SUSPENSION SYSTEM Introduction

The suspension system connects the wheels to the bodywork. The wheels must remain in contact with the road under all conditions. Suspension systems have a major influence on comfort and handling. Due to the construction of the suspension, the position of the wheels can be adjusted somewhat to the driving conditions. This results in optimum handling. Springs force the wheels onto the road. There are mechanical, pneumatic and hydraulic spring systems. Shock absorbers prevent the suspension system oscillating.
Suspension systems are concerned with sprung and unsprung weight. The unsprung weight must be as light as possible. The system of axles, links and/or arms that connects the wheels to the bodywork is called the suspension. There are independent, semi-independent and dependent suspension systems. When driving, there is a tendency for the wheels to follow the direction that the vehicle is moving. Influenced by side forces, the vehicle can start to 'drift'. Consider here the forces resulting from side wind and the transverse forces that occur when taking bends. When the drift of the front axle is unequal to that of the rear axle, oversteer or understeer is created. When maintaining suspension systems, look for cracks, pivot-point wear and leaks (shock absorbers). Defective parts must be replaced

-The purpose of suspension system is to make the road wheels to follow the ups and down of the road surface. This cannot be totally achieved but the shocks transmitted from the wheels to the vehicle can be reduced by the use of springs.

SPRINGS

-Mounting the axle directly to the frame (chassis) would subject the occupants and general components to severe shocks. A spring fitted between the axle and the chassis (frame) allows the axle and the wheel to move up and down. Without causing similar movement to the frame. The spring absorbs the road shocks and allows the wheel to follow the irregularities of the road surface for this purpose the wheel assembly should be as light.

-Road shocks can be reduced by using pneumatic (Air) tires which acts as spring suspension system can be said to be the mechanism which is fitted between the wheel and the frame. The main items are spring and dampers.

TYPES OF SPRING

(A) Steel springs

(ii) Laminated (leaf) springs

(ii) Helical coil springs

(iii)Torsion bars

(A) Rubber

(B) Pneumatic

1. LAMINATED LEAF SPRING

-The leaf or laminated springs are of different lengths to give even stress distribution. This also allows for varying frequency of spring vibration. The stiffness (rate) of a leaf spring is determined by its.

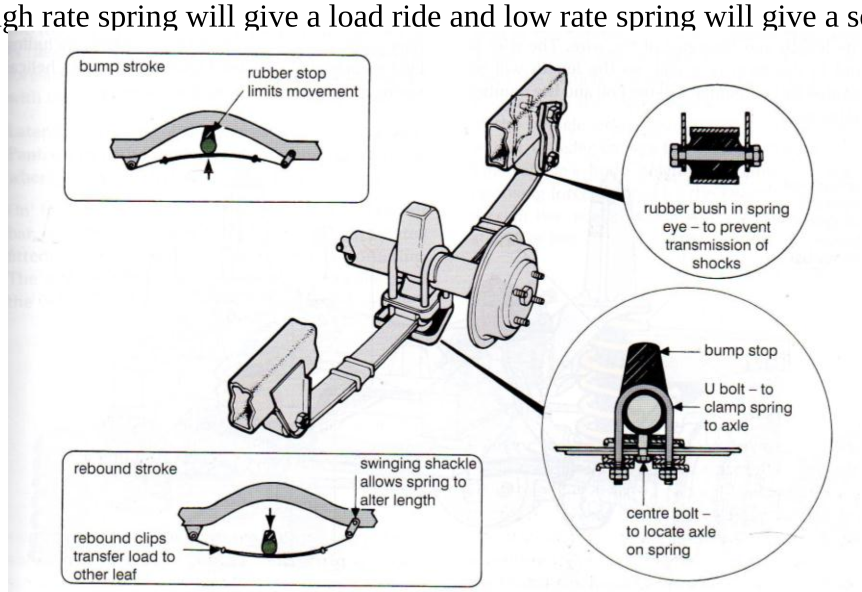
(I) Length-shorter spring give high rate.

(ii) Width-wider springs give high

(iii)Thickness the thicker the leaf the higher the rate.

(iv)No of leaves many leaves give high rate

- A centre bolt is used to prevent the leaf from sliding and two u-bolt is used to hold the springs to the axle, Additional spring clips are used to hold the leaves together and prevent sideways movements and overloaded of the main leaf.
- A high rate spring will give a load ride and low rate spring will give a soft ride.



igure 4.71 Laminated or leaf spring

2. HELICAL SPRING

This type of springs is used with independent suspension coil and torsion bar spring are better than leaf spring in energy storage. The rate of coil springs depends on the length and diameter of the wire used. The spring length is controlled by the diameter of the coil and the number of the coil.

3. TORSION BAR SPRING

This is a straight bar circular as square section fitted to the vehicle frame at one end. The other end is connected by a level or wish bone-shaped member to the wheel.

-Torsion bars are a form of coil spring and their rate depends on the length and diameter of metal used.

4. RUBBER SPRING

Rubber can store more energy per unit weight than any other type of spring materials. When used rubber has the advantages of being a light form of suspension rubber spring may used to act as the main suspension springs. Also rubber can be used together with metal springs to modify the su

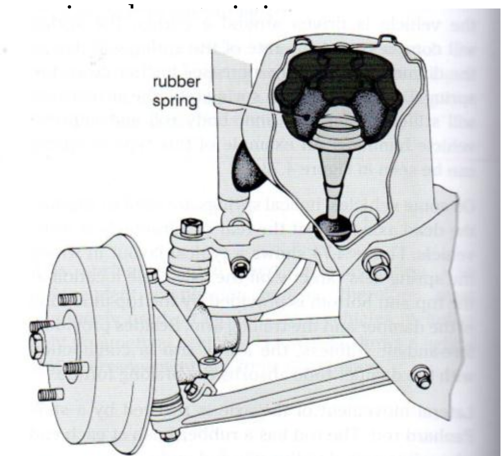


Figure 4.77 Rubber spring suspension

5. AIR (PNEUMATIC) SUSPENSION

The reinforced rubber bellows are fitted between the Axle by the chassis air capacity tank..Air supply to the spring is regulated by leveling valve. This value can be adjusted to maintain a set distance between the frame and ground clearance respective of the load. Instantaneous correction of rebound and roll movement is prevented by delay device in the value. A compressor supplies the reservoir air to maintain a pressure of 550km/m^2.When a load is gradually applied to the chassis. The spring will be compressed and the leveling value opens to the spring.

-This additional air extends the bellows and raises the chassis to the original position thereby closing the value.

ADVANTAGES OF AIR SUSPENSION

1. Constant step height in the case of P.S.V.
2. The stiffness of the spring increases as the increases as the deflection increases.
3. Constant frequency of vibration.

- Metal spring oscillate more rapidly the vehicle is unloaded.

6. HYDRO-PNEUMATIC SUSPENSION

-This suspension differs from the normal pneumatic suspension in a number of ways. The main difference is that the suspension unit is supported by a mass of gas which remains constant irrespective of the load carried by the wheels. The gas pressure increases as the volume is reduced .This means that the suspension stiffness as the load on the wheel increases.

The liquid is used to transmit the force from the suspension piston to the nitrogen gas in a closed container.

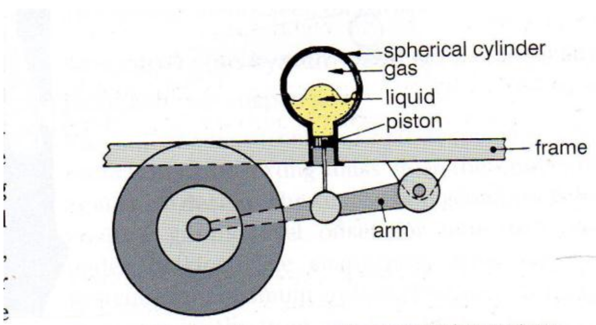


Figure 4.80 A hydro-pneumatic suspension system

DAMPERS/Shock Absorber

-After the initial deflation of vehicle spring oscillation of the chassis on the suspension are set up. Then a series of road bumps can build up a dangerous and uncomfortable oscillation. This oscillation can be damped down by converting their energy into heat energy as by fluid resistance of hydraulic dampers. (The damper restricts a rapid or excessive vibration of the spring mass).

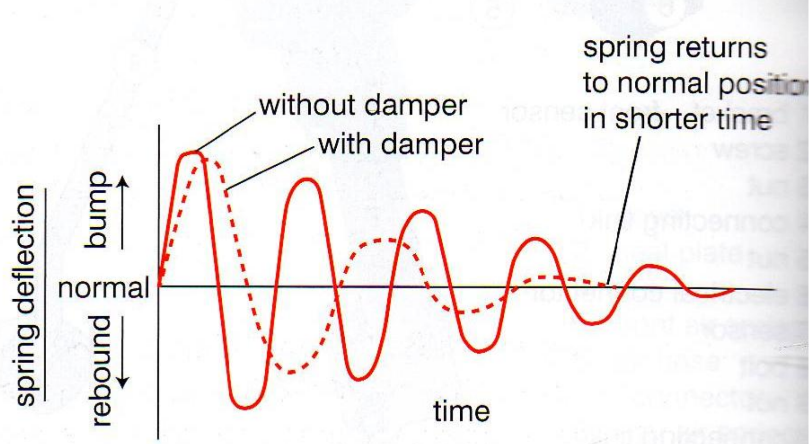


Figure 4.87 Spring oscillation curves

1. **TELESCOPIC DIRECT-ACTING TYPE**

This damper is directly connected between the frame and the suspension members are axle. This layout of this damper has a top and a bottom assembles. The top assembly consists of a dust guard piston rod and piston with valve assembly. The lower assembly consists of two thin tubes which forms the cylinders and reservoir.

-Rubber bushed eyes provide a connection to the frame and axle.

-Bump-: movement of the axle pushes the piston into the cylinder and forces the oil through the valve to the upper part of the cylinders. This makes the volume above the pistons to be less than that below the pistons.

- Then some oil is not now forced out through the base valve to reservoir.

-On rebound, a reverse flow will take place. Résistance to each stroke is government by the valve design and orifice diameter.

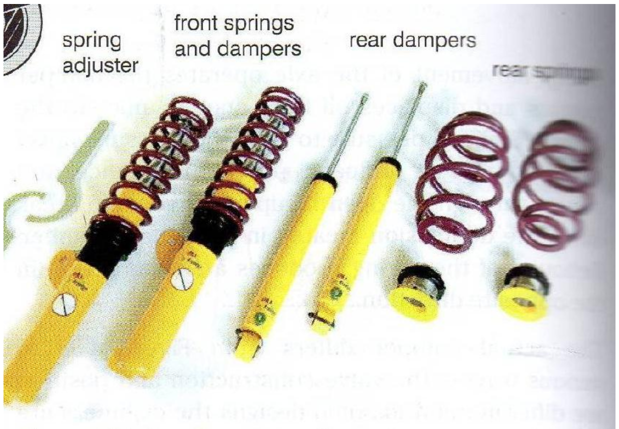


Figure 4.91 A performance coil-over damper assembly

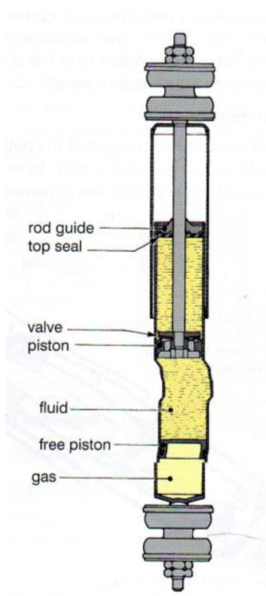
LEVER TYPE DAMPERS

(A) SINGLE LEVER DAMPER

This type of damper is mounted to the frame and connected by s lever and link to the Axle. The horizontal cylinder contains two pistons which are fitted with pressure valves. The dampers are filled with thin mineral-base damper oil through the filler plug.

-Bump move of the axle operates the damper piston and displaces oil from one chamber to the other oil exact pressure to open the pressure valves. The oil flow through the valves helps to balance the pressure different created by levers move, in the two chambers.

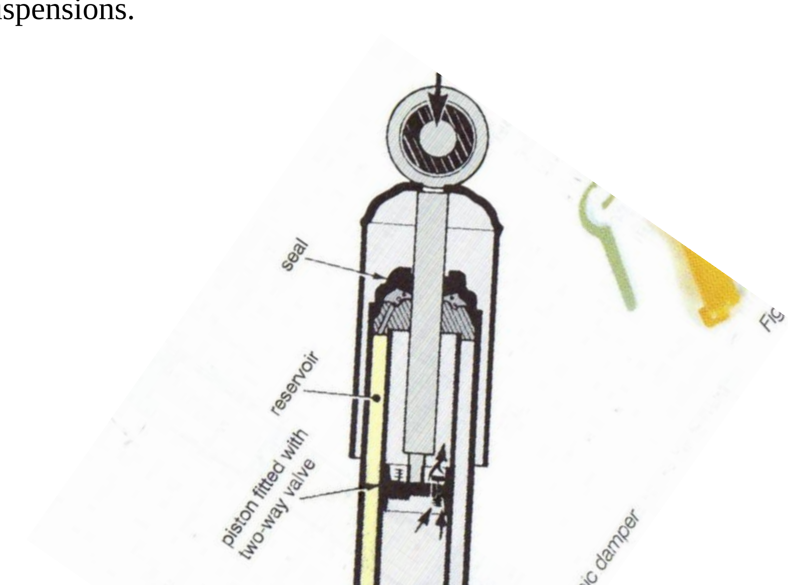
-Rebound of the springs produces a similar action in the opposite direction.



single-tube telescopic damper

2. DOUBLE LE

Two pistons are used in this damper and are operated by the ends of the double lever assembly. At the outside end of levers are carried on a shaft which is coupled by the passages length and meter which houses some form of valve assembly. The damping action is done by forcing the fluid through the valve passages. This type of dampers are normally used with independent suspensions.



INDEPENDENT SUSPENSION

-This is the suspension where the two opposite road wheel are not connected and each wheel is independent of the others. In order to understand the advantages of independent suspension the following axle disadvantages should be considered.

(a) The vertical axle movement is limited by the clearance between the front axle and the engine. This gives a small spring deflection and hard springing.

(b) Steering geometry is not accurately controlled due to alteration of cam free angle which occurs when the wheel spikes a bump. The caster angle changes when the springs deflected.

(c) The engine has to be moved to the rear of the front axle to give clearance. This prevents the whole wheel base from being used in accommodating passengers/loads.

(d)The suspension has a high unsparing mass and therefore a max wheel adhesion is not obtained.

(e) The front spring has to be mounted close together and this gives poor roll-stiffness and therefore tends to produce “over steer”.

INDEPENDENT FRONT SUSPENSION:

-The design of the suspension and the steering must be co-ordinate because the features of one affect the features of the other two.

-Cars and some lighter commercial vehicles are fitted with a forms of independent front suspensions (I.F.S) .These have the following advantages over the beam axle.

1. Much less upspring weight (mass)
2. The steering is not affected by the gyroscopic effect of deflected wheel being transmitted to the other wheel.

3. Better steering stability due to the wider spacing of the springs.

4. Better road holding as the centre of gravity is hour due to the engines being arranged heaver to the ground.

5. More space in the body due to the engine being lower and possibly further forward.

6. Move comfortable ride due to the used of lower rate spring.

EXAMPLES OF INDEPENDENT FROM SUSPENSION (I.F.S)

1. **DOUBLE LINK.**

Two link mounted in the normal manner connect the stub axle carrier to the frame. A semi-trailing radius rod is fitted between the lower link and the frame.

This rod resists longitudinal dynamic loads braking torque. The spring can be positioned above the top link or a torsion bar can be connected to their inner ends of the lower link.

DOUBLE LINK AND RADIUS ROD MACPHERSON STRUT-I.F.S

-These system consists of a long telescopic tube incorporating a damper it is pivoted at the ends and rigidly connected to the stub Axle track control is maintained by simple transverse link attached to the frame by rubber bush. If is connected to the stub axle by a bolt joint the coil spring is located between the fixed and floating suspension member.

-Both front suspension lower links are interconnected by a stabiles bar which prevents the front and leak movement. As many other suspension system castor camber and king pin inclination are set in production and cannot be changed.

INDEPENDENT REAR SUSPENSION (I.R.S)

-Many of the advantage of I.F.S are the same as in I.R.S. The most important is to reduce the upspring mass (**weight**) in the system example of I.R.S system as follows.

(i) **TRANSVERSE SPRING TYPE:**

In this arrangement the spring is mounted above the find drive and both are attached to the chassis .The upper end of the leaf spring and the lower ends to tubular dampers. There dampers are inclined and there upper ends are fitted in rigid arms which form port of the subframe. The half shafts are driven through universal joints at the different end.

SWINGING HALF-AXLE

The round wheel and rear axle tube are pivoted at the final drive which secured to the chassis and the outer end of axle tube together with inclined tubular damper .The axelend located by radius rods and the half-shaft are driven via constant velocity joint arranged at the centre of swing of each axle.