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INVESTIGATION OF THE INFLUENCE OF AN UNCERTAIN COEFFICIENT OF FRICTION IN DIFFERENT FRICTION LAWS

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One of the main research topics at the Institute of Dynamics and Vibration (IDS) is the measurement of friction processes in brake systems using pin on disc tribometer [1] to investigate Noise Vibration Harshness (NVH) problems, such as squealing. These problems are still research topics with a high significance in the automobile industry, since so far no satisfactory predictions are possible, because of uncertainties within the friction model and the measurement data.
From many measurements, it becomes clear that the coefficient of friction μ is not a constant – as assumed in many friction models. It depends on many variables and has its own dynamic signature [2,3], which is the main reason of the high degree of uncertainty in models if μ is modelled as a constant. To improve the friction model and describe its uncertainty, the more than 100,000 single brake applications that have been carried out over the last decade at the IDS are used in a higher-level analysis to describe the uncertainty of μ at different accuracy levels. For this purpose, the data are evaluated systematically and are subdivided according to the measuring parameters, such as the type of friction material, sliding speed or normal force, which leads to a decreasing uncertainty of μ. In the first step, the coefficient of friction itself is initially described by a probability density function with a constant mean value and a varying number of higher-order moments. In the second step, μ is described by means of stationary functions depending on the measuring parameters, which again leads to a reduction of the uncertainty. The main aim is to derive a friction law that can adequately describe the dynamics of the coefficient of friction and minimize its uncertainty.
The influence of the uncertainty of μ is illustrated by an exemplary stability analysis of a mode coupling friction self-excited system [4]. In this minimal model, which is used commonly to describe NVH problems, the stability of the limit cycle is significantly determined by the coefficient of friction. Thus, any uncertainty of μ strongly affects the dynamical behaviour.

REFERENCES

[1] G.-P. Ostermeyer, T. Schramm, S. Raczek, F. Bubser, N. Perzborn, The Automated Universal Tribotester, Proc. Eurobrake 2015 Dresden, EB2015-STQ-015
[2] G.-P. Ostermeyer, On the dynamics of friction coefficient, wear 254,Nr.9, 852-858, 2003
[3] G.-P. Ostermeyer, M. Mueller, T. Srisupattarawanit and A. Voelpel, On Uncertainty in Friction Measurements. Proc. Appl. Mathematics and Mechanics, Weimar, 2017.
[4] N. Hoffmann, S. Bieser and L. Gaul, Harmonic Balance and Averaging Techniques for Stick-Slip Limit-Cycle Determination in Mode-Coupling Friction Self-Excited Systems. Technische Mechanik, Vol. 24, pp. 185-197, 2004.