Modelling of wheel/rail vibration instabilities in curves: application to squeal noise and rail corrugation

Main discipline: solid mechanics, dynamics of structures and systems.

Keywords: vibration, instabilities, acoustics, non-linear dynamics, squeal noise, friction and tribology, numerical methods, modelling, finite element methods, rail transport, tramway network, on-site experimentation, noise reduction.

Company: Vibratec (web : www.vibratecgroup.com).

Location: Lyon area (Vibratec, Ecully ; Univ. Eiffel, Bron ; Ecole Centrale de Lyon, Ecully).

Remuneration (CIFRE PhD): 2500 gross euros brut/month

Supervisor: Jean-Jacques SINOU, Ecole Centrale de Lyon, LTDS UMR 5513 (web : jean-jacques.sinou.fr).

Co-supervisor: Olivier CHIELLO, Univ. Eiffel/UMRAE (web : www.umrae.fr).

Industrial supervisor: Rita TUFANO, Vibratec, Ecully (web : http://www.vibratecgroup.com)

Industrial context and scientific objectives

The thesis is part of research aimed at reducing the squeal noise emitted by rail-guided vehicles (trains, trams, metros) in small radius curves. This undesirable phenomenon is characterised by high sound pressure levels, sometimes more than 20 dB higher than rolling noise levels, and a spectrum of mid to high frequency lines. The occurrence of unstable wheel/rail vibrations can also cause significant rail corrugation, forcing operators to perform costly grinding operations, currently the only effective means of controlling the phenomenon.

The objective of this thesis is to achieve a better understanding of the phenomenon of wheel/rail vibration instabilities in curves and of the squeal noise generated. The scientific approach adopted is based on an exploitation and analysis of experimental tests, as well as a modelling and numerical simulation of the instability phenomena. The first objective of the thesis is the development of a model allowing to reproduce wheel/rail instabilities in curves and to determine the levels of self-sustained vibrations and the associated noise. Elaborate numerical models of wheels and rail tracks and advanced numerical techniques will be implemented to meet this objective. The second objective is to use the model to carry out parametric studies to propose a typology of the phenomena and to decide on the effect of tribological and mechanical parameters, with a view to finding solutions for noise reduction. The simulation results will be compared with experimental measurements carried out on the Lyon tramway network. Particular attention will be paid to the ability of the model to reproduce the squeal levels observed on the operating tracks and to quantify the effect of various possible technical solutions (damping, lubrication).

To apply: CV and cover letter to be sent to recrutement_vtc@vibratec.fr.