Squeal noise of railway disc brakes: correlation between experiments and transient computations from updated simplified pad models

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ABSTRACT

Research and /or Engineering Questions/Objective: (max. 100 words)

The goal of this research is to explore the relations between the disc brake noise and the design of the pad from an experimental and a numerical point of view. Transient and stability analysis have been conducted on large industrial models with the numerical tool developed in the "Acoufren" french project. This tool allows introducing simplified 3D Finite Elements (FE) pad models built from 2D drawings. The objective is to conclude on the ability of the tool to distinguish brake vibration/noise from different specific pad.

Methodology: (max. 150 words)

The method to reach the objective is to conduct both experimental campaign and numerical study on a set of 3 existing pads:

For each of the pads, squeal measurements (noise and vibration) are conducted on a test bench for several configurations (velocities, pressures, direction of rotation).

For the numerical study, both stability and transient simulation are conducted on an assembled brake model. This global brake model is not updated but the FE models of each component of the brake (calliper, disc) are updated from experimental modal analysis. The "Acoufren" tool allows to import a simplified pad model (built from 2D drawings) which complete the global brake model.

A specific method has been developed here to update the simplified pad model according to specific measurements.

The final step is the comparison between measurements and numerical results for the 3 kind of pads.

Results: (max. 150 words)

Relations between experimental noise/vibration of the brake and mechanical parameters of the pads have been found.

The simplified pad FE model is updated in 2 phases :

- measurements of the elastic moduli / damping of friction material

- measurements of the modal parameters of the first modes of the pad in free conditions and/or clamped on a marble (depending of the mechanical architecture of the pad)

A good agreement can be found on some pads between numerical results and experimental results

Limitations of this study: (max. 100 words) The study is limited here to one brake type only (but with variability of pad).

What does the paper offer that is new in the field in comparison to other works of the author: (max. 100 words) The paper offers :

- *transient numerical results on large industrial models.*
- Numerical strategy/model able to simulate different brake pad squeal responses

Conclusion: (max. 100 words)

A strategy has been proposed to explore the relations between the disc brake noise and the design of the pad. With the numerical tool developed in the "Acoufren" french project, a good agreement has been found on some pads between numerical results and experimental results. This result is a new step in the prediction of noise/vibration railway disc brakes related to pads.