

Suspension in Bikes Considering Preload, Damping Parameters and Employment of Mono Suspension in Recent Bikes

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ABSTRACT - Shock absorbers are important part of vehicle's suspension, which is fabricated to reduce shock impulse. Shock absorbers work on the principle of fluid displacement on both the compression and expansion cycle. The modern motorcycle uses suspension to accomplish several things; it provides a smooth comfortable ride absorbing bumps and imperfections in the road. It also allows the rider to fine tune the machine to give him/her better control over the machine when riding.

Motorcycles with only one shock absorber are called mono shock motorcycles. When mono suspension is mentioned everyone should remember that it should be on the rear side. The performance of mono suspension motorcycles is vastly superior to twin suspension motorcycles.

They are used not only in automotive industries but are also used in various other manufacturing and processing industries.

Keywords - Shock absorbers, suspension, shock impulse, mono suspension.

I. INTRODUCTION

Shock absorbers are important part of vehicle's suspension, which is fabricated to reduce shock impulse. Shock absorber minimizes the effect of traveling on a rough ground. Modern vehicles are designed with strong shock absorbers to tolerate any type of bouncy conditions. If supposedly shock absorber is not used then to control excessive suspension movement, stiffer springs will be used.

The shock absorbers duty is to absorb or dissipate energy. One design consideration, when designing or choosing a Shock absorber is where that energy will go. In most dashpots, energy is converted to heat inside the viscous fluid.

In hydraulic cylinders, the hydraulic fluid will heat up, while in air cylinders, the hot air is usually exhausted to the atmosphere.

In a vehicle, it reduces the effect of traveling over rough ground, leading to augmented ride quality, and increase in comfort due to substantially reduced amplitude of disturbances. Without shock absorbers, the vehicle would have a bouncing ride, as energy is stored in the spring and then released to the vehicle, possibly exceeding the allowed range of suspension movement.

II.CONSTRUCTION AND WORKING

- Construction:

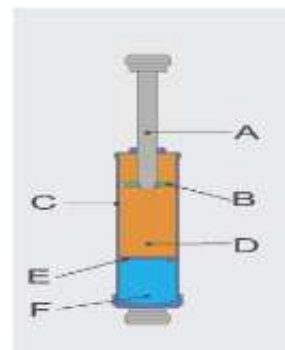


Fig 1: Construction of Shock Absorber.

Components are:

- A-Rod
- B-The piston with seals.
- C- Cylinder.
- D - Oil reservoir.
- E - Floating piston.
- F - Air chamber.

Shock absorbers are attached at the end of the piston rod and works against hydraulic fluid in the pressure tube. The oscillating movements of suspension force the hydraulic fluid through the minute holes inside the piston. However, only small amount of fluid is forced inside the piston. The insertion of fluid reduces the speed of the piston which in turn slows down the piston, resulting in slowing down of spring and suspension movement.

• Working :

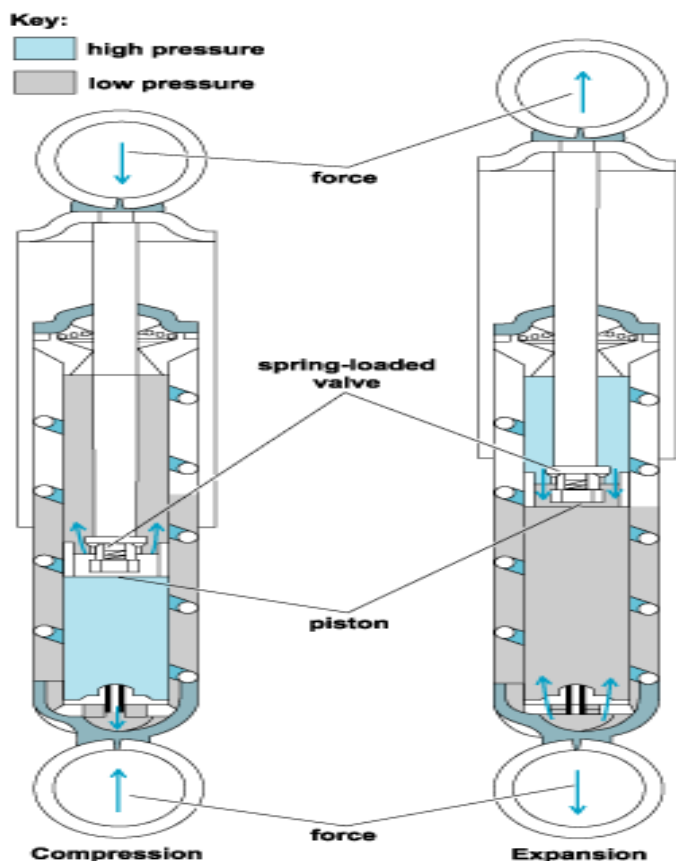


Fig 2: Working of Shock Absorber.

Shock absorbers work on the principle of fluid displacement on both the compression and expansion cycle. The compression cycle controls the motion of a vehicle's unsprung weight, while extension controls the heavier sprung weight. There are two cycles in which Shock Absorber works:

a. Compression

In the compression cycle the piston moves downward and compresses the hydraulic fluid in the chamber which is situated below the piston. In this cycle or downward movement, the fluid flows to upper chamber from down chamber through piston. Some of the fluid also flows into reserve tube through the compression valve. Flow is controlled by valves in the piston and in the compression valve.

b. Extension:

In the extension cycle the piston moves upwards toward the top of the pressure tube. The upward movement results in the compressing of the fluid in the chamber lying above the piston. The extension cycle generally provides more resistance than compression cycle.

III SUSPENSION IN BIKES

The modern motorcycle uses suspension to accomplish several things; it provides a smooth comfortable ride absorbing bumps and imperfections in the road. It also allows the rider to fine tune the machine to give him/her better control over the machine when riding.

a. Springs

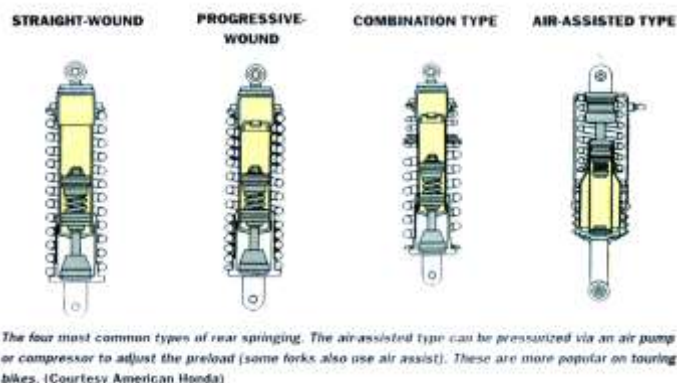


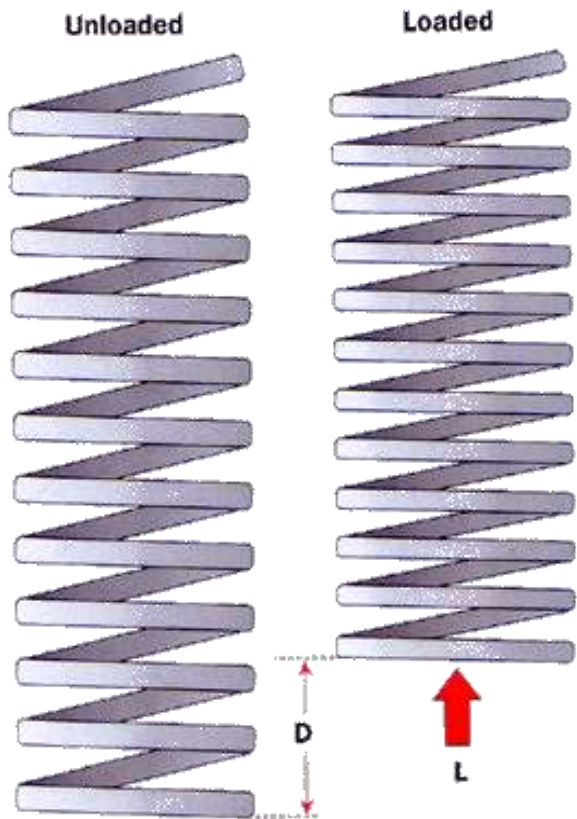
Fig.3 Types of Rear Springing

The main function of suspension springs are to support the motorcycle above its wheels and to isolate the chassis and rider from the up and down motion of the wheels as they roll over bumps.

A spring's rate is a measure of how much force is required to compress the spring a given distance. The higher the rate, the more force it takes to compress it a given distance, and the less it compresses under a given force.

Spring rate is normally expressed in pounds per inch. A common spring rate is 100 pounds per inch; this means it

takes 100 lbs to compress it one inch; 200 lbs to compress it two inches, and so on until it's completely compressed. Ideally the spring rate on your suspension is stiff enough to keep the bike from bottoming out (fully compressing the suspension) on all but the very worst bumps; yet soft enough to provide a comfortable ride.



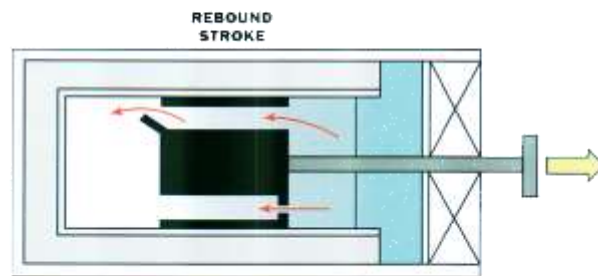
Spring rate is calculated by determining how much of a load it takes to compress the spring a given amount. In the drawing, D is the distance (usually one inch), L represents the load, (normally expressed in pounds).

Fig.4 Unloaded and Loaded Spring

Springs come in two basic types; straight-rate and progressive-rate. Straight-rate springs compress at one rate until coil bound. Progressive-rate springs are built to have a spring rate that increases as the spring compresses. With progressive-rate springs, the result is a spring (and suspension) that reacts well to light hits but becomes increasingly stiff when a big jolt occurs.



As the shock compresses, the damper piston must force oil through a narrow oil orifice, slowing travel.



On rebound, oil escapes easily through a spring-loaded flap.

Fig.5 Damper

b. Preload

Preload is a load placed on a spring before it's used. It may have means to apply pressure on suspension to compress the spring without effecting suspension movement. It can be an adjuster in a front fork or a collar on rear shocks. This loads the spring to alter the point at which the spring begins to compress. Preload is useful; because the correct spring can be chosen with the right rate for a comfortable ride and then using preload the weight of the rider and the motorcycle doesn't compress the suspension more than is desirable.

This sag should be about one third of the suspensions total travel. Leaving equal amounts of spring travel up as well as down to prevent the suspension from bottoming or topping out. Using preload suspension can be set up for riders of different weights on the same motorcycle and setting ride height.

If the sag of a motorcycle's suspension for a given rider cannot be properly set using pre-load adjustments, typically the spring must be replaced with one of a different rate. If the sag is too great, a higher rate spring must be used, and vice-versa. Even when the sag is set correctly sometimes the springs have to be replaced. This is dependent on the weight of the rider and motorcycle. If the rider is too light for the design of the springs the ride will be harsh, even when sag is correct. If the rider is too heavy the ride may be mushy, brake dive may be excessive, etc

c. Damping

With springs alone the motorcycle would oscillate up and down depending on the conditions and would not settle down until the springs had lost all of their stored energy.

Motorcycle's suspension is designed to absorb or damps much of the energy transferred to it from the wheel when it rolls over a bump.

The force of the front wheel hitting a bump is transferred to the suspension. To damp this shock which stores energy in the spring, we use fluid (oil) as a shock absorber; by pumping oil through small orifices as the suspension goes through its motion. For the same sized orifice thin oil gives less damping action, and a thick oil more. Similarly, for the same viscosity oil, a large orifice gives less damping and a small orifice more.

Today's dampers use valving instead of orifices, which allow them to be compliant over small bumps and yet provide enough damping for large ones.

Modern suspensions also damp in both directions when the wheel strikes an object and is driven upward (compression), and when the wheel is forced downward by the springs and gravity to its normal position (rebound).

Ideally rebound damping is four times as powerful as compression damping. Overly stiff compression rates prevent the wheel from following the pavement, so it's better to let the spring rate control the majority of upward wheel movement, rather than oil flow.

Motorcycle suspension uses springs and damping together, in the form of forks up front and shock absorbers in the rear to soak up bumps and keeps the wheels on the ground. Damping and spring rates must always be in balance.

If the motorcycle has too much damping, it will overwhelm the spring and the suspension will be unresponsive, forcing the wheels to hop and bounce over every little bump. If there is too little damping, the motorcycle is said to be over sprung, and it wallows and pitches through the turns and after the least little bump. In either case, both ride and handling suffer.

2.2 MONO SUSPENSION IN BIKES

A motorcycle's suspension is similar to the suspension in an automobile in its purpose. Suspension systems serve a dual purpose - contributing to the vehicle's handling and braking for good active safety and driving pleasure, and keeping vehicle passengers comfortable and reasonably well isolated from road noise, bumps and vibrations. But a motorcycle suspension is usually simpler, since it does not have to contend with lateral forces such as body roll. The typical motorcycle has a pair of fork tubes for the front suspension, and a single swing arm with one or two shock absorbers for the rear suspension.

Motorcycles with only one shock absorber are called monoshock motorcycles. When mono suspension is

mentioned everyone should remember that it should be on the rear side. By positioning the suspension close to the centre of gravity of the machine, turning characteristics, stability during braking and the overall riding performance is substantially enhanced.

Original technology of mono suspension comes from the world of racing where bikes compete in most extreme conditions. More advanced version of this technology is employed in these bikes. Even the international production models incorporate mono suspension to give statement of style and comfort.

The performance of mono suspension motorcycles is vastly superior to twin suspension motorcycles.

2.2.1 ADVANTAGES OF MONO SUSPENSION

- 1) Mono-shocks eliminate torque to the swing arm and provide more consistent handling and braking.
- 2) It is easier to adjust, since there's only one shock to adjust, and there is no worry about matching two shocks.
- 3) Also, the linkages used to connect the shock to the swing-arm are frequently designed to give a rising rate of damping for the rear.
- 4) It decreases friction loss through employing single shocker. As a result mono suspension can move freely, improving tractability on road surface.
- 5) Mono suspension design ensures centralization of mass. By positioning suspension close to the center of gravity of the machine, turning characteristics, stability during braking and overall riding performance is substantially enhanced.
- 6) The mono suspension improves both the ride and handling if tuned well.
- 7) The mono suspension gives a more shift of gravity to the bike.
- 8) The simple reason for it being better can be understood by the following explanation- "Whenever you encounter a bump on an M/cycle with two shocks, both the shocks compress, but there is never a situation when both of them compress for the equal length. This leads to downgraded dynamics when it comes to stability. But with a single shock absorber, this problem is solved.
- 9) In a recent test conducted by Bike Magazine, Pulsar, Apache and Unicorn were pitted against each other on a test track. Although the unicorn was not the fastest, they said it is the most confidence inspiring and the most balanced of the lot.

2.2.2 APPLICATIONS OF MONO SUSPENSION

- Some British manufacturers (e.g. Greeves) used a version of the swinging arm for front suspension on their motocross designs. A single-sided version of the idea is also used in motor scooters such as the Vespa.
- The Hub-center steering as developed by Ascanio Rodorigo, on a concept associated to Massimo Tamburini is a complex front swing arm alternative system that entails suspension and steering, as seen in projects such as Bimota Tesi and Vyrus motorcycles.
- The mono suspension is used in bikes such as Honda-unicorn, Bajaj-pulsar, Hayabusa, Harley Davidson, Intruder etc.

2.3 GENERAL FEATURES OF SHOCK ABSORBERS

- Shock absorber has seals that keeps the oil in and contaminant out .
- The metal used is stronger and harder. Modern shock absorber uses sintered metal which provides durability and longer life.
- Flat metals are used for constructing most of the cylinders which are welded at the seam.
- Shock Absorbers are velocity sensitive.

II. TYPES OF SHOCK ABSORBER

Based on their mechanism and usage, there are various types of shock absorbers.

- a. Air Shock Absorber .
- b. Damper Shock Absorber.
- c. Twin Tube Shock Absorber.
- d. Spring Shock Absorber.

a. Air Shock Absorber :

The air shock absorber consists of an air chamber, an iron piston and a fluid. Together these work to give an excellent shock absorber that aids the suspension springs of a vehicle. The presence of compressed air in it makes it a stiff shock absorber. The air shock absorber is a load-adjustable shock absorber as it abates the burden of any load on the suspension. In some air shock absorbers, a rubber cylinder is also used to aid the function of the suspension springs. The air chamber of the shock absorber consists of a valve

that can be used to adjust the pressure inside the gas chamber. Air shock absorber is a commonly used air absorber and it provides a smooth and a comfortable ride of a vehicle. Other than cars, this shock absorber is also used in the engines of high-speed boats.

b. Damper Shock Absorber :



Fig 6 :Damper Shock Absorber

A damper shock absorber consists of a single or two chambers. It may be fluid or air filled. It is commonly used to absorb the shock during the linear motion of a vehicle. The damper shock has a configuration that can be adjusted and the presence of valves allows the increase or the decrease of the force capacity by allowing the gas or the fluid to surge out.

c. Mono Tube Shock Absorber



Fig 7: Mono Tube Shock Absorber.

The mono tube damper consists of single tube with two valves. It is mostly oil filled and is used in larger vehicles. When the damper compresses, the first valve opens and when the damper extends, the other valve opens and the first one closes. The amount of the fluid released depends on the speed of the bumps it comes across while moving. If it receives low speed small bumps the larger vents get opened and there is large amount of fluid is released. On the other hand, if gets high speed strong bumps the smaller vent gets opened and a small amount of oil is released.

d. Twin Tube Shock Absorber :

The twin tube shock absorber consists of two tubes and valves. One of the two valves has a piston rod and is fitted to the outer tube while the second valve is fitted into the inner tube. The inner tube is smaller in diameter and handles the bump control of the vehicle and the outer tube which has the piston fitted valve handles the rebound control.



Fig 8: Twin Tube Shock Absorber.

When the twin tube damper gets a shock through bumps the fluid inside tubes is forced towards the outer reservoir. The presence of two valves and tubes makes it an effective shock absorber but the only problem with this shock absorber is that it can only work when there is a limited space to work in.

e. Spring Shock Absorber :



Fig9: Spring Shock Absorber.

The spring shock absorber uses the effect of a spring to absorb the shocks. The tighter the spring coil will be the stiffer the shock absorber will be. The spring shock absorber is fluid filled and the centre of the shock absorber consists of a rebound unit.

ADVANTAGES AND DISADVANTAGES

a. ADVANTAGES

- To absorb impact load caused by irregularities of road surface.
- To provide safety for passenger & driver.
- To prevent wobbling effect.
- It provides safe guard to component of vehicle etc.

b. DISADVANTAGES

- Maintenance is required.
- It increases sprung weight.
- Cost is high

III. APPLICATIONS

Shock absorbers are designed to absorb shocks. They are used not only in automotive industries but are also used in various other manufacturing and processing industries. Some of the other applications of the shock absorbers can be summarized as follows:

1. Automotive robotics: OEM shock absorbers are used for controlling high drive forces for precise robot positioning and improved assembled product quality.
2. Foundry-conveyor line: The shock absorber reduces the velocity of the metal flasks traveling on a conveyor line thereby eliminating the risk of damaging the flask.
3. Rolling Door: The shock absorbers used in automatic rolling doors protect precision mechanical components and prolong door life.
4. Air cylinder: Cylinder cushion often becomes ineffective because operating velocity of the cylinder is high. However the use of shock absorber not only accommodates high impact forces but also results in noise free operations and increase production rates.
5. Printing: The shock absorber used in the printing machines, assists in paper positioning and prevents the equipment from damage during printing press test runs.
6. Packaging machinery: The shock absorber in packaging industry controls rapid movement of a table transportation of loaded packages to an automated case packer sealing station.
7. Overhead cranes: Trolley movement of the crane is decelerated quickly by the shock absorber thereby serving as safety stops when mounted at each end of an overhead crane bridge.
8. Transport equipment: Shock absorber when installed at the end of the cable and other

transport systems. Eliminates the Jarring of passengers.

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