Comparative Study on the Complex Eigenvalue Prediction of Brake Squeal by Two Infinite Element Modeling Approaches

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Abstract: The complex eigenvalue analysis is currently a common approach to predict squealing vibration and noise. There are two methods for modeling friction contact in the complex eigenvalue analysis of friction systems. In one method, contact springs are used to simulate friction contact. In another method, no contact spring is used. However, it has been uncertain whether these two modeling methods can predict approximately identical results. In order to clarify the uncertainty, two finite element models of the same brake system for the brake squeal prediction are established and simulated by using ABAQUS and NASTRAN software tools, respectively. In the ABAQUS model, friction coupling is applied to determine normal contact force and no contact spring is assumed. Whilst in the NASTRAN model, the contact spring is assumed by the penalty method to simulate contact connection. Through the numerical simulations, it is recognized that even if the same mesh geometry is applied, generally, these two finite element approaches are not capable of predicting approximately identical unstable frequencies. The ABAQUS approach can predict instabilities of high frequency up to 20 kHz or more, while the NASTRAN approach can only predict some instabilities of high frequency, not all. Moreover, the simulation results also show that both the contact spring stiffness and mesh size have influences to some extent on the prediction results of squeal. The present comparative work illuminates that the modeling method without contact springs is more suitable to predict squealing vibration and noise, comparing to the modeling method with contact springs. It is proposed that one should prefer using the modeling method without contact springs to predict squealing vibration and noise. The proposed study provides the reference for predicting squealing vibration and noise.

Key words: friction, brake, squeal, noise, finite element

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