POLITECNICO
MILANO 1863

SCUOLA DI INGEGNERIA INDUSTRIALE
E DELL'INFORMAZIONE

Laurea Magistrale in Ingegneria Meccanica

SIMULATION OF THE DYNAMIC BEHAVIOR OF A SELF-DRIVEN ELECTRIC VEHICLE

Supervisor
Prof. MASSIMILIANO GOBBI

Master's thesis by
FEDERICO FRERA

ID code 841840

Academic Year 2016/2017

2.5 Center of gravity

The measurement of the center of gravity is essential to correctly define the vehicle dynamics. The overall mass is known by the data sheet, the height of the center of gravity and the load on each axle needs to be measured.

Figure (2.2) shows the resultant vertical force in the stationary condition for the front and rear axle. In order to calculate the position of the center of gravity, it is necessary to weight the load acting on the front and rear axle.
The useful data for the calculation of the center of gravity position are listed in table (2.3).

Table 2.3: Vehicle mass and wheelbase

Mass m	[Kg]	690
Wheelbase l	[m]	1,65

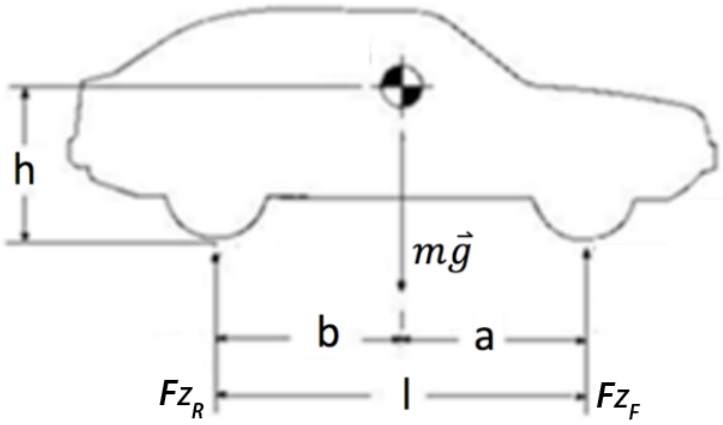

Figure 2.2: Vehicle center of gravity

The measured load on the front and rear axle is listed in table (2.4). The load

Table 2.4: Measured axle load

Rear axle load F_{z_R}	[N]	4512,4
Front axle load F_{z_F}	[N]	2256,4

acting on each wheel is half of the axle load, b is obtained by writing the equilibrium of moments about the rear axle,

$$- F_{Z_F} \cdot l + m \cdot g \cdot b = 0 \tag{2.1}$$

$$b = \frac{F_{Z_F} \cdot l}{m \cdot g} = 0,550\ m \tag{2.2}$$

a is obtained by writing the equilibrium of moments about the front axle,

$$F_{Z_R} \cdot l - m \cdot g \cdot a = 0 \tag{2.3}$$

$$a = \frac{F_{Z_R} \cdot l}{m \cdot g} = 1,1\ m \tag{2.4}$$

To calculate the height of the center of gravity the loads acting on the front and rear axle is measured on an inclined plane, Figure (2.3). The measured load at the

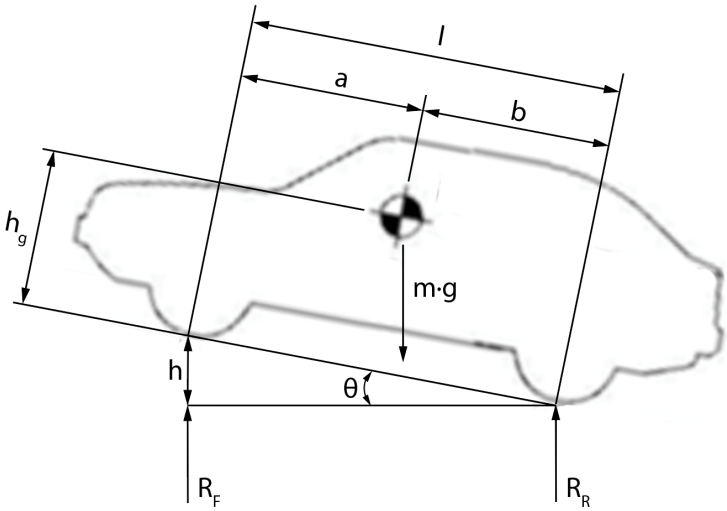

Figure 2.3: Axes loads on a slope

front and at the rear axle is listed in table (2.5).

Table 2.5: Measured axle loads and slope properties

Rear axle load R_R	[N]	4242,3
Front axle load R_F	[N]	2526,6
Step height h	[m]	0,3
Wheelbase l	[m]	1,65
Wheel radius r	[m]	0,235

Measuring the load acting on the front and rear axle the h_g is derived. The angle ϑ is defined as:

$$\vartheta = asin\left(\frac{h}{l}\right) = 0,128\ rad = 7,3339° \tag{2.5}$$

The height h of the center of gravity is obtained with the following formula [21]:

$$h = \left[b - l\left(\frac{R_F}{m \cdot g}\right)\right] * cot\vartheta + r = 0,5\ m \tag{2.6}$$

The center of mass position is calculated and resumed in the table (2.6)

Table 2.6: Center of mass position.

front axle distance a	[m]	1,1
rear axle distance b	[m]	0,55
heigth h	[m]	0,3