Improving simulation models through damping measurements

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In heavy vehicle development, simulation models are widely used to evaluate designs and concepts in an early stage in the product development process, eliminating the need of physical prototypes. In this thesis the focus has been to improve simulation models by measuring the damping of a physical system, and implementing the damping as a model input.

Damping can be explained as the removal of mechanical energy from a system in motion and is the reason that the motion will eventually stop unless energy is supplied to the system at an equal or larger rate than it is dissipated. Many different sources of damping exists, in this work the most important one is friction between parts bolted together and within materials such as rubber. Friction transforms kinetic energy into heat mostly.

When creating a model of a dynamic mechanical system, such as a heavy vehicle chassis in this case, knowledge of the damping is of great importance for successful simulations and prediction of for example the life span of the vehicle. In this thesis a simulation model of a part of a heavy vehicle was created, based on an existing experimental setup. The damping was measured in the experimental setup and from the measurement results damping was implemented into the simulation model. The simulation results were finally compared to the physical measurements.

The results show that knowledge of and correct modeling of the damping in the system is crucial in order to obtain reliable results from simulation models. Implementing damping based on measurements can greatly improve the simulations, however the implementation itself proves not to be straight forward. The study also shows that the detail level in the modeling together with the modeling of the bolted joints also affects the ability to successfully predict the behaviour of the system. In conclusion the study contributes to increasing the knowledge of damping in the physical system as well as in the model and how the model can be improved. However, further improvements can be made and the thesis suggests future studies in the field.

As the development of computers continues at a fast pace, the amount of computational power we have access to is growing. More computational power means that we can create better, more detailed and more complex simulation models. For the models to be useful they must be verified and compared to real measurements. The use of this thesis is to verify the currently used models, showing strengths and weaknesses. The thesis also suggests how to improve the current models with respect to damping. Our models will only serve useful if we are aware of their limitations.

The work in the thesis was conducted in cooperation with heavy vehicle manufacturer Scania, who provided the necessary parts, equipment and knowledge. Figure 1 shows the experimental setup, which was subject to random vibration while the acceleration was measured at different locations. From the acceleration data information about energy dissipation and the deformation of the different parts was obtained.

Figure 1: The experimental setup, consisting of a heavy vehicle chassis frame with a number of mounted components.

The information from the physical experiment was then used to make the simulation model shown in Figure 2 mimic the motion of the physical system, using the same random vibration signal as input.

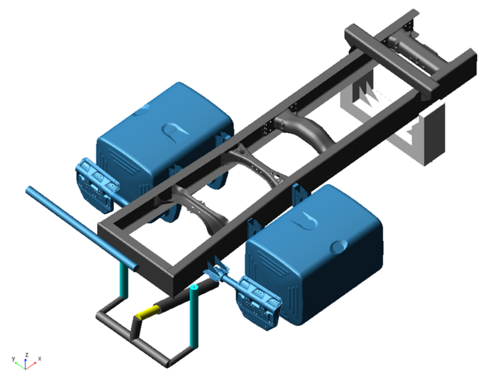

Figure 2: Simulation model of the experimental setup.

Improving the simulation models opens up the possibility in the future to completely remove the need for physical prototypes and physical testing. As the simulation models are easily modified more concepts can be tested and optimized virtually, resulting in better products.

From the results it is shown that the damping of the experimental system is successfully identified and implemented into the simulation model. The implementation leaves room for improvement. Finally it is concluded that the prediction of the lifespan of the involved components is improved through better knowledge and modeling of the damping in the system.