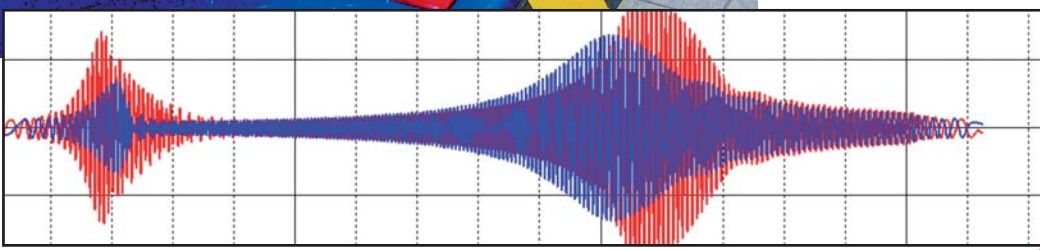
Maschinenbau Haldenwang MAHA

Wir im Allgäu.

Shock Absorber Tester

Model: MAHA-Shock-Diagnostic MSD 3000



NEW INNOVATION

For easy and accurate testing of the shock absorbers -
Indirect shock absorber test based on the new Theta principle.

Premium Workshop Equipment

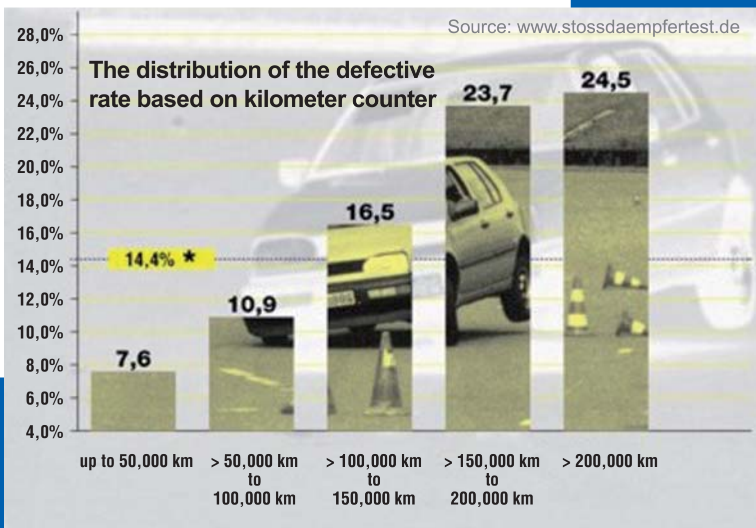
Defective Shocks?

Every seventh car in Germany is traveling with at least one defective shock absorber. This has been confirmed time and time again by various test organizations and vehicle institutions. Once the 100,000 kilometer reading has been reached, the defect quota increases dramatically. Other worn and deflected damping components, such as e.g. rubber bearings, can contribute negatively to an overall poor shock absorption quality.

The result is an increased accident risk, because the quality of braking distance, curve position, ABS and anti-swerve protection all directly depend on the condition of the shock absorption.

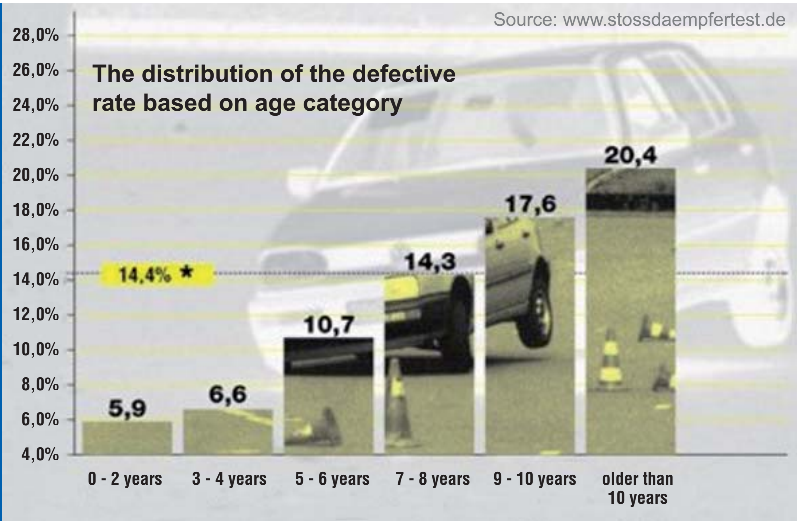
Defective Shock Absorber as Safety Risk

With an increasing kilometer reading, the damping components such as shock absorbers wear out due to age, dirt and corrosion thanks to salt and moisture. The loss of performance is a slow process and the driver gets use to the less effective shock absorption meaning the damage goes undiscovered for a long period of time. In dangerous situations this defect can have horrendous consequences.



Defective Shock Absorber as Safety Risk

Based on experts estimates, approximately 14 % of the vehicles in Germany (this means 5 to 6 million vehicles) have at least one defetive shock absorber. Many drivers underestimate the effects of wear and tear. The most frequently overlooked fact is that even new vehicles can have one or more defective shock absorbers.



Consequences of Defective Shock Absorbers

Worn out or defective shock absorbers represent a major safety risk! The braking distance is longer (see following table); aquaplaning occurs at even low speeds. Tires and chassis wear out more quickly and the optimum effectiveness of modern electronic safety systems such as ABS, ESP or ASR are negatively influenced, as all these systems require optimum wheel surface contact. The vehicle driving quality is especially sensitive to side winds and in curves, whereby the vehicle breaks out faster and/or tends to understeer.

Equipment	Brake distance* with a damper performance of	
	100 %	50 %
without ABS	37.5 m	39.1 m = + 4.3 %
with ABS	38.2 m	43.6 m = + 14.1 %

* Initial speed 80 km/h
on uneven surface

(Source: TÜV Rheinland)

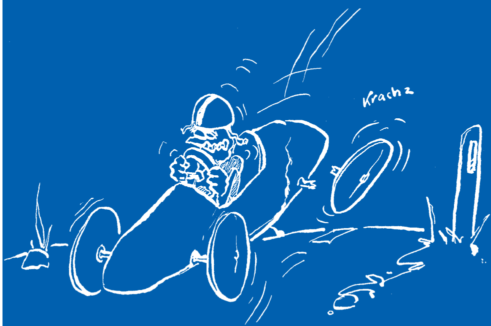
Why is shock absorption so important for driving safety?

In principle, it is the task of the shock absorbers to absorb shock during the drive thereby creating the best possible contact of the wheels with the road surface.

On vehicles with only spring mounting, the wheels would oscillate against the heavy autobody and lift up, depending on the road surface.

Consequences: The wheels would be in the air some of the time and the contact between tires and road surface would be reduced.

Vehicles, on the other hand, **which are too heavily damped** transfer the shocks to the vehicle occupants and load.



Consequences: The shocks from the outside make the vehicle uncomfortable to ride in and there is premature wear on autobody and axle components.

The necessary shock absorption then becomes a compromise between driving comfort (suspension) and driving quality (reduction of spring oscillation) for obtain better road surface contact.

Requirements and Effectiveness Principle of Shock Absorption

The demands placed on shock absorption are high:
As little damping as possible should be used for comfortable road performance;
For safe handling performance as much as is needed.
The goal is a balance between comfort and safety.

Effect of intact shock absorbers in relation to …

…driving safety

> already no wheel bouncing on normal roads

> no vehicle break out at braking

> no swerving due to poor tracking in curves

…driving comfort

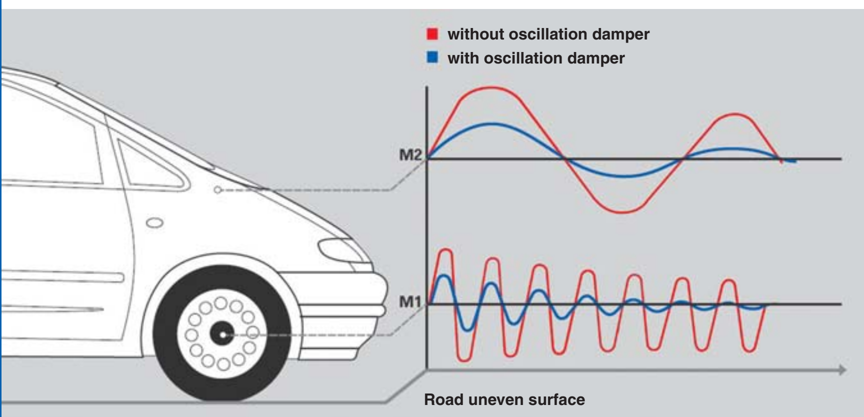
> no long coast down oscillation of the vehicle chassis

> no oscillating of the vehicle on a series of uneven surfaces

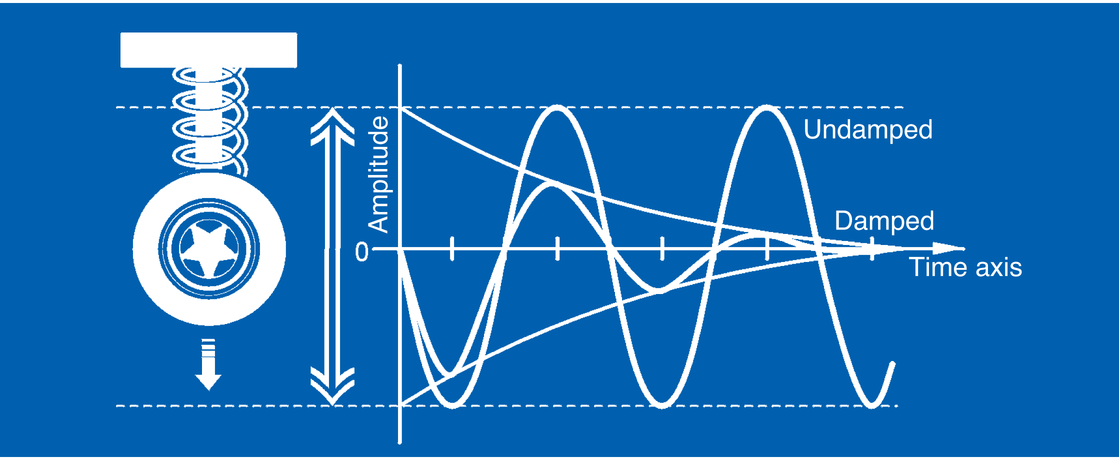
> no vehicle pitching at acceleration and/or no heavy diving at braking

Effectiveness of an Oscillation Damper

When driving over an uneven surface, the impacting shock is absorbed by the springs. It prevents the cushioned mass M2 = vehicle body + load from coming into contact with the uncushioned mass M1 = Axle + Wheels. After the springs are pressed together, the springs attempt to push the cushioned mass away from the uncushioned mass. The shock absorbers abate the oscillations of axle and body which have been created.



The Shock Absorption as Oscillation Absorption



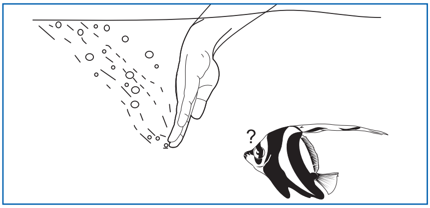
The subsiding of the oscillation amplitude (= Amplitude, oscillation amplitude) acts on the shock absorption; it brakes the oscillating wheel movements in both directions.
For this, counter (damping) forces are created which

> **> are largest when the wheel moves the fastest**
> **→ when passing through of its original resting position.**
>
> **> zero when the wheel reverses its oscillation movement**
> **→ no braking is needed at the reverse points.**
>
> **> depend on the respective oscialltion speed**
> **→ are proportional in the easiest case**

The damping force is always directed against the movement. This decelerating counter force is comparable with the force which a hand feels when moving it through water:

> slow: → very little counter force

> fast: → a large amount of counter force

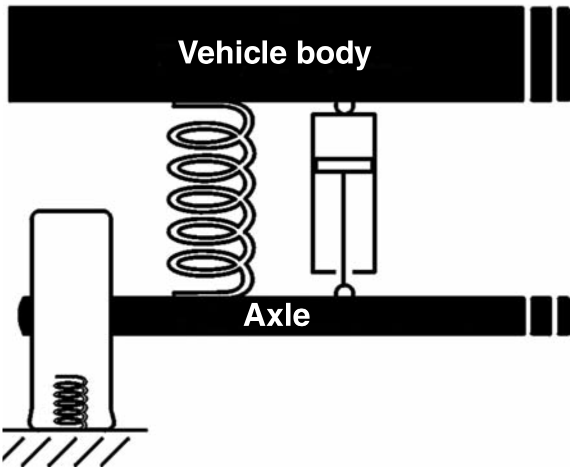


During the oscillation procedure, higher speeds are reached the larger the oscillation frequency per time is (higher frequency = more frequent oscillating between the reversal points) and/or the oscillation amplitudes (the larger the amplitudes = further distance of the oscillation in the same time).

Measuring the Shock Absorption

When measuring the shock absorption, the point is to judge the effectiveness in depedence between damping on the one hand as well as vehicle mass and spring constant on the other hand.

If the vehicle is seen in a simple diagram, a picture is made consisting of vehicle body, vehicle springs, shock absorbers, suspension, as well as axles and wheels. This also helps to explain why components such as shock absorbers cannot be tested as individual elements in an installed condition.



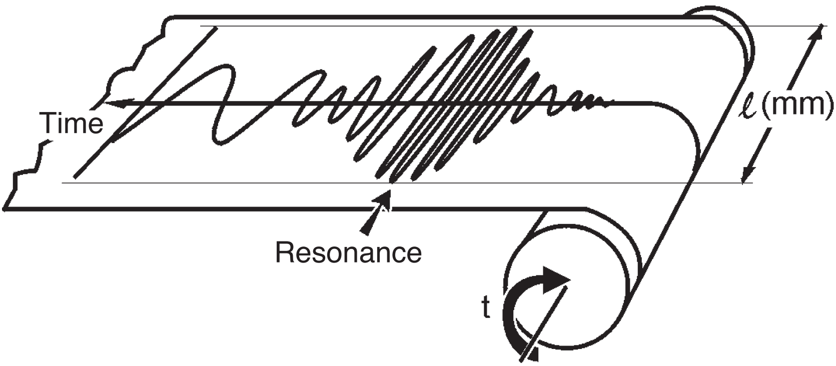
It is therefore very important to measure and judge the vehicle shock absorption as a total concept, as was designed by the engineer during the vehicle development.

The Test Method (Resonance method based on BOGE)

The wheels of an axle stand on the horizontal test plates of the MSD 3000, which are moved up and down during the test.

The wheels and their corresponding axle masses start oscillating against the much heavier vehicle mass, which can be considered dormant, by the movement of the test plates at the start of the testing procedure. The so-called excitement frequency is controlled to a frequency of 10 Hz, before it is continuously controlled back to almost 0 Hz. The system oscillates in a coast down against the dormant vehicle body.

At coast down, the oscillation frequency subsides constantly and also passes through the range of the resonance frequency of masses which hang on the vehicle springs and shock absorbers. The energy stored in the oscillation system during the excitement drives the masses to more and more amplitudes while approaching the resonance point; the maximum is reached at resonance frequency - see following picture:



The speeds created at the resonance point correspond with those existing during a conventional road drive, meaning the resonance method is as close to the average driving situation as it gets.

The osciallation amplitudes are measured by the test plate which is following the movements of the wheel, electronically recorded and evaluated.

The maximum resonance amplitude, whose size is essentially determined by the shock absorption, is measured and compared with the timely subsiding plot of the oscillation.

Evaluation of the Shock Absorption – The Physics

Using the physical consideration of a passenger car as an example, the dimensionless **damping degree „D“** or the **Lehrsches damping measurement** can be determined by a differential equation.

The equation for this is :

$$D = \frac{d}{2\sqrt{c*m}}$$

Hereby :

D = Damping degree or damping mass (no unit)
d = Damping constant (kg/s)
c = Spring constant (N/m)
m = Mass (kg)

The damping degree is theoretically between 0 and 1 and provides the quality of the tested shock absorption and/or the “the damped oscillation“ as a number. This value is calculated and displayed by the test stand from the result of various physical values such as vehicle weight, spring constant and damping constant.
Already during the vehicle development phase, the damping mass is of particular meaning: based on the manufacturers philosophy the motor vehicle can be designed either as "comfortable" or "sporty". Definition: D = 0,2 ≤ δ ≤ 0,35 (target). The smaller D is, the more "comfortable" the damping.

The **damping constant,** also known as **subsiding constant** with the designation **Theta** (δ), describes the timely subsiding plot of the oscillation and is defined as follows:

$$d(\delta) = \frac{(C_{Ges} * r)}{2\pi * f_{Measurement} * X_1} - d_{Test\ Stand}$$

Hereby are:

d (δ) = Damping constant in Theta (Ns/m)
C_{Ges} = Sum of the spring rates which are installed in the test stand (N/m)
r = Stroke of the test plates at test stand with slow spinning of the crank drive from bottom dead center to top dead center (mm)
$f_{Measurement}$ = Frequency at which the plate amplitude is maximum (1/s)
x1 = double plate amplitude with plate resonance frequency (mm)
$d_{test\ stand}$ = Damping constant of the test stand (self-damping). This is determined by the coast down trial. (Ns/m)

Evaluation of the Shock Absorption – The Physics

By changing the excitement frequency in the test stand (oscillating test stand plates, from higher to lower frequencies) 3 essential eigenfrequency ranges can be differentiated:

- **Range 1**
  at higher frequency, is considered as eigenfrequency of the wheels/tires and is 12-20 Hz. Is not essential for the determination of the shock absorption quality.

- **Range 2**
  applies to the eigenfrequency of the test stand with the vehicle at which the amplitudes are evaluated. It is approximately 6 - 7 Hz. This is the frequency at which the test stand plates as well as the essential vehicle components with wheel and immediately corresponding mass shows the largest amplitude. This is used as operand.

- **Range 3**
  with the eigenfrequency of the vehicle body which then oscillates along. (ca. 1.2 - 1.6 Hz). This is not essential for the determination of the shock absorber quality. It would also distort the desired result which should relate to only one wheel or one axle (two wheels).

As these three eigenfrequency ranges are separated in a sufficient and differentiated manner, the repeatability is high. This also means that the parameter of wheel/tire and the vehicle body parameter have a minuscule influence on the measurement results with relevant frequency range 2.

Summary

The new MSD 3000 from MAHA is in a position to determine a physically clearly defined value and to show exactly when various damping components need to be exchanged.

The new MSD 3000 is a technological advance.

Additional advantages:

- **Clear measurement results as they are displayed as a physical value.**
- **Measurement results with high reproducibility.**
- **Comparability with all other shock absorber tester which function using this principle.**
- **A clearly defined value which serves as a basis for declaring the necessity of replacing worn out damping components.**

Ideal prerequisites have been created for the time when axle damping and/or shock absorber quality inspection programs are introduced- which will require that a uniform testing principle be developed.
The requirements for this have been fulfilled:

- A procedure for valuable quality information about the shock absorption (Lehrsches damping mass or damping degree).
- And the necessary testing equipment to determine this quality value - **the MSD 3000.**

Technical Data

Floor assembly	**MSD 3000**
Axle load testable	2.5 t
Axle load drive-over	2.5 t / 13 t (Option)
Drive power	(2 x) 1.1 kW
Excitement stroke	6.5 mm
Excitement frequency (regulated)	ca. 2 - 10 Hz
Maximum plate stroke	ca. 70 mm
Track width	min. 800 mm max. 2.200 mm
Measurement range damping mass „D“	0.02 - 0.3 (unitless)
Voltage supply / Fuse	230 V, 1 Phase, 50/60 Hz / 16 A slow
Start up of the test stand	automatic with 2 sided loading of more than 60 kg (adjustable)
Display accuracy	2 % of measusurement range end value 2 % difference betw. left and right-hand side
Dimensions floor assembly (L x W x H)	2320 x 800 x 280 mm
Dimensions packing (L x W x H)	2400 x 1000 x 700 mm
Total weight	ca. 650 kg
Display/control	**communication desk 3000**
Display unit	digital via screen
Control	fully automatic via communication desk
Measurement values	Damping mass „D“, difference right/left, results, axle weight
Dimensions communication desk (H x W x D)	1400 x 800 x 670 mm

Please see the current price list for further accessories!

Wir im Allgäu.

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