EasyDyn problem: braking of a truck

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1 Description of the problem

The purpose of the study is to assess the braking performances of a truck whose structure is illustrated in figure 1. The particularity of the vehicle is that the two rear axles are attached to a support plate which rotates with respect to the main body of the vehicle.

2 Technical data

The proposed model consists of 3 bodies: the main body, the front wheel and the rear support plate. The own rotation of the wheel needn't to be taken into account. The road-tire contact will be modelled only by a vertical spring and a friction force during the braking. The numbering proposed for bodies and degrees of freedom is illustrated in figure 1. The lengths L_f and L_r are equal respectively to 4.26 and 1.38 m.

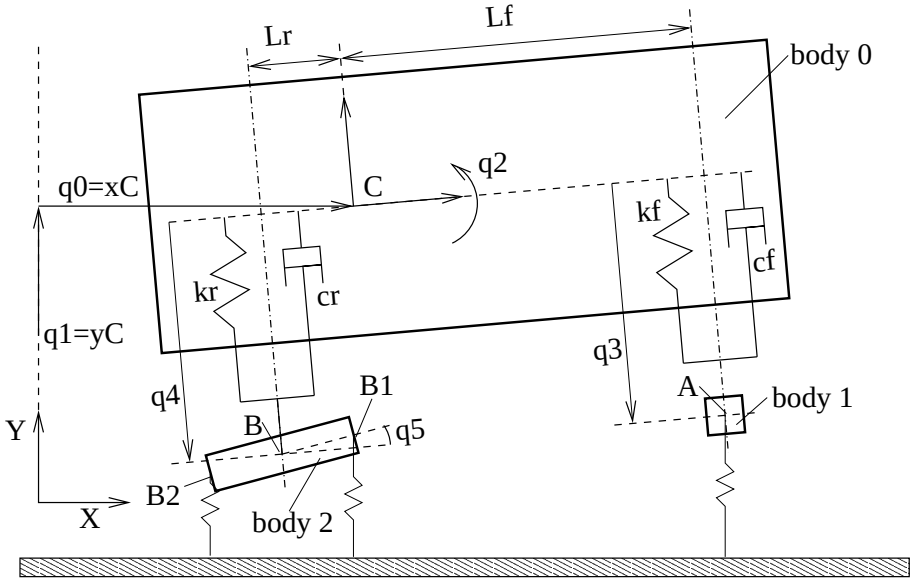

Figure 1: Bodies and degrees of freedom

The masses and inertia tensors (expressed in the axes of the body) are the following

$$m_{S0} = 15219\,kg$$

$$m_{S1} = 992\,kg$$
$$m_{S2} = 3027\,kg$$

$$\Phi_{G,S0} = \begin{pmatrix} 20000 & 0 & 0 \\ 0 & 20000 & 0 \\ 0 & 0 & 20000 \end{pmatrix} \quad \text{, in } kg.m^2$$

$$\Phi_{G,S1} = \begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix} \quad \text{, in } kg.m^2$$

$$\Phi_{G,S2} = \begin{pmatrix} 2840.68815 & 0 & 0 \\ 0 & 2840.68815 & 0 \\ 0 & 0 & 2840.68815 \end{pmatrix} \quad \text{, in } kg.m^2$$

The stiffness and damping characteristics of the suspensions are listed below

- kf=458014 N/m
- kr=3034614 N/m
- cf=30000 Ns/m
- cr=40000 Ns/m

The rest length of the springs will be chosen in such a way that q_3 and q_4 are equal to 1.15 m at equilibrium (variable `hC`).

The vertical stiffness of the tires is assumed to be equal to 2.4E6 N/m. The corresponding force is strictly vertical and is applied at points A, B1 and B2 of figure 1. The tangential force on the tire will be calculated according to the law of Coulomb, with a friction coefficient equal to 0.6.

The aerodynamic drag D must be taken into account in the simulation. It will be expressed from the velocity V, according to the classical law

$$D = C_a S V^2 \tag{1}$$

with C_a=0.6 and S=5 m^2 in our case. The drag will be applied at a point which is 0.1 m above the center of gravity.

3 Requested results

The purpose of the simulation is to determine the time and distance needed to stop the vehicle from an initial velocity equal to 12 m/s. The distribution of vertical efforts between the 3 axles will also be studied.

4 Typical results

The time evolution of the different configuration parameters and their first time derivatives is depicted in figures 2 to 3, in case the braking starting at t=1 s.

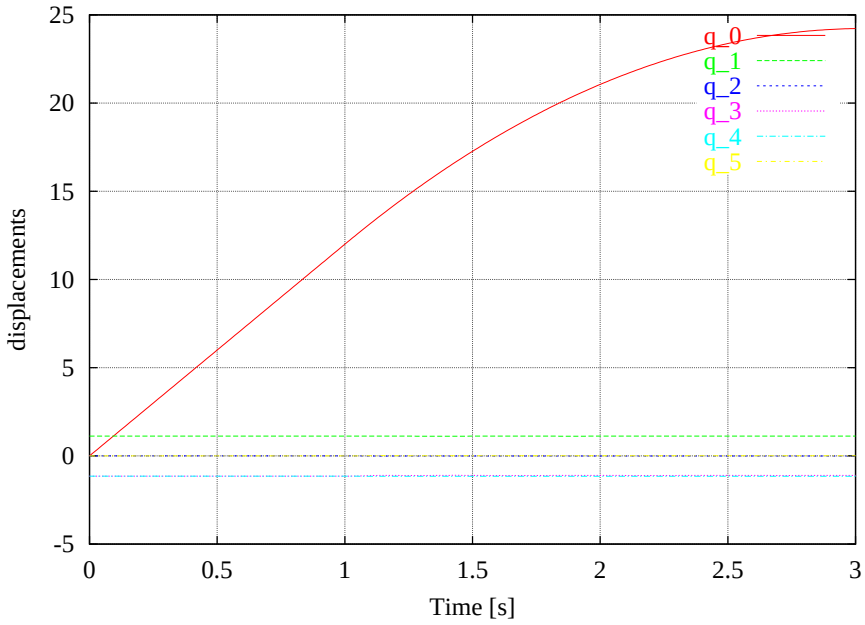

Figure 2: Time evolution of parameters

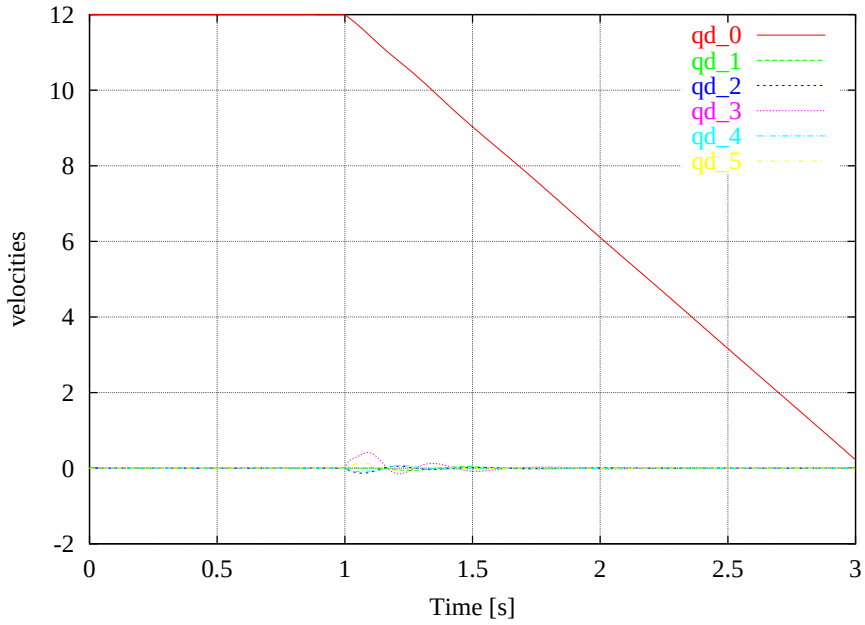

Figure 3: Time evolution of time derivatives of parameters

The evolution of the tire efforts is plotted in figures 4 to 6.

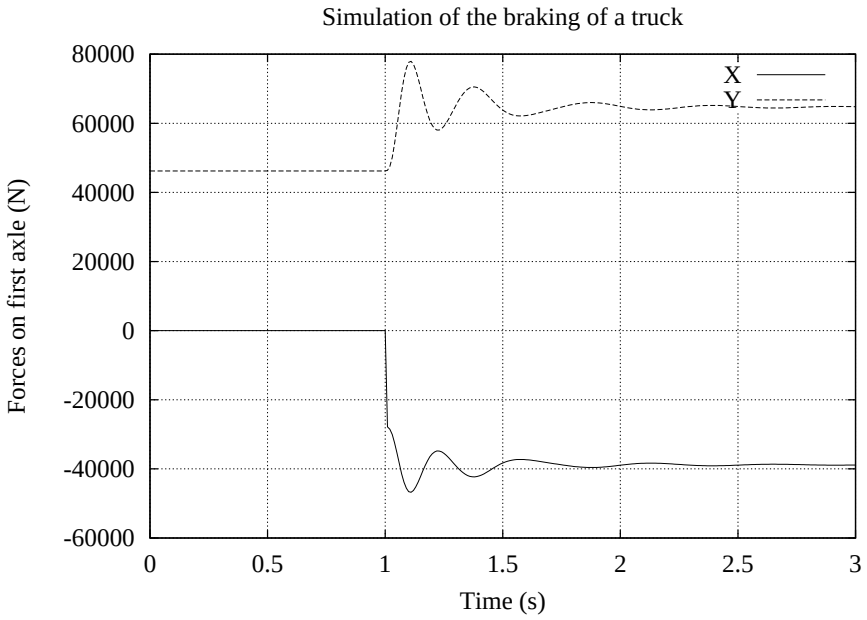

Figure 4: Time evolution of efforts on first axle

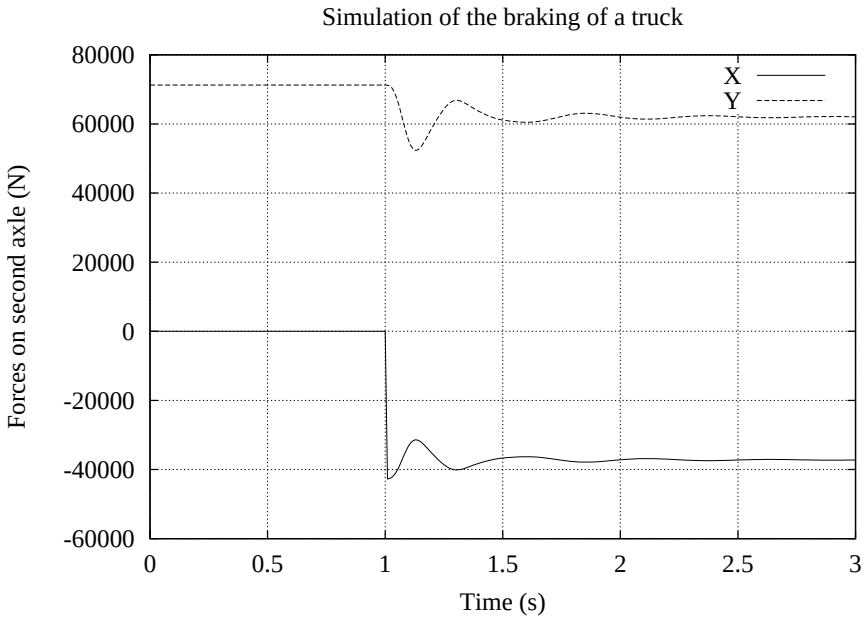

Figure 5: Time evolution of efforts on second axle

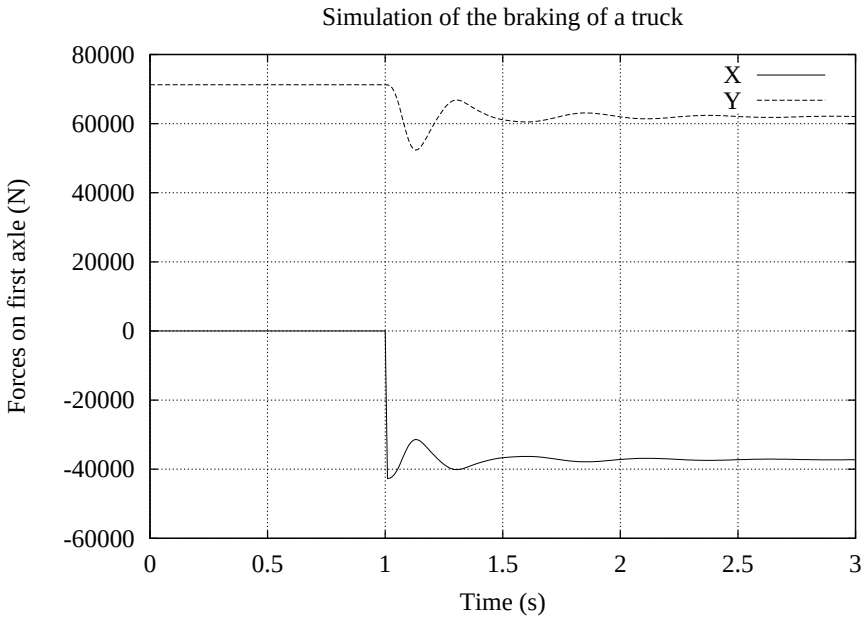

Figure 6: Time evolution of efforts on third axle