recommendations

Maximum mileage and best vehicle handling is obtained only by maintaining 100% correct inflation pressures



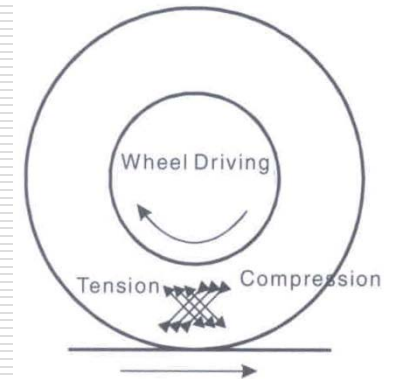
Basic tyre forces - traction

- Sidewalls in shear due to traction / drive forces



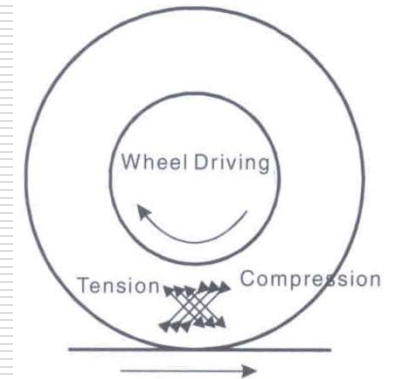
Basic tyre forces - traction

- ❑ Sidewalls in shear due to traction / drive forces



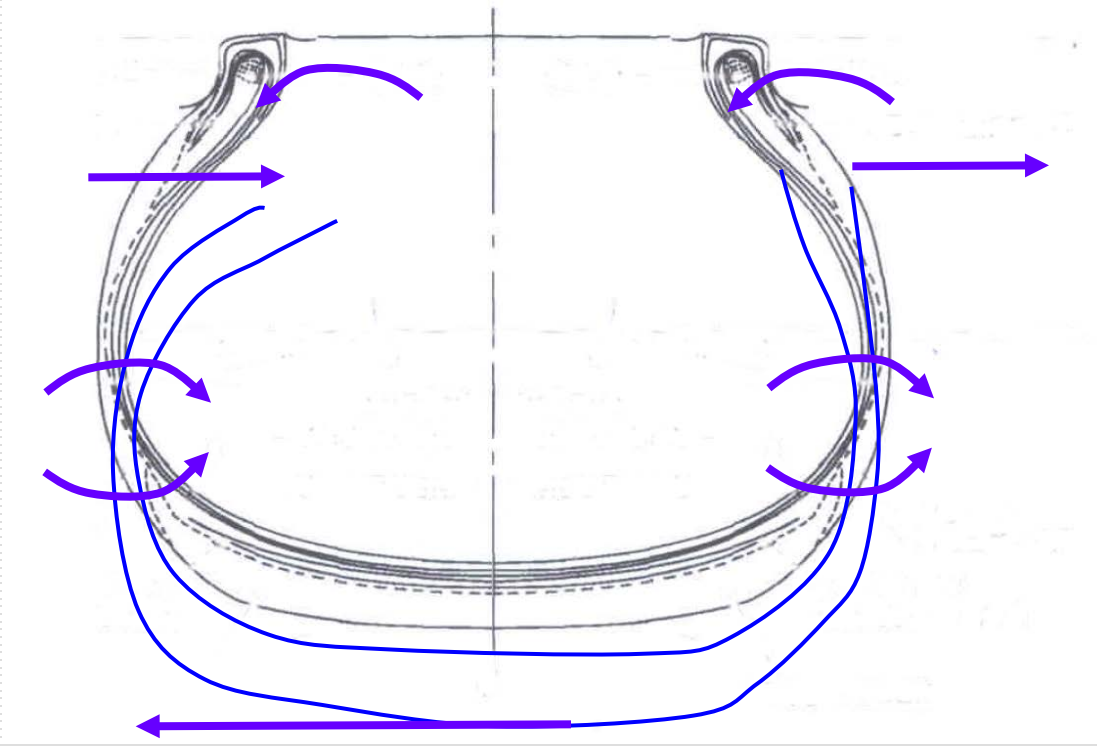
Basic tyre forces - traction

- ❑ Sidewalls in shear due to traction / drive forces



Basic tyre forces – Lateral force

- ❑ Sidewalls in bending due to lateral forces
- ❑ Beads react moments as well as forces

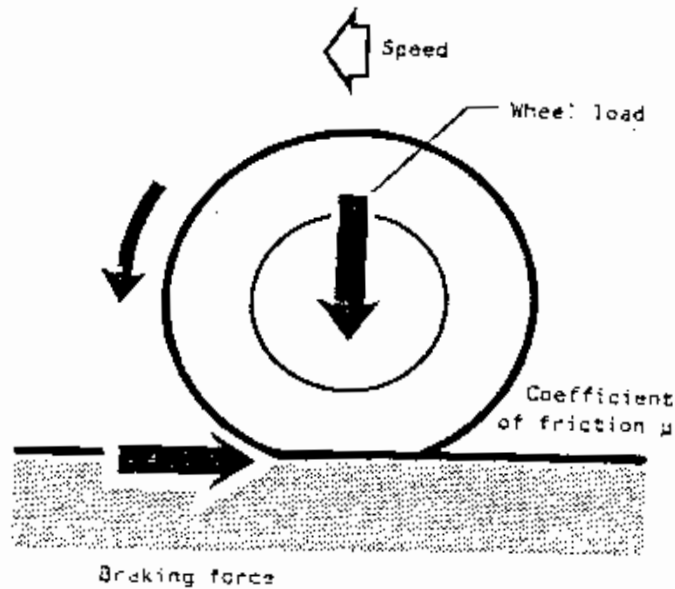


Carcass Distortion

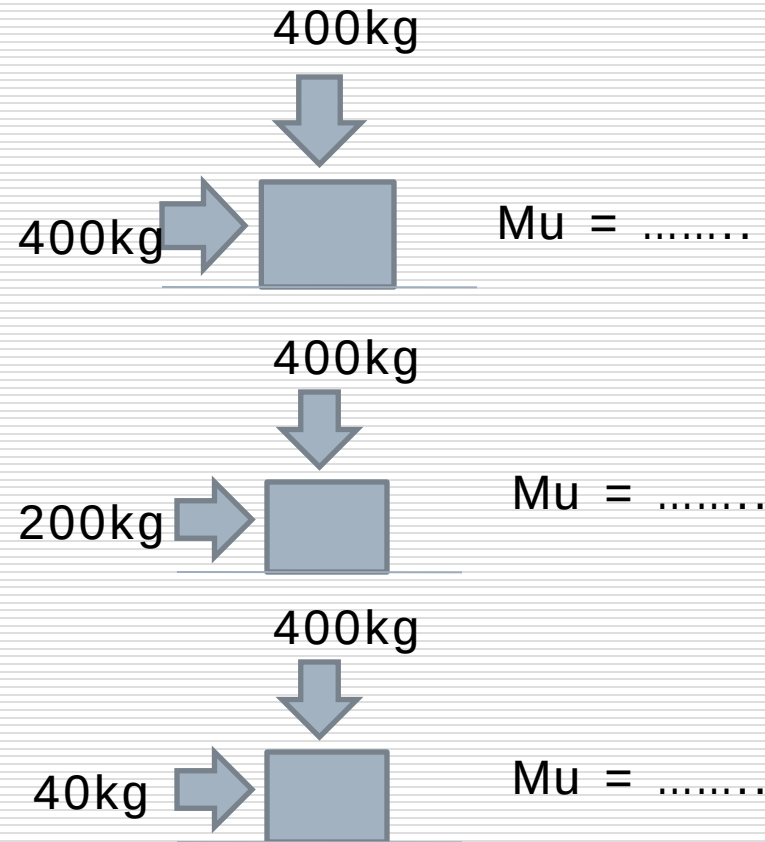
- ❑ The tyre does distort and deform when reacting the forces we demand of it.
 - ❑ In a performance event the continual stretching and relaxing of the rubber can lead to heat build up. In extreme causing a blow out.
 - ❑ However there is an 'optimal' temp for the tyre to work at.
 - Summer tyres/winter tyres
 - Race tyre warm up and monitoring
-

Coefficient of friction - Mu

$$\text{Mu} = \frac{\text{Horizontal force (push) Kg}}{\text{Vertical force (weight) Kg}}$$



A tyre on the road



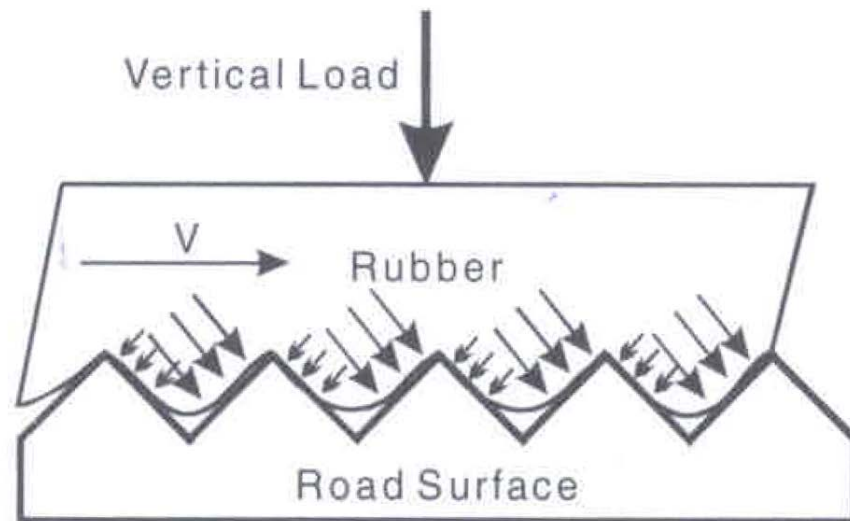
Frictional forces

- Several mechanisms for generating ‘frictional’ forces
 - hysteresis
 - adhesion
 - tearing
-

Frictional forces

□ Several mechanisms for generating 'frictional' forces

- hysteresis



- adhesion

- tearing

Frictional forces

- Several mechanisms for generating ‘frictional’ forces
 - hysteresis
 - dominates “real world” tyre grip on uneven (textured) surfaces
 - generates pressure differential between loading and unloading faces of rubber
 - also known as “mechanical keying”
 - high level of damping (hysteresis) in compound promotes grip on textured surfaces
 - sensitive to sliding velocity and road texture
 - insensitive to lubrication (liquid, powder)
 - adhesion
 - tearing
-

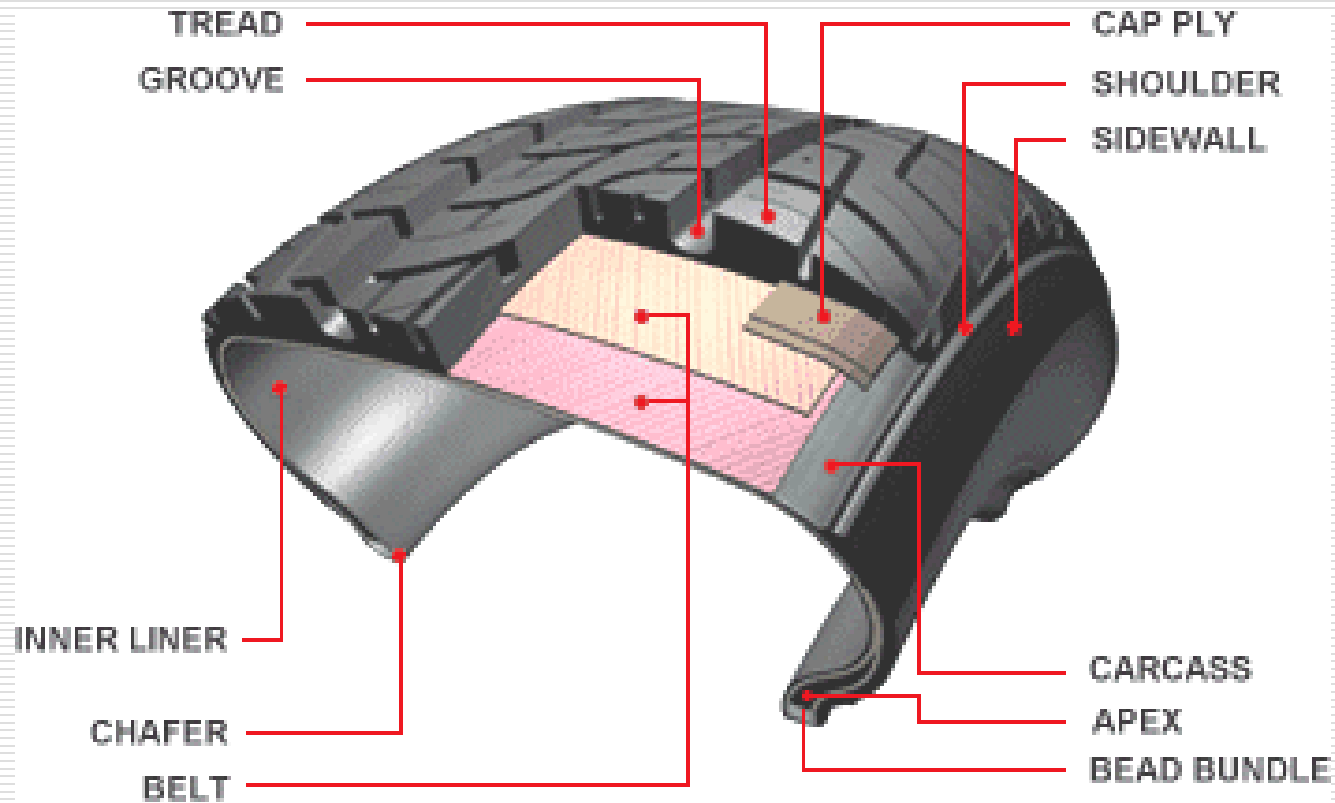
Frictional forces

- Several mechanisms for generating ‘frictional’ forces
 - hysteresis
 - adhesion
 - “momentary molecular bonding” between tyre and road
 - uses “residual electrostatic forces”
 - primary mechanism for “rubber on glass” friction
 - “tops up” grip for dry, unlubricated surfaces
 - highest at very low sliding velocities
 - tearing
-

Frictional forces

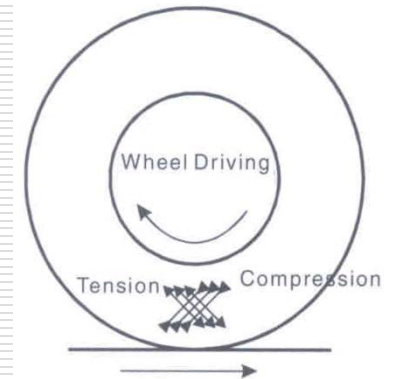
- Several mechanisms for generating ‘frictional’ forces
 - hysteresis
 - adhesion
 - tearing
 - physical limit of rubber cohesion
 - surface of rubber dragged away from body
 - deposits on road (“skid marks”), rubber dust on bodywork, tyre graining
 - responsible for tread wear, always occurring to some extent
-

Tyre construction

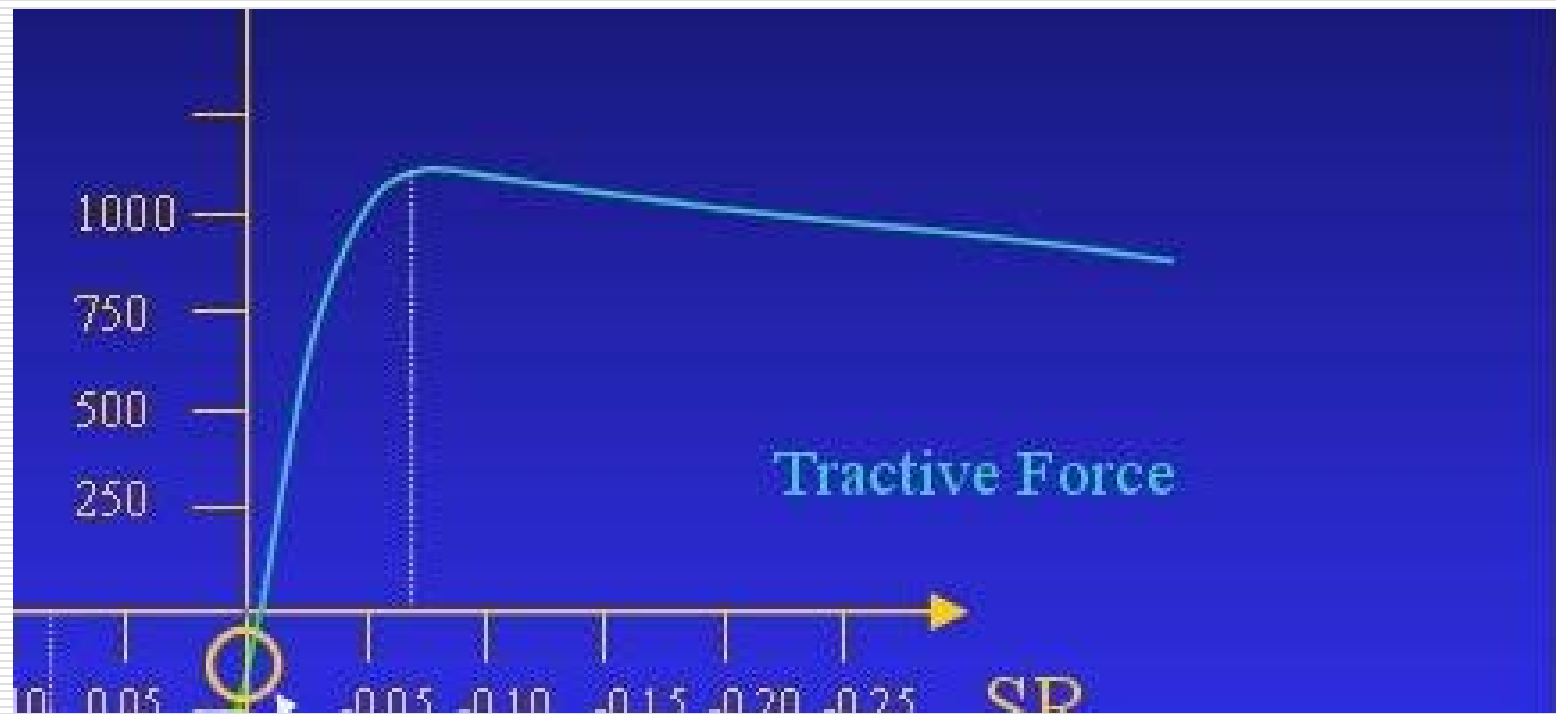


Basic tyre forces - traction

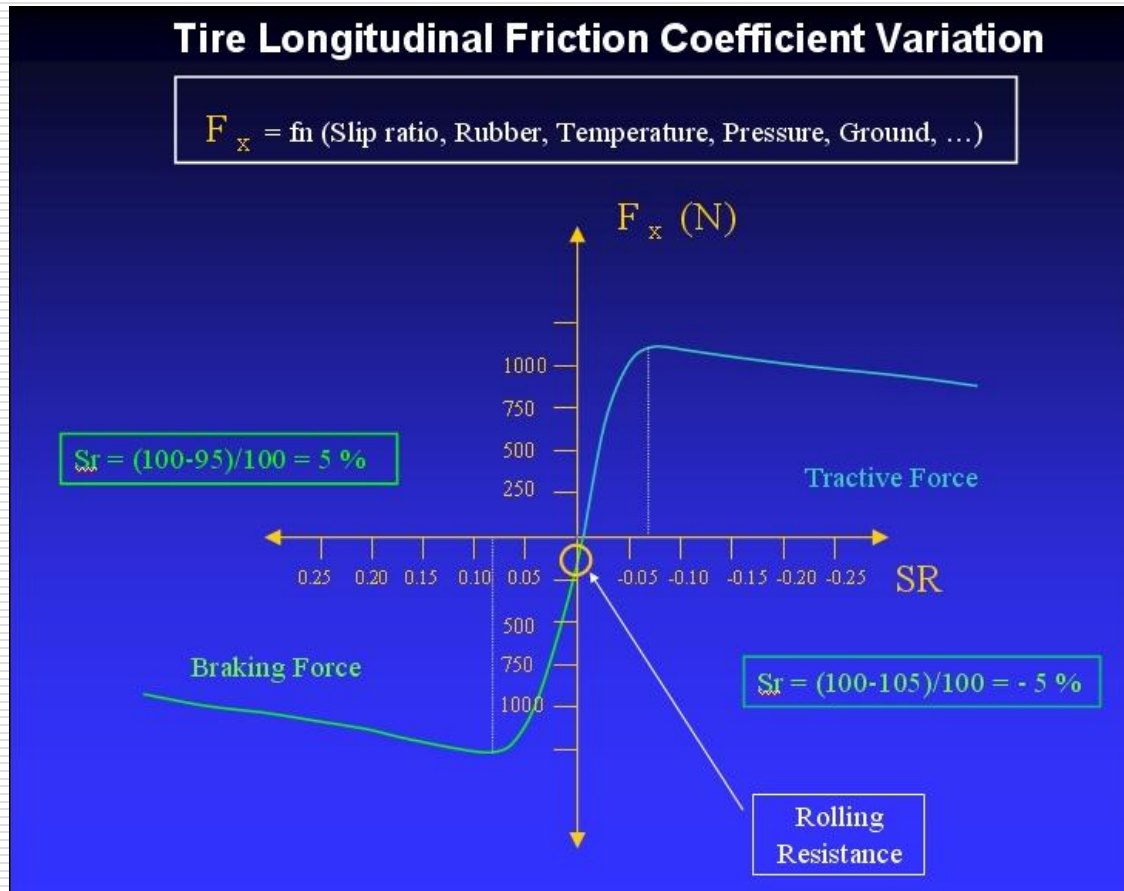
- ❑ Sidewalls in shear due to traction / drive forces



Tyre characteristics



Tyre characteristics



School of Automotive Engineering

Introduction to Vehicle Tyres

Mark Sandford