Disc Brake Low Frequency Creep Groan Simulation Using ADAMS

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Disc brake creep groan is a wide band low frequency noise produced at low vehicle speed and moderate brake pressure. Much experimental work has been done in this area in the last decade. The experimental results showed strong nonlinear vibration and characteristics of stick-slip dynamics. Due to the complexity of modeling and restricted CAE capabilities, there were few papers published before for a full brake system creep groan simulation.

In this work, a disc brake system exhibiting creep groan noise was modeled using ADAMS 10.0 with contact forces, flexible links, elastic components, etc. The model was able to mimic the creep groan vibration showing the details of the stick slip phenomenon when the system was excited. This presentation will demonstrate ADAMS modeling capabilities in this area as well as the simulation results.

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Model Introduction

Creep Groan and Stick-slip

Summary



Disc brake creep groan vibration Friction Coefficient, Outer Pad Tangential Acceleration, And Outer Pad to Rotor Relative Tangential Velocity



Outer Pad CM Accelerations



Inner Pad CM Accelerations



Close view of the stick-slip burst cycle



Outer Pad CM to Rotor Relative Vibration Phase Plot



Caliper CM Rotational Acceleration



Caliper CM Translational Acceleration



Pin Guide 1 Acceleration



Pin Guide 2 Acceleration



Disc brake groan vibration

Brake System Instability Study

DrivingFrictionSystemMechanismCouplingDynamics

Rotor/Wheel

Assembly

Pad/Caliper/Carrier assembly

Work Done by Friction Force During Stick-slip



Observations





Friction force provides energy





Friction force consumes energy

Disc brake creep groan vibration Outer Pad Tangential Accelerations



Sensitivity to Friction Slope

 Vibration magnitude decreases with the decrease of friction slope

 Sticking time decreases with the decrease of friction slope

SUMMARY

- An ADAMS model was built to successfully simulate creep groan vibration
- An important characteristic of creep groan stick-slip is a short slip time and a long stick time
- Friction force inputs energy during stick and consumes energy during slip Groan vibration is very sensitive to friction slope