Järnvägsgruppen

Invitation to KTH Railway Group seminar (+lunch)

When: Thursday 29th September 2016 at 09.15-11.50

Where: KTH, Teknikringen 8, ground floor, Vehicle Engineering Laboratory

09.15-09.30	Coffee etc
09.30-09.35	Welcome
09.35-10.00	Yuyi Li, Roger Enblom, Sebastian Stichel and Wenlin Shen: *Prediction and validation of wheel profile wear on a Chinese high-speed train*
10.05-10.30	Jennifer Warg: *Timetable evaluation with focus on quality for travellers* (TET C3)
10.30-10.45	Information from the Director
10.45-10.55	Break
10.55-11.20	Hailong Liu, Ulf Olofsson and Pär Jönsson: *Effect of the sliding velocity on the particle emission from dry sliding wheel-rail contacts*
11.25-11.50	Carlos Casanueva, Visakh Krishna, Roger Jönsson and Bo-Lennart Nelldal: *Novel articulated wagon designs for increased capacity*
11.50	Lunch

For participation in the seminar and lunch, please inform Mats Berg at mabe@kth.se by 26 September.

Welcome!

Sebastian Stichel and Mats Berg
2016-09-16

Prediction and Validation of Wheel Profile Wear on a Chinese High-Speed Train

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The shape of the wheel profile is very important for the performance of the wheel-rail system. Due to the interaction between wheel and rail, the shape of wheel profile changes with the running mileage increasing. The wheel profile wear has influence not only on the vehicle dynamic response but also on the maintenance cost, especially for high-speed wheelsets that achieve high mileages in a very short time. Therefore there is a demand to optimise the wheel profiles on Chinese high speed trains to maximize mileage between reprofiling and to minimize reprofiling cost. Therefore KTH Rail Vehicles was asked to predict the wheel profile wear for a number of different profiles. Evaluation criteria for the investigated wheel profiles are mainly the amount of wear, the conicity development and the dynamic behaviour of the vehicle with worn wheel profiles.

The work is divided into two parts. One part is to calibrate the parameters of the wear prediction tool, which has been developed by Jendel and Enblom at KTH. The calibration is based on field measurements of S1002CN wheel profiles on a Chinese high-speed train. The second part of the project is to predict the wear behaviour of modified S1002CN wheel profiles on the same vehicle.

The wear prediction tool includes several parts, the load collective, the vehicle-track interaction, the wear model, the profile update and an iteration loop.

To determine the load collective and the wear rate calibration factors a sensitivity analysis with respect to key simulation set parameters is performed. The reference wear rate of S1002CN is validated through comparison with in-service measurements at different mileages. The expected simulated tread wear is 0.20 mm for 37,500 km mileage. It also turns out that a selection of varying worn rails and variable transition curves have to be used in the process of wheel wear prediction.

The calibrated prediction model is used to predict wear for modified wheel profiles for a Chinese high-speed train based on the S1002CN wheel profile. One of the profiles (S1002CN-RF) was tested on one trainset in parallel to the simulations. A comparison between simulations and measurements for this profile shows that the calculated wear distribution and depth are very similar to the measured one after 400,000 km. The simulation somewhat overestimates the wear after 100,000 km though. Thus it can be concluded that the prediction methodology is accurate and can be used to find wheel profiles that reduce maintenance costs for Chinese high-speed trains in the future.

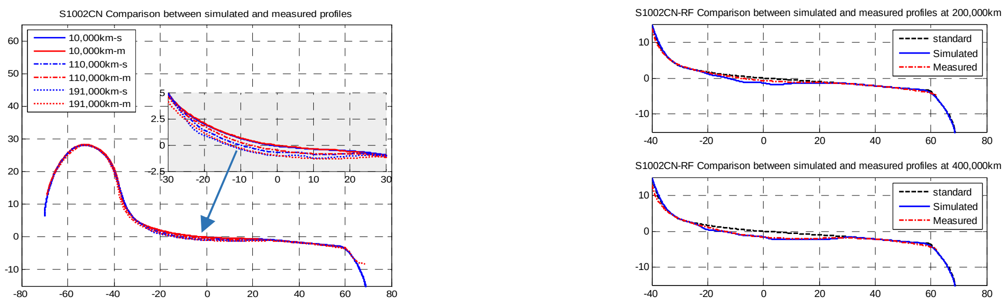

Fig. 1 Comparison results of S1002CN and S1002CN-RF, left: S1002CN, right: S1002CN-RF

Timetable evaluation with focus on quality for travellers

Jennifer Warg
Department of Transport Science, KTH Royal Institute of Technology

Punctuality and reliability are important for travellers. Railway lines with heterogeneous and dense traffic have proved to be prone to generate delays. Faster services and increased traffic have to be counterbalanced with measures for increased reliability. Efficient timetable planning can improve the use of such lines. Usually, that aim is treated from either a capacity or a socio-economic point of view. Because both are important, this thesis aims to combine the fields. A new method to evaluate timetable alternatives is developed. Commonly used methods are combined in a novel way to reveal values for different variables as input for evaluation of alternatives. That enables the comparison of timetable strategies using relevant input data. The idea is to estimate the benefits of a timetable for a traveller by expressing them as a timetable performance index (TTPI). For this purpose, quality indicators and methods to reveal them are identified. In the next step, traditional valuations for relationships between the indicators are used to test different model configurations for evaluation of alternatives, for example alternative departures on the same line or different timetables.

To treat this multidisciplinary task, several case studies were performed on the Swedish Southern and Western Main lines. As part of a study focussing on methods to measure and evaluate capacity based on travellers' valuations, the importance of delays was analysed in a questionnaire study and relationships between several variables describing the timetable were found. The other case studies aimed to identify relevant variables and use them to evaluate alternatives. Static and dynamic variables are distinguished. The static ones describe the timetable before operation, the dynamic ones the result of operation or estimated outcome revealed by means of, for example, simulation. Empirical delay data is used in one study, simulation with the microscopic tool RailSys in the others. In one of the studies, analysis is combined with the macroscopic timetabling tool TVEM (Lindfeldt, 2010). The case studies showed the characteristics of the analysed lines described by the chosen variables and which methods and variables are relevant to use for a comparison of timetable slots or evaluation of effects of changes in the timetable. An evaluation method was developed where simulation and timetable analysis reveal the variables. The idea is to construct an analytical function using traditional weights for relationships between the variables to convert the values of the variables into a performance index (PI). Based on a PI for each train slot (TSPI), the TTPI for the whole timetable is estimated. It describes the quality of a timetable in terms of timetable time, i.e. the resulting value is a time that is comparable to the scheduled travel time of one train departure, but includes additional information. With this method, complex timetables can be evaluated regarding their robustness to perturbations, which is valuable for socio-economic analysis of effects of measures applied on the railway system.

As shown in a one of the case studies, quality in terms of punctuality and reliability is important for travellers, at the same time as the design of the timetable has significant impact on these aspects. Timetable analysis and simulation are relevant methods to reveal variables that describe these characteristics and evaluation with the presented method is recommended. The configuration of the TTPI is essential for the outcome whereas it is important to choose variables and parameters adequately. If this is taken into account, the approach can be an efficient way to adjust timetables and choose the best alternative, for instance if a train path or timetable change is to be chosen among several.

Effect of the sliding velocity on the particle emission from dry sliding wheel rail contacts

***Supervisors**: Ulf Olofsson and Pär Jönsson*

***PhD student**: Hailong Liu, hailongl@kth.se*

The contact between wheels and rails consists of a mixture of rolling contact and sliding. The sliding takes place on both tangent and curved tracks. As a result, the sliding velocity increases in curves and in particular reach a relative peak when braking in a narrow curve. On one hand, this variation in the sliding velocity affects the wear behavior in the wheel rail system. On the other hand, it may lead to an increased emission of submicron particles (< 1 µm) to an underground railway environment due to a high contact temperature. Thus, it is of interest to investigate the effect of the sliding velocity on wear behavior, contact temperature, and particle emission in a dry sliding wheel rail contact.

Experiments have been carried out in a laboratory setup (**Fig. 1**), which consists of a pin-on-disk tribometer and an environmental chamber. The results show that the value of PNC (particle number concentration) increases remarkably as the sliding velocity increases from 0.1 to 3.4 m/s. Significantly, a high level of PNC (millions/liter) dominated by submicron particles was observed for high sliding velocities (1.2 and 3.4 m/s). This observation was related to the variation of the measured contact temperature (**Fig. 2a**). According to SEM and EDS observations, the oxide layers were detected within the pin worn surface (**Fig. 2b**) and the collected particles were found to exist in the form of iron oxide (**Fig. 2c**) for high sliding velocities. As indicated by the above outcomes, an oxidative wear was identified as the dominating mechanism leading to the formation of a substantial number of iron-oxide containing submicron particles. In addition, the formation of oxide layers within the pin surface also avoids a severe wear and results in a low wear rate and a smooth worn surface at high sliding velocities.

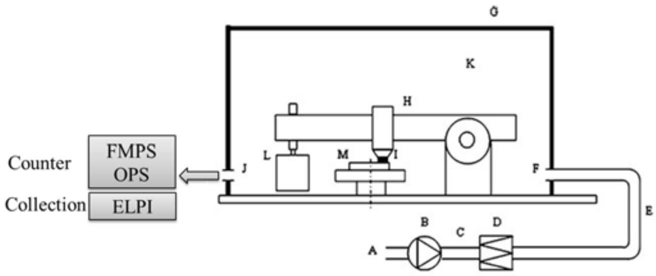

Fig. 1. Schematic diagram of the laboratory test setup

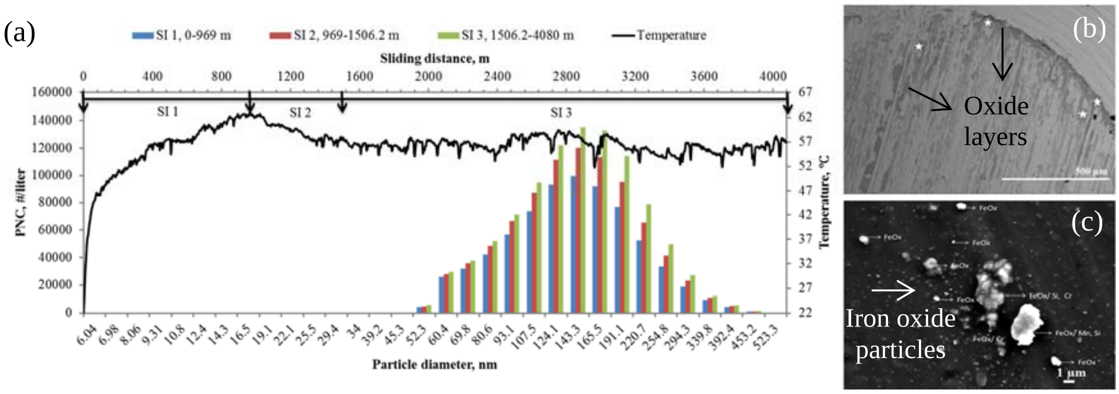

Fig. 2. The experimental results with respect to a sliding velocity of 3.4 m/s: (a) the particle number concentration (FMPS) and the contact temperature, (b) SEM image of the pin surface after the test, (c) SEM image of the collected particles.

Novel articulated wagon designs for increased capacity

Carlos Casanueva[1], Visakh V Krishna[1], Roger Jönsson[2], Bo-Lennart Nelldal[1]

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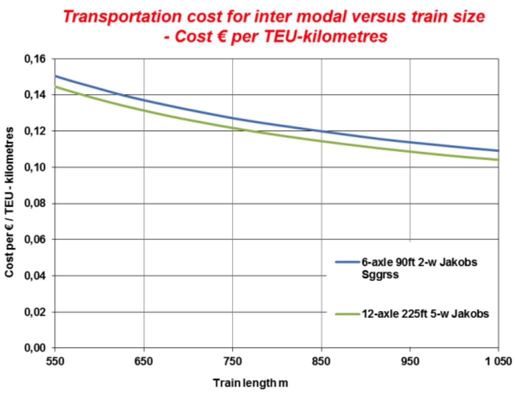
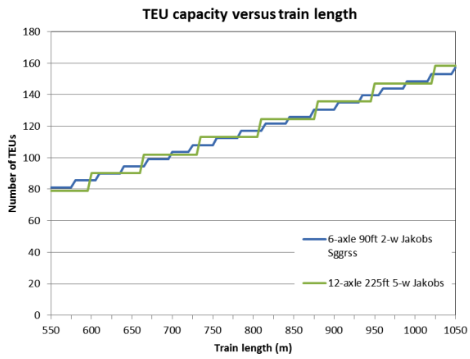
Capacity4Rail is a EU project whose aims are improving the competitiveness and reliability of rail freight in order to make it more attractive more sophisticated and modern market requirements. This work focuses on increasing the capacity of the overall system by using novel vehicle designs with higher payload per meter, both from the system design and the vehicle dynamics point of view.

The proposal is an articulated spine wagon composed by five car bodies and six bogies, of which four of them are shared between one car body and the next one. In the WP, an effort has been made to look into the implications of these type of very long wagons in all aspects of freight operation, and this presentation focuses on three of these: the increase in payload by using different but related configurations, the challenges in vehicle design, and the dynamic analysis of the running gear.

The developed new wagon concept is a 12-axle 225ft spine car with 5 frames and Jacobs bogies. The 45ft module has been chosen because there is an increasing demand for these containers. An evaluation has been done of the 12-axle 225ft wagon and a conventional 6-axle 90ft wagon with Jacobs bogie and two frames (class Sgrss). The 225ft 12-axle wagon gives 4% less cost per TEU-kilometre than a conventional 6-axle 90ft-wagon. The figures also indicate the savings of longer trains: an extension from 630 to 740m will decrease the cost by 10%, and increasing it up to 1050m would reduce it by 25%.





The dynamic analysis of the vehicle starts with the calculation of the critical speed for different vehicles. Figure 3 shows that, for an increasing number of wagons in the articulated system, the critical speed is slightly higher. However, conventional four axle vehicles have a higher axle load available for all the wheelsets, as the load is split evenly amongst them, unlike articulated vehicles where the load of the first and last bogie are lower than the limiting load in intermediate bogies. Thus, the higher load in the lead and trailing wheelsets makes them more stable.

With no further changes in the running gear, the proposed vehicles have a reduced critical speed. The conclusion is that, from vehicle performance point of view, it is worth to explore the possibility of increasing payload by slightly reducing the dynamic behavior of the system, as the 12-axle vehicle is much more flexible when it comes to modern multimodal transportation.