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NUMERICAL COMPUTATION OF NOISE RADIATION FROM BREAKING SYSTEMS FOR SQUEAL NOISE PREDICTION

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Many trains have braking systems made of disks and pads which can generate very high noise levels. During the braking, instabilities can be generated in the contact zone between the pad and the disk leading to high vibrations and high levels of noise radiations. The global numerical simulation of vibrations and noise radiation of these systems are necessary to understand their physical behaviour in a first step and to build quieter systems as a final aim. Analysis of these systems shows that noise spectra are generally made of discrete frequencies corresponding to unstable vibration modes. These instabilities are responsible for the high levels of vibrations. The unstable modes are usually located in the middle and high frequency ranges, typically between 1000Hz and 10000Hz and can generate sound as loud as 100dBA.

Numerical computation of noise radiation at these high frequencies for systems having the size of usual train braking systems and their geometrical complexities are difficult with classical methods and thus require special attention. In this paper, different strategies based on the boundary element methods are used for computing the sound radiation from the knowledge of the surface velocity at different frequencies. This approach is suited for braking at constant force which leads to stationary noise or noise levels with low variation with time which is the current and interesting situation. According to the frequency, usual boundary element methods, fast multipole boundary elements methods or high frequency approximations are used and compared for these problems. Examples of sound radiations for different trains and braking systems are presented. Contributions of the parts of the systems among the disk, the pads and the callipers to the global sound levels are identified. Analysis of the system radiation in terms of spectra and directivities are also presented.