Effect of Friction and Braking Pressure on Automotive Disc Brake Squeal

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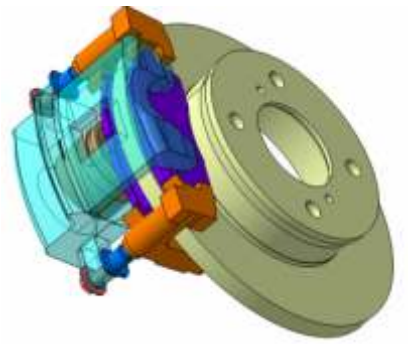
Abstract:

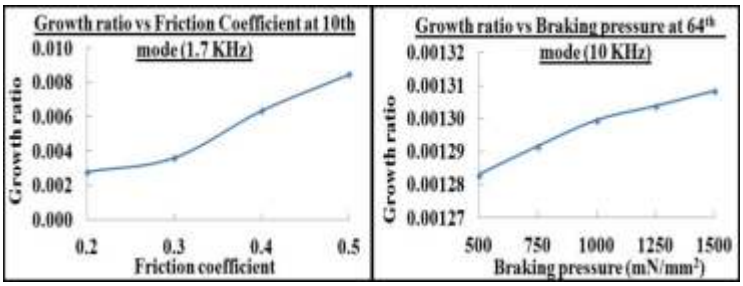
Brake squeal is one of the major problems faced by the automotive industries for several decades. Squeal frequency ranges from 1000 to 16000 Hz. But the most annoying squeal frequency where the humans are more sensitive to hear is from 1000 to 10000 Hz. More than 10000 Hz, high sound pressure level is needed for the people to hear. The brake squeal irritates the people who travel inside the vehicle as well as the surrounding people. This leads to high warranty cost for the brake companies. So reduction of squeal is one of the important tasks considered in this project.

To predict the brake squeal, complex eigenvalue analysis was performed on the finite element model of the disc brake system under different operating conditions. The effect of friction and braking pressure on squeal characteristic was studied. The analysis explains that if the real part (σ) or growth ratio ($\tau = \sigma / (\ |x|\ |)$) is positive then it represents that the particular mode is unstable. Unstable modes are the result of modal coupling that varies with friction and braking pressure. The presence of unstable modes gives the disc brake system the tendency to squeal.

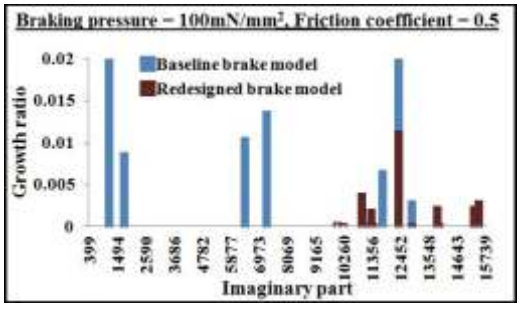
If either the back plate or the disc's out-of-plane modes are coupled, that could cause the brake system to have unstable modes. More number of unstable modes has high tendency to squeal. The unstable modes are represented by positive τ. Increase in friction coefficient or braking pressure leads to high τ. The out of plane motion of the back plates, that causes instability to the brake system are reduced by stiffening the back plates. The stiffness of the components has to be altered for decoupling the modes. Stiffening one component may decouple modes at one operation condition and may couple other modes at other operating condition.



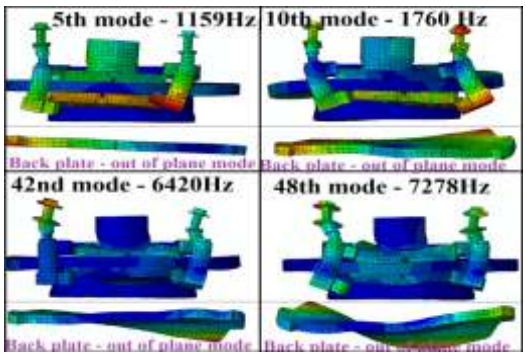
Disc brake geometric model



Effect of friction and braking pressure on squeal characteristics



Comparison of unstable modes frequencies of baseline model and redesigned model



Unstable modes shapes of baseline model