Doctoral Dissertation Thesis Topics for academic year 2024/2025
Study program: Transport Means and Infrastructure

Performance assessment of lubricants and friction modifiers for the wheel-rail interface
Supervisor: Assoc. Prof. Petr Voltr, Ph.D.
Supervisor specialist: Ing. Stanislava Liberová, Ph.D.
Form od study: full-time/part-time

Annotation
In railway operation, materials for lubrication or, more generally, modification of friction conditions at the wheel–rail interface are used. Laboratory assessment of performance of these materials (i.e. if and to what extent they display the required effect on friction conditions) employs twin-disc machine testing. Testing methods exist and are even reflected in European standards; in practical use, however, some uncertainties and imperfections show up. The dissertation should aim at improvement and clear definition of methodology for twin-disc testing or possibly propose new procedures. The research should also include finding correlation between results of these tests and full-scale roller rig measurements.

Transient phenomena and combined factors in wheel–rail adhesion
Supervisor: Assoc. Prof. Petr Voltr, Ph.D.
Form od study: full-time/part-time

Annotation
Conditions determining the adhesion performance of rail vehicles in operation result from a superposition of many factors which, in addition, can change in time. It is desirable to deal particularly with the cases of opposite effects, e.g. contamination and HPF modifier or conditioning by sliding. These phenomena are often studied in a constant slip setup, however real vehicle performance depends on realistic scenarios with variable slip. The aim of the dissertation should be to progress knowledge on combined and non-stationary adhesion phenomena with the use of roller rig experiments and modelling.

Modelling of longitudinal train dynamic effects
Supervisor: Assoc. Prof. Petr Voltr, Ph.D.
Supervisor specialist: Ing. Tomáš Michálek, Ph.D.
Form od study: full-time

Annotation
The effects of longitudinal dynamics of freight trains represent one of the factors that influence the maximum permissible loading of couplers, as well as the running safety of the vehicles forming the train. The problem is related to both traction and braking of trains. Currently, there are efforts to increase the weight and length of freight trains in the Czech Republic; moreover, Europe is considering the introduction of a new type of central coupler (DAC – Digital Automatic Coupling). In this context, the issues of longitudinal train dynamics gain importance. The aim of the research is to create a computational model allowing assessment of various factors that impact the intensity of the longitudinal dynamic effects, considering the safety of railway transport.

Research of selected dynamic and transient phenomena in electromechanical system of rail vehicle drives
Supervisor: Assoc. Prof. Michael Lata, PhD.
Form od study: full-time/part-time

Annotation
In electromechanical systems, such as the individual drive of a rail vehicle, a number of dynamic processes arise in connection with the very properties of the motor on the one hand and adhesion phenomena on the other side of this system. For a more detailed knowledge of these processes, which should be the output of this work, it is possible to use simulation calculations or use a tram wheel-rail stand and simulate these conditions here, with wide variations of parameters. This is, for example, the response of the electromechanical system to the change of selected parameters in a short period of time.

Analysis of the context of torsional dynamics of driving rail vehicles and rail surface defects (corrugation)
Supervisor: Assoc. Prof. Michael Lata, PhD.
Form od study: full-time/part-time

Annotation
In railway operation, there are regular defects in the surface of rail tracks, both in curves and in straight track. The output of the work should be to clarify whether there is a connection between these defects and the torsional dynamics of the wheelset drive. The solution to this problem should be mainly in the field of simulations and modeling, a detailed description of the adhesion parameters between the wheel and the rail and the conditions of self-excited oscillations are also assumed.

Fatigue curve determination using non-destructive method
Supervisor: Assoc. Prof. Bohumil Culek, Ph.D.
Form od study: full-time/part-time

Annotation
Content of the thesis will be:

- statistical comparison of different approaches to determination of the material characteristics as parameters of fatigue curves;
- proposal of methodology for determination of the fatigue curve of the construction node by means of a non-destructive method;
- use of computer models and simulations to determine fatigue life of steel structures;
- verification of the methodology by experimental testing.

The aim will be to develop a methodology for determination of material characteristics of the fatigue curve by non-destructive method, to verify this methodology by experimental testing.

Identification of fatigue crack propagation
Supervisor: Assoc. Prof. Bohumil Culek, Ph.D.
Form od study: full-time/part-time

Annotation
Content of the thesis will be:

- literature search of current state of knowledge, identification method of fatigue crack propagation;

- Sensitivity analysis of the Beach Mark method;
- Proposal of methodology focused on using Beach Mark method with regard to material grade and sample geometry.

The aim will be to develop a methodology of evaluation of the fatigue crack propagation by identifying the fracture surface based on the change in loading shape during the fatigue test (Beach Mark method).

Construction of analytical fragility functions with stochastic nonlinear backbone curve modeling parameters
Supervisor: Assoc. Prof. Ladislav Řoutil, Ph.D.
Supervisor specialist: Ing. Özgür Yurdakul, Ph.D.
Form od study: full-time/part-time

Annotation
The nonlinear modeling parameters for constructing the backbone curve of the vulnerable reinforced concrete (RC) members are investigated by considering the inherent uncertainties. The creation of a dataset by collecting the available experimental results for the specific RC member is followed by obtaining the nonlinear modeling parameters for the backbone curve. The scatter in the nonlinear backbone curve model is characterized by a probabilistic approach. The model parameters with stochastic character are then implemented at the building level to develop the analytical fragility functions. Those demonstrate the quantification of the risk losses with probabilistic approaches. Overall, a potential risk-assessment tool is obtained for reliable estimations of the strong ground motions on the fragility of the structures together with expected damage and losses. An application of the fragility functions within a performance-based engineering framework for quantifying expected losses is demonstrated.

Retrofit of deficient structures with shear-thickening fluid
Supervisor: Assoc. Prof. Ladislav Řoutil, Ph.D.
Supervisor specialist: Ing. Özgür Yurdakul, Ph.D.
Form of study: full-time/part-time

Annotation
The retrofit of deficient reinforced concrete (RC) members with premature failure is investigated. The RC specimens constructed from low-strength concrete and plain round bars with improper reinforcement details simulating non-engineered structures are tested. Owing to the phase transformation capability of shear-thickening fluid, the RC member is damped, which can eliminate premature failure and upgrade the performance of RC members. To do so, the mechanical characteristics of the shear-thickening fluid are first determined and followed by developing a functional sample. The prototype is then implemented for deficient RC members to enhance the engineering demand parameters of prime interest. The overall response of the RC member is also simulated in the numerical environment.

Axial failure of footing-to-column joints due to low level of confinement at footing
Supervisor: Assoc. Prof. Ladislav Řoutil, Ph.D.
Supervisor specialist: Ing. Özgür Yurdakul, Ph.D.
Form of study: full-time/part-time

Annotation
Field reconnaissance after recent earthquakes revealed severe damage in the footings of the side or corner reinforced concrete (RC) columns, where the concrete is crushed, and the reinforcement steel is buckled right after the footing-to-column interface. The presence of adequate transverse

reinforcement prevented the axial failure of the column. However, axial failure occurred in footings where transverse reinforcement does not confine the column's longitudinal bars in the footing. This thesis will evaluate the performance of current standards and guidelines where the extension of transverse RC columns to footings is compulsory. Additionally, preventive actions for existing footings without confinement will be proposed. Numerical and parametrical studies will provide insight into the effect of different parameters on the overall response. The parameters of interest include the level of confinement, length of the transverse reinforcement extension into foundation, column position in the direction of loading, and the axial load ratio.

Bond-Slip Model for Fan Anchors in FRP jacketed RC columns
Supervisor: Assoc. Prof. Ladislav Řoutil, Ph.D.
Supervisor specialist: Ing. Özgür Yurdakul, Ph.D.
Form of study: full-time/part-time

Annotation
The thesis aims to investigate the effectiveness of carbon fiber fan anchors as anchoring elements for externally bonded reinforcement (EBR), typically composed of carbon fiber-reinforced polymers (CFRP). This retrofitting strategy will be applied to reinforced concrete (RC) columns where slip could be a critical factor. The goal is to develop a mathematical model for the interaction between the fan anchor and concrete, which will later be implemented in the numerical model. It's worth noting that the fan anchor comprises two parts: the anchor component, a bar-type dowel pre-impregnated with epoxy and inserted into epoxy-filled holes in the foundation; and the fan component, impregnated in situ, fanned out, and then bonded to the column with EBR. Subsequently, an analytical relationship for the anchor part dowelled into the concrete will be evaluated. The mathematical model for the fan component will be developed by subjecting an RC column, strengthened with fan anchors and externally bonded reinforcement (EBR), to pull-out tests. Parameters of interest include the size and number of anchors, anchor distance, fan angle, and fan length.

Impact of electromagnetic compatibility in transport on safety
Supervisor: Prof. Jan Leuchter, Ph.D.
Form of study: full-time

Annotation
The aim is to analyze the effects of electromagnetic compatibility on safety in transport. It will be necessary to analyze the legislative requirements for the electromagnetic compatibility of electrotechnical equipment and to determine critical points that may be caused by the effects of electromagnetic interference and the electromagnetic resistance of the electrical equipment used in transport from the point of view of safety in transport. It will be necessary to support the analyzes required above by verifying individual parameters of electromagnetic compatibility and to design an automated workplace for measuring these effects using the LabVIEW environment.