Distance Attenuation of Tram Noise

Abstract

The aim of this work was to investigate how the rate of the sound attenuation from a tram changes over distance in an open city environment, and to get a better general understanding of the tram as a sound source. By setting up an array of microphones with an internal distance of approximately 8 meters, perpendicular to the tracks, measurements were carried out at three different locations in Oslo and two in Gothenburg, and the sound attenuation was analyzed for a total of five different tram types. The sound pressure level (SPL) as function of time, the average maximal A-weighted SPL at the different microphone positions, the rate of sound attenuation with distance, the spectral content as well as the spectral attenuation with distance of the various tram types are presented and analyzed. The measurements are compared with results from a developed model using sets of point sources, performed in Matlab. Parameters which seem to affect the rate of the sound attenuation is the strength of any point source present (individual wheels or the engine) as well as the width of the sound source. Strong point sources dominating the sound field close to the tram lead to a high rate of the sound attenuation in this region, and a wide sound source leads to low attenuation further away from the tram. A wide sound source can for instance mean that strong point sources are located at the edges of the tram (front and rear) or that there is substantial noise coming from the rails in front of and behind the tram. The spectral content varies a lot between different tram types, and it also seems to depend on the speed of the tram. The spectral attenuation with distance depends in the same way as for the total SPL attenuation on the distribution along the tram of sound sources with different spectral content. An evenly spread rumbling of the tram body would for example give a lower rate of attenuation with increasing distance than the distinct sound originating from an individual wheel. The measurements show that there are clear differences between the various tram types regarding sound attenuation and spectral content, and in Oslo there are also large variations from one location to another within individual tram types. This can be due to the fact that the measurement conditions were less optimal in Oslo, and it might be wise to distinguish between a completely open environment and a semi-open city environment when looking at sound attenuation from trams.

In order to more accurately be able to predict the sound attenuation from trams in the future, the placement and strengths of important sound sources should be identified and their spectral content determined. How the speed of the tram affects the strengths of the various sources as well as their spectral content can also be examined further.