Rail Research UK
The universities' centre for railway systems research

PhD Project: Development of models for rail vibration and noise radiation including the effects of rail dampers

Engineering Interfaces

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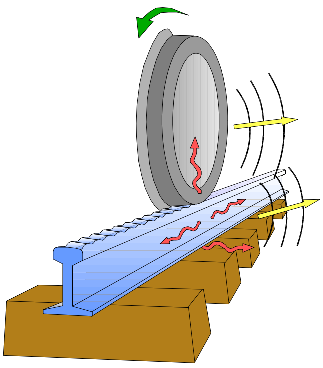
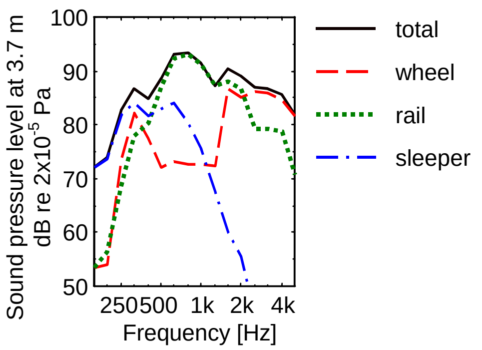
Background:

Rolling noise is the dominant source of noise from trains. It is produced by the interaction between the wheel and the rail, as indicated in the figure. The wheel and rail surface roughness induces high frequency vibration, which propagates through the wheel and track structures and radiates sound.



Concept of noise generation and radiation due to wheel/rail interaction

Theoretical models for rolling noise were first developed by Remington[1]. This basic model was later expanded and implemented in the TWINS software[2,3]. The figure below shows an example of the contribution of each component as predicted using TWINS. The rail is the dominant contributor to rolling noise in the frequency range 400 Hz to 2 kHz.



Contribution of components to overall rolling noise as predicted using TWINS[3]

A promising technique to attenuate the noise radiated by the rail is to increase its damping. This increases the decay rate of vibrations along the rail and decreases the effective radiating rail length[4]. To achieve this, a tuned mass-spring damper system has been developed. Such tuned vibration absorbers are used in many applications to control troublesome resonances or particular forcing frequencies[5].

In the present application a damping effect is required over a broad frequency range. To achieve this, steel masses are embedded in a high damping elastomer. These rail dampers, developed by ISVR and Corus in an EU project, are already in use at several locations in Europe and have been found to give reductions in rail noise of up to 6dB, depending on the initial track design[6].

Clip on Corus rail dampers attached to an SNCF track.

Objectives:

- Evaluate effects of design parameters on the performance of a rail damper with multiple tuning frequencies.
- Improve the accuracy of noise prediction models by introducing a modal sleeper vibration model and the interaction between the two rails through the sleepers.
- Investigate effects of temperature on the stiffness of rail pads and the resulting noise radiation from the track and assess the implications for the design of rail dampers.
- Improve noise radiation models at low and high frequencies.

References

1 P. J. Remington, 1976, Wheel/rail noise, Part IV: Rolling noise. *J. Sound Vib.*, 46, 419-436.

2 D.J. Thompson, B.Hemsworth, N. Vincent, 1996, Experimental validation of the TWINS prediction program for rolling noise, part 1: description of the model and method. *J. Sound Vib.*, 193, 123-135.

3 D.J. Thompson, P. Fodiman, H. Mahé, 1996, Experimental validation of the TWINS prediction program for rolling noise, part 2: results. *J. Sound Vib.*, 193, 137-147.

4 C.J.C. Jones, D.J. Thompson, R.J. Diehl, 2006, The use of decay rates to analyse the performance of railway track in rolling noise generation, *J. Sound Vib.*, 293, 485-495.

5 J.P. Den Hartog, 1956, *Mechanical Vibrations*, McGraw-Hill, New-York

6 D.J. Thompson et al, 2007, A tuned damping device for reducing noise from railway track, *Applied Acoustics*, 68, 43-57.

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