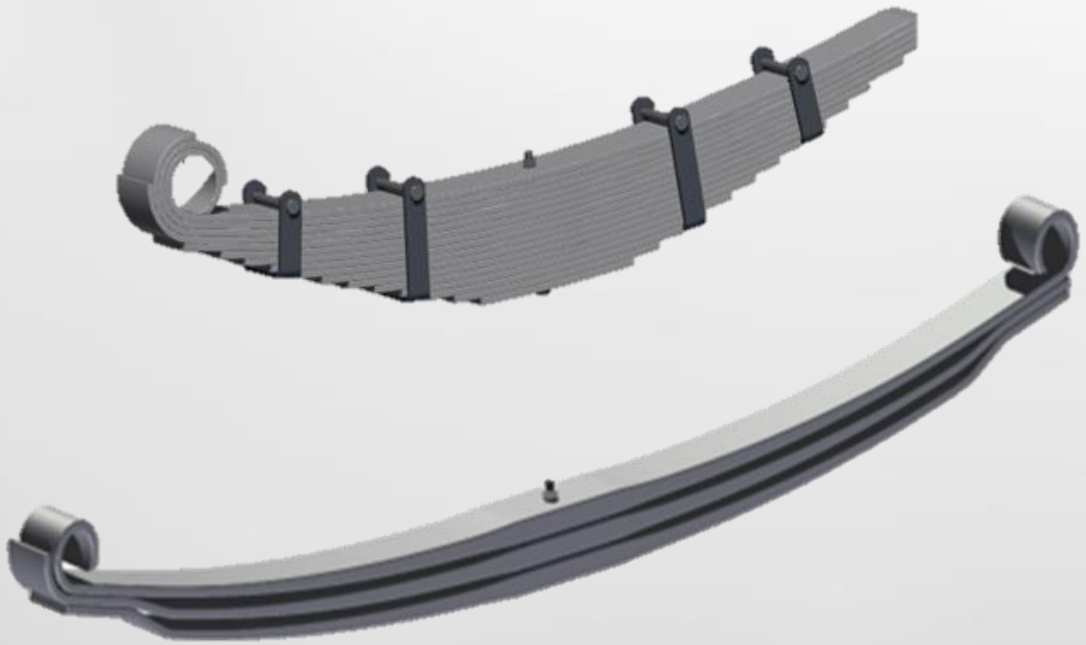
KEY DIFFERENCES BETWEEN MECHANICAL AND AIR SUSPENSION

Comparison Of Suspension Systems

Mechanical:

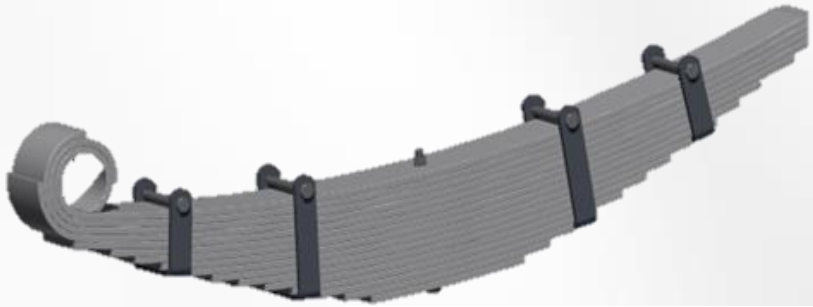
- Leaf suspension
- Parabolic suspension



Air Suspension:

- Fabricated
- Spring Steel

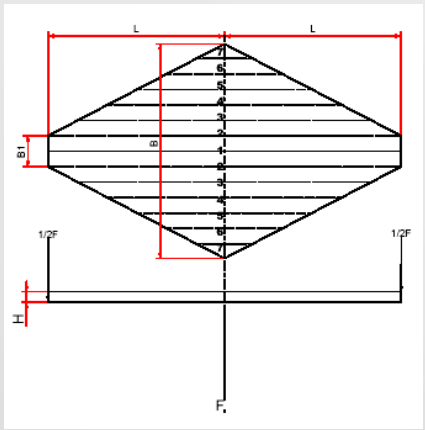
Leaf Spring

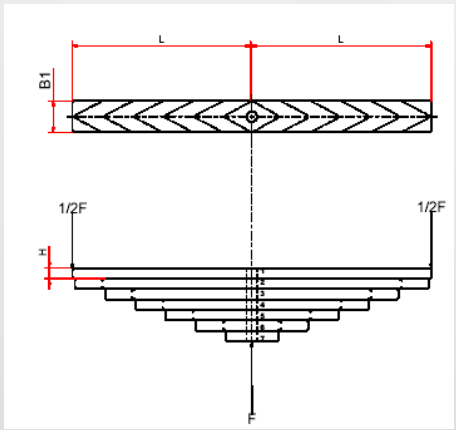


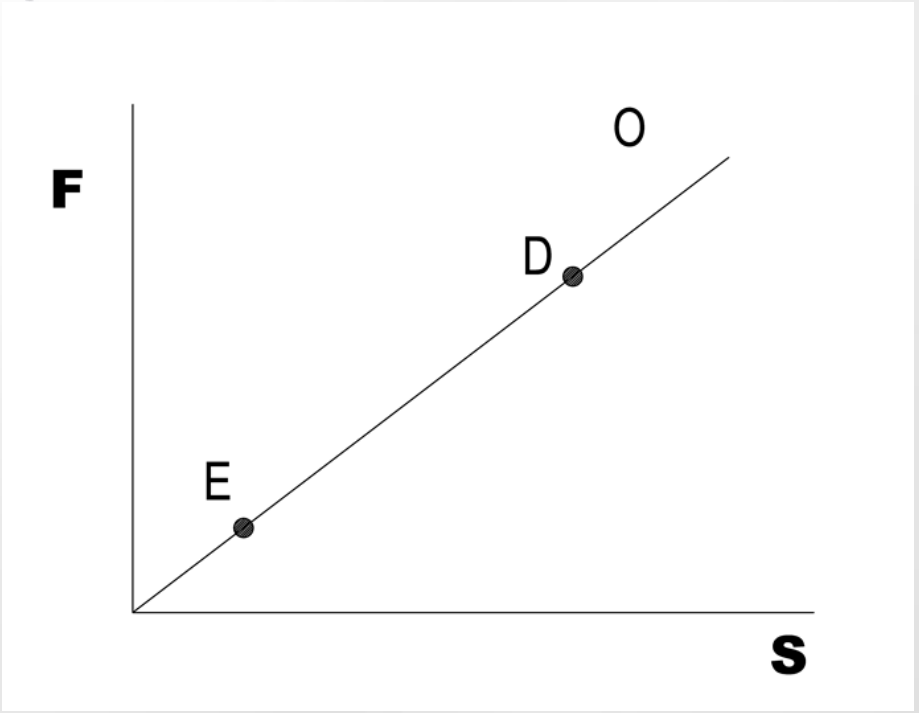
Leaf spring Characteristic

- Frequency is dependent on the load
- Empty: Too stiff
- Overload: Too Weak

- Diamond shape of loose blades/ leafs.
- As a package it generates high friction



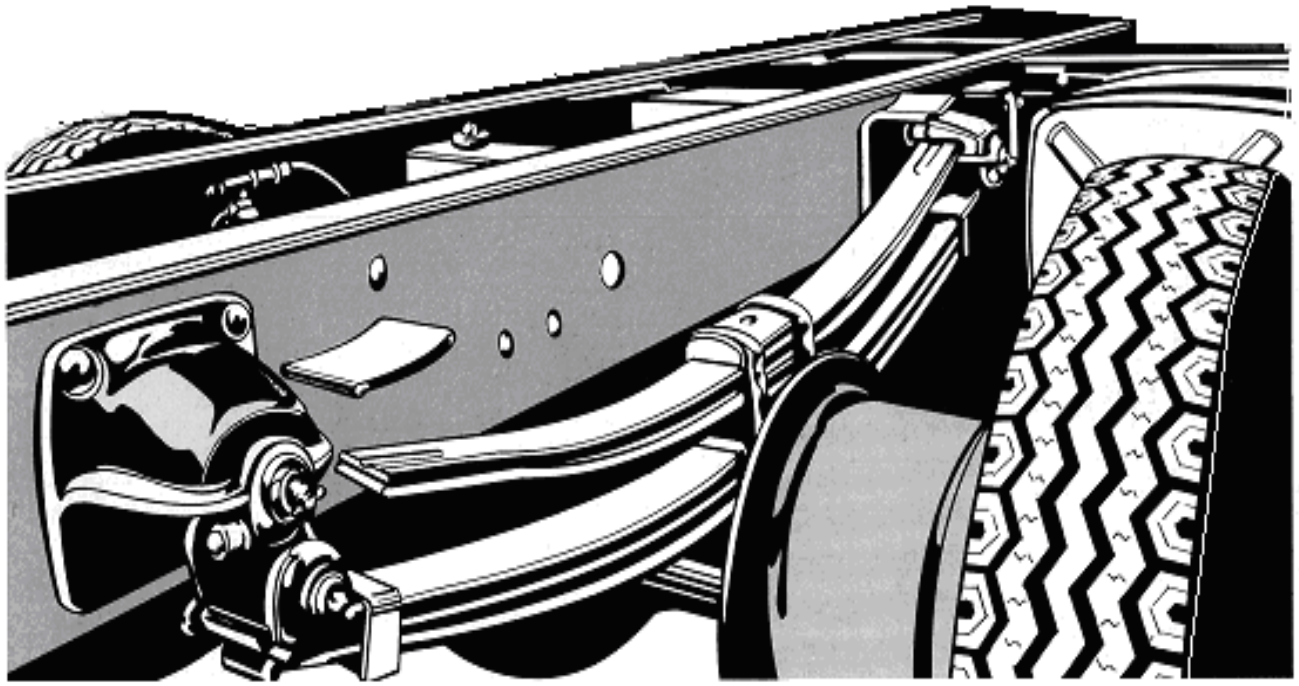




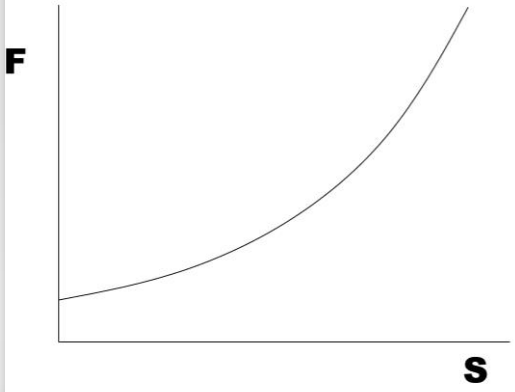
F= Load
S= Axle travel = deflection of spring
E= Empty
D= Design load
O= Overload

Parabolic Spring

- Thickness not constant (parabolic).
- No contact of leaves.
- Less leaves, with same length.
- So less friction.

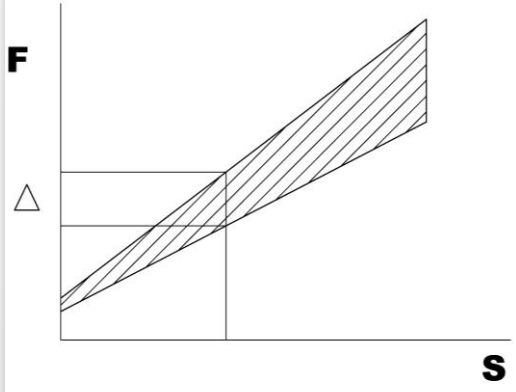


Spring Characteristic



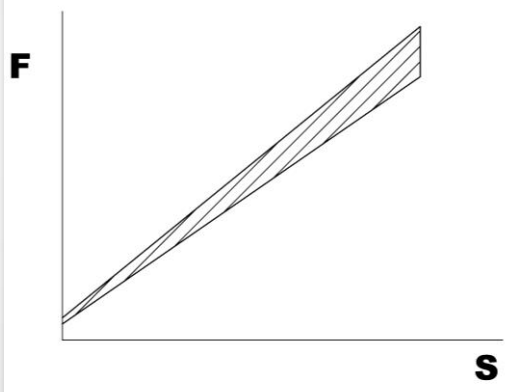
Ideal characteristic

- Mono frequent (does not exist).



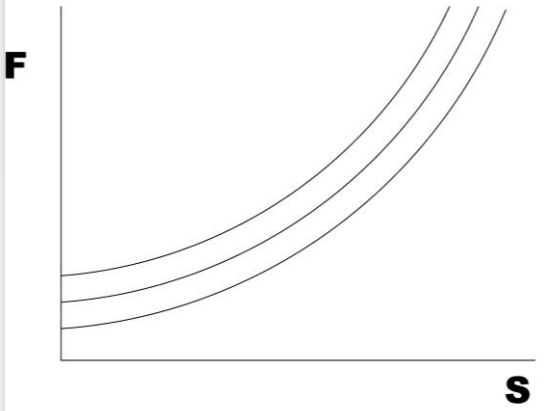
Multi leaf

- High friction (static): first a high threshold before flexing.
- Moving friction is less.
- This is the opposite of what is wanted.



Parabolic

- Less friction so more comfort.
- A shock absorber is mostly needed.



Air Suspension

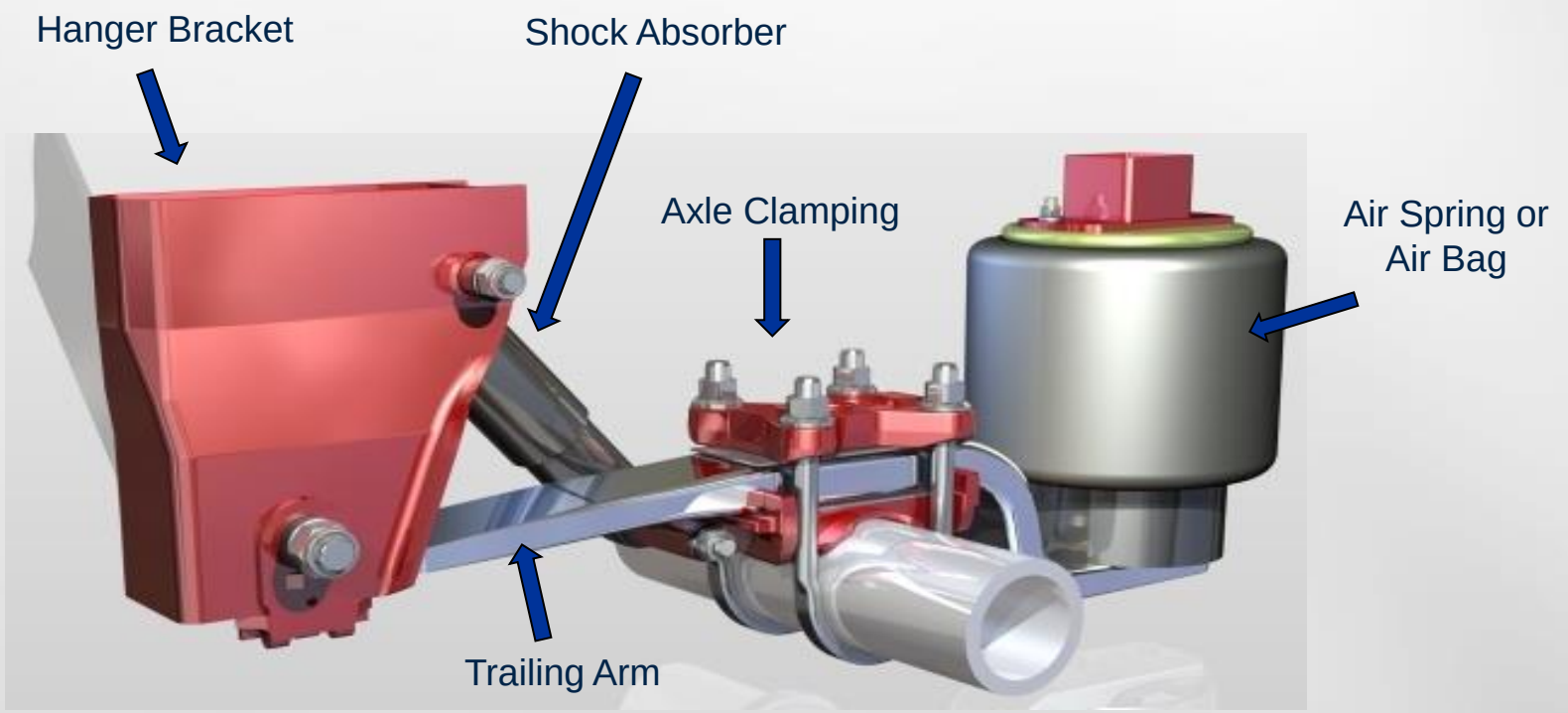
- Almost mono frequent. (Every load another pressure is available!)
- A good ride unladen, laden and even overladen.
- Especially for vehicles with different laden / unladen condition.
- No friction so a shock absorber is needed.

F= Load

S= Axle travel = deflection of spring

Air Suspension

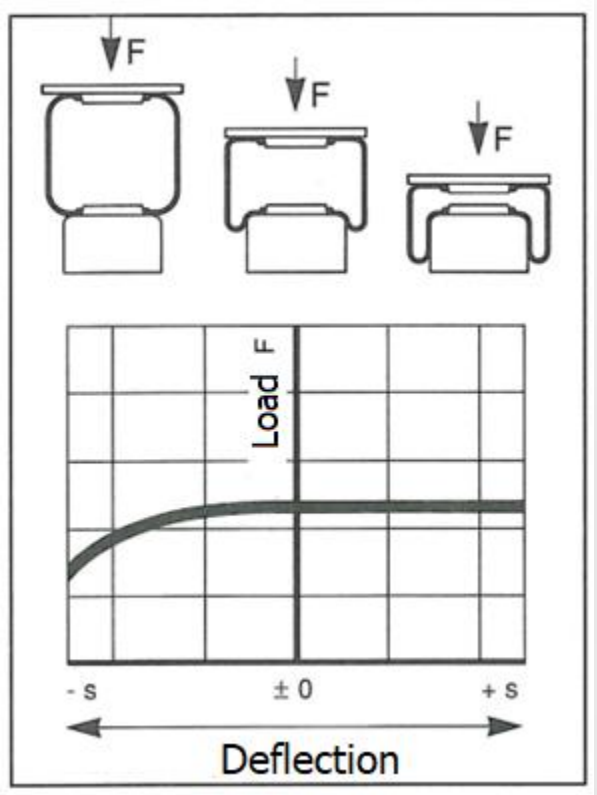
- Both spring steel trailing arms keep the axle in position and can rotate in the hanger bracket.
- The axle clamping needs to be strong and without movement.
- The air spring acts as a spring and is carrying most of the load!

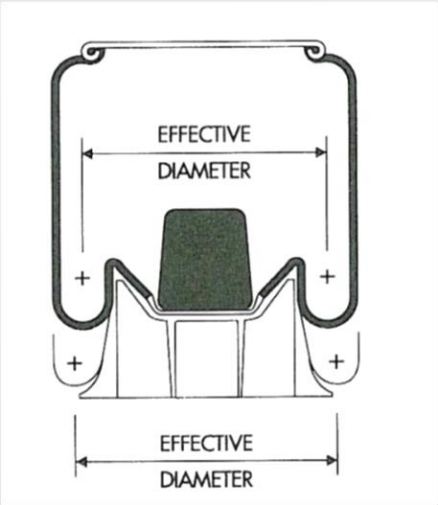


Air Suspension

The Air Spring or Air Bag is the official spring

- The air spring is carrying the load.
- Pressure is related to the force (F). *(Axle load)*
- Determines stroke of suspension.
- Rolling sleeve rubber rolls over piston.
  - Same Effective Area (Ae) as long as rubber is rolling over the piston.

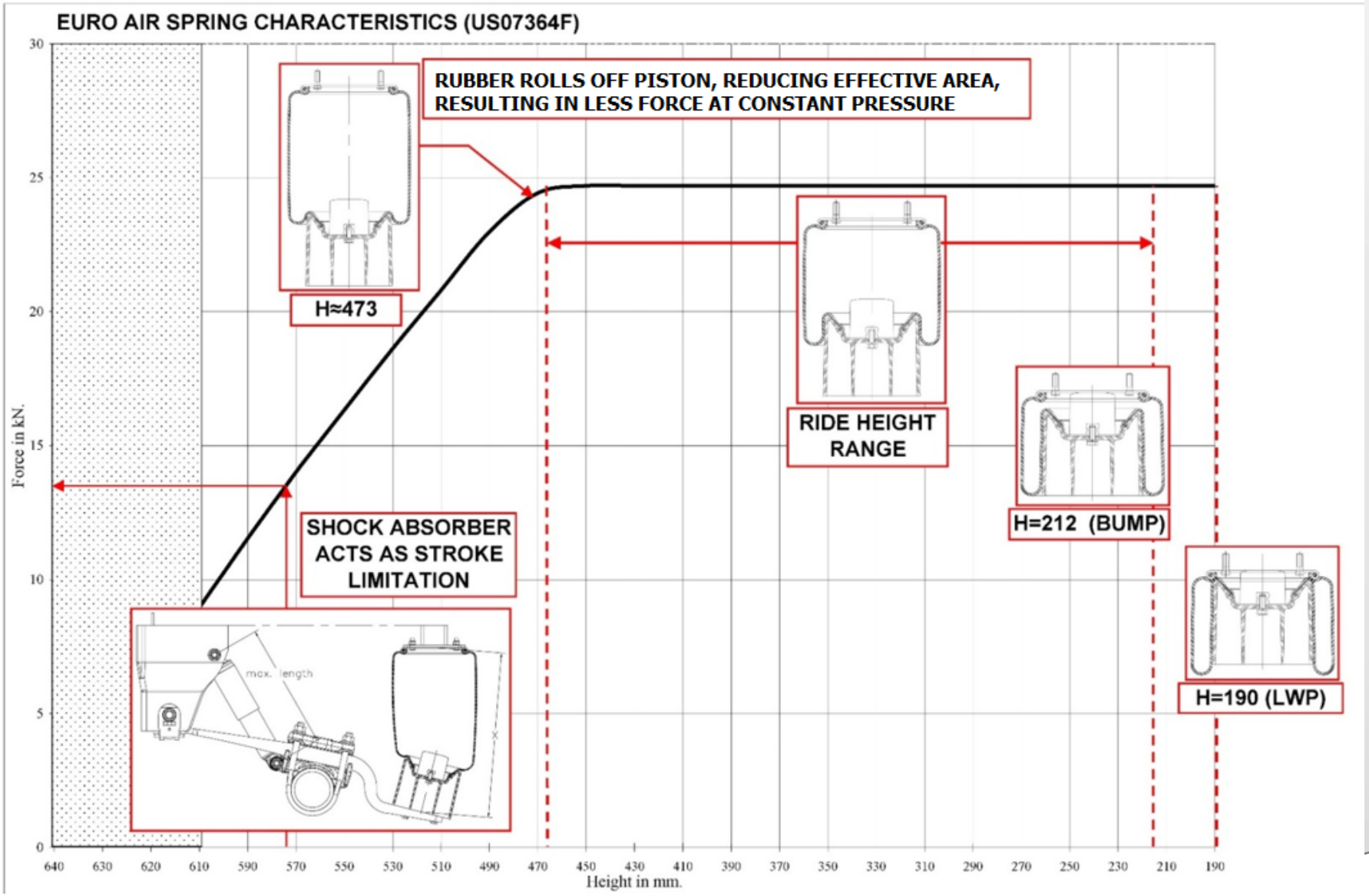




- Min height = internal bumper.
- Max height = max rubber length = internal stresses in rubber.
- Limited by shock absorber (later).
- Cannot hold lateral forces.
- Cannot hold axle in position.
- Has no friction and needs a shock absorber.

Air Suspension

Air Spring characteristics

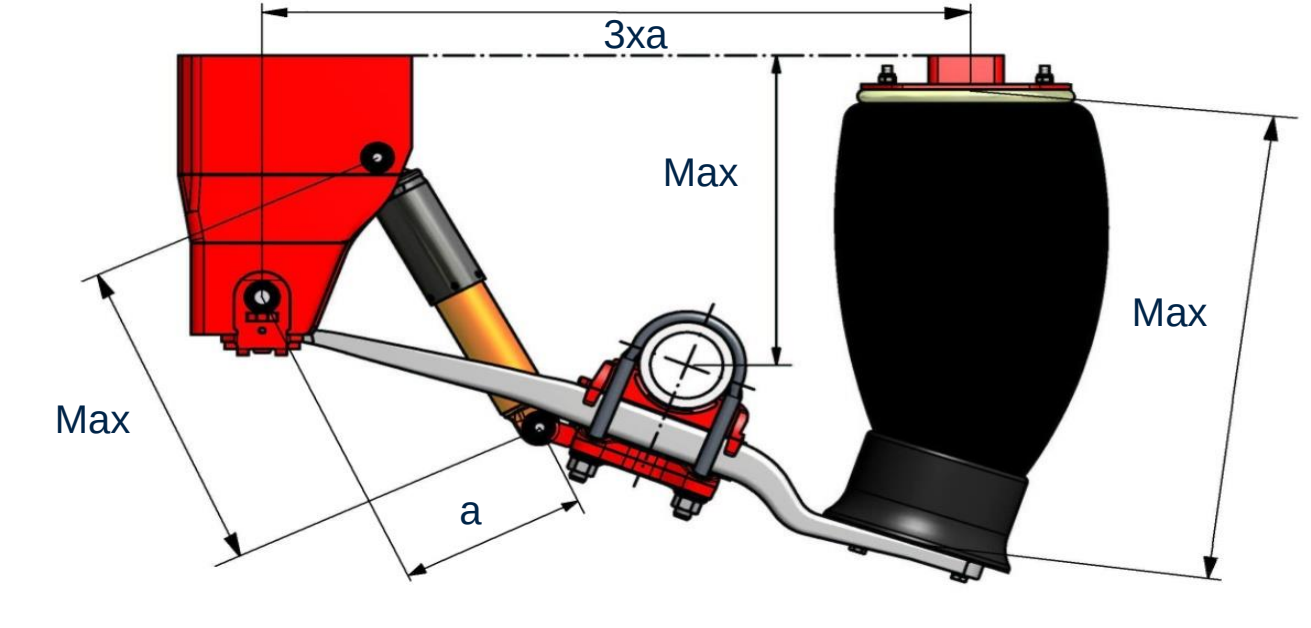


Air Suspension

Stroke Limitation

- The shock absorber limits the maximum stroke of the suspension and therefore will avoid damage to the rest of the suspension.

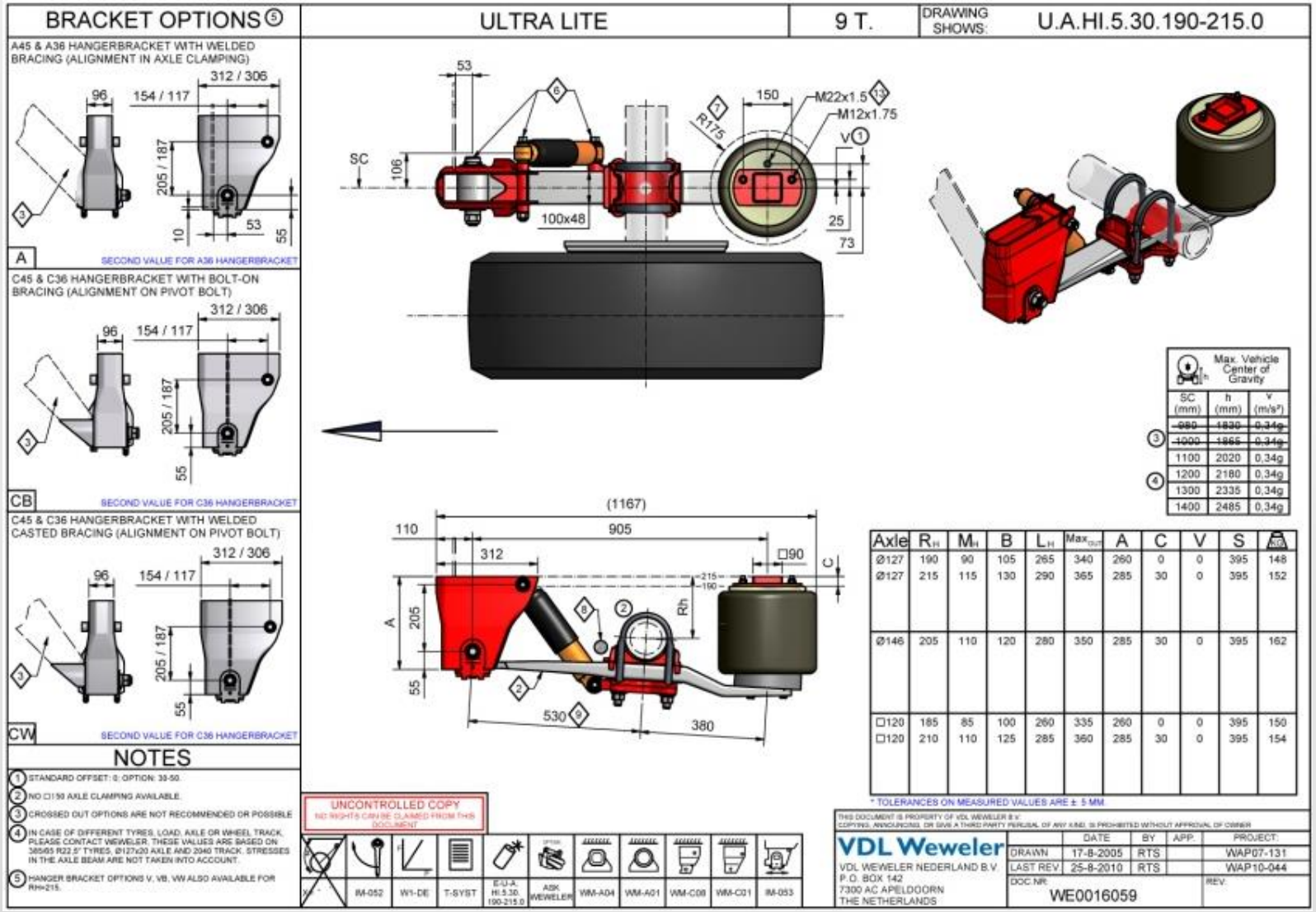
- Max. air spring height related to maximum shock absorber length.



It is important is to understand that the hanger bracket height is related to air spring pedestal. You cannot change one without the other.

Air Suspension

Important dimensions on VDL Weweler system drawing(s)

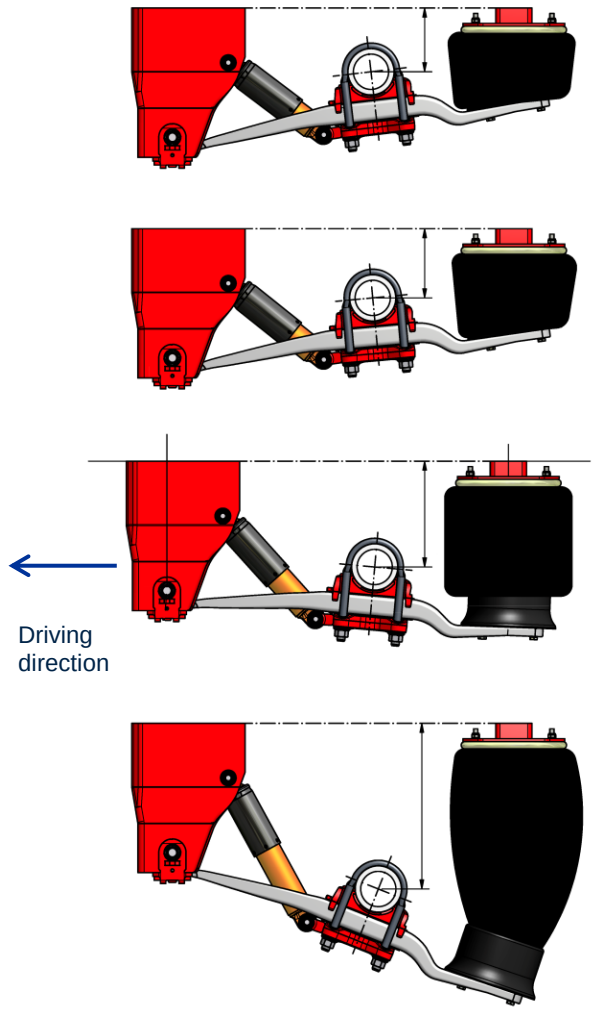


- RH = Ride height
- B = Minimum height at bump
- Mh = Minimum height laden
- Lh = Height when raised
- Max out = maximum height

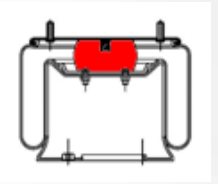
- A = Height of hanger bracket
- C = Height of air spring pedestal
- V = offset air spring
- SC = spring track

Air Suspension

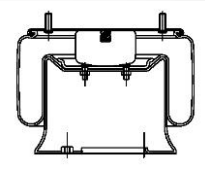
Total movement



- Mh = Laden without pressure
  - Including deflection bump



- B = Bump-contact
  - Lifted position

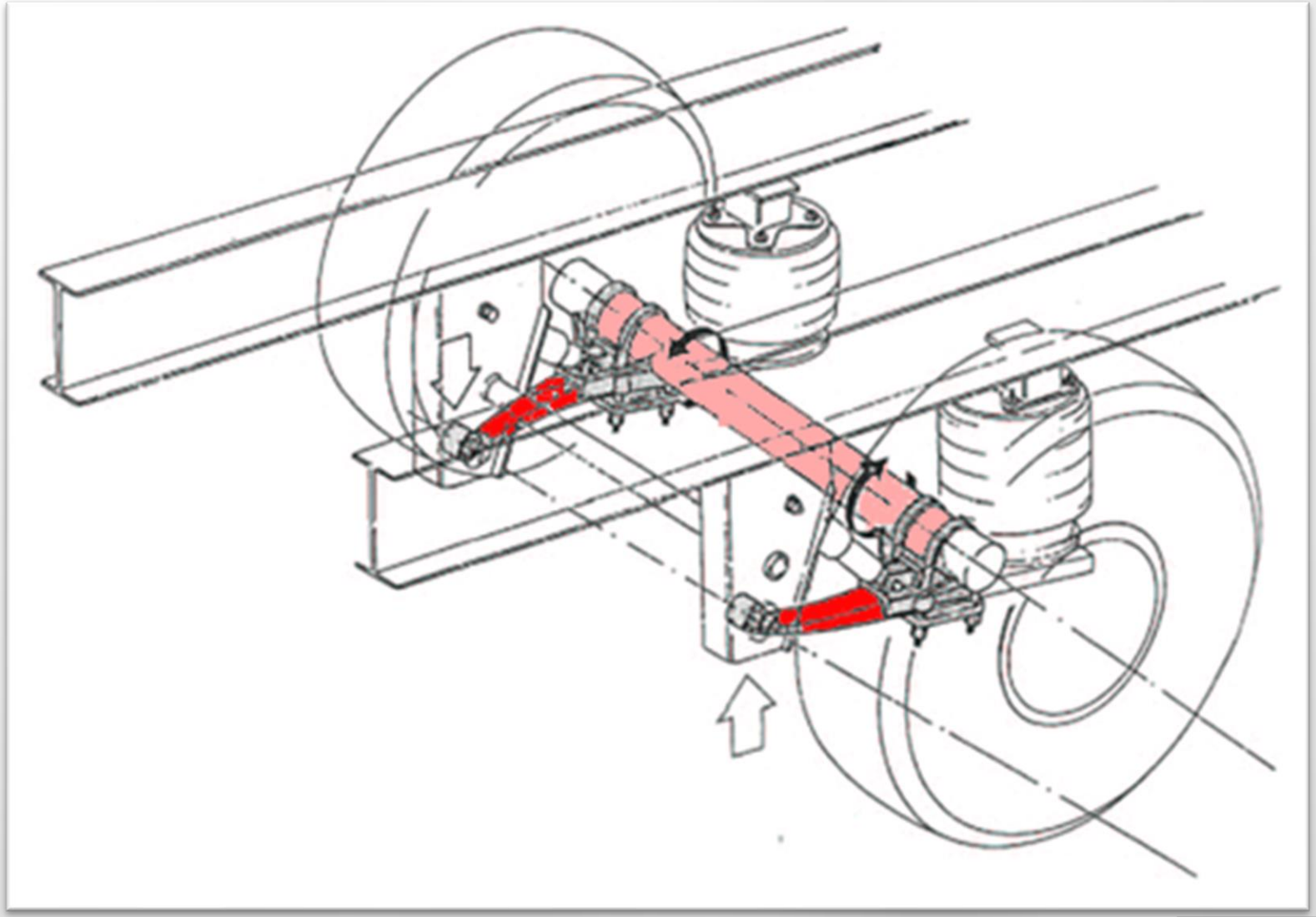


- RH = Ride height
  - Normal driving position
- Max out = Max. height
  - Shock absorber max length = stroke limitation

Air Suspension

Spring Steel Trailing arm(s)

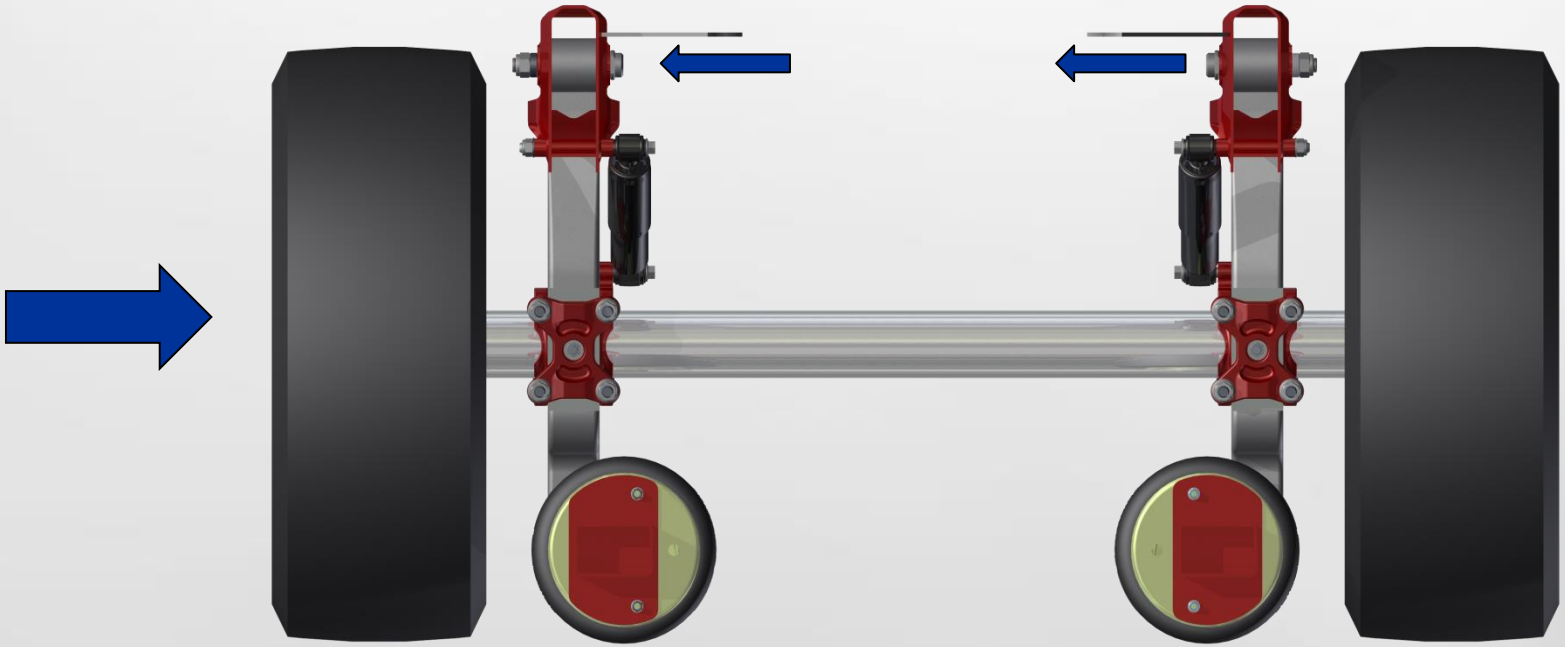
- Trailing arms are flexible and have a parabolic shape to assure equal stresses.
- Two flexible trailing arms act like U- shaped anti-roll bar.
- Roll stiffness is mainly determined by stiffness of trailing arms and spring track.
- Round tube better regarding torsional forces.



Air Suspension

Side forces

- Via axle clamping to pivot bolt, through bracing of hanger brackets to chassis.
- So correct axle clamping and bracing is essential!

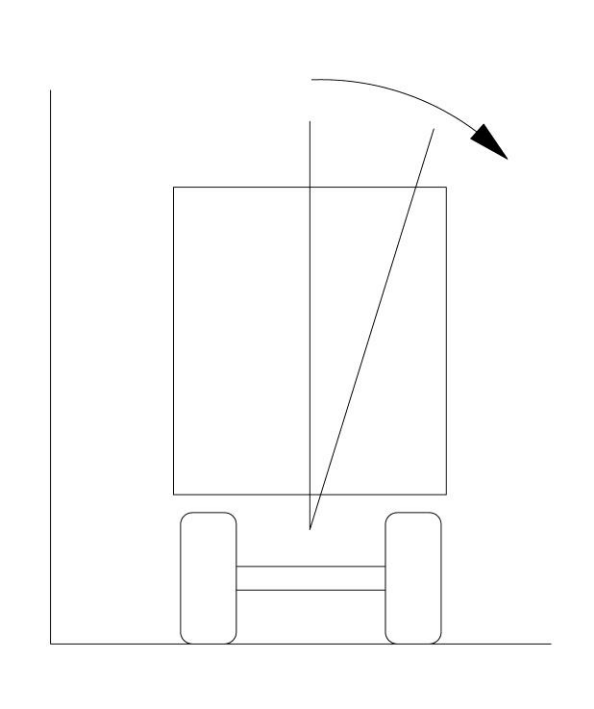


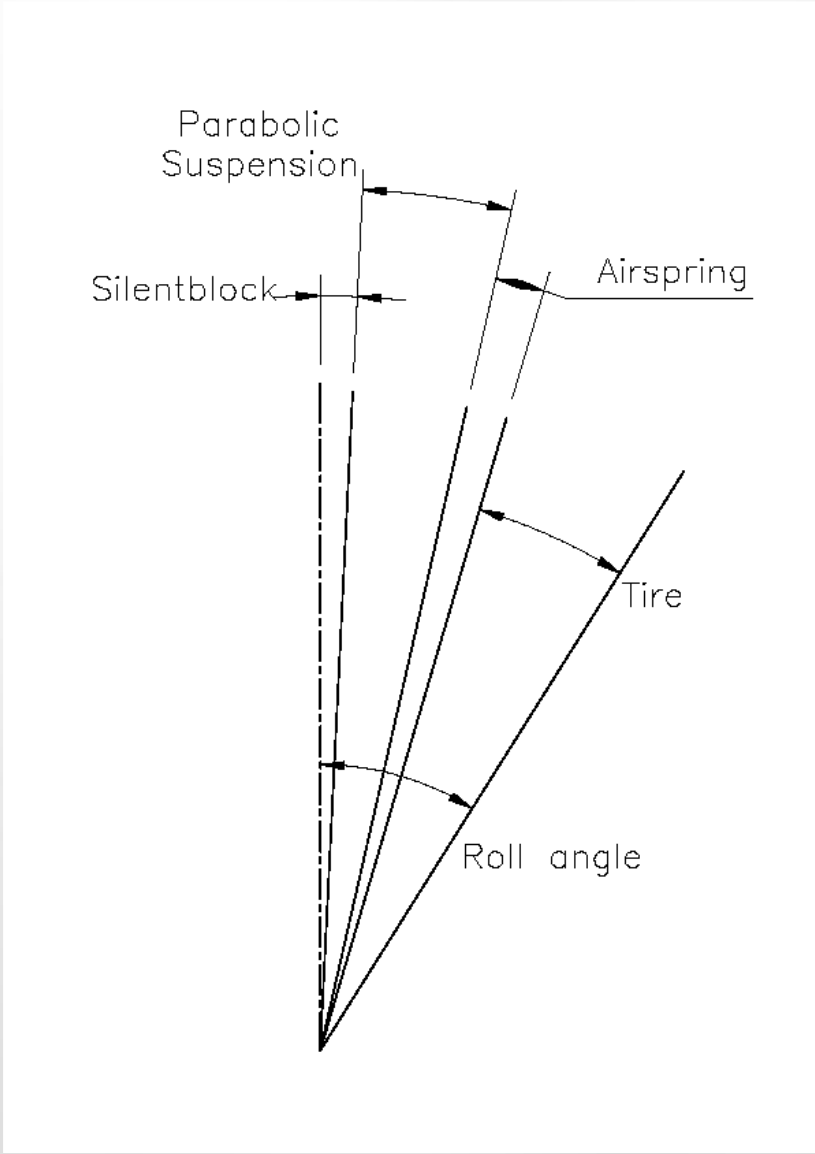
Air Suspension

Roll Behaviour

Roll of vehicle

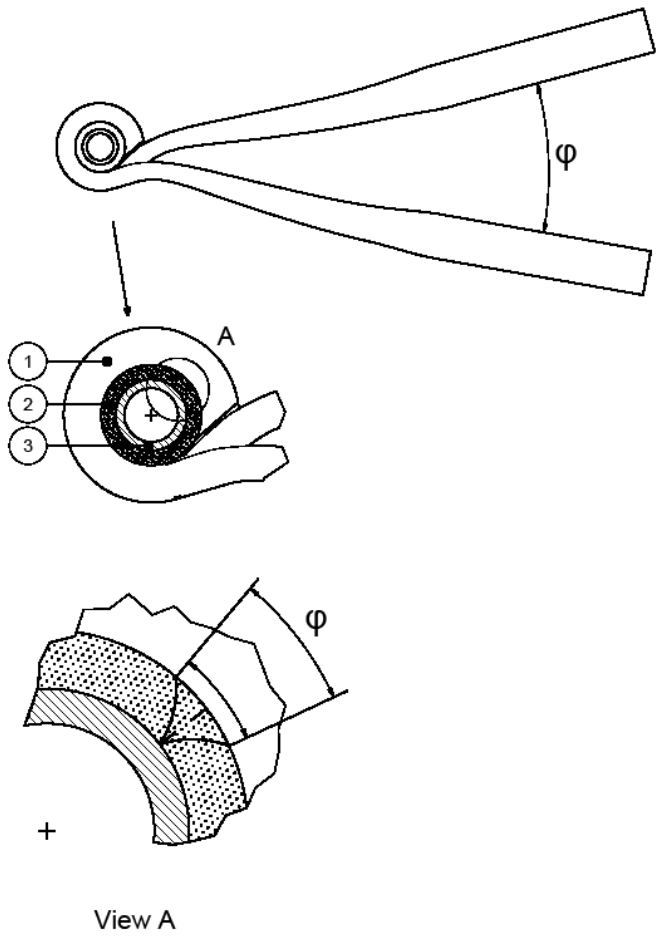
- Roll angle 50% by tire
- Air spring is approx. 10%





Air Suspension

Silent Block or Pivot Bushing



Trailing arm rotates around pivot bolt.

1. Spring eye
2. Rubber bush
3. Steel inner bush

The rubber silent bush acts like a bearing.
The steel inner bush should never rotate!

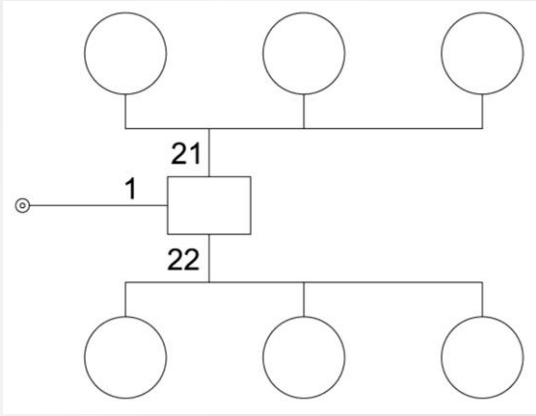
- Therefore it is important the torque setting of the pivot bolt is high and correct.
- Torque at ride height!!
- The rubber may not be pre-stressed at ride height.
- This is the same for setting the shock absorber bolts.
- Tool to be used during torque setting pivot bolts if pre-assembled.

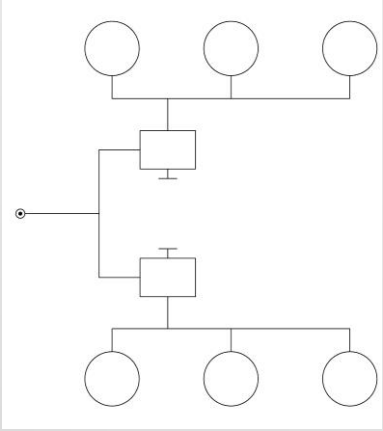
Air Suspension

Levelling Valve helps with Constant ride height (RH)

Standard single levelling set-up.

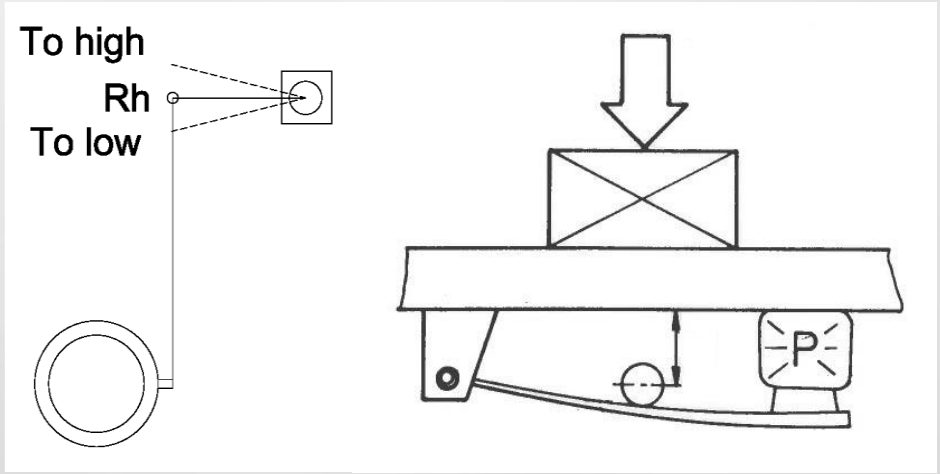
- Separates Left / Right.
- Connection between 1 and 21 and 22.
- Internal throttle between L R to avoid airflow during cornering





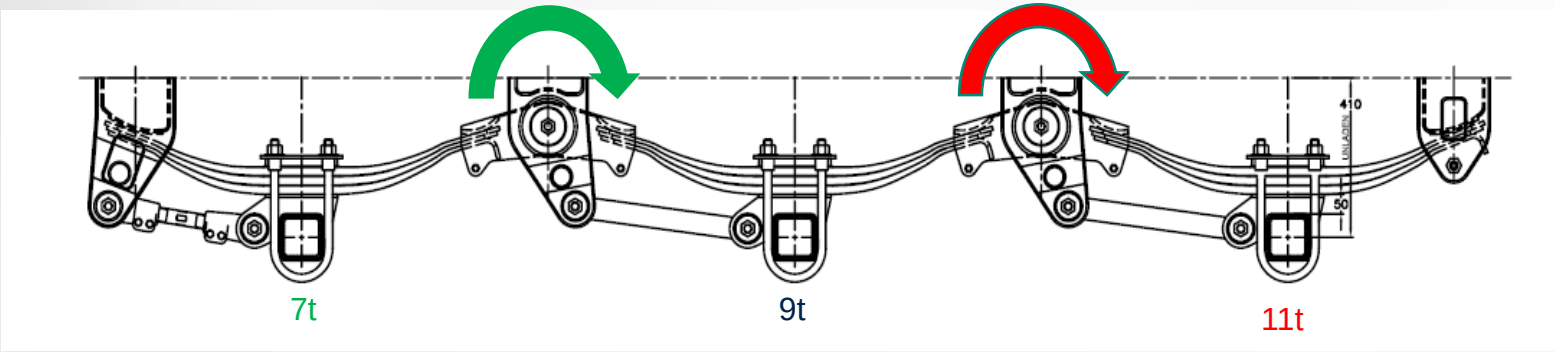
Special double levelling valve set-up

- In case of asymmetrical load
- Animal transport
- Concrete mixer



Mechanical vs. Air Suspension

Mechanical Compensation vs. Air Suspension

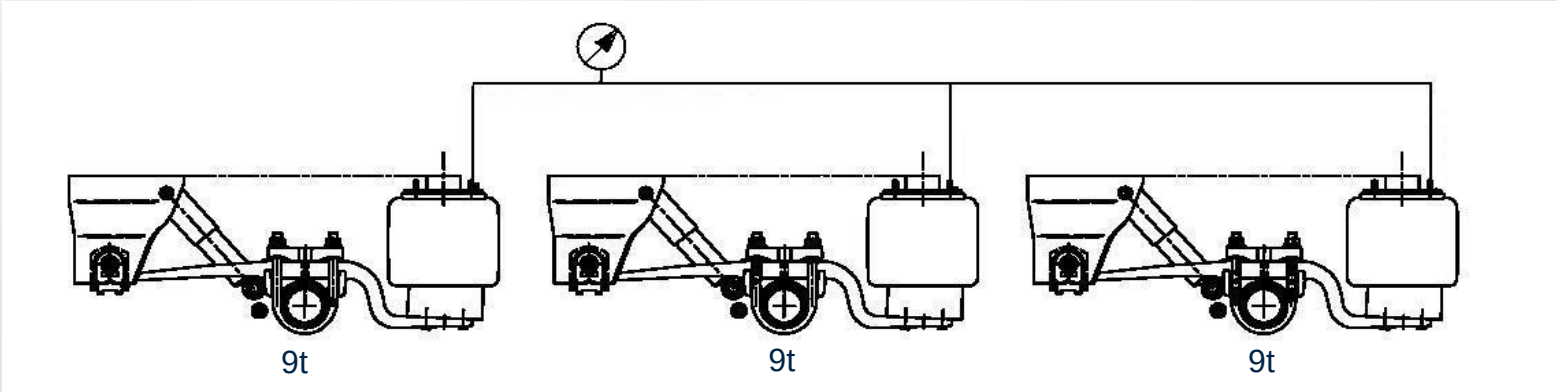


Mechanical suspension

- Multiple axles.
- Mechanical suspension needs equalizers.
- Road unevenness = static load compensation.
- Braking: no compensation!
  - **Example 7 - 9 - 11 ton**.

Air suspension

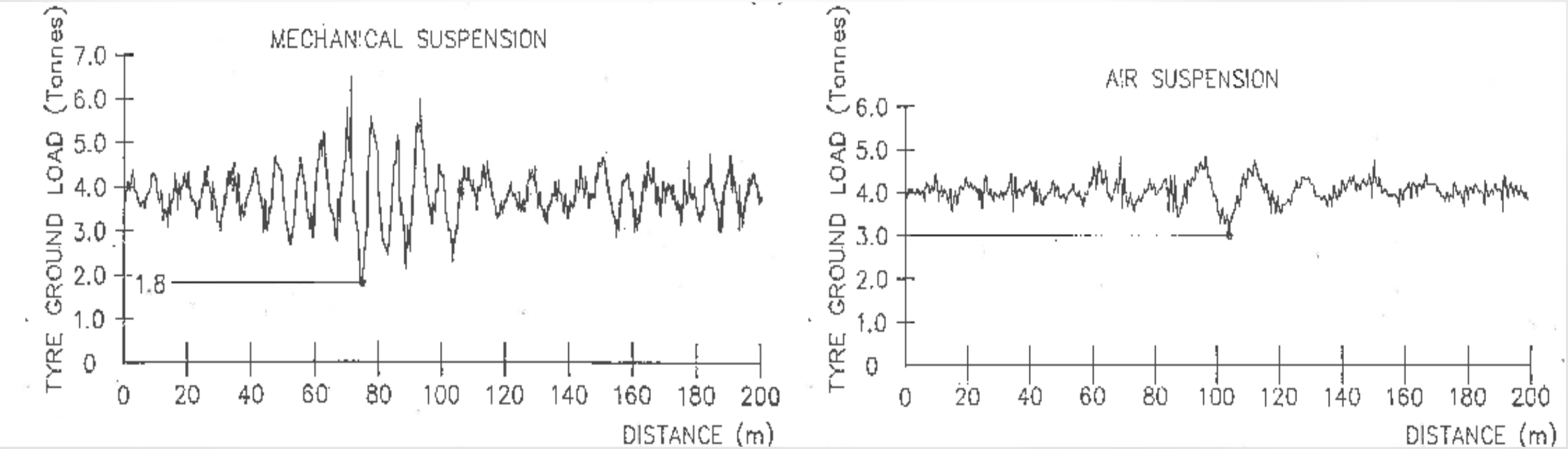
- Static and dynamic compensation, because;
  - **Air springs are connected so same pressure (P).**
  - **Air springs have the same diameter and so same force, same axle load.**
  - **Independent road unevenness and or braking.**



This is why European regulations stipulates that you can have 1t. extra load capacity per axle if air suspension is used

Mechanical vs. Air Suspension

Difference tire – ground load



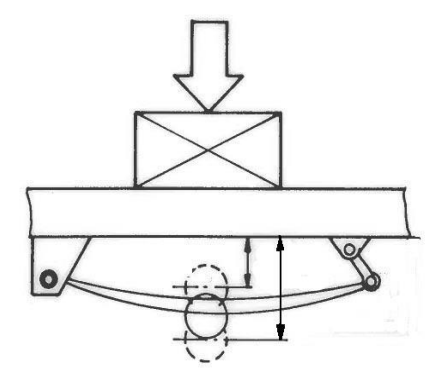
The two graphs are actual tire ground contact load traces measured on Air and Mechanical Suspensions.

Mechanical vs. Air Suspension

Summary

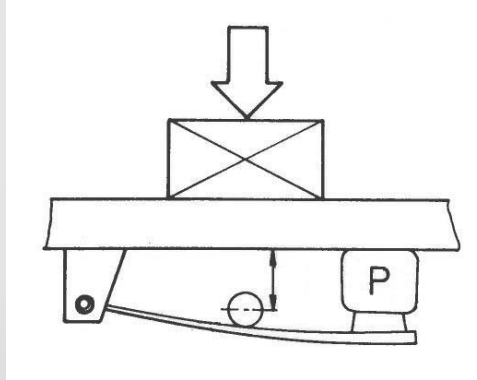
Mechanical suspension

- Ride height determines spring stiffness.
- So determines load.
- Frequency / comfort dependent on load.
- Overload gives bad ride on bump.
- Empty spring too stiff. (high frequency)
- Optimum spring designed for a certain load (front axle truck).
- A soft ride spring needs extra anti roll bar.
- Friction of spring gives undesired comfort level.
- Needs different brake actuators for dynamic compensation.



Air suspension

- Height is constant (by leveling valve).
- Height is independent of the load.
- Always good comfort empty as well as (over)loaded.
- Pressure is varying depending on load.
- Brake signal is directly related to the axle load!
- Needs shock absorber.
- No antiroll bar.
- Compensating static and dynamic.
- Still good ride when overloaded.
- Axles liftable.



Mechanical vs. Air Suspension

Summary

Most important differences

- Mechanical suspension with linear spring rate is optimized around the design load.
- Air suspension is dependent on the air spring pressure and directly related to the axle load, thus giving an optimal comfortable ride in all load situations.
- If rate, empty vs laden is > 3, it is recommended to use air suspension.
- In comparison to mechanical suspension, air suspension has constant ride height due to levelling valve.
- Air suspension is less damaging to; axle, chassis, load and road. Due to this ECE regulations state that extra load can be carried per axle if air suspension is used.