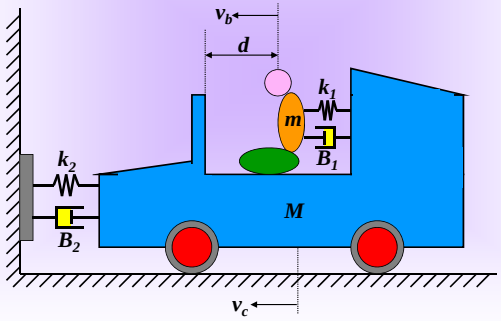
8th Homework

- In this homework, we shall model and simulate a mechanical system as well as exercise the state selection algorithm.
- We shall first model a car bumping into a wall using the 1D mechanical (translational) wrapped bond graph library.
- We shall then model the same car using a bond graph directly.
- Subsequently, we shall read out the model equations from the bond graph.
- Finally, we shall change one of the state variables using the state selection algorithm.

Mechanical System

- We wish to analyze the following system:



Mechanical System II

- Questions of interest:
  - Are the shock absorbers (k_2,B_2) and the safety belts (k_1,B_1) capable of preventing the driver from hitting his head on the front windshield if he drives with a velocity of ***40 km/h*** against a solid wall? What happens when the velocity at impact is ***80 km/h***?
  - How large is the maximal force that the driver experiences at these velocities?
  - How large is the critical velocity, below which the driver neither hits his head on the windshield, nor breaks his ribs?

Mechanical System III

- Data:

  Mass of vehicle (M) = 1500 kg
  Mass of driver (m) = 100 kg
  Stiffness of safety belt (k_1) = 10'000 N/m
  Stiffness of shock absorber (k_2) = 300'000 N/m
  Damping of safety belt (B_1) = 500 Ns/m
  Damping of shock absorber (B_2) = 80'000 Ns/m

- Limit values:

  Safety belt tested up to (F_1) < 13'340 N
  Ribs break beyond (F_2) > 6670 N
  Distance to windshield (d) = 0.5 m

Mechanical System IV

- Model the car and the driver using two sliding masses of the translational sub-library of the mechanical sub-library of ***BondLib***.
- Simulate the system across ***0.5 sec*** of simulated time, and answer the questions that were raised before.

Mechanical System V

- Draw a bond graph of this system.
- Simplify the bond graph using the diamond property.
- Add causality strokes.
- Simulate the simplified bond graph model using ***BondLib***, and compare the results with those obtained earlier.

Mechanical System VI

- Read the model equations out of the simplified bond graph.
- What is the model order?
- Which are the natural state variables?
- We now wish to include the relative position and the relative velocity of the spring representing the seat belt among the set of desired state variables.
- Use the state selection algorithm to derive a modified set of equations that make use of the desired state variables.