MODELING NOISE ORIGINATING AT A SLIDING CONTACT

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ABSTRACT

Noises originating from the action of dynamic forces at sliding or rolling contacts are ubiquitous in our daily lives. Noise from squealing brakes, squeaking doors, creaking floors, rustling leaves, and various forms of scraping, rubbing and scratching are always around us. Many machines and devices that radiate noise also include moving contacts as sources. An extensive review by Akay (1) touches on most of the acoustic phenomena in which friction plays some role. To model the full tribo-acoustic problem, the excitation at the contact, the vibratory response of the system, the conversion of the vibration to radiated sound and its subsequent propagation to the receiver in an acoustic space, must be included. In this paper we model a relatively simple case wherein a pin on disc apparatus operates in a controlled acoustic environment, namely at the end of a square duct with an anechoic termination. The source of excitation is roughness being swept through the contact as the disc rotates against the nominally stationary pin, i.e., rubbing noise. The conversion of the resulting disc vibration into sound invokes the concept of radiation efficiency that accounts for the fact that not all of the oscillating air flow adjacent to the disc is converted into propagating sound. Since the frequency range goes from 500 to 5000 Hz, the transverse duct modes are also included. The input to the model is the power spectrum of the fluctuating contact force. Multipication by the plate mobilty gives the vibratory response as the mean square plate velocity. The levels are then adjusted by the fraction of the duct cross-section occupied by the disc. The duct response is included next. The radiation radiation efficiency is then introduced to provide the sound level above the disc averaged over the cross-section of the duct.

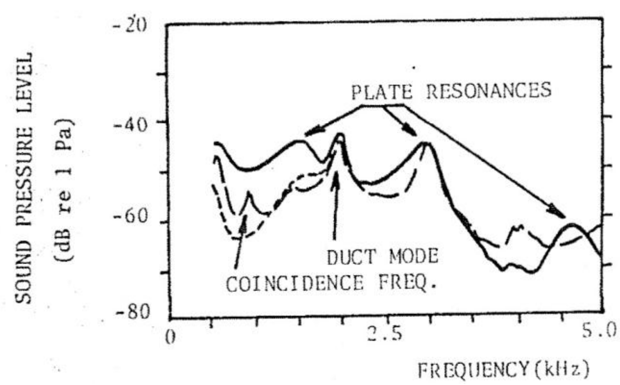

Figure 1. Measured (long dash), Modeled with radiation efficiency =1 (solid), Modeled with radiation efficiency estimated from theory (short dash)

The measurements are compared with the estimate/model as shown in Figure 1. The model that includes radiation efficiency matehes the measurements quite well. The model that assumes a radiation efficiency of unity, overestimates the sound at low frequencies where there is some cancellation due to out of phase rocking motion of the disc. The radiation efficiency accounts for this. The coincidence frequency, at which the plate bending waves travel at the same speed as the sound in air is not included in the model. The sound radiation from plates is known to be enhanced in the neighborhood of the coincidence frequency.

REFERENCES

[1] Akay, A. J. Acoust. Soc. Am. **111** (4), April 2002