Master's thesis project:

Development of a model for multibody dynamic simulation of a railway overhead power supply system based on an absolute nodal coordinate formulation

The Swedish Transport Agency (Transportstyrelsen) has been commissioned to determine guidelines for maximum permitted particle concentrations (PM2.5 and PM10) in covered railway stations. There are significant gaps in the available knowledge about wear particle emissions caused during rail transport and this makes the railway sector ill-prepared for the introduction of these restrictions. The current project is part of an ongoing research effort that applies numerical simulations with the ultimate goal to improve air-quality and reduce the negative consequences of rail transportation on human health. A fundamental question that still is not sufficiently investigated regards how particle emissions distribute between the different available sources on a train, i.e. wheel–rail contacts, brakes and the pantograph–contact wire system. The current work focuses on the modelling of the latter, see Figure 1.

The overhead power supply system is designed to provide uninterrupted current flow to the train with lowest possible level of wear generated in the sliding contact between the pantograph and the contact wire. Its low structural damping, high-frequency vibration content and large displacements/translations makes the catenary particularly challenging to model. In recently published literature, the so-called absolute nodal coordinate formulation (ANCF) has been introduced which enables the implementation of non-linear structural beam elements in a standard finite element framework [1]. In the current project, the possibilities associated with this simulation technique is explored. The ANCF is implemented in an open platform (e.g. Python or C++ programming language). From initially modelling a simple numerical case with a clamped beam, the complexity is gradually increased to finally capture the entire catenary system.

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References

[1] Gerstmayr J., Shabana A.A., Analysis of thin beams and cables using the absolute nodal co-ordinate formulation. Journal of Nonlinear Dynamics. 2006;45:109–130.

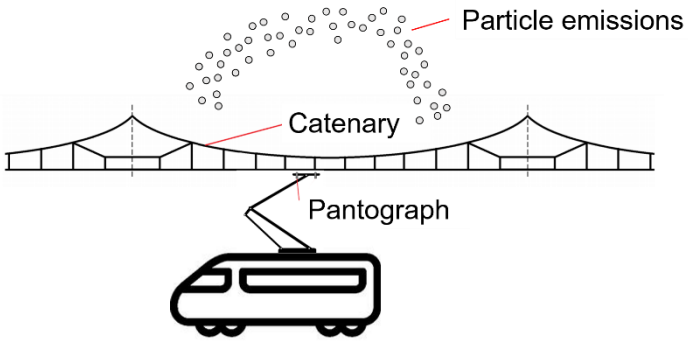

Figure 1. Sketch of the railway catenary–pantograph system including illustration of wear particle emissions