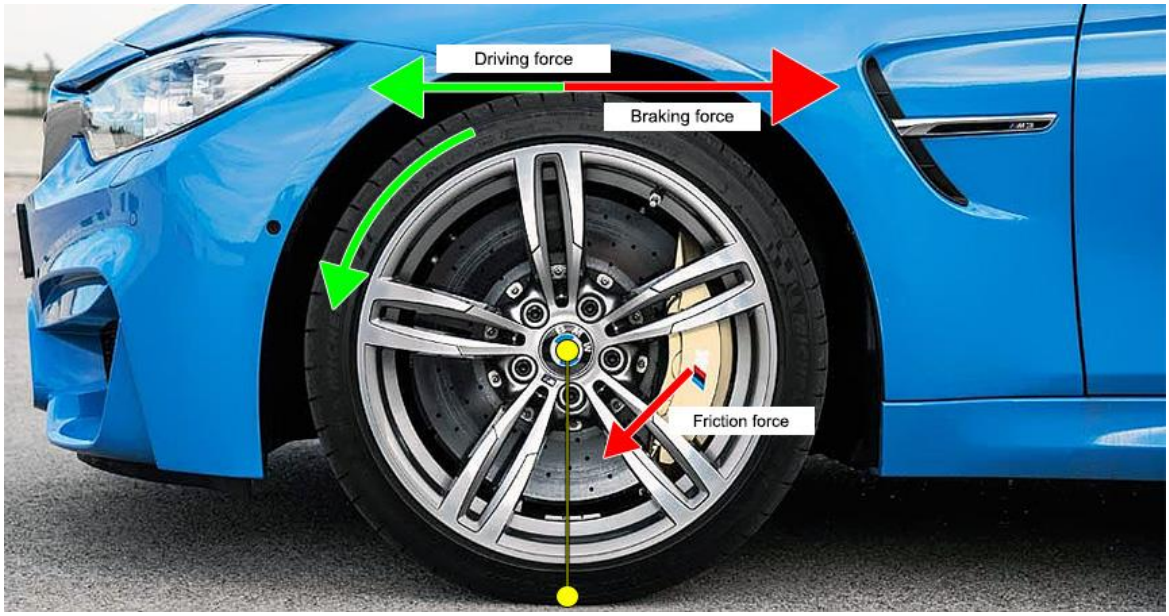
Extract of « Braking Dynamic »
Online course « Brakes »

Braking Performance

Braking performance is the importance of stopping the vehicle in terms of distance in time.

It is measured by the deceleration (negative acceleration) that takes place during the braking process. As a rule, it is considered that the braking performance reaches 100% when the deceleration measured is equal to the gravitational acceleration (9.8 m/s^2), also represented as 1G.

Although the friction acquired in the tyre tread should be considered, it will be seen that there are different factors that intervene for a better performance when braking.



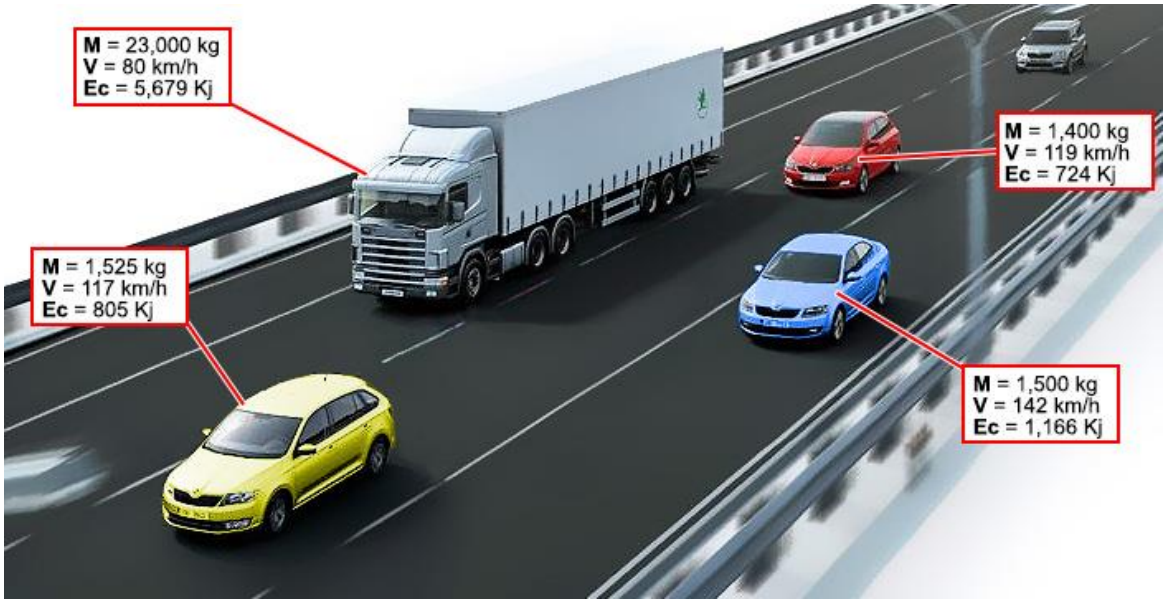
Factors that intervene in the braking performance:

Deceleration

In physics, acceleration (*a*) is the magnitude that indicates the speed variation of a body in a unit of time. Generally, it is understood that this variation is positive, in other words, that the object increases its speed over time. When the variation is negative (as during braking), it is commonly known as deceleration or deacceleration.

Kinetic Energy

Kinetic energy is the energy resulting from the work done in order to achieve the movement of an object, that is to say, the force that is applied on a body so that to reach a specific speed. The kinetic energy of a body is obtained from two essential values: the mass (*m*) of the object and the speed (*v*) at which it moves.



Exerted Force

Exerted force is the force applied by the driver on the braking control in order to modulate the braking.

Brake Force

It is the force that is developed so that to reduce the speed or stop the vehicle.

Effects produced by the weight transfer

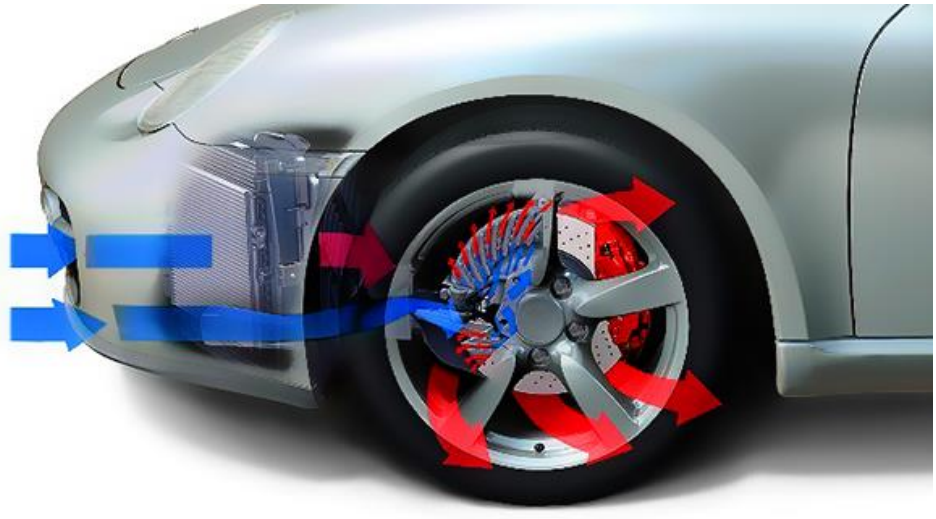
The brake force must be distributed between the wheels in accordance with the weight they support, which varies depending on the arrangement of the engine, gearbox, number of passengers, load distribution, etc.

Hence the importance of providing the vehicle with a braking system in optimal conditions, which will allow to improve the equilibrium and stability when braking.

Contact Surface

It is the surface on which two elements come into physical contact and it is measured in m^2. In braking systems, it usually refers to the friction surface between the pad and the disc, between the brake shoe and the drum or between the tyre and the road. In all cases, the greater the contact surface, the higher the possible braking force.

The braking system bases its performance on friction and on heat transmission. The greater the evacuated heat is, the more kinetic energy will be transformed, and the braking of the vehicle will become more efficient.



Friction Coefficient

This parameter expresses the power of friction, that is, the force of opposition to the movement provided by the surfaces of two elements in contact. It is represented with

the Greek letter μ (*mi*) and the higher its value is, the greater the braking force will be.

Materials in contact	Coefficient of static friction	Coefficient of dynamic friction
Steel - Steel	0.74	0.57
Steel - Aluminium	0.61	0.47
Steel - Brass	0.51	0.44
Steel - Copper	0.53	0.36
Steel - Teflon	0.04	0.04
Wood - Wood	0.37	0.20
Teflon - Teflon	0.04	0.04

Adherence Coefficient

It is the friction coefficient between the tyre and the asphalt and just like the friction coefficient, it is an experimental value, which is determined by a maximum value of 1. In any case, the contact of the tyre with the terrain is what determines the efficiency and limit of useful braking force of the vehicle.

Speed of movement	Tyre condition	Dry road	Wet road	Wet road surface	Puddle	Frozen road
Km/h	μ	μ	μ	μ	μ	μ
50	New	0.85	0.65	0.55	0.5	Less than 0.1
	Worn	1	0.5	0.4	0.25	
90	New	0.8	0.6	0.4	0.2	
	Worn	0.95	0.2	0.1	Less than 0.1	
120	New	0.75	0.55	0.2	0.1	
	Worn	0.9	0.1	Less than 0.1	Less than 0.1	

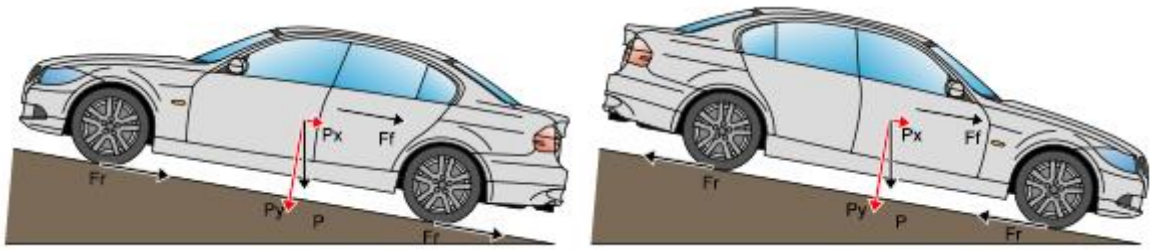
Maximum Brake Force (without slipping)

It is the limit force that can be developed to make a vehicle come to a stop without causing the wheel slipping on the road. It is calculated based on the tyre adherence coefficient (*μ*) and the weight (*W*) of the vehicle (in physics it is the mass multiplied by the gravity). Its value is measured in *Newtons* (*N*).

Road Slope

Another determining factor is the road slope, as under normal operating conditions of the vehicle the slope is usually small.

When a car travels on a slope, two main forces are acting: the weight of the vehicle (W), which due to the gravity force is divided into a force perpendicular to the floor (*Py*) and a longitudinal force (*Px*) towards the base of the slope, and the friction force (*Fr*), which always opposes the movement of the vehicle.



Braking Distance and Time

Braking distance (*e*) is the space that the vehicle runs from the moment the brake is applied to the time the vehicle comes to a complete stop.

Braking time is the total time that the driver needs to make the vehicle come to a complete stop.

The braking time can be divided into the following phases:

- Response time (t_1)
- Threshold time (t_1)
- Active braking time (t_3)
- Total braking time (t_4)

Remember to keep your braking system in shape!