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RULES AND HINTS FOR THE DESIGN OF VISCOELASTIC INSULATORS TO PREVENT BRAKE SQUEAL

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Avoiding Brake Squeal Noise is a great challenge in railway, aeronautic, automotive and bicycle industries. Adding damping is known to be quite efficient to achieve this goal, see for instance [6], [5], [4]. Our talk will deal with the design or the viscoleastic insulators used to prevent and avoid brake squeal. For several years, our work has been done in the framework of a partnership with BOSCH Brake Systems in order to help this company in the development of their products. Thus the presented examples come from automotive industry. First, we present the motion of the brake-pads measured during an occurrence of squeal. The analysis shows that the motion is governed by propagating bending waves. Both the normal load, i.e. the fluid pressure applied to the back side of the pad, and the joints with the caliper are responsible for non-linear behaviors. The normal load increases slowly during the tests and it is shown that it induces frequency increasing. The impacts with the caliper are shown thanks to harmonics detection in a time-frequency analysis. More informations can be found in Renaud et al. [3]. Secondly, we present several numerical results, previously published in Thouviot et al. [1] and Festjens et al. [2]. These results show that the added-damping can be very effective when it shifts the coalescence of the modes in the "Friction Force vs Real Part of the eigenvalues" map. It can also useful when it decreases the Real Part of the eigenvalues. More rarely, it can also be inefficient when it generates new coalescence between the complex eigenmodes. Several examples will illustrate these three configurations. Thirdly, we present some interesting results on the use of multi-layered viscoelastic parts. It is shown that the strain energy is higher in the normal direction of the pad and it adresses questions on the optimality of the shims that are widely used in automotive industry instead of simple rubber pads.

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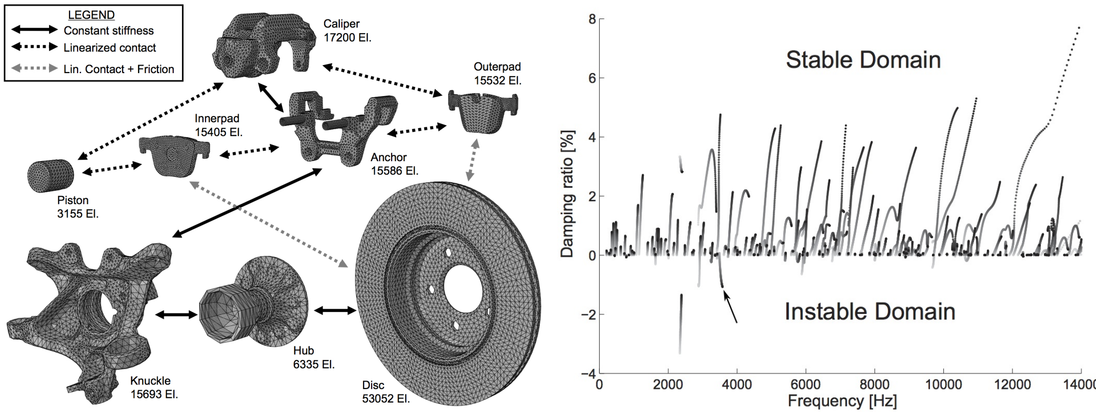

Figure 1: Left: Mesh of the studied realistic Automotive Brake System. *Courtesy of Bosch Brake System France*
Right: Root Locus of the Complex Eigenvalue Analysis performed to highlight the stable and instable eigenmodes according to viscoleastic damping.

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