Virtualisation of the brake noise development process for guarantee of a robust start quality

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02/2013
☑ ongoing ☐ finished

Motivation
The dissertation is dealing with robustness evaluations in the numerical securing of brake systems concerning brake noises.

In the parameters of a real brake system variations are occurring. They are characterised by outer influences, for example tolerances in production. The aim is the variations’ consideration in the numerical model. The scatter can be divided into manufacturing induced variations, geometric variations or influence from environmental variations. An example for this categories are scatter in the stiffness of the singular parts, wear of brake pads or influences from temperature or velocity. In total for a reduced brake model 30 different input parameters are defined. Therefore only the most important parts for the noise emission are considered, this is the brake disc, brake pad and their neighbouring components.

Objective
The objective of the work is the derivation of an algorithm for the assessment of the brake system’s robustness. It is modelling the parameter´s variation in the numerical system and calculates a prediction of the brake system´s noise behaviour. While developing the procedure different objectives come into account. The most important one is the derivation of an objective function for characterizing the propensity for brake squeal and the assignment of a scalar value. Additionally a theory for the generation of surrogate models is developed. Based on this the behaviour can be determined in an easy way and an instability probability can be calculated.
Approach
The development of the algorithm is based on different analytical and experimental methods. With combinations of simulations and sensitivity analyses the most influencing parameters on the brake system´s noise emission are identified. Additionally a method for the assessment of the system´s robustness is determined.

Fig. 1: Finite Element brake model.

A major step in the derivation of the assessment is the development of an objective function for the evaluation of the different simulations and the classification of the system´s status with a scalar value. Another one is the determination of the input parameters´ scatter and its probability density function. A method for the calculation of surrogate models for the brake systems has to be created. Therefore the parameters included in the system are reduced. At least a robustness index and a squeal probability under the input scatter are calculated.

Fig. 2: Visualisation of the calculated surrogate model.

Result
The aim of the brake system´s robustness assessment is the placement of the system in a stable and robust region so that the parameter scatter doesn´t have influence on the system´s stability.

References

Reference B: Alexander Buck, Simulation von Bremsenquietschen (Brake Squeal), Shaker Verlag, 2008

Stand: 30.11.2015