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Making better use of railway research

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Introduction

Successful research consists of several steps. Seeing a problem or area of improvement. Understanding the problem. Researching a solution. If successful, implementing the solution. At this point, research is finished and monitoring and evaluation starts which may lead to new research. This contribution aims to shed light at the weak points of this process.

Current situation

Trafikverket supports a lot of research in the field of railway technology. Partly, this is done because the government has tasked TRV with distributing funds. But a large part of the research is supported because Trafikverket hopes to improve. Improvement can be in the form of increased reliability and availability of the track system. It can also be improvement of maintenance, safety or efficiency. In order to achieve improvement, it is necessary to understand the problem. As an example, Trafikverket, the infrastructure manager, does not have a lot of in-house personnel that does the out-of-house work, such as inspection and maintenance. Organisations performing inspection and maintenance have the goal to make profits while Trafikverket has the goal to keep a cost-efficient safe infrastructure. Those goals do not always match. The split also adds an information barrier between the people in field, which know the track and the people which administrate the track. The reasons behind a technical problem can in fact be organisational or contractual.

If a problem is indeed technical, data of some form is almost always needed in the process of research. Trafikverket has different systems that collects huge amounts of various kinds of data. A few examples on how the data is used today will be shown. In order to conduct successful research, relevant data should be provided by Trafikverket to research organisations. The question is if that is the case today, considering the above-mentioned organisational challenge.

Provided that research yield results that can be used, Trafikverket has to implement them. Depending on the level of maturity, further development and testing might be needed. It might also be a demand from the Swedish Transport Authority to see test results in order to grant permission to permanently use a new solution. Implementation is also affected by the complications of the organisation. A few examples will be shown.

Goal

By lifting some of the challenges surrounding research at Trafikverket the ambition is to increase understanding and, as a result, improve research projects and their impact.

CHARMEC's novel brake roller test rig

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Introduction

The development of numerical models for railway applications needs to be verified by results from experimental testing, either small-scale tests, full-scale tests or field tests. For study under controlled conditions, or when component integrity is a concern, full-scale testing is the preferred option. For this reason, a brake roller test rig has been established at Chalmers Railway Mechanics. The demand for making controlled brake rig tests was evident at the onset of the project "Tread braking – capacity, wear and life" and the new facility was designed specifically to conform to several research topics in that project. After discussions with our industrial partners, the brake rig functionality has been extended even further.

Analysis

Development and functionality of the brake test rig is described. The two main stages of development are described. Stage 1 means that tread brake testing of a single wheel can be performed at constant brake power and speed. This set-up allows for testing of wheels at extreme temperatures and for study of wear of wheel tread and blocks. In Stage 2, a so-called rail-wheel is added to the set-up along with another electric motor for either powering the rail-wheel or for providing supplementary power to the tread braked wheel. The addition of the rail-wheel means that the brake rig could be used to quantify the influence of tread braking on RCF life and to study the influence of temperature on tread plastification and wheel–rail wear. Testing of disc brakes will be possible with minor modifications of the brake rig.

Conclusions

A novel brake roller test rig has been established at CHARMEC. It is intended mainly as a flexible test facility that can support research projects, but testing for commercial purposes also is feasible.

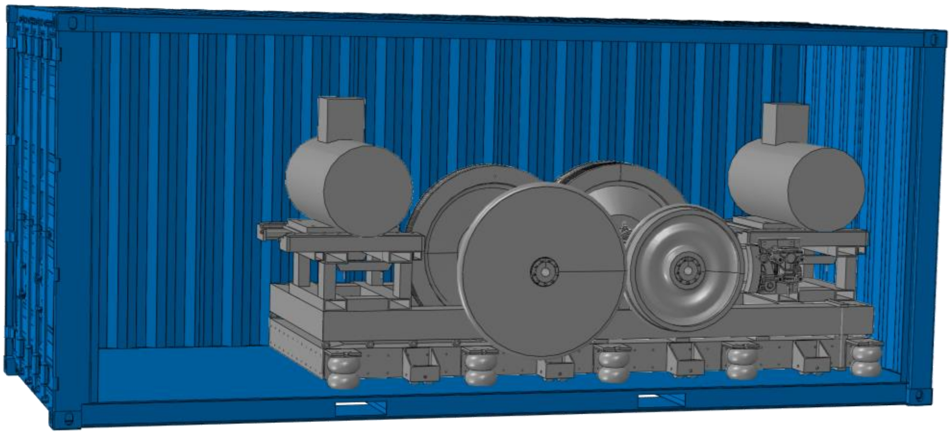

Figure 1: CAD drawing of CHARMEC's brake roller test rig

The KTH Roller Rig

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Introduction

Scaled roller rigs have been developed by different research institutes e.g. DLR, MMU, UoH and CTU among others, see chapter 20 of Handbook of Railway Vehicle Dynamics by Iwnicki (2020). The development of a scaled Roller Rig at the Division for Rail Vehicles at KTH started officially during autumn of 2020. The project aimed to create a platform for research and education in topics like rail vehicle dynamics and wheel-rail interaction among others. After three years of intensive teamwork, the first phase of the development is almost finalized with a one wheelset running over a roller-set.

Development

The development of the rig has relied highly on internal resources at KTH where PhD and master students have played a key role in the design, dimensioning, modelling, and prototyping.

From the very beginning, it was decided that the KTH Roller Rig should have a modular design to provide a flexible platform for future tests. The rig allows for different gauges and wheelbases, and it can support both 1/4 and 1/5 scaled models.

The development of the rig is divided into two major phases. The first phase of the development is building a rig which allows running of one wheelset over one roller-set. This is almost realized now, see Figure 1. At the time of writing this abstract, the team is working with instrumenation and commisioning of the rig. In the second phase, the rig will be extended to support a bogie with two wheelsets.

The rig is designed to be capable of three operaion modes where the two first ones are already feasible for phase one while the third one requires further dovelopment. The three opereational modes are 1- Tanget track 2- Curved track, and 3- Tangent track with track irregularities.

Figure 1. Roller Rig mounted at the MWL lab at KTH.

Future steps

Once the test rig is commissioned it will be open to use for collaborative research and educational purposes. In parallel, the development of the second phase will be followed.

References

Iwnicki, S.; Spiryagin, M.; Cole, C.; McSweeney, T.; “Handbook of Railway vehicle Dynamics”, CRC Press, London, 2020

Systems engineering applied in rail infrastructure – a systematic literature search

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Introduction

Sweden will enhance existing systems and invest in new rail infrastructure the coming years. More adaption to Systems Engineering practices (SE) has been brought up. This review aims to identify to what extent SE is applied in rail infrastructure systems. What exist, but under different naming and other roles of responsibility. This study exemplifies existing approaches in various domains and identifies "white fields".

Analysis

Web of Science Core Collection, Scopus and TRID (Transport Research International Documentation) was used with different combinations of search terms of “system engineering” or “lifecycle” or “asset” and “rail” and “process” or “model”. Further, the same databases were also searched with different combinations of search terms of “adapt”, “legal”, “political”. In total the search resulted in 2 987 unique references. The results were mainly structured in rail infrastructure systems (Figure 1) and SE activities.

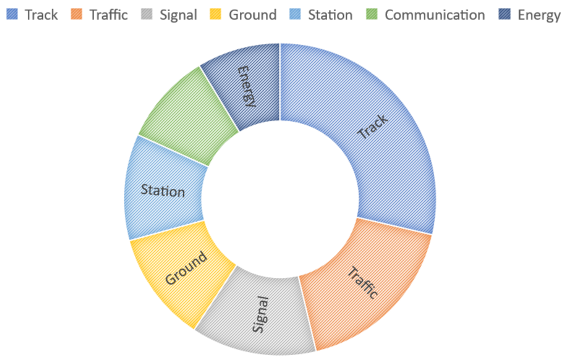

Figure 1. Rail infrastructure systems reflected in the search documentation.

Conclusions

The rail sector is concerned with issues related to migration strategies for introducing change and coping with legacy systems (Elliot et al, 2010), the latter is reflected by the number of publications on health assessment activities. Modelled-based SE is a dominating approach to critical infrastructures such as bridges. SE approaches to traffic management systems are not covered as much. Light rail systems apply SE more, number of papers mentioning passengers is a factor of eight compared to goods.

References

Elliott, B., O'Neil, A., Roberts, C., Schmid, F. and Shannon, I. 2010. Overcoming barriers to transferring systems engineering practices into the rail sector. Systems Engineering, 15, 203-212.

Understanding wheel damage during railway shoe-braking: insights from innovative small-scale testing

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Introduction

The study focuses on evaluating the performance of wheel steels in railway braking applications using an innovative testing rig called “4-Contact Machine”. This machine allows for small-scale tests to simulate wheel-rail-brake shoe interactions and assess the evolution of damage in wheel materials over time. The research aims to enhance the understanding of braking systems and improve their efficiency and reliability.

Analysis

The 4-contact machine (see Figure 1), designed for small-scale tests, replicates real-world conditions by applying specific contact pressures and rotational speeds to simulate wheel-rail-brake shoe interactions. Data collected from sensors, including load cells, torque meters, and thermocouples, provide insights into braking power and friction coefficients for each material coupling.

After testing, weight loss measurements and microscopic analyses of wheel samples reveal significant differences in performance when coupled with different brake materials. Light optical microscopy (LOM) and scanning electron microscopy (SEM) help evaluate microstructures and plastic deformation, while Vickers microhardness tests and qualitative chemical analysis using an energy-dispersive X-ray spectrometer (EDS) further elucidate damage in the contact zone.

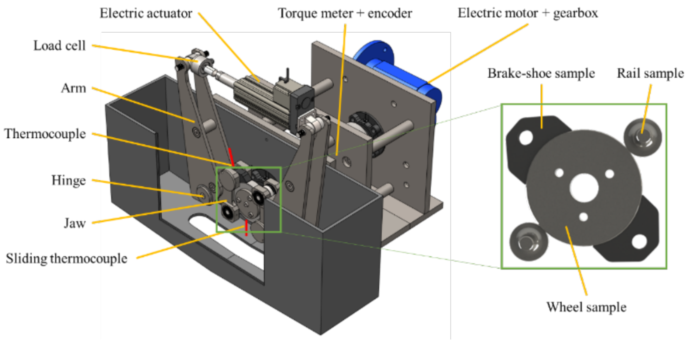

Figure 1 - Schematic of the 4-contact machine

Conclusions

The analysis reveals significant differences in the performance of wheel steels when coupled with different brake materials, highlighting the importance of material selection in railway braking systems. The 4-Contact Machine proves to be an effective tool for simulating wheel-rail-brake shoe interactions and studying the evolution of damage in wheel materials. This research contributes to a deeper understanding of braking system dynamics, offering insights for improving efficiency and reliability.