Investigation on Thermal and Mechanical Influences on Distance Sensors in a Tow Bar

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Abstract

Most technical systems become smart over time, therefore those systems will have improved safety and comfort functions. An example is a new development by Westfalia-Automotive. The German company produces up to one million tow bars (Figure 1) a year. A new generation of smart tow bars, equipped with a sensor system, is able to inform the driver of a car with a connected trailer about vertical and trailing loads. This helps to ensure a safety load distribution and to avoid overloading.
An important part of this system are distance sensors. Those sensors measure a distance change (proportional to applied loads) at defined positions in the tow bar. Unfortunately, distance changes between the measuring points of the sensors are not caused only by mechanical loads. Thermal expansion may also influence the measured distance. This investigation focusses on the deformation of the tow bar, caused by thermal influences and the thereby occurring distance change at the measure points.
The CAD model of the tow bar was provided in step format, exported from CATIA®. The geometry was repaired and simplified with the virtual geometry operation features of COMSOL Multiphysics® software. In addition, virtual measure points in form of parallel plates were integrated with different geometry operations (Figure 2). These plates represent the measure points of the real sensors, which were not part of the study.
Rigid connectors enable the transmission of kinematic motion from the tow bar deformation to the plates. The simulation includes three user-defined materials, partly with temperature dependent material properties, for example Young's modulus, thermal expansion coefficient and thermal conductivity coefficient. The material properties are added to local tables and are approximated with spline functions. A boundary material with a surface emissivity property represents a cathodic dip-paint coat. The tow bar is mounted with fixed constraints on relevant surfaces. A boundary load represents a vertical trailer load. This helps to get information about distance change caused by mechanical loads. The convective heat flux boundary condition of the Heat Transfer Module is used to simulate the heat flux between the tow bar and the surrounding fluid. The influence of the radiation of the sun is approximated by a constant heat flux through different boundaries. Finally, the strain caused by temperature change was calculated using the multiphysics coupling Thermal Expansion.
The results show the dimension of distance change caused by thermal effects. Thus, it helps to determine the influence on the measured trailer loads. In further investigations, it is planned to sub model the area around the measure points to get more detailed results.

Those results could then be used for a detailed study of the sensor behavior itself. Finally, it will be possible to predict the influence of temperature changes in the surroundings on the measured loads by the sensor.

Reference

[1] Westfalia-Automotive GmbH, online: https://www.westfalia-automotive.com/de/produkte/anhaengerkupplungen/starre-anhaengerkupplungen/ (2016)

Figures used in the abstract

Figure 1: Illustration of a tow bar [1].

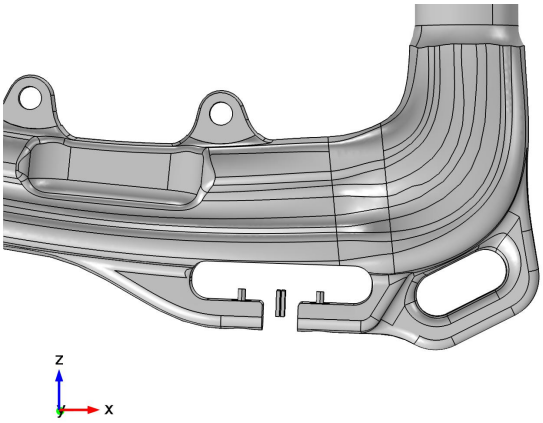

Figure 2: Simplified measuring point.