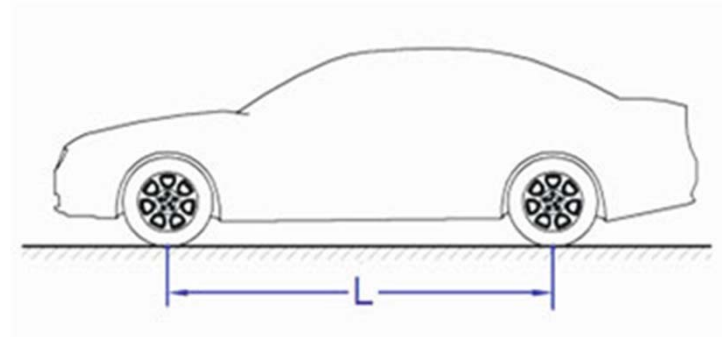


Suspension Kinematics

- Suspension kinematics determine the spatial movement of the wheels during jounce/rebound (compression/ extension) and steering.
- In order to calculate suspension kinematics, such parameters are required:
 - position of the center of gravity,
 - axle weights,
 - axle loads,
 - brake force distribution, and propulsion power distribution for all-wheel-drive vehicles etc.

Wheelbase L

- The distance in the vehicle's xy plane between the center of tire contact at the front wheels and the center of tire contact at the rear wheels.



Wheelbase *L*

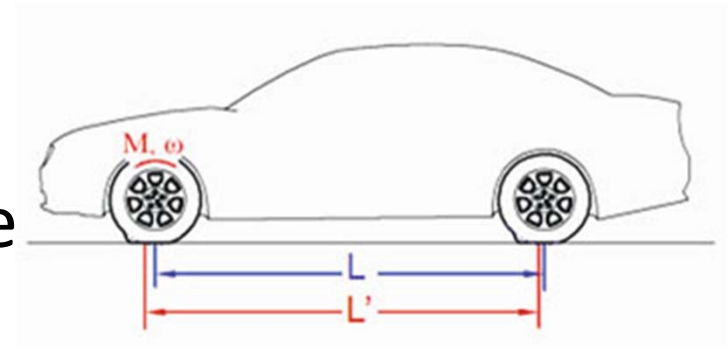
- A vehicle with a longer wheelbase features:
- ♦ more room for passengers
- ♦ improved ride comfort
- ♦ improved safety

Wheelbase L

- A vehicle with a shorter wheelbase features:
- ♦ better maneuverability (cornering, parking)
- ♦ lower costs and lower weight

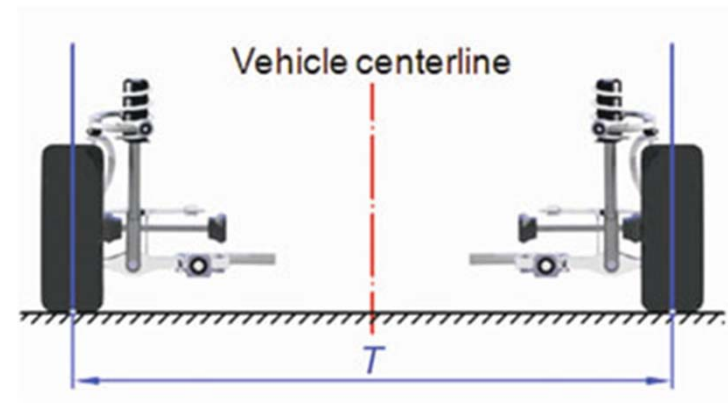
Wheelbase change

- The advantages of this are:
- Horizontal impacts are mitigate compliance.
- The springing motion of the suspension is increased.
- The disadvantages of this are:
- Fluctuations in wheel RPM
- Torsional vibrations in the drivetrain.
- Wheel-speed signals (ABS) can be incorrect.
- Wheel hop during braking can result.



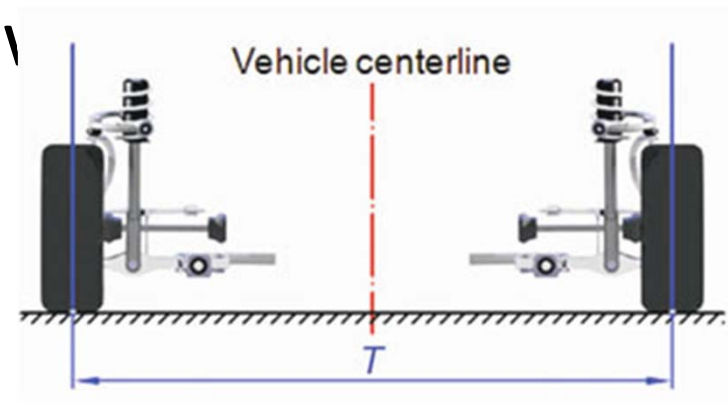
Track width T

- The distance in the yz plane between the centers of tire contact on a single axle
- Wide track width results in:
 - Better driving behavior
 - Reduced vehicle roll
 - Improved design aesthetics



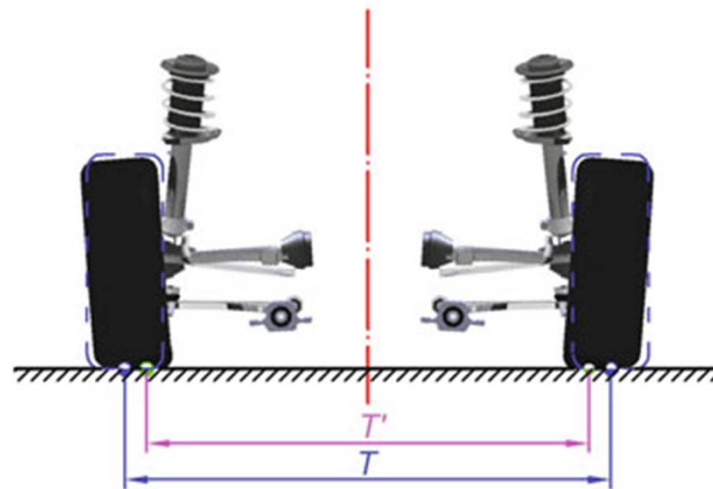
Track width T

- The distance in the yz plane between the centers of tire contact on a single axle
- Narrow track width has following disadvantages:
 - Less stability
 - Increased vehicle roll
 - Less room for passengers and powertrain



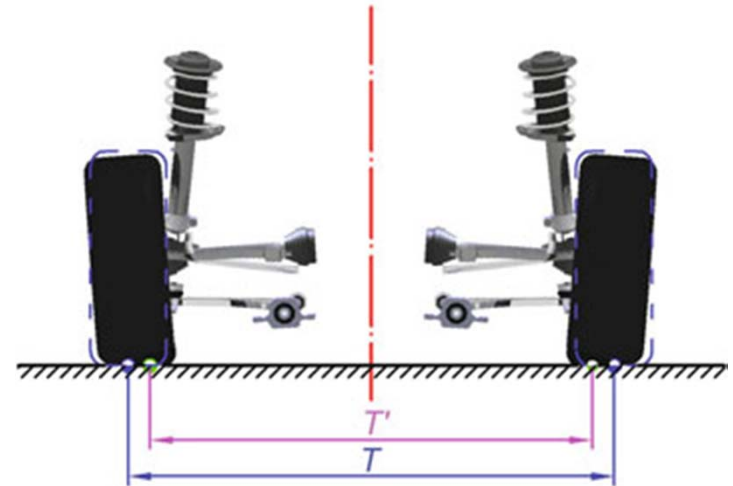
Track width change

- Camber changes and suspension kinematic effects during suspension compression and extension can change the position of the contact patch, thus changing the track width



Track width change

- The disadvantages of this are:
- The tire slides along the road surface.
- Straight line tracking is impaired.
- Lateral forces are created.
- Rolling resistance is increased.
- Steering is affected.



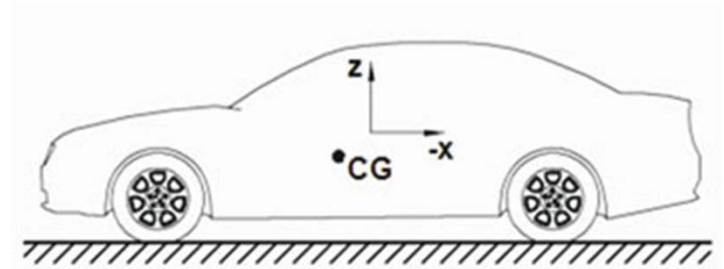
Vehicle center of gravity

- The imaginary point at which the vehicle's entire mass can be concentrated.

A low center of gravity results

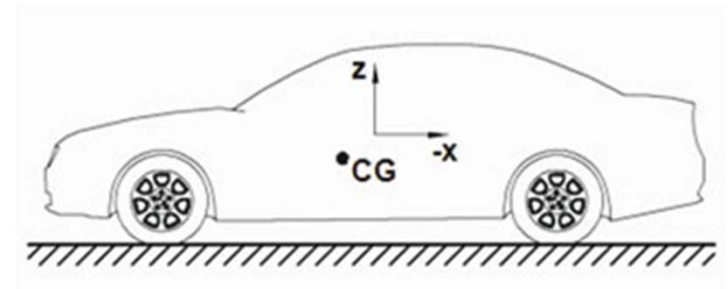
in:

- Good handling and driving safety
- Reduced vehicle pitch and roll
- Reduced wheel load fluctuations on inclined surfaces



Vehicle center of gravity

- The imaginary point at which the vehicle's entire mass can be concentrated.
- A high center of gravity results in:
- Increased rear axle load on inclined surfaces.

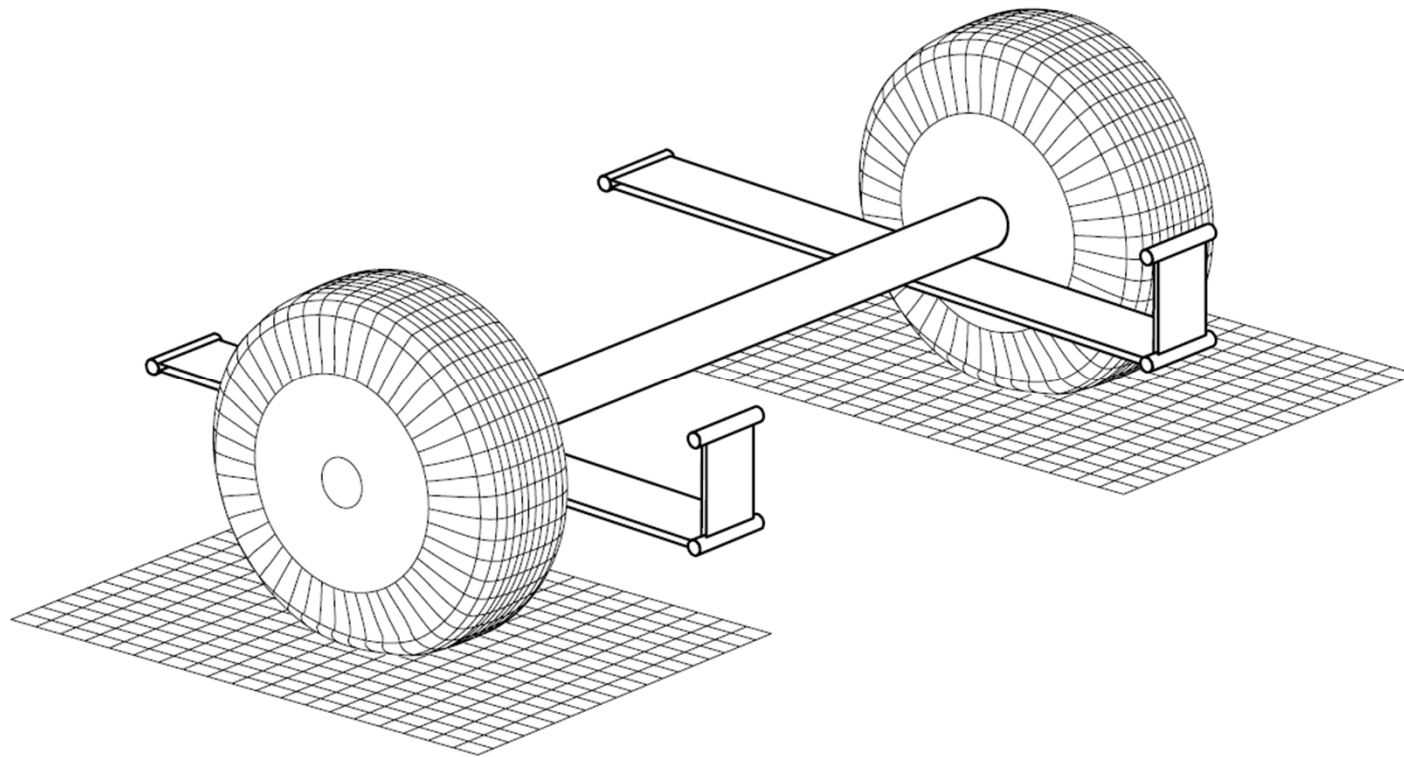


Axle-load distribution

- The ratio of the distance in the x-direction between the center of gravity and the front and rear axles.
- Typical values in vehicle neutral position:
- 44:56 to 56: 44.

Dependent suspension systems

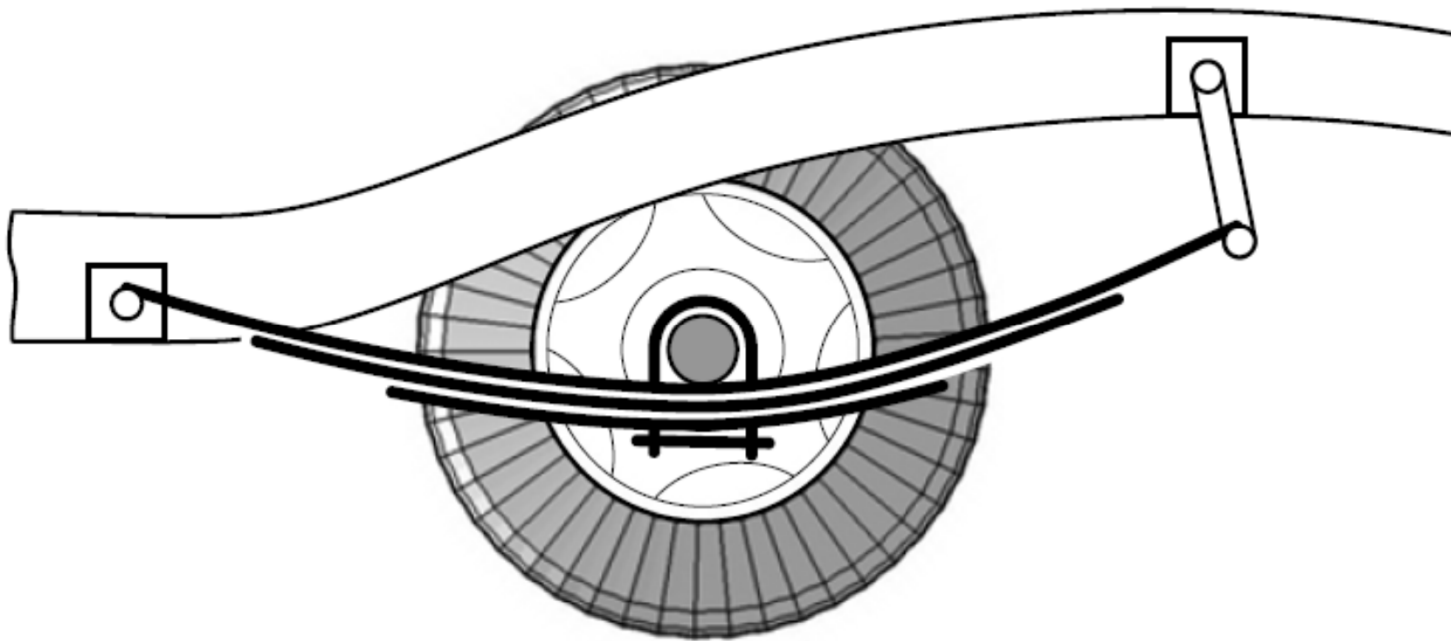
A suspension with a solid connection between the left and right wheels is called dependent suspension.



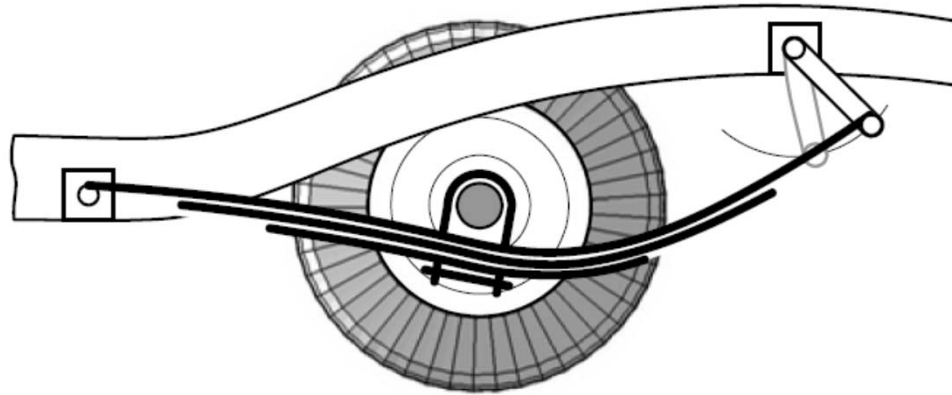
A solid axle with leaf spring suspension

Hotchkiss drive

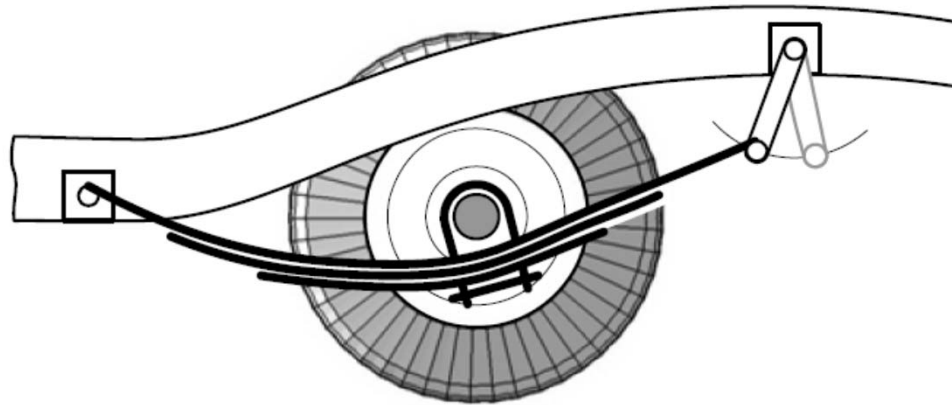
When a live solid axle is connected to the body with nothing but two leaf springs, it is called the Hotchkiss drive



Hotchkiss drive drawbacks

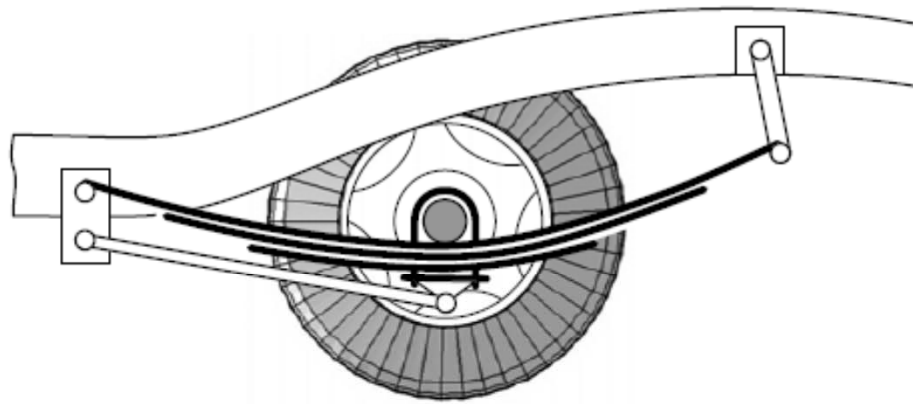


(a) Acceleration

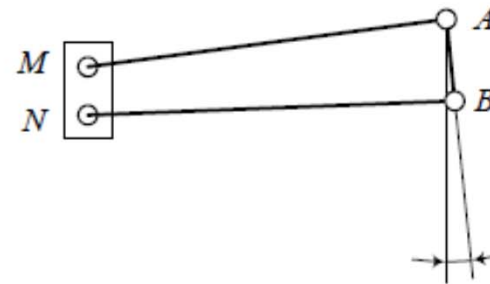


(b) Braking

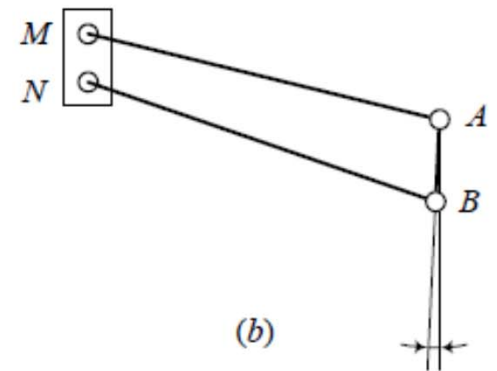
Anti-tramp bar



(a)

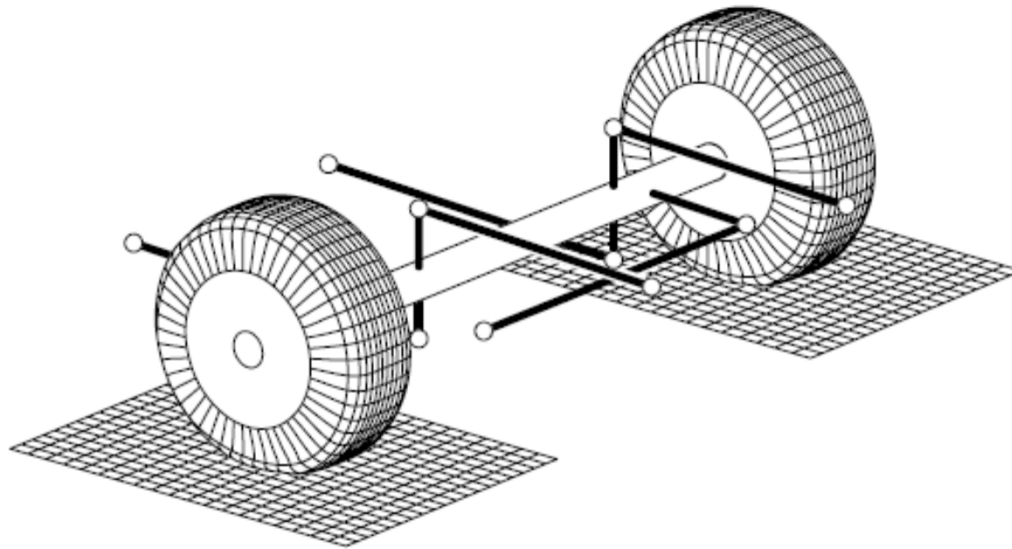


(a)



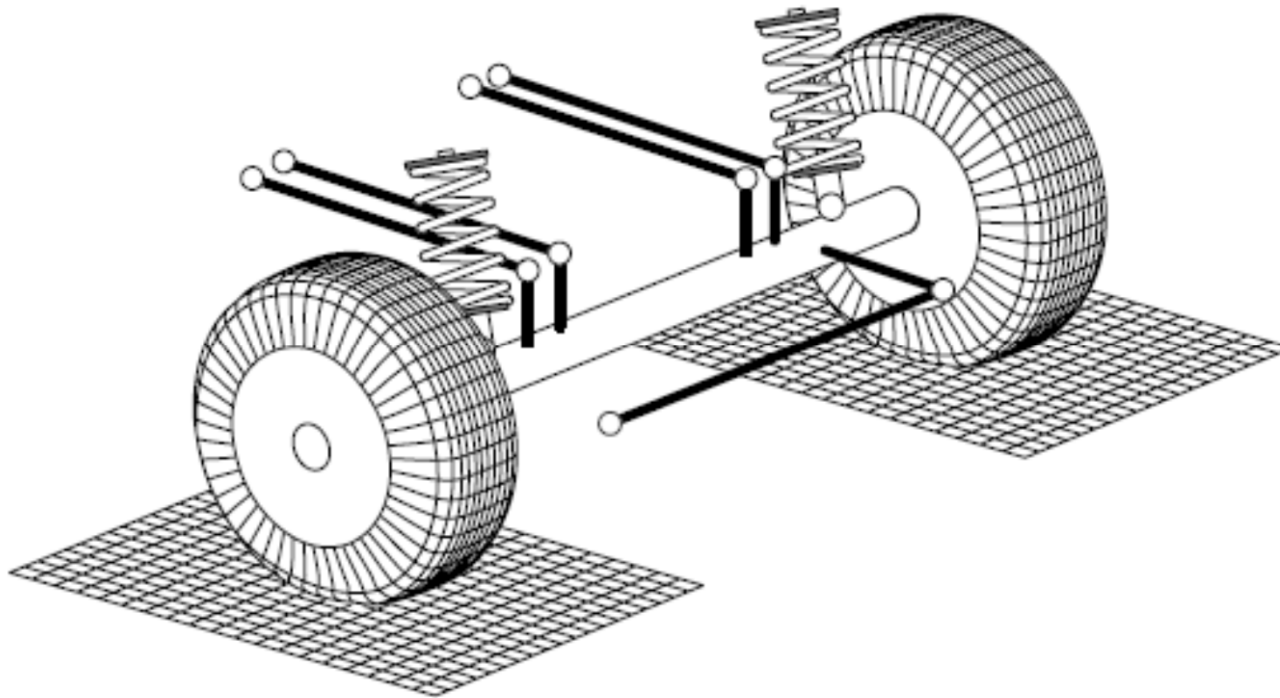
(b)

Watt linkage and Panhard arm

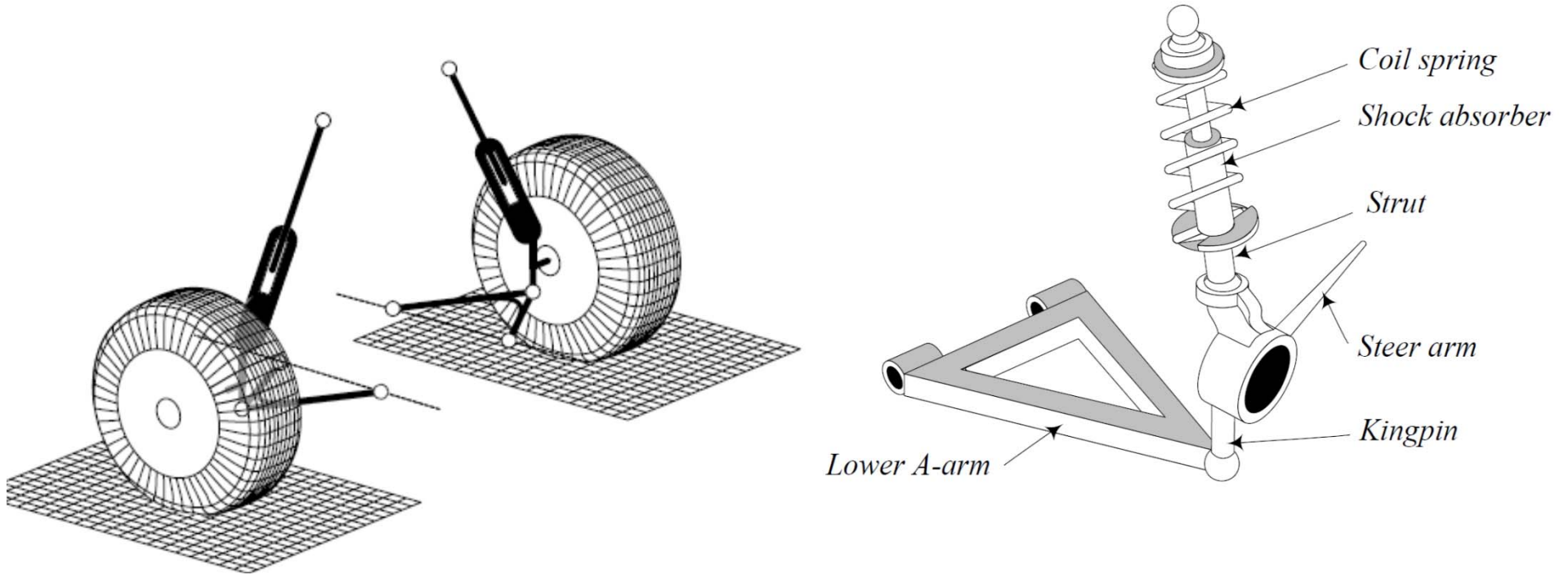


- A panhard bar prevents the rear axle from moving side-to-side.

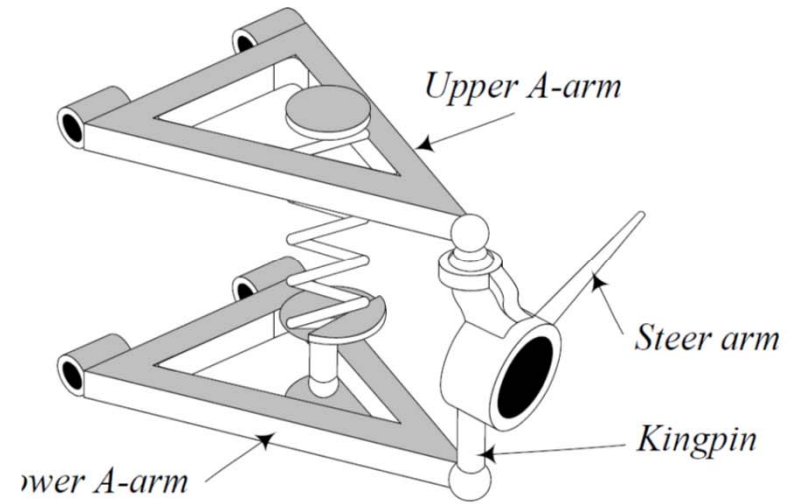
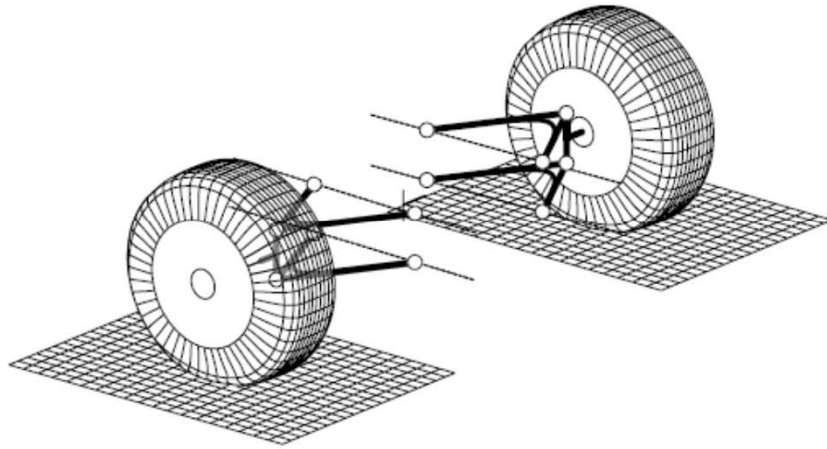
Coil spring solid axle



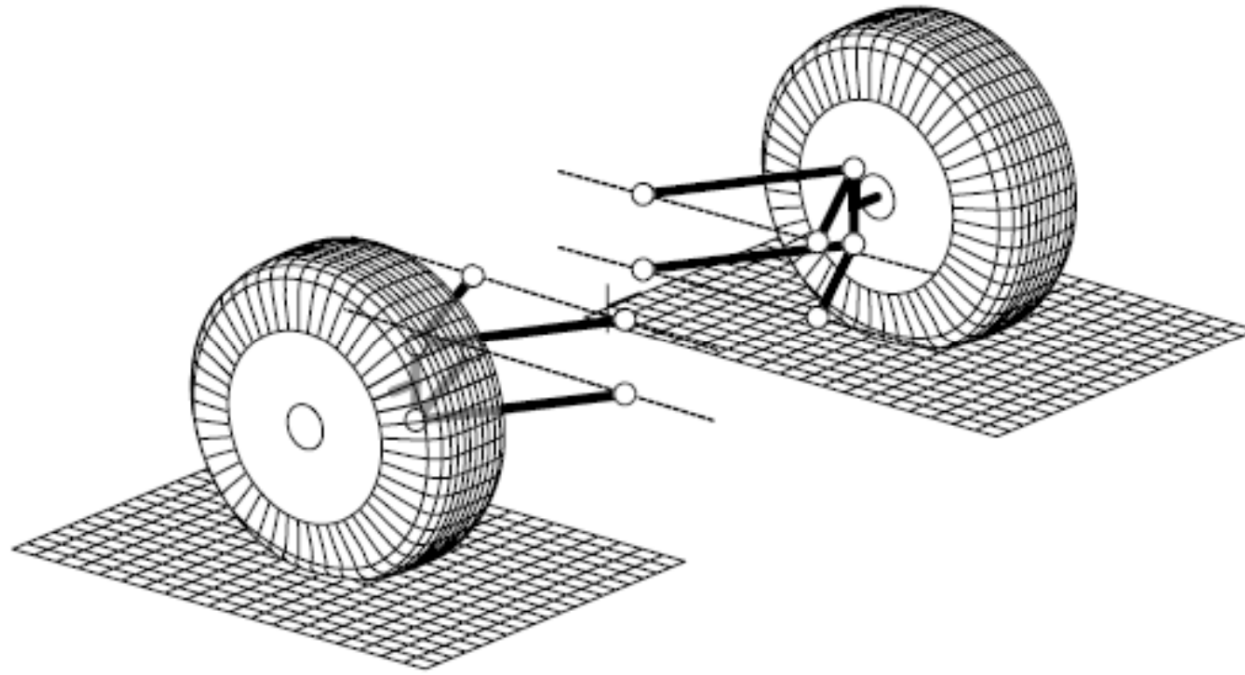
Independent suspension systems



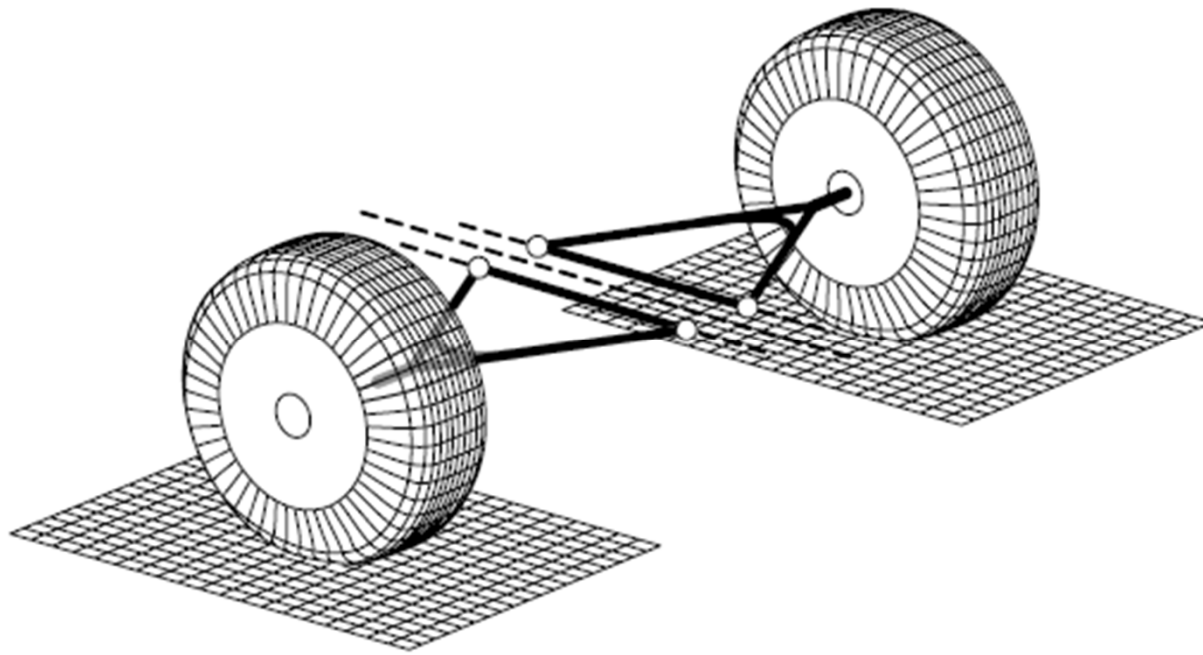
Doble A arm suspension



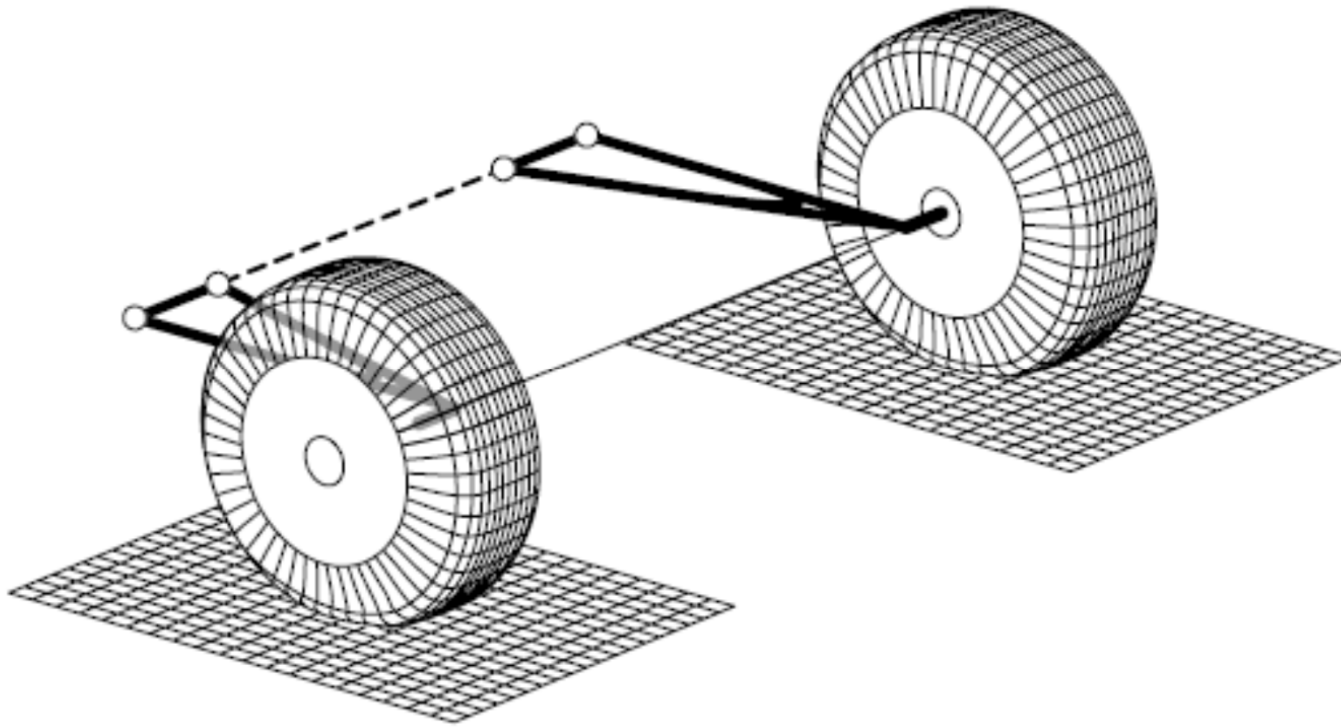
Multi-link suspension mechanism



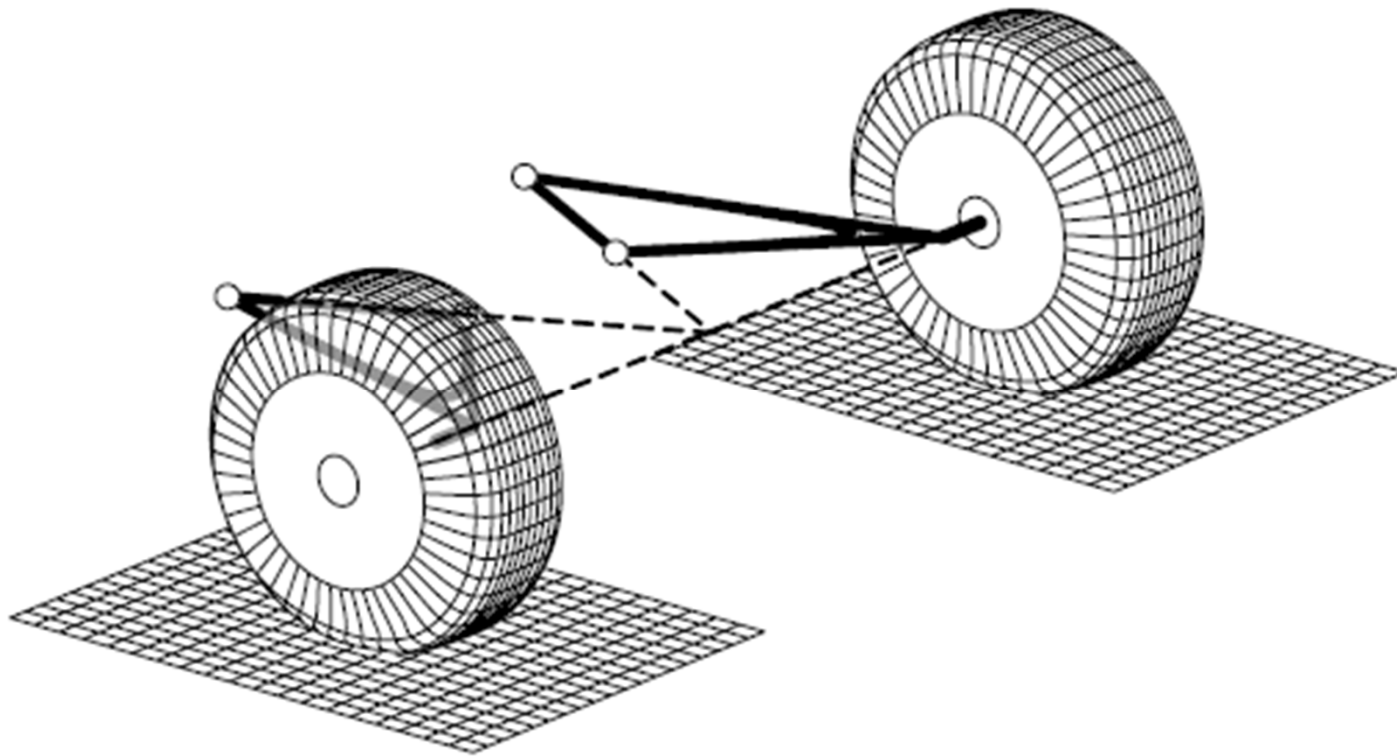
Swing arm suspension



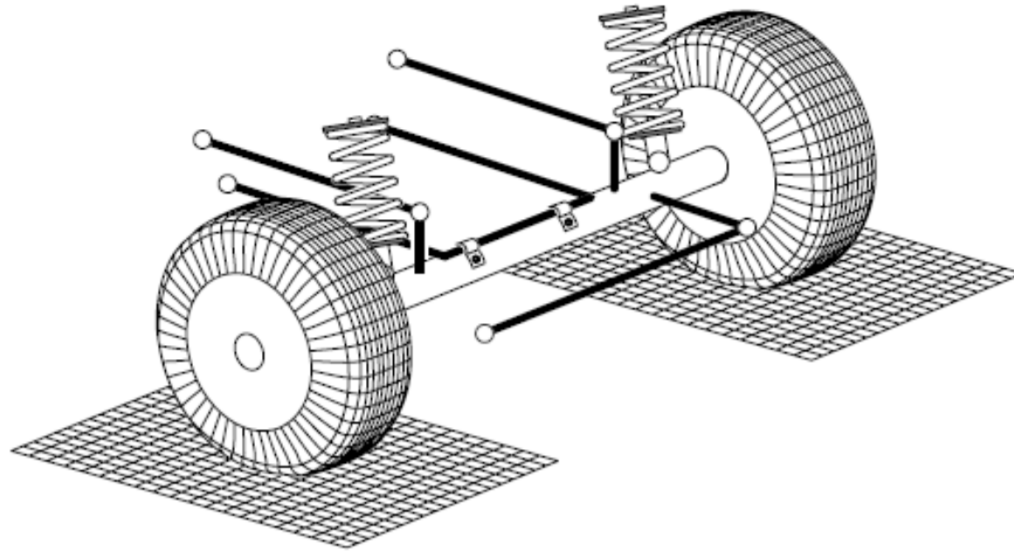
Trailing arm suspension



Semi-trailing arm suspension

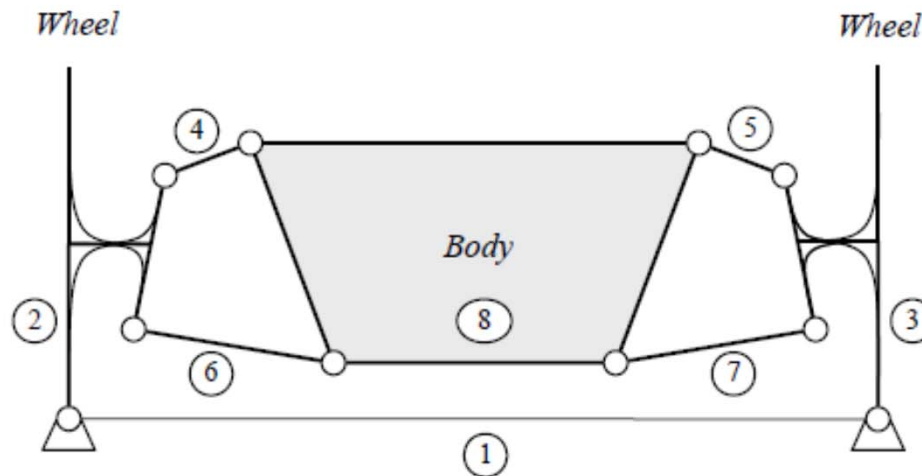
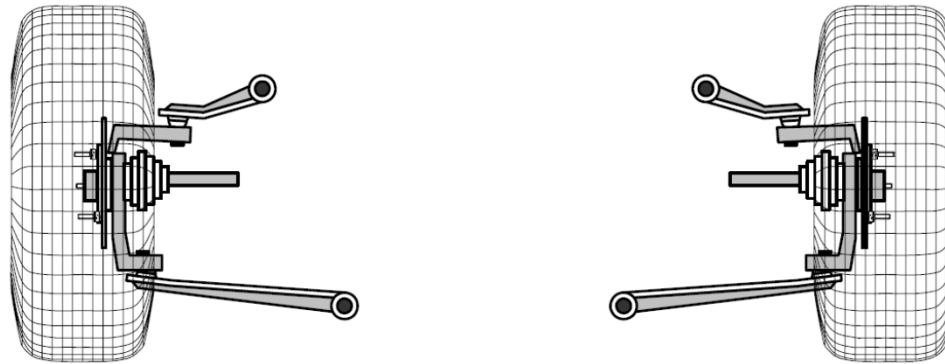


Anti-roll bar/Stabilizer



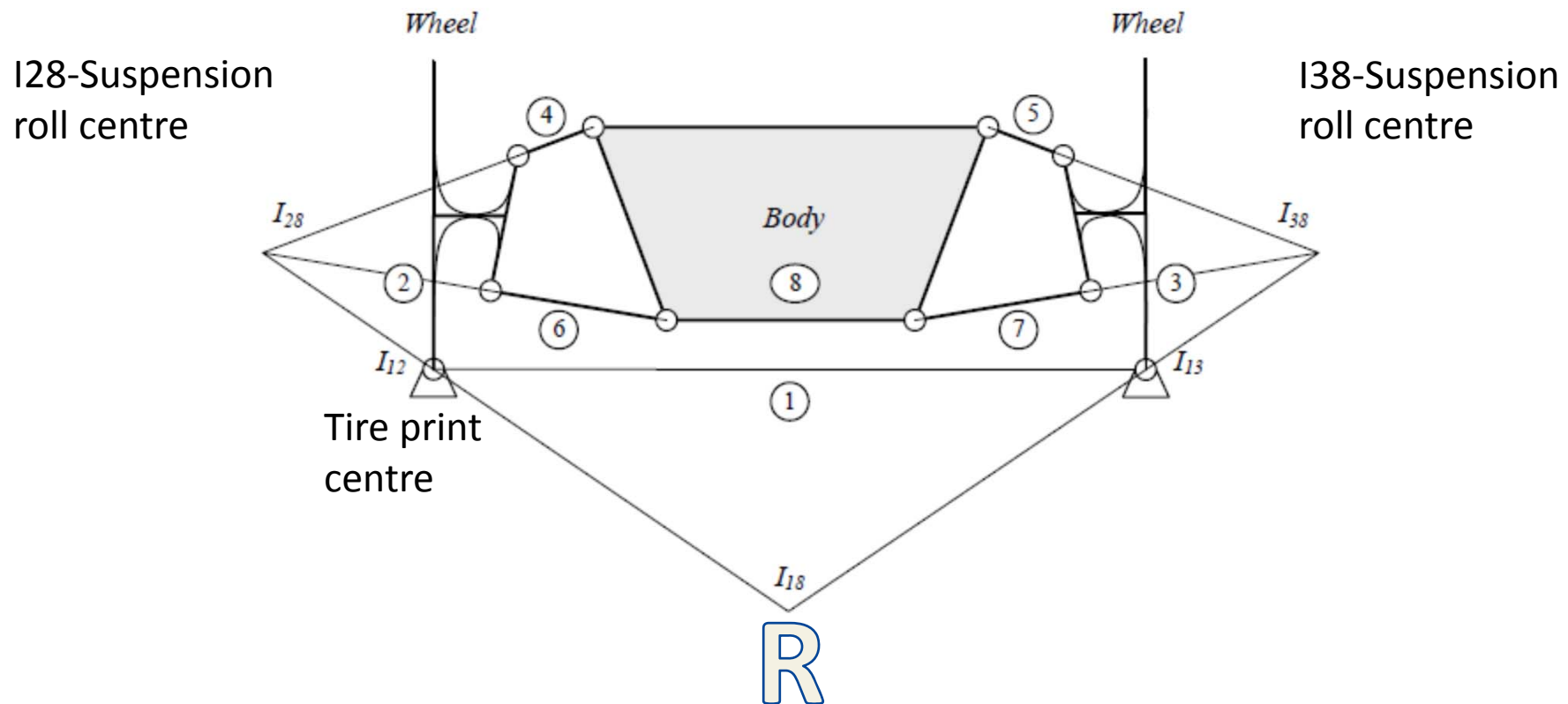
Coil springs are used in vehicles because they are less stiff with better ride comfort compared to leaf springs. therefore, the roll stiffness of the vehicle with coil springs is usually less than in vehicles with leaf springs. To increase the roll stiffness of such suspensions, an antiroll bar must be used. The antiroll bar is also called a stabilizer.

Roll Center



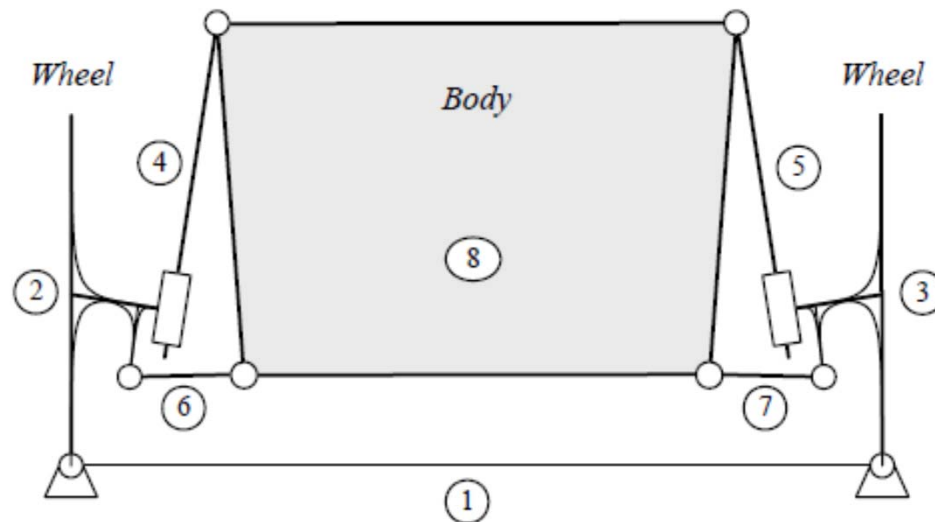
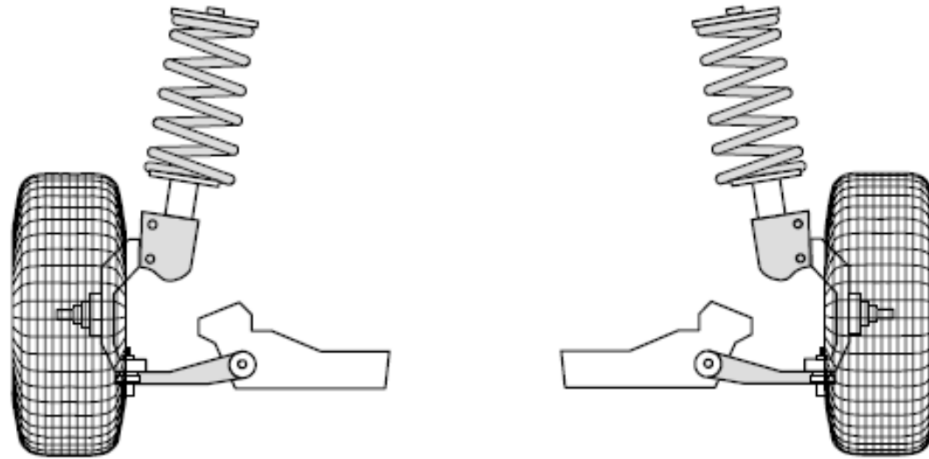
The roll axis is the instantaneous line about which the body of a vehicle rolls. Roll axis is found by connecting the roll center of the front and rear suspensions of the vehicle.

Roll center/Kennedy theorem Double-A arm

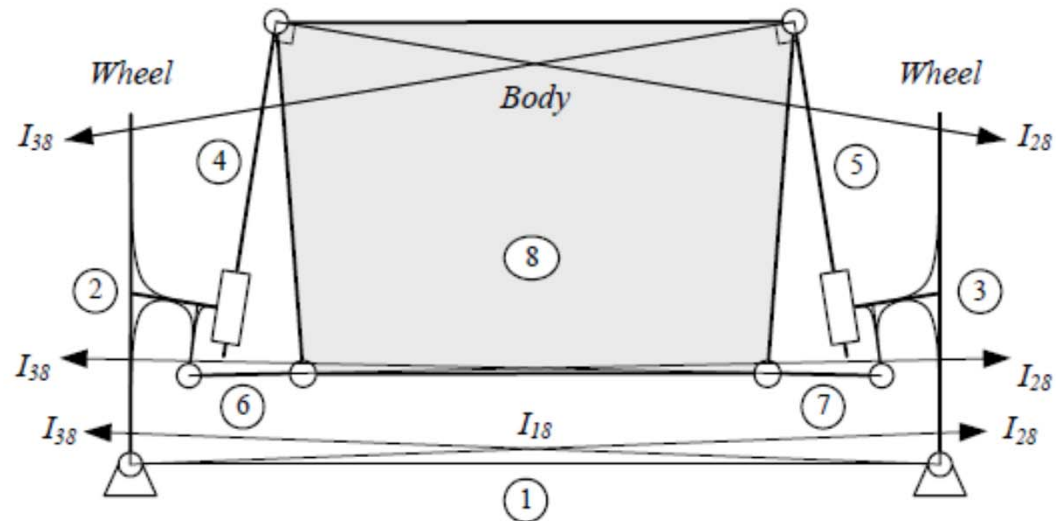
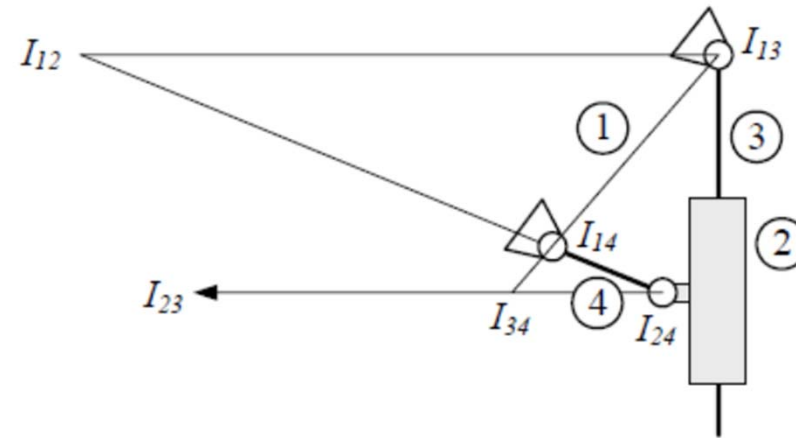


The instant center of rotation of a wheel with respect to the body is called suspension roll center.

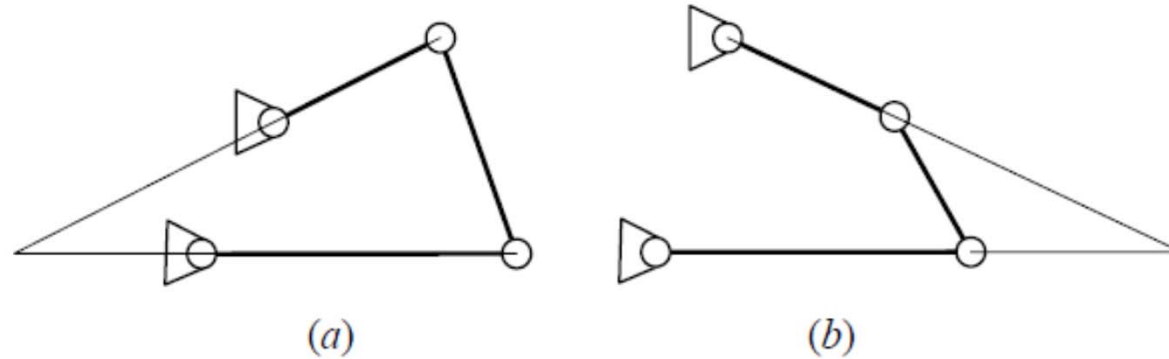
McPherson Roll centre



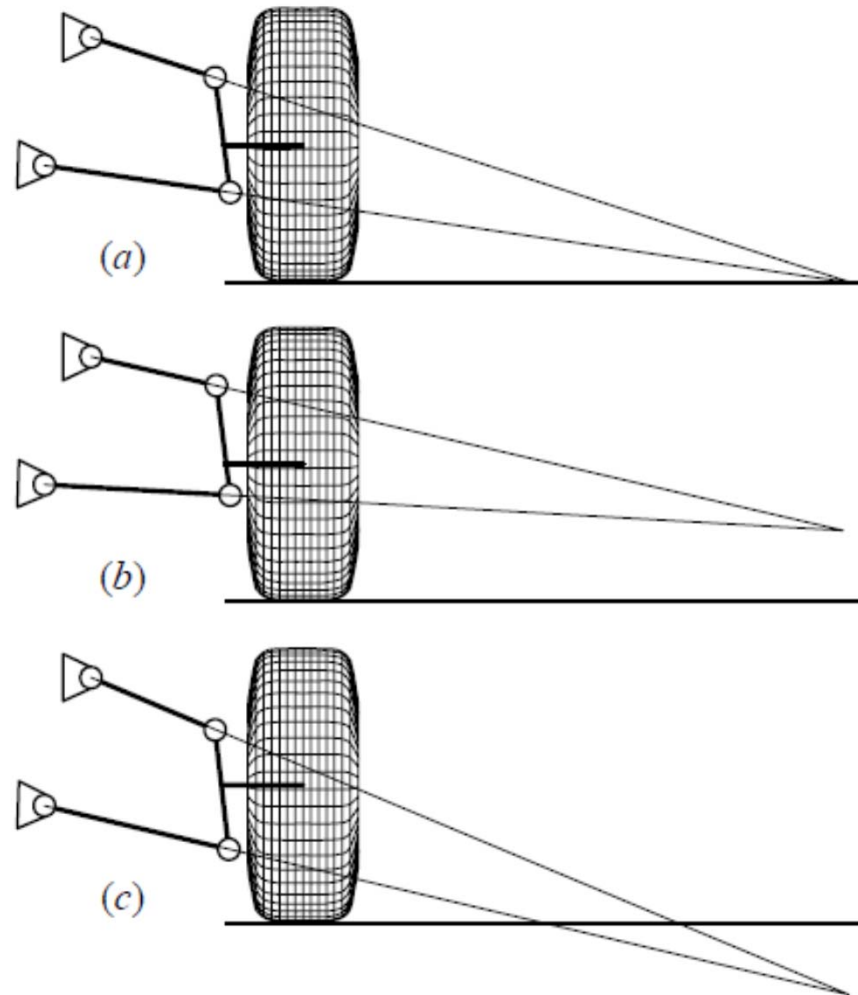
McPherson Roll centre



Internal/External suspension roll centre

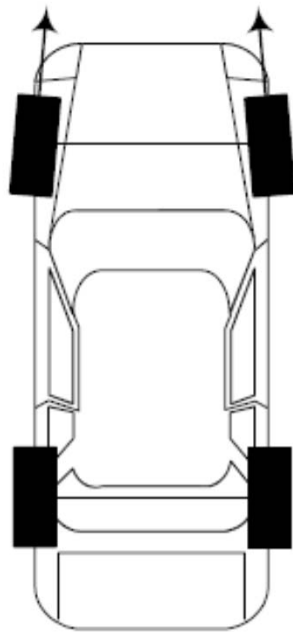


Suspension roll centre height

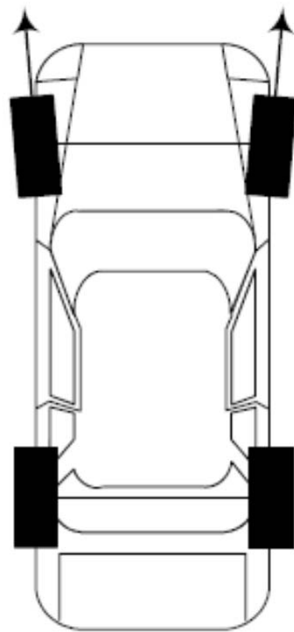


Car tire relative angles

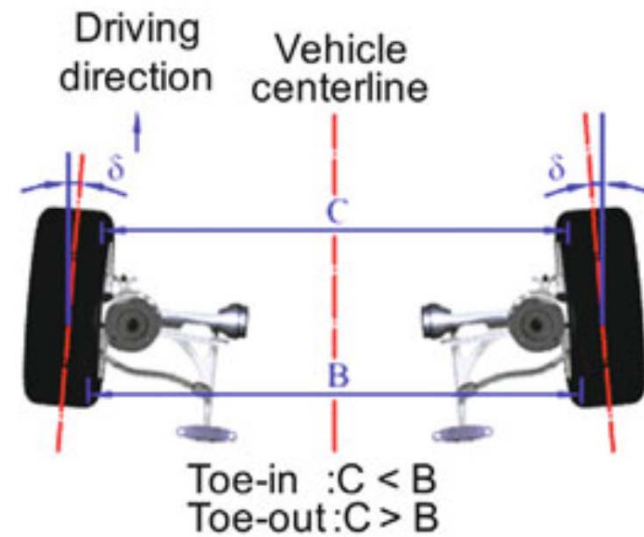
Toe-in and Toe-out



Toe-in

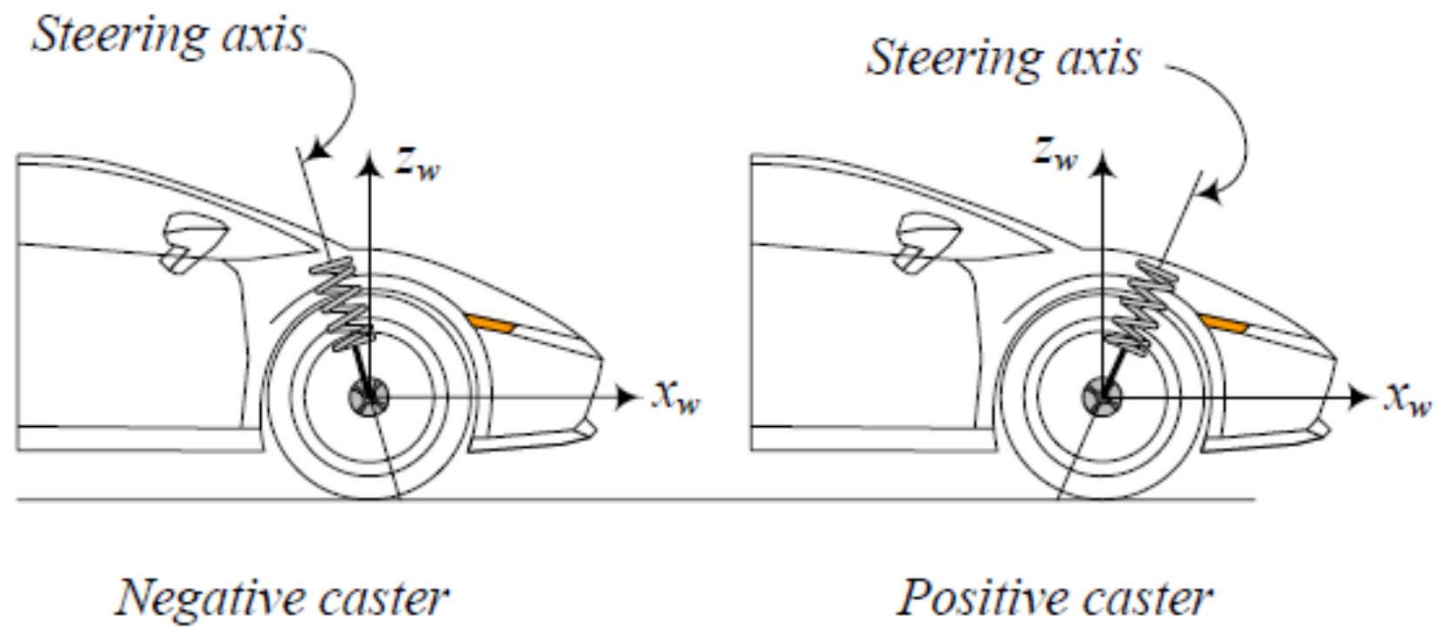


Toe-out



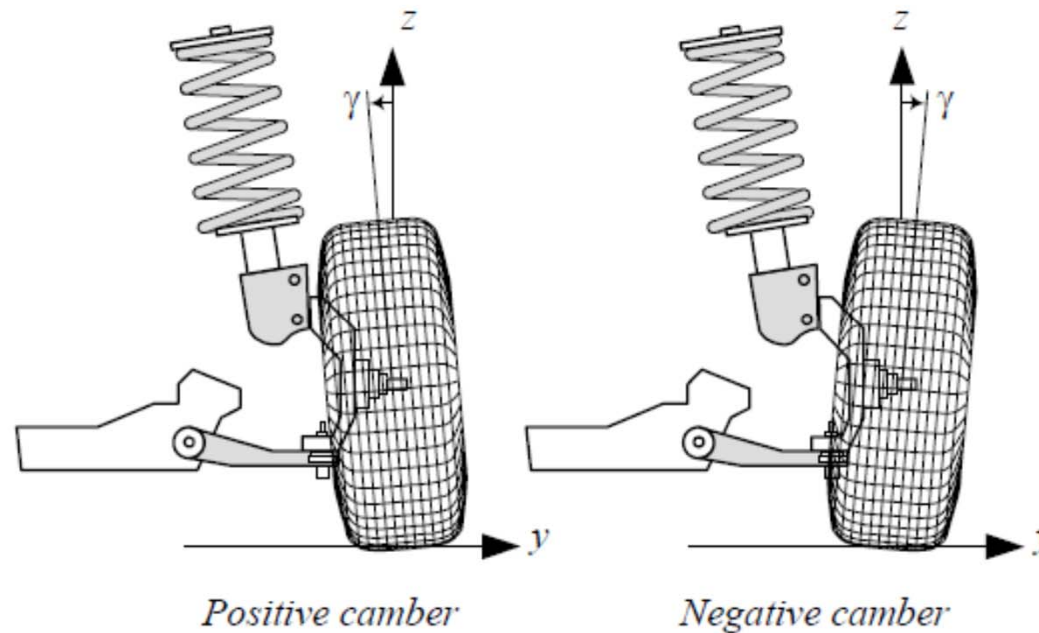
Toe settings affect three major performances: tire wear, straight-line stability, and corner entry handling.

Caster angle



Camber

Camber is the angle of the wheel relative to vertical line to the road, as viewed from the front or the rear of the car.



-2° to $+2^\circ$ @ Neutral position

Trust

