Special issue on the pantograph–catenary interaction benchmark

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The mechanical interaction between the pantograph and the overhead equipment is a very important technical issue in the design and operation of railway systems and is one major limiting factor in raising the maximum service speed of railway lines. Significant effort has been spent over the last decades to develop suitable numerical models allowing the quantitative study of this problem and supporting the development of new design solutions for both the rolling stock and the infrastructure.

The pantograph–catenary interaction models currently in use share part of the modelling approaches and many of them have been successfully validated, for example by comparing simulation results to line measurements. However, there are still a number of open points concerning some key modelling issues such as the minimum required discretisation of the catenary, the contact model adopted to reproduce the sliding contact between the pantograph head and the contact wire, the methods to determine the static position of the catenary, the model of catenary damping, the effect of flexibility in the collector strips, the introduction of aerodynamic effects and degraded conditions, etc.

In late 2011, Politecnico di Milano proposed to carry out a benchmark among software packages for the simulation of pantograph–catenary interaction. The idea was very well received, resulting in the involvement of 10 simulation software developed at companies, research institutes and universities across 9 countries in Europe and Asia. Other research groups did not take part in the benchmark exercise directly, but contributed to the initial discussion about the terms of this initiative.

Aims of the benchmark were to compare modelling approaches across the existing software and to quantitatively analyse results produced by different software for some common simulation cases, thereby assessing the dispersion of results and allowing the identification of open issues in the simulation of pantograph–catenary interaction.

Each participant was asked to provide a description of the methods used, so that a comprehensive picture of the present State-of-Art could be obtained. Modelling and simulation approaches were compared identifying differences and commonalities. Next, the participants agreed on a set of input data for the simulation cases to be examined in the benchmark considering a non-existing but realistic pantograph–catenary couple for high speed. The simulation cases include one static case (calculation of the static position of the catenary under the action of gravitational loads) and three dynamic cases, considering the interaction of single/multiple pantographs with a two-dimensional or three-dimensional catenary model. Results for these cases were provided by all participants and compared to each other. A procedure to assess

the dispersion of results was agreed and the results obtained were thoroughly analysed and discussed also through web conferences and physical meetings.

The results of this extensive work are now summarised in this special issue of Vehicle System Dynamics. For each software involved in the benchmark, a ‘statement of methods’ paper is included in the issue, with the aim of describing in full the simulation methods available in the software and how these were applied in the benchmark exercise. These papers also contain an optional section devoted to the participants’ own statements concerning the results of the benchmark. One conclusive paper, authored by representatives of all participant organisations, describes in full the results of the benchmark and lists the inputs for the simulation cases in the appendix. Besides the discussions that led to the final results and to the statements-of-methods, all papers have been independently reviewed by experts, not necessarily involved in the benchmark.

We believe that the results of this cooperative effort provide a useful picture of the present status of research in the field and we hope readers will find in this special issue inspiration to further enhance methods for the simulation of pantograph–catenary simulation.

As a final note, we would like to thank all of the authors for their contributions to this special issue, and their institutions for allowing them to contribute to this work. We also wish to thank the reviewers for their insights and recommendations that greatly helped the authors to enhance their contributions. Finally, we would like to thank the editor for rail-related topics, Professor Simon Iwnicki, and the journal’s editorial team for their commitment on the publication of this special issue.