# The quarter car model

The *quarter car model* of a vehicle is used to describe the vertical dynamic of a wheel and its suspension.



Blocks and represent, respectively, the car and wheel masses involved in the suspension system, while springs and are the car and wheel masses stiffness (also called spring constants).

The quantities and represent, respectively, the displacements of the car and wheel masses (assuming that only a vertical motion is allowed), and the vertical direction is conventionally considered positive; is the displacement input acting on the wheel, modelling road profile.

The damper is modelling the damping action of the suspension system which, strictly speaking, is only consisting of a spring (, in this case) and the damper itself. In case of a passive system, the value of is a constant parameter set by the manufacturer and cannot be modified. In case of semi-active systems, can be modified while driving.

The dynamic equation describing the suspension system is the following:

|  |  |
| --- | --- |
|  |  |

where , , and represent, respectively, the masses’ velocities and accelerations.

The previous equation can be split into two separate equations, yielding the vertical accelerations for the two masses:

Typical values for parameters , , and are the following:

|  |  |
| --- | --- |
| **Parameter** | **Value** |
| Car body mass () | 380 Kg |
| Wheel body mass () | 31 Kg |
| Suspension stiffness () | 29.000 N/m |
| Wheel stiffness () | 228.000 N/m |
| Damping ( | 1.500 Ns/m |

# The Skyhook controller

To improve the performance of a vehicle and to guarantee a better comfort of the vehicle occupants, a semi-active suspension system is adopted where a control low is used to change the Damping in relation to the suspended mass and wheel speed.

The Skyhook principle is the following: