Design scenarios of cars

The aim of TD is to show that it is possible to study a system, a car here, using simplified models in the plan.

1. Power and consumption of a vehicle

We want to calculate the power required to ensure the movement of a vehicle for a given speed.

1. Propose à diagram and the corresponding equation to model the vehicle in translation and in particular taking into account the forces due to the gravity due to a slope (α angle), the aerodynamic drag and the rolling resistance.

In fluid mechanics, the drag is the force that opposes the motion of a body in a fluid, or, by car, the force that opposes the movement of the vehicle in the air. This force can be calculated by:

$$F_d = \frac{1}{2}\rho C_x S v^2$$

where :

- ρ = 1.20 is the density of air (kg/m^3)
- v is the velocity of the vehicle relative to air (m/s)
- S is the frontal area (in m^2)
- C_x is the drag coefficient (unitless).

The rolling resistance, sometimes called rolling friction or rolling drag, is the force resisting the motion when a body (such as a ball, tire, or wheel) rolls on a surface. It is mainly caused by non-elastic effects; that is, not all the energy needed for deformation (or movement) of the wheel, roadbed, etc. is recovered when the pressure is removed. The "rolling resistance coefficient", is defined by the following equation:

$$F_r = C_{rr} N$$

Where :

- F_r is the rolling resistance force
- C_{rr} is the dimensionless rolling resistance coefficient (here $C_{rr} = 100.10^{-4}$)
- N is the normal force, the force perpendicular to the surface on which the wheel is rolling.

2. Calculate the power and the consumption of the following different cars (slope is null) for 100 km/h speed. For numerical calculation: 1 l essence is equivalent to 35 MJ, the efficiency of motor is equal to 0.3.

			
Mass M	1800 kg	1150 kg	490 kg
C_x	0.38	0.35	0.159
Frontal area S	2 m²	1.85 m²	1 m²
Power (100 km/h)			
Consumption (l/100 km)			

Figure n° 1 – Consumption of different cars

2. Critical speed in cornering

On a flat road, a car (m = 1500 kg) is cornering with a radius of 35 m. The coefficient of static friction between the tires and dry pavement is estimated to 0.5.

1. Determine the maximum speed at which the car can cornering.
2. For a rainy day, the car of this example begins to slide 8 m / s. Determine the static friction coefficient under these conditions.

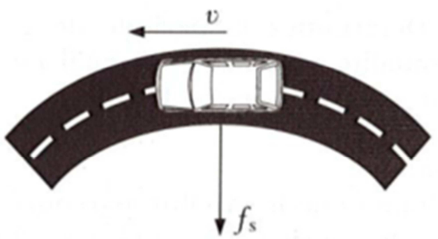

Figure n° 2 – Critical speed in corner