

# Abstract

The aim of the present Thesis is to develop models for the study of very high-frequency phenomena associated with the coupling dynamics of a railway vehicle with the track. Through these models, this Thesis intends to address squeal noise as a particular case of rolling noise when the train negotiates a small radius curve.

Wheel/rail interaction is the predominant source of noise emission in railway operations. Rolling contact couples the wheel and the rail through a very small area, characterised by strongly non-linear and non-steady state dynamics that differentiates rolling noise from any other noise problem. Wheel/rail contact problem is studied based on Kalker's variational theory and the local falling behaviour of the coefficient of friction is introduced by means of a regularisation of Coulomb's law. Its implementation shows that the influence of the falling friction on the creep curves can be assumed negligible, thus rolling contact is finally modelled using a constant coefficient of friction.

Flexibility is introduced in railway substructures through the Finite Element (FE) method in order to cover the high-frequency range. This work adopts a rotatory wheelset model that takes computational advantage of its rotational symmetry. It also develops a cyclic flexible rail model that fixes the translational contact force in a spatial point of the mesh through a technique called Moving Element (ME) method. A modal approach is used to reduce significantly the number of degrees of freedom of the global problem and a diagonalisation technique permits to decouple the resulting modal equations of motion in order to increase the computational velocity of the time integrator.

Simulations in curving conditions in the time domain are carried out for constant friction conditions in order to study if the proposed interaction model can reproduce squeal characteristics for different curve radii and coefficients of friction.

**Keywords:** train/track dynamic interaction, rotatory wheelset, cyclic track, wheel/rail rolling contact, falling friction, regularisation of Coulomb's law, Moving Element Method, decoupling techniques, curve squeal.