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Nonlinearity in continuous structural dynamics: From modelling to identification

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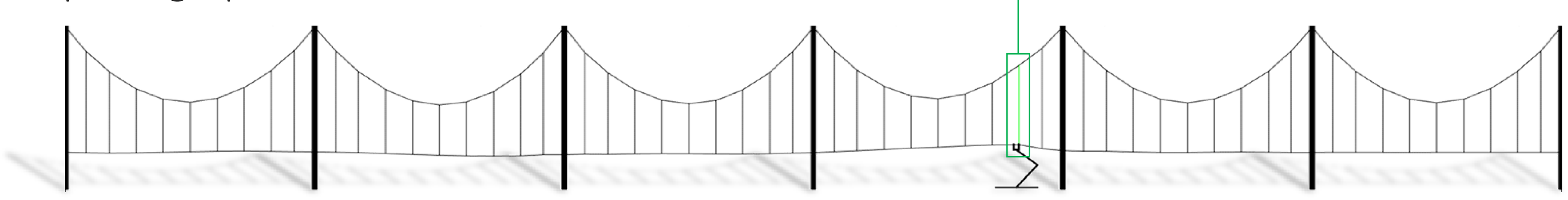
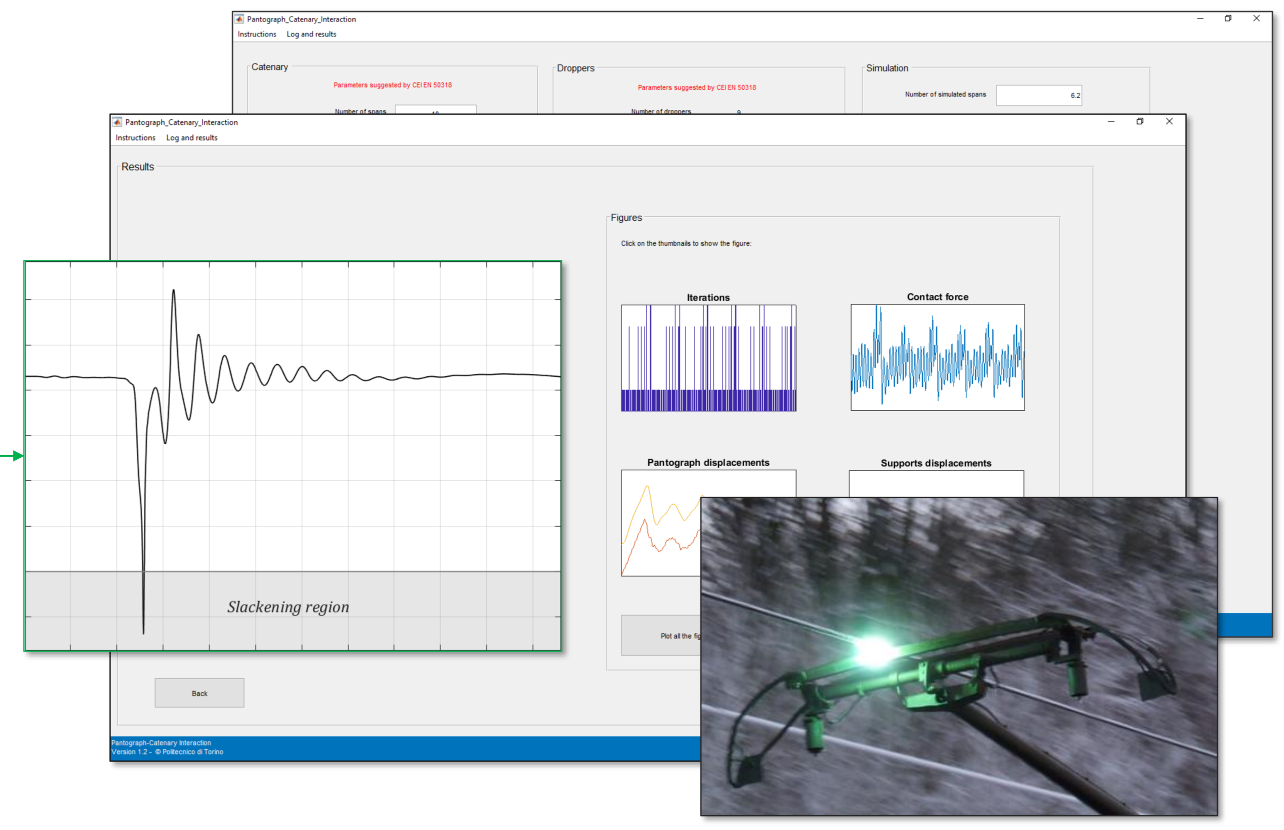
Nonlinear modelling: dynamics of overhead contact lines

Pantograph-Catenary Interaction

- Finite element model to study the dynamics of the Pantograph-Catenary interaction for high speed trains.
- A nonlinear time integration scheme is adopted to account for the system nonlinearities: droppers slackening and contact between the contact wire and the pantograph.

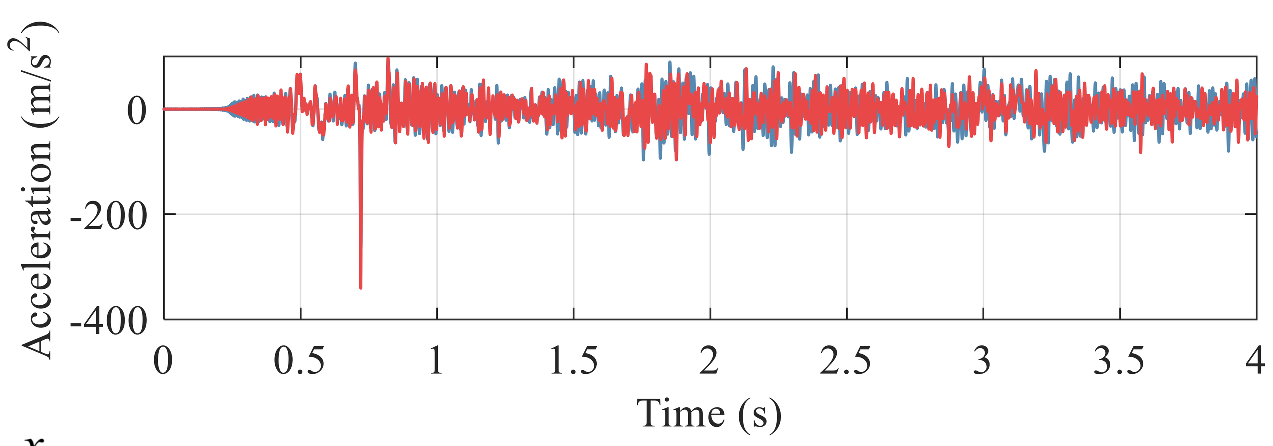


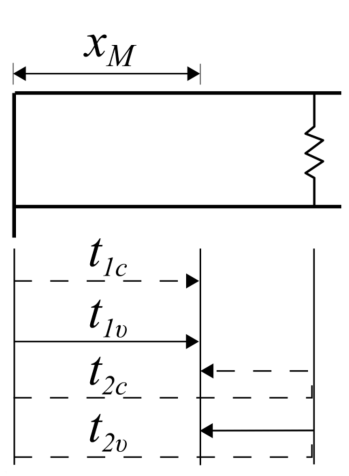


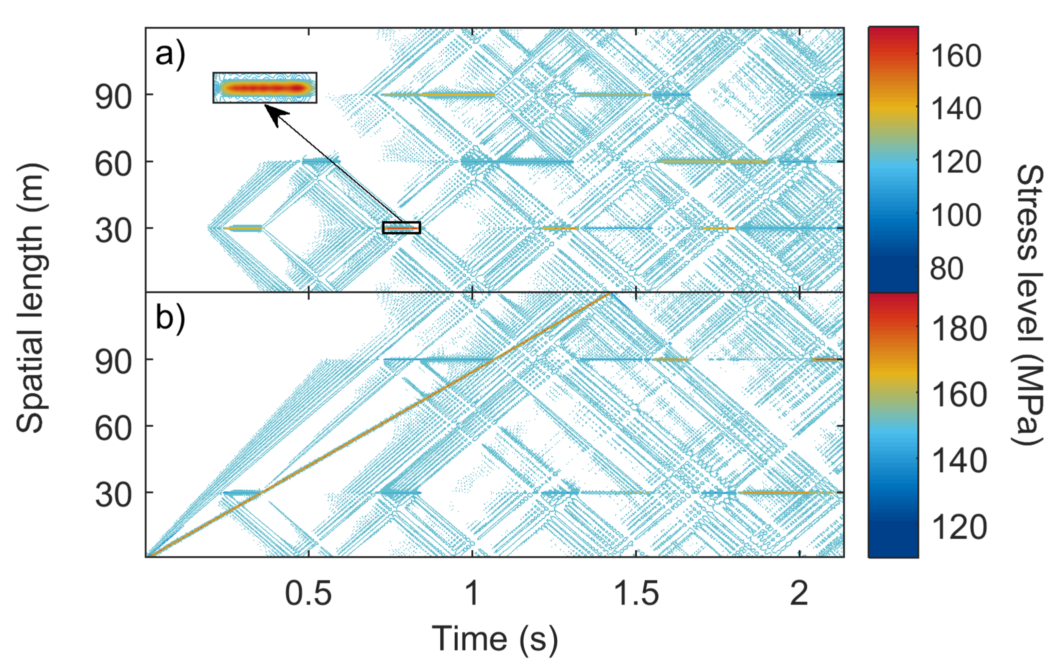
Wave propagation modelling

S. Sorrentino, D. Anastasio, A. Fasana, S. Marchesiello, *Distributed parameters and finite element models for wave propagation in railway contact lines*, Journal of Sound and Vibration, 410 (2017) 1-18.

- Distributed parameter model for the analysis of the coupled wave dynamics and comparison with direct time integrations of a FEM of the system.
- Study on the correct tuning of FEM for overhead contact lines: errors produced by the FE models can be reduced implementing a numerical dissipation technique, provided that a proper tuning is performed.







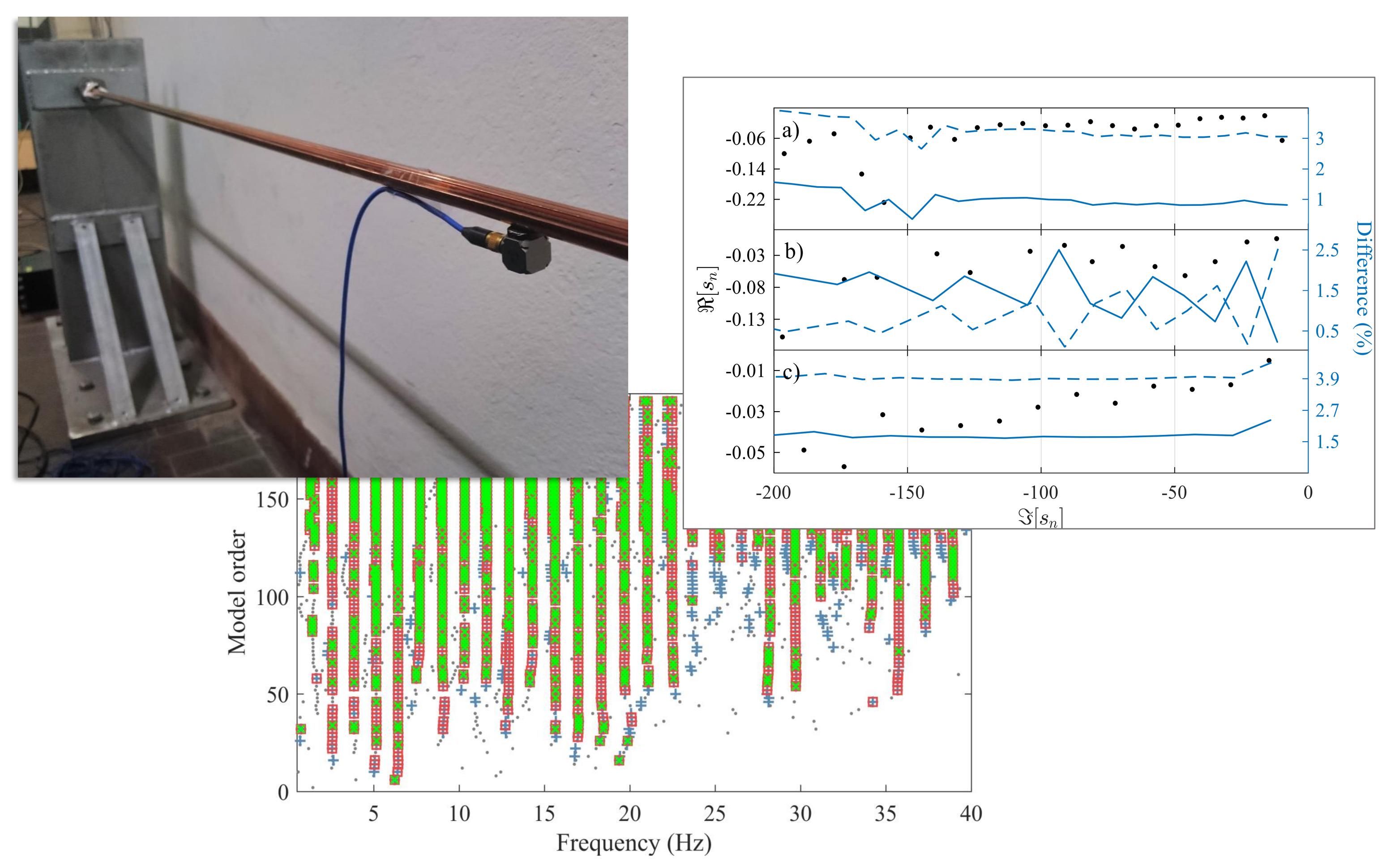
Damping distribution of contact wires

D. Anastasio, A. Fasana, G. Garibaldi, S. Marchesiello, *Analytical investigation on the dynamic behaviour of railway overhead contact lines and comparison with experimental results*, ICEDyn 2017, Ericeira, Portugal, 3-5 July 2017.

- Analytical model for several kinds of continuous vibrating systems:

$$M\left[\frac{\partial^2}{\partial t^2}w(\mathbf{x},t)\right]+C\left[\frac{\partial}{\partial t}w(\mathbf{x},t)\right]+K[w(\mathbf{x},t)]-\mathrm{T}[w(\mathbf{x},t)]=f(\mathbf{x},t)$$

- Study on non-proportional damping distributions.
- Experimental measurements on railway contact wire and comparison with model predictions to analyse its damping properties under several operational conditions.

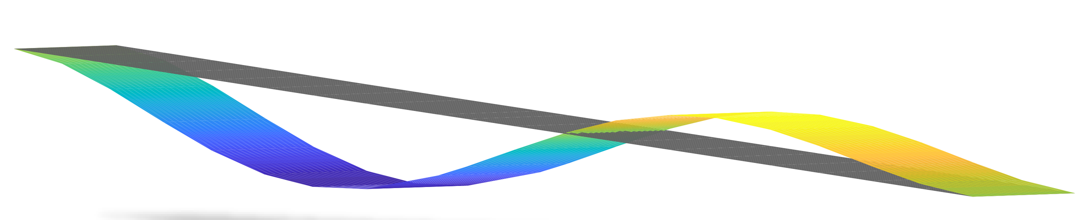


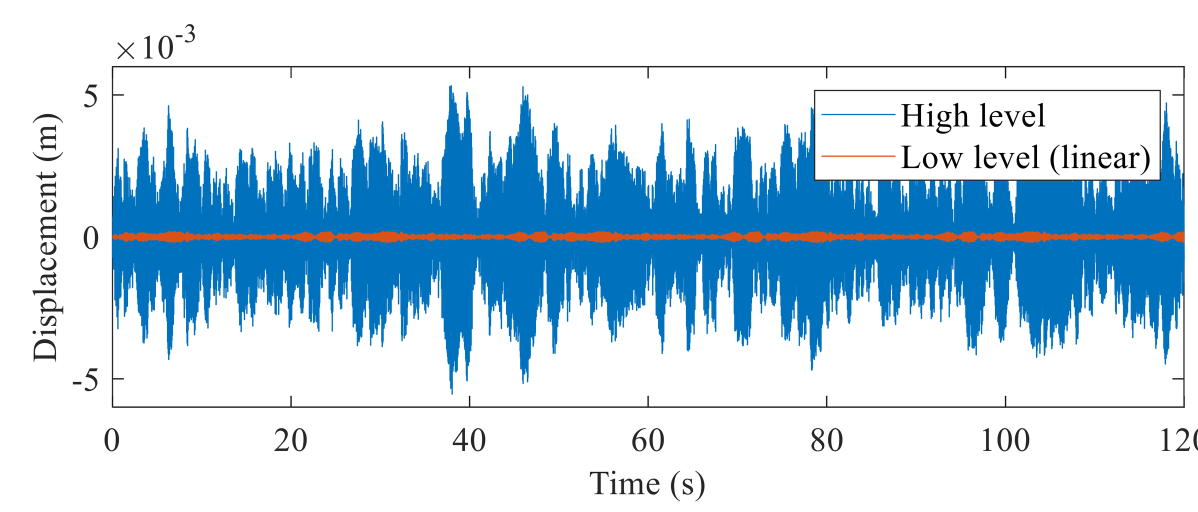
Nonlinear system identification: distributed nonlinearities

Beam under large oscillations

- Constitutive nonlinear equation:

$$\mu\frac{\partial^2 w}{\partial t^2}+EI\frac{\partial^4 w}{\partial x^4}-\frac{EA}{2L}\left(\int_0^L\left(\frac{\partial w}{\partial x}\right)^2 dx\right)\frac{\partial^2 w}{\partial x^2}=f(x,t)$$





- Modal decomposition is used to pass to the modal coordinates.
- TNSI(1) (Time Domain Nonlinear Subspace Identification) method is be used to extract the modal parameters of the underlying linear system, and to identify the nonlinear coefficients.

(1) S. Marchesiello, G. Garibaldi, A time domain approach for identifying nonlinear vibrating structures by subspace methods, Mechanical Systems and Signal Processing 22 (2008) 81–101