Fundamental tests of low-frequency noise phenomena especially creep groan, with a simplified test setup

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ABSTRACT

Research and/or Engineering Questions/Objective: (max. 100 words)
The objective of the research are investigations of the low frequency phenomenon creep groan of automotive brake systems with a special test rig, which e.g. allows a characterisation of friction component vibration behaviour with different setups. The accomplished investigations include In-Situ observations of dynamic friction processes by using a borosilicate glass disc and inquiries for tribological properties between different brake lining materials and cast iron brake discs. The main purpose of these studies is to understand the tribological and physical mechanisms which cause brake system vibrations at very low vehicle speed.

Methodology: (max. 150 words)
For the investigation and phenomenon description a test rig has been developed, which allows the user to depict various brake system parameters, such as different velocities, pressures or temperatures of the friction couple and it is now possible to examine the interaction between them and the friction coefficient or other physical effects. The built test rig allows to use different visualisation methods for capturing effects of friction. Some of those methods are high speed recordings/video capturing of vibrating brake subsystems by using a high-speed and high-accuracy microscope optic or using a telescope optic for the capturing of macroscopic effects. All those visualisation methods are coupled with simultaneous measurement of particle flow, airborne sound and structure borne sound.

Results: (max. 150 words)
The results of the investigations are objective insights into the friction zone at different scales and under different conditions during creep groan events and comprehensive measurement data from the accelerometers and microphones which for example provide the possibility to correlate friction effects like the gradient of friction coefficient at the transition from stick to slip with the sound events. The studies reveal the effect of the height of static and dynamic friction coefficient on the stick slip phenomenon, especially on the duration of stick and slip periods and on the amplitude of the breakaway impulse. The effects of the variation of sliding speed, humidity, temperature, pressure on the stick-slip effects and on the vibration and sound radiation were also determined.

Limitations of this study: (max. 100 words)
For the researches only two different kinds of disk material, five different brake lining compositions and one certain brake calliper design along with a special pad geometry had been used.

What does the paper offer that is new in the field in comparison to other works of the author: (max. 100 words)
In difference to known studies, this study visualizes effects of creep groan which appear directly in the friction zone. For example it is now possible to visualize the motion of wear particles at stick-slip-movement during creep groan of automotive brake systems. Another advantage of the presented method is the investigation of the complex vibration behaviour of the friction lining in microscopic scales which for example helps to understand the effects of elastic deformation of brake force transmitting areas of the pad, so called patches, upon application of a driving torque or brake pressure.

Conclusion: (max. 100 words)
The purpose of the test rig development was to find a way to describe effects of creep groan accruing directly in the friction zone between the brake pad and the disk. Therefore the challenge of generating a stable, long lasting creep groan noise on a test rig had to be accomplished. After some preliminary investigations regarding sensor application and creep groan boundary condition (parameter) identification examinations on the dependence of the noise event on different influences was carried out.