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

INTERNSHIP PROPOSITION 2023

Subject

Determination of self-sustained vibrations involved in wheel/rail curve squeal noise by a harmonic balance method

Recommended level

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

Compétences requises

Vibrations, Structural dynamics, Stability, Nonlinear dynamics, Numerical methods, Matlab

Description

Most of the works in the literature agree to attribute the generation of wheel/rail squeal noise in curves to the important lateral slip imposed in the curve and the resulting instabilities. In the models, the occurrence of the phenomenon is thus generally studied through a stability analysis based on the linearization of the contact forces. In spite of its undeniable interest, the stability analysis does not allow the prediction of the amplitudes of the nonlinear self-sustained vibrations resulting from the instabilities, an essential step for the determination of the squeal levels. These non-linear vibrations are most often calculated using a numerical integration of the dynamic equations of the system in the time domain. The possible stationary regimes or "limit cycles" obtained are then re-expressed in the frequency domain for the calculation of the acoustic radiation and the comparison with experimental results. A disadvantage is that the integration must be carried out over a sufficiently long period of time for the transient regime to stabilize. Some authors have proposed simplified methods allowing a direct calculation of the steady state. These methods are mainly based on the assumption of a mono-harmonic limit cycle. Unfortunately, they are limited to a reduced modal description of the system dynamics.

The objective of the internship is to develop a harmonic balance method for the determination of these self-sustained vibrations. The method is well documented and has already given good results for the modelling of other frictionally destabilized systems. A first step will be to implement the method for a reduced model of curve squeal with 1 or 2 degrees of freedom. The results obtained will be validated by comparison with a temporal approach. In a second step, a more general method of condensation using the wheel/rail contact mobilities in the frequency domain will be tested allowing the consideration of more elaborate models of wheels and railway tracks.

The development will be achieved with Matlab. For the second step of the internship, the wheel/rail mobilities will be determined from existing wheel and track models.

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