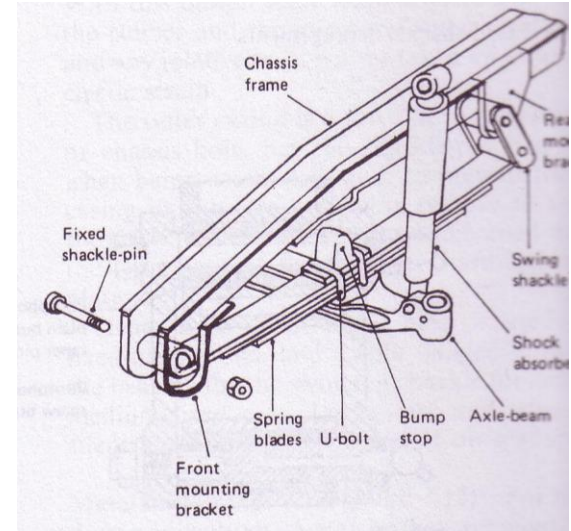




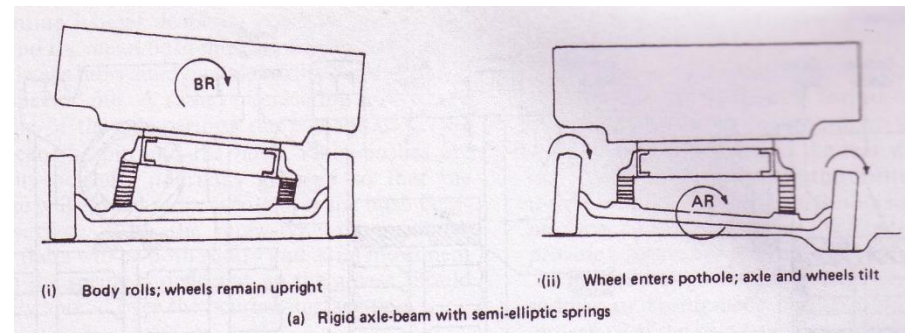
Suspension Systems

Rigid Axle beam Suspension

- Oldest and simplest design
- Rigid solid forged non-drive axle
- Tube-section with half-shafts inside
- Wheels remain at 90 degs to road under normal conditions
- If one wheel enters a pothole, the entire axle tips
- Still used on commercial vehicles



- Advantages
 - Provides cross vehicle stiffness
 - Good grip and pro-longed tyre life
 - Ground clearance does not change with payload
 - Reliable
 - Cheap
- Disadvantages
 - Unsprung weight
 - Wheels linked
 - Package

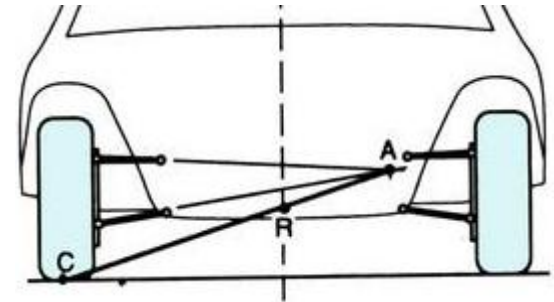


Independent Suspension

- Characteristics

- Roll Centre

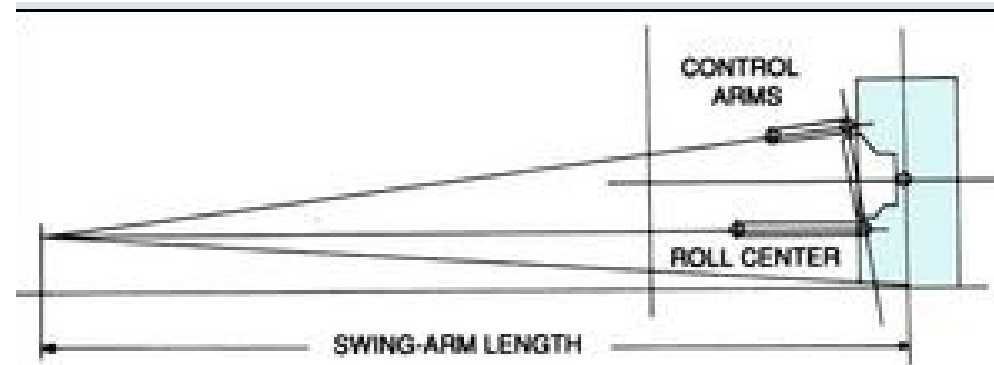
- Imaginary point about which the car rolls
- Amount of roll experienced by vehicle depends on roll centre relative to cog.



Calculating the roll centre for a double wishbone suspension

- End-view swing arm length

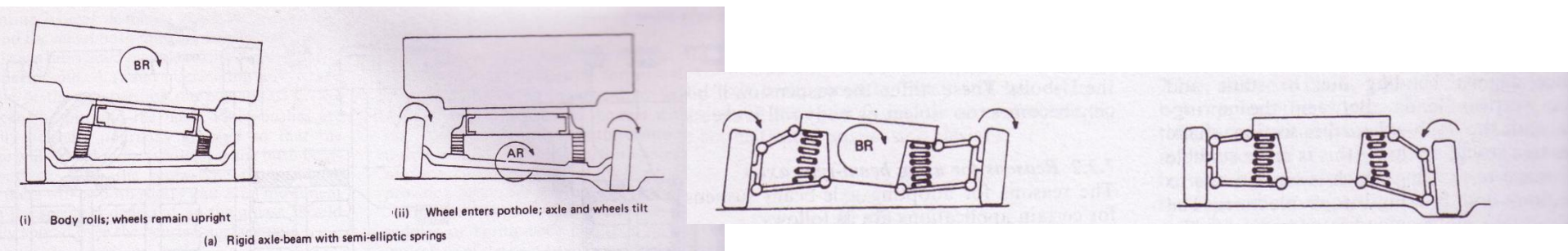
- The shorter this length
 - the greater the track change with vertical movement.
 - The greater the camber change with vertical movement.



Benefits of independent suspension

Benefits

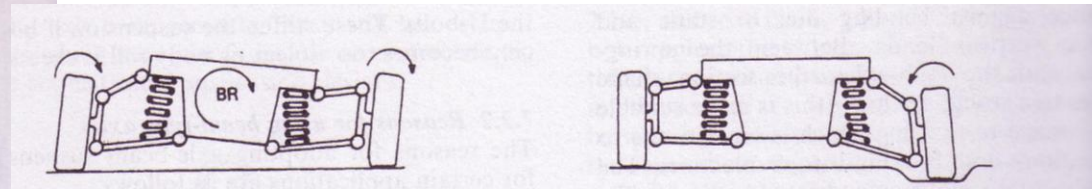
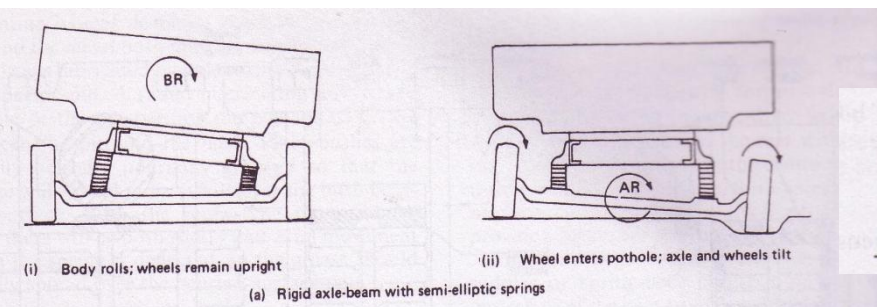
- Springs can be placed further apart meaning softer springs can be used resulting in the same body roll but with less road shocks being transmitted.
- Coil or torsion-bar springs are lighter for the same elastic strain energy
- Driving, braking and lateral forces are separated from the springs by the suspension linkage
- Unsprung weight is reduced so the wheels follow the road better
- Used with an anti-roll bar even lighter springs may be used
- Less interaction between wheels
- Wheels can move vertically
- Engine and thus c.o.g. can be lowered
- Roll centres can be lowered



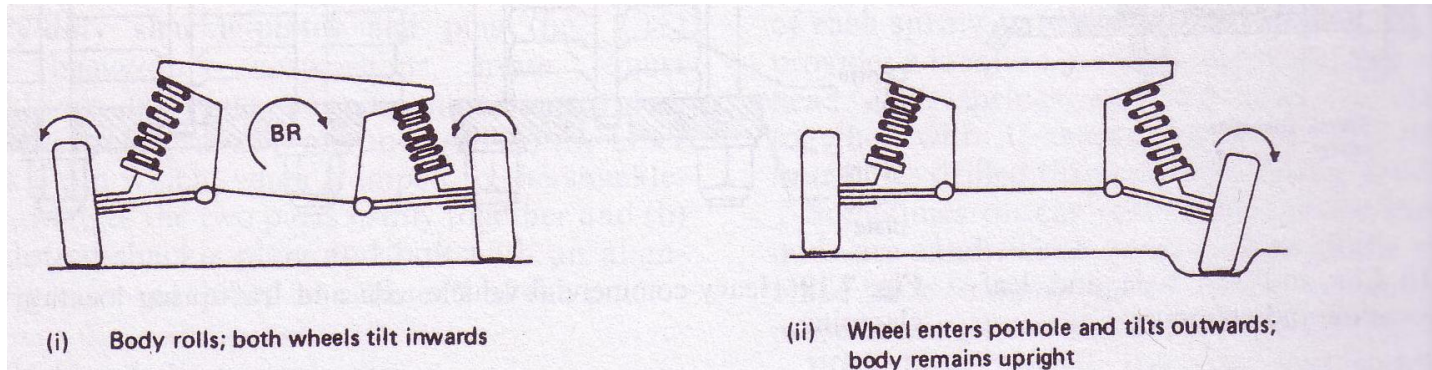
Limitations of independent suspension

Limitations

- When one wheel bounces there will be a slight change in wheel track
- More rigid chassis required
- More complicated (joints etc)
- Unbalanced wheel effects transmitted to driver are more pronounced
- Steering geometry alignment is more critical and need more frequent servicing



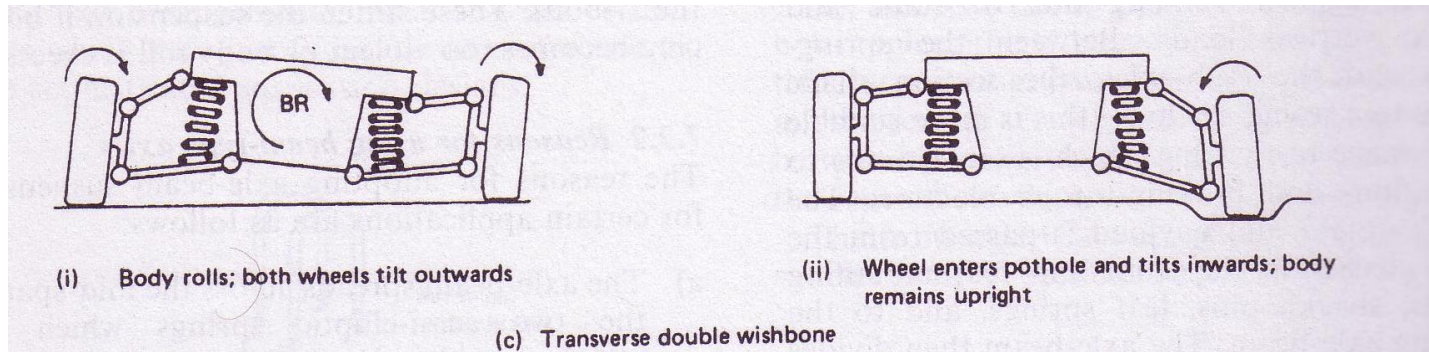
Basic types of independent front suspension



Independent short swing arm

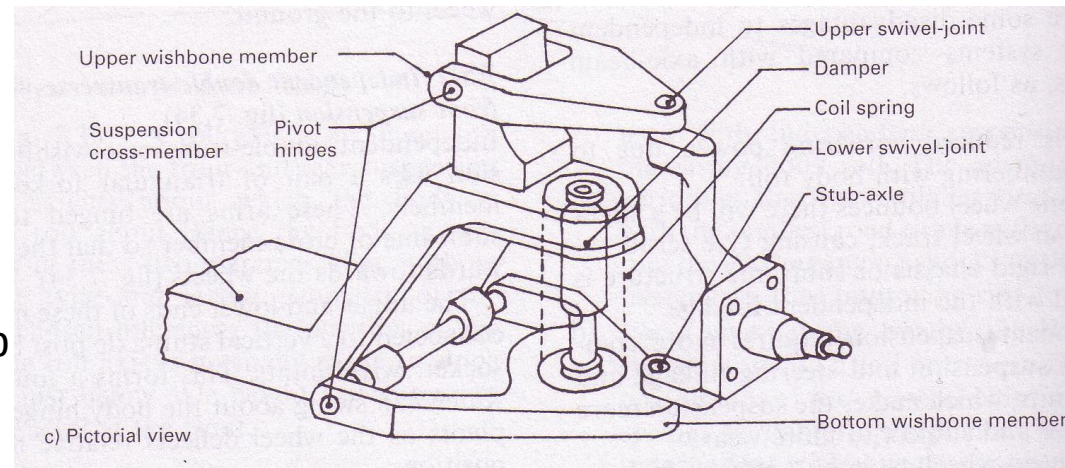
- Simple
- One transverse arm (wishbone member) held rigid on wheel and pivots on body
- Spring takes vehicle weight, swing arms support side forces and reactions
- Wheels lean into a turn
- Wheels are completely independent
- Body height remains level if wheels drop into hole
- Wheel uprightness changes significantly if swing arm rotates

Basic types of independent front suspension



Transverse double wishbone

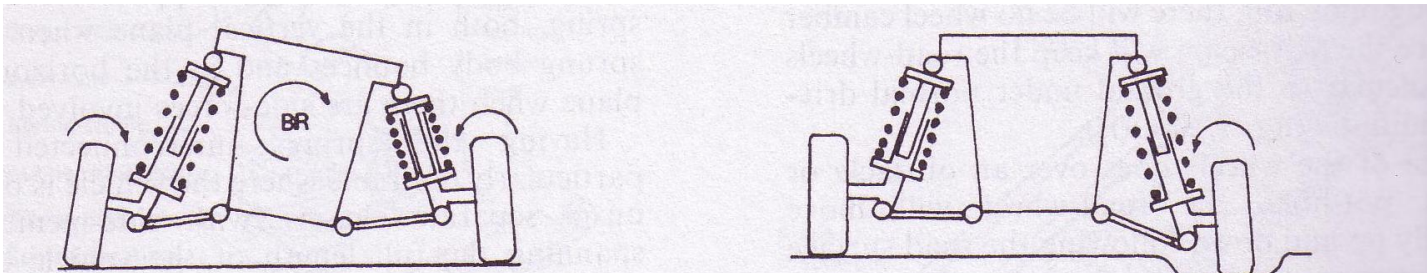
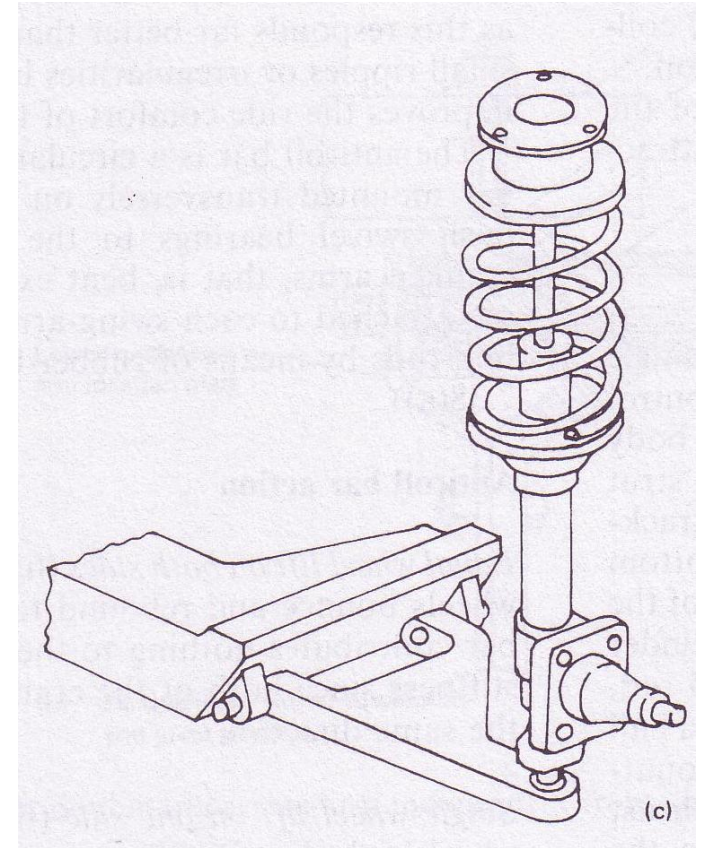
- A pair of triangular forked wishbones connected to a vertical stub axle forming a four bar linkage
- Spring and damper connect lower wishbone to body. Wishbones provide pivot for stub axle.
- Wheels lean out of a turn
- Wheels are completely independent
- Body height remains level if wheels drop into hole
- Upper wishbone skewed to cause rearwards movement as the wheel rises
- This increases the caster angle and steering stability



Independent Front Suspension Terminology

MacPherson leg-strut

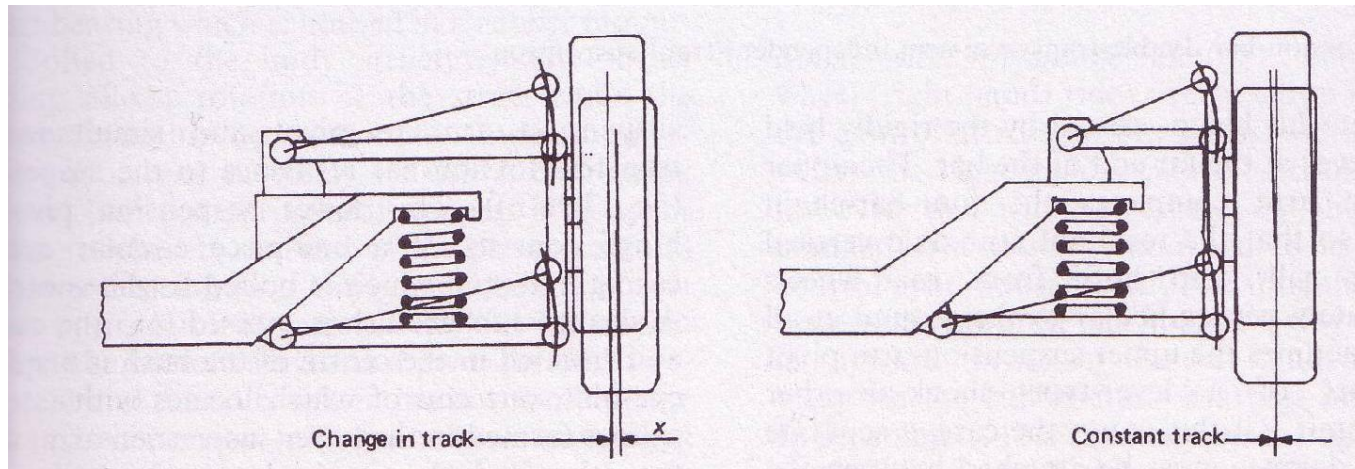
- Track control arm hinged to body and connected to stub-axle by a ball and socket joint
- Upper part of stub axle is spring/damper which is then connected to the body
- Both wheels lean toward the car in a turn
- Both wheels act independently



Independent Front Suspension Terminology

Constant track unequal length wishbones

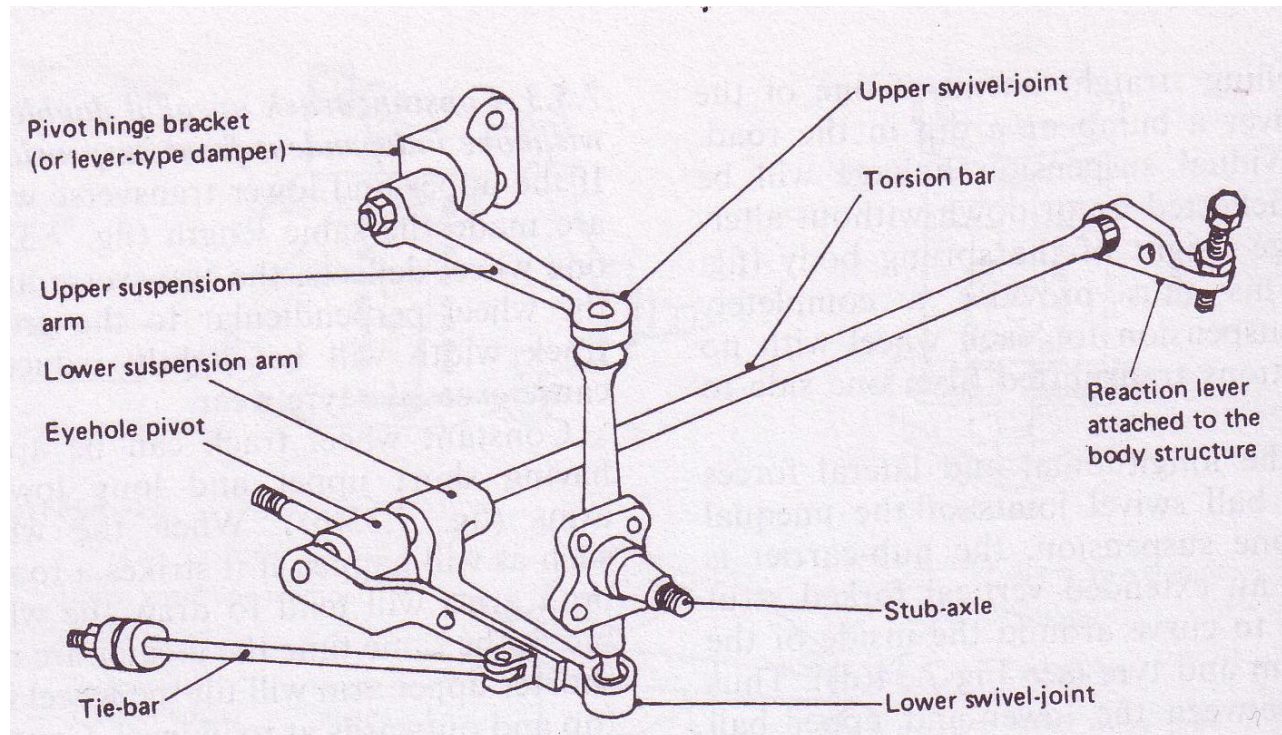
- If the upper and lower arms are equal length the wheel remains upright but the trackwidth reduces causing excessive tyre wear
- Fitting shorter upper arms tilts the wheel slightly causing the trackwidth to stay the same



Independent Front Suspension Terminology

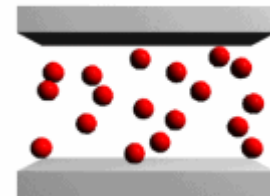
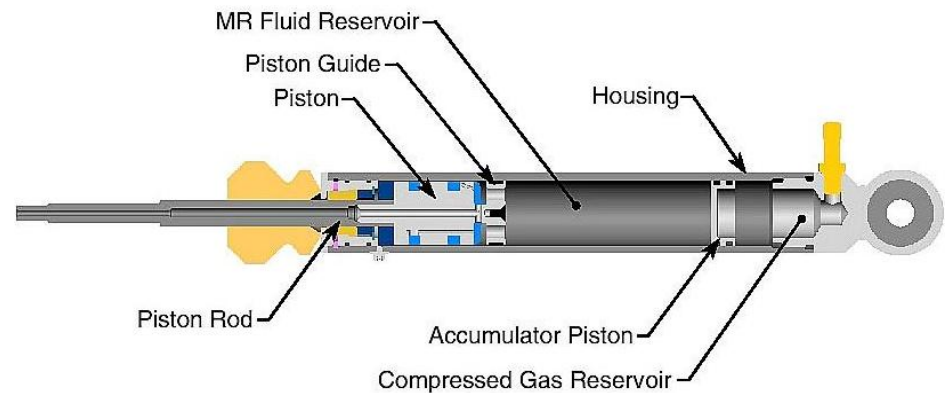
Torsion-bar Transverse double wishbone

- Uses a torsion bar instead of a helical spring
- Simple
- Compact
- Separate damper still needed



Magnetic Dampers

- Iron particles in the damper fluid
- Viscosity of fluid is altered by electric current
- Advantages
 - Easily (retro) fitted
 - Can be electronically controlled
 - Can interface with ABS etc



Notes Adapted from/Further reading:

Autospeed: Front Suspension Designs. <http://www.autospeed.com/cms/article.html?&A=2934>

Vehicle and engine technology. Heinz Heisler