Joint Research Unit in Environmental Acoustics
(University Gustave Eiffel – Cerema)
INTERNSHIP PROPOSITION 2024

Subject

Railway noise emission models for computing dynamic acoustic indicators

Recommended level

☒Master (M2) ☐Master (M1) ☒Ingénieur ☐Licence ☐Bac + 2

Compétences requises

Acoustics, Matlab

Description

Background. *The subject is part of research aimed at gaining a better understanding of the noise nuisance caused by passing trains, in order to anticipate changes in regulations and devise levers to effectively reduce the annoyance felt by local residents. The issue thus concerns "new annoyance indicators for the railways" in close relation with the recommendations of article 90 of the French law n°2019-1428 of December 24, 2019 on the orientation of mobilities. The noise emitted by high-speed trains does indeed seem to cause annoyance to surrounding communities in a way that is not fully taken into account by current indicators (e.g.,* L_{DEN}*). For example, the suddenness of passing noise, its spectral content and the density of peaks have been highlighted in the scientific literature. Neighborhood associations emphasize short-term indicators (e.g.,* $\mathrm{L}_{\mathrm{Amax}}$*), although this is not supported by scientific works.*

Scientific problem*. At present, the sound emission models used for railway noise mapping and impact studies (CNOSSOS-EU and NMPB-08 methods), and therefore for noise exposure assessment, are suitable for computing averaged acoustic indicators of the* L_{DEN} *type. However, they can only be used to determine the average sound power emitted by a passing train on a given section of track over a long period of time, relative to the duration of the passage (day, evening, night). The energy contributions of the various noise sources on the train are summed indistinctly, and the temporal variation in noise emission due to train movement is not taken into account. Computing "dynamic" indicators therefore requires improvements to existing models.*

Objective of the internship. *The aim of the internship is to contribute to the development of advanced emission models by proposing, on the one hand, an appropriate decomposition of the sound emission of a rail vehicle in terms of equivalent acoustic sources and, on the other hand, a relevant method for calculating the acoustic signature - the temporal evolution of sound levels - from the geometric (position, height) and acoustic (power, directivity) characteristics of the equivalent sources. The study will focus in particular on the minimum conditions required by the model (both in the description of sources and in the calculation of the signature) to determine "dynamic" indicators with sufficient accuracy. Particular attention will be paid to the case of high-speed trains. For the purposes of this internship, the study will be restricted to a straight-line pass-by at constant speed over a flat surface of given impedance (with no obstacle giving rise to reflection or diffraction and no meteorological effects).*

Methodology. *The first part of the internship will be devoted to the analysis of existing emission models, in particular the standard operational models (CNOSSOS-FR, NMPB08), but also other models more suited to the calculation of pass-by signatures that will be identified in the literature, including in particular non-quasi-static effects due to source movement (convection, Doppler effect). The second part of the internship will focus on the numerical development of the models. Several options will be implemented, both in terms of the signature calculation method and the source* *description. These options will reflect the different levels of accuracy to be tested. For the purposes of this internship, the study will be restricted to a straight-line pass-by at constant speed over a flat surface of given impedance (with no obstacles giving rise to reflection or diffraction). Uncertainties may be taken into account as the course progresses. In the third part of the course, the student will compare the results obtained from the different models. These comparisons will be carried out on several configurations taking into account a sufficient diversity of parameters such as vehicle type and length, composition, speed, distance from the track and height of the receiving point, or absorption of the ground. Conclusions will be drawn on the ability or inability of the models to determine the acoustic signature and therefore the dynamic indicators with sufficient accuracy.*

Internship location

☒ **Uni Eiffel, Campus Lyon** (25, avenue François Mitterrand, Case24, Cité des mobilités, F-69675 Bron Cedex)

☐ **Uni Eiffel, Campus Nantes** (route de Bouaye, CS4, F-44344 Bouguenais Cedex)

☐ **Cerema – Strasbourg** (11, rue Jean Mentelin, Strasbourg-Koenigshoffen, F-67035 Strasbourg)

Internship duration *(detailed dates have to be adapted)*

Starting date: 01/03/2024
End date: 31/07/2024
Duration: 5 months

Contact

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Gratification

Indemnity equivalent to 15% of the hourly ceiling of the Social Security, for a public organization
https://www.service-public.fr/simulateur/calcul/gratification-stagiaire