CETRA 2026

9th International Conference on
Road and Rail Infrastructure
27–29 May 2026
Bol, Island Brač, Croatia

KEYNOTE LECTURE:

Digitisation of diagnostics for critical parts of the track superstructure

Assoc. Prof. Otto Plášek, PhD

Head of the Institute of Railway Structures and Constructions,
University of Brno

Assoc. Prof. Otto Plášek has more than three decades of experience in the field of railway infrastructure and specializes in the structural behavior, diagnosis and innovation of railway superstructures and components. After obtaining his M.Sc. in Structures and Transport Structures (1986) from Brno University of Technology, he began his professional career as a railway engineer at Czechoslovak Railways (1986–1991), where he worked on construction projects, station design and track assessment. In 1991, he joined Brno University of Technology, where he received his PhD in Theory of Structures (1999), and he is currently an associate professor. He is the head of the Institute of Railway Structures and Constructions and a senior researcher at the Centre for Advanced Materials and Structures (AdMaS). His research includes static and dynamic analyses of railway superstructures, fatigue of rails and sleepers, bridge-track interactions and diagnosis of switches, crossings and welded tracks. Dr Plášek has led and contributed to numerous national and international research and development projects, including EU-funded initiatives such as S-CODE - Switch and Crossing Optimal Design and Evaluation (Shift2Rail Horizon 2020) as well as projects of the Technology Agency of the Czech Republic on smart diagnostics (e.g. Turnout 4.0, Advanced Diagnostics of Railway Turnout Movable Parts), railway bridges and innovations in sleeper pads. His applied research has resulted in patents, utility models, industrial designs, and certified methodologies that have been implemented in railway practice. He has published widely on switch and crossing design, diagnostics, AI-based monitoring techniques, smart autonomous diagnostics and train type identification. Since 1994, he has collaborated with industry partners on more than 130 projects, helping to shape innovations in rail safety, performance and sustainability. At the international level, he is a member of technical committees such as CEN TC 256/SC1 (Bridge Track Interaction) and the National Technology Platform for Railway Infrastructure, where he holds leadership roles.

He is an elected Fellow of Engineering Mechanics Institute (EMI) of American Society of Civil Engineers (ASCE). He is the recipient of ASCE Walter L. Huber Research Award (2022), Rutgers Outstanding Engineering Faculty Award (2023), New Jersey DOT Research Implementation Award (2021; 2023; 2024), ASCE New Jersey Educator of the Year Award (2019), and AASHTO High Value Research Project (2014; 2024). Dr. Wang Obtained his Ph.D. from University of Illinois at Urbana-Champaign, M.S. from Virginia Tech, and B.S. from Southeast University (China).

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Abstract: The digitisation of railway infrastructure is the subject of many current research projects and development around the world, implemented at universities, research institutes, industrial and construction companies, and railway administrations. The aim is to make infrastructure monitoring and diagnostics more efficient, i.e., to reduce the need for human effort, obtain information on an ongoing basis where possible, and assess the technical state to prevent critical states of infrastructure components and predict necessary maintenance work and interventions.

This challenge involves developing advanced sensing techniques. In addition to developing sensors that can withstand adverse conditions on the track for long periods of time, it is also necessary to find the optimal location of these sensors on the monitored track components in order to obtain the necessary data. The big data obtained must be stored and managed, and then evaluated and mined for information about the technical state. To this purpose, current tools and procedures such as Internet of Things, Digital Twins including numerical models, and generally AI and ML technologies are used. The technical condition of the track deteriorates with time and with traffic load, and it is necessary to predict its development. Advanced tools such as dynamic Bayesian techniques are used to implement predictive maintenance. An important part of the system is also the organisation of diagnostics and the integration of management information systems so that data can be used effectively. Showing results in a way that is easy to understand is crucial for both mid-management and operational staff.

Research teams at Brno University of Technology, in cooperation with industrial partners, are currently working on, or have recently worked on, critical components of the railway superstructure in terms of operation and maintenance. These are mainly switches and switch structures, where routine maintenance and fault repair are costly and have a significant impact on the availability of the transport route. Research and development work is focused on the digitisation of diagnostics of the technical condition of switches, crossings, tongue breaks, and bonded insulated joints. Infrastructure managers are showing an increasing interest in the results of this research, and the early implementation of these systems can be expected.