Multibody analysis of a disc brake system with various contacts and the coefficient of friction as function

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Audible oscillations of disc brake systems are an important quality criterion because these squealing noises create uncertainty by users. Therefore, much effort is made for improving these systems with different methods. The present work shows a computer-aided multibody (MB) approach for the depiction of brake systems and their oscillations. A locally constant and a locally distributed coefficient of friction as function are mapped on the contact points between a brake disc and a brake pad. The results show the influence of the locally distributed coefficient of friction to the frictional behaviour of the system.
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1. Introduction

Disc brake systems are still a vital element in many technical products like trains, bikes or cars because they can quickly transform kinetic energy. By doing so, they are able to quickly reduce the speed of e. g. a car and help controlling hazardous situations.

A common side effect in disc brake systems is the creation of audible oscillations, which unsettle users. Therefore, the brake systems are analysed and improved in terms of reducing disturbing and unsettling noises.

2. State of the art and method

Oberst and Lai [1] list different models for the investigation of brake squealing. The list starts with minimal models and reaches up to models with several thousand degrees of freedom, which require different input data and much time to conduct.

The hereby presented approach aims for product engineers, who have only CAD data available. These CAD data was imported in commercial MB software.

For the disc brake simulation model, the CAD geometry of a brake system with high affinity to squealing was used. The assembly comprised a disc, two pads and a calliper. Speeds up to 30 km/h were investigated because at these speeds the oscillations are audible and therefore unsettle users.

The special feature with this model is the depiction of a coefficient of friction as function in various MB contacts. The brake pad was split up to multiple parts to model various contact points between disc and pad. At each point, a pressure and velocity dependant coefficient of friction as function was implemented with a subroutine.

3. Results

The system coefficient of friction was then computed by summing up the tangential forces and dividing it through the corresponding sum of the normal forces. The results for the system coefficient of friction show that with an increasing disc pad contact pressure the coefficient of friction increases. Figure 1 depicts the brake acceleration of a model with one contact and a model with various contacts. The brake acceleration in the model with one contact is constant and the movement stops after 3.6 s. The model with various contacts shows an absolute smaller acceleration with a slightly curved course and the movement stops after 5.2 s.

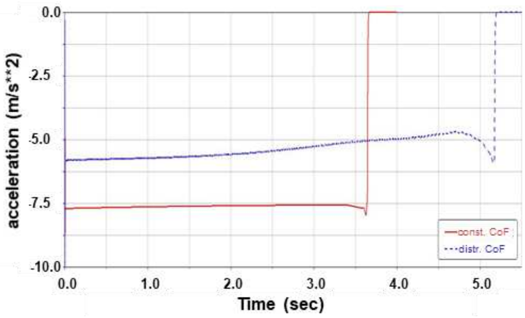

Figure 1. Brake acceleration over time.

4. Discussion

The slightly curved course of the brake acceleration curve is the consequence of the various contacts in the MB simulation. In case of a single contact the acceleration is constant. This is a hint, that the inner contacts with lower speeds have a different influence to the brake acceleration than the outer points with higher speeds. These differences in the friction interface can create oscillations and will be focused on in future work.

5. Conclusion and outlook

The presented approach shows a method to model various contact points with different tribological properties in MB simulations. The next step of the project comprises the evaluation of the lateral and longitudinal oscillations in the pad and disc. These oscillations will be used to analyse the squeal affinity of the brake in the simulation.

References

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