Technische Universität Braunschweig

GRK 2075

Vortrag im Gästeprogramm des GRK 2075

Juan Chiachío-Ruano, Ph.D.
University of Strathclyde, Glasgow

From the plasticity of soil to railway track Geometry Degradation prognostics: An asset management perspective

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Institut für Wissenschaftliches Rechnen
Mühlenpfordtstrasse 23, 8. OG, Raum 812

Railway track degradation and maintenance modelling to date has a strong empirical retrospective character, mainly grounded on data-based models with limited prospective capability. The prediction accuracy of those models strongly depends on the quality and quantity of the available historic data, and thus they are prone to misjudgments especially under medium-to-long term future scenarios implying changing operational and environmental conditions. To overcome this limitation, some authors have investigated the mechanical behaviour of ballast materials under cyclic loading conditions and have proposed physics-based models to predict the progressive degradation of the track from first principles. However, a typical criticism of these models is that they are unable to account for the uncertainty in the predictions since they are based on deterministic input-output relationships. In this talk, a paradigm shift for track geometry degradation modelling and maintenance will be presented. Instead of making maintenance decisions based on either a retrospective data-based modelling of the track, or, alternatively, using a purely deterministic physics-based approach, a knowledge-based prognostics framework for track geometry degradation will be presented. This approach fuses information from an elasto-plastic model about yielding of soils and available data about track degradation within a Bayesian learning paradigm to sequentially reduce the initial modelling uncertainty in order to obtain increasingly accurate forecasts of the future condition of the track. These forecasts enable the testing of various load and utilisation scenarios, and more importantly, allow us to answer the question of "when will failure occur" with quantified uncertainty. This will be shown to be a key piece of information to enable informed, anticipated, and risk-based decisions about optimal railway track asset management.

The suitability of the proposed methodology will be demonstrated and discussed in a case study using data taken from a laboratory simulation of railway track degradation under cyclic loads, carried out at the University of Nottingham (UK). The results show that the proposed methodology is able to provide accurate predictions of the remaining useful life of the track after a model training period of about 10% of the process lifespan.