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

INTERNSHIP PROPOSITION 2023

Subject

Determination of the vibro-acoustic behaviour of a railway track using the WFE method

Recommended level

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

Compétences requises

Vibrations, Structural dynamics, Numerical methods, Matlab

Description

Background. *The subject is part of research aimed at reducing noise emissions from railway infrastructures. In a wide range of speeds, the main source of noise when rail-bounded vehicles pass over rails is rolling noise. This noise results from vibrations initiated at wheel/rail contacts by surface irregularities. The track itself emits an important part of the noise, due to the acoustic radiation of the vibration waves that propagate on both sides of the excitations. The modelling of the vibro-acoustic behaviour of the track is necessary to estimate its noise contribution. The identification and the understanding of the mechanisms at the origin of the noise ca also be useful to propose means of reduction.*

Scientific problem*. In a first approach, the track can be considered as an infinite and invariant structure in the longitudinal direction. The waveguide methods are therefore naturally adapted to the calculation of its vibratory behaviour. The SAFE[1] method couples a wave description in the longitudinal direction and a finite element discretization (FEM) of the cross-section and allows the decomposition the vibrations on the basis of a sum of waves characterized by a wavenumber and a cross-sectional deformation - a mode - which depend on the frequency. However, the method requires a specific finite element formulation that is not often implemented in commercial codes. Moreover, railway tracks are generally not invariant but rather periodic. The WFE[2] method, based on the finite element discretization of a complete cell of the periodic structure, seems to be more adapted. Concerning the sound radiation, the fluid medium being open, other methods are generally used, in particular the BEM[3] but alternatives exist in the literature such as infinite elements or PML[4]. A 2.5D approach, based on the wave decomposition of the exciting vibratory field is often preferred.*

Objective of the internship. *The objective of the internship is to develop a vibratory model of a railway track using a WFE method coupled with a 2.5D acoustic radiation calculation using PML. The main waves will be identified and characterized from a vibratory (dispersion, attenuation, deformation) and acoustic (radiation factor, directivity) point of view. The vibro-acoustic response to localized vertical and lateral excitations on the rail will also be studied.*

[1] Semi-Analytical Finite Element

[2] Wave Finite Element

[3] Boundary Element Method

[4] Perfectly Matched Layer

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: 01/03/2023
End date: 31/08/2023
Duration: 6 months

www.umrae.fr

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