

ProRail Research on Wear and Rolling Contact Fatigue Problems in the Railway Switches

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1 INTRODUCTION

ProRail is the infrastructure manager of the Dutch railway network. Each day 5400 passenger trains and around 300 freight trains ride over the Dutch railway network. They transport daily 1.2 million travellers and 100000 tons of goods. That mobility is of capital interest, as well economic as social. ProRail manages more than 6500 km of track with 4500 bridges and tunnels. ProRail track has more than 2000 signalled level crossings, 8200 switches (6500 central controlled), 9800 signal equipment, 4500 km of electrified track and 376 stations. At this moment it is one of the busiest railway networks in Europe.

ProRail encourages innovations to reach the targets and to improve the performances. The company is continuously searching for the newest techniques and methods of maintenance, operation, management and development of the railway network.

These are the core business of ProRail:

- Management of the capacity on the railway network;
- Offer of safe train paths for operators;
- Provide information to travellers;
- Construction of new railway lines and building of new stations;
- Management and maintenance of the existing railway network;
- Management and maintenance of the existing stations and transfers.

From 2001 till now ProRail organise numerous research activities concerning RCF with partners like TU Delft, LRRE and DeltaRail. The first years were focused on control of safety issue of RCF problem, mainly Head Checks (HC) and Squats. Nowadays ProRail is active to optimise the maintenance budget in combination with high safety. Safety must be guaranteed at 100%.

After success with control and prevention of RCF in the plain track, ProRail is paying more attention on measures to prevent RCF in switches. On initiative of ProRail a large research programme may be started to consider all range of contact problems between railway vehicles and switches.

Switches represent very important elements of the railway infrastructure providing flexibility of the system by enabling railway trains to be guided from one track to another at a railway junction. Due to track discontinuities introduced by the switches and crossings (S&C) they experience high impact loads from passing vehicles, which makes S&C sensitive to damages. Statistically switches and crossings failures cause large operational disturbances in a railway network. The performance of the switches, in terms of safety and reliability, are putted under pressure with current requirements to accommodate higher speeds, greater axle loads, and shorter intervals between trains. Currently wheel/switch contact problems are one of the hot issues for railways.

2 WEAR AND RCF PROBLEMS AT SWITCHES

Switches have a number of contact problems originated from disturbed vehicle motion and high impact loads introduced by the track discontinuities at S&C. The crossing nose experiences high impact loads from a vehicle while having a quite small contact area with a wheel, which leads to occurrences of RCF. Simultaneous contact of the wheel with the stock rail and closure rail generates large creep forces which leads to HC propagation at stock rails and wear at closure rails. Disturbed motion of the wheelset through the switch is constrained by the guard rail. Contact between the flange back and the guard rail generates large creep forces, consequently the area of the stock rail around the guard rail is also sensitive to HC damage.

Traditionally rails in a switch have no inclination, in contrast to plain track. This gives extra deviation in wheel/rail contact. The construction of the switch (especially the frog) is stiffer in comparison to plain track which leads to different energy dissipation behaviour.

As can be seen, all kind of RCF problems are concentrated in a switch. However, treatment of the problems is very difficult. Grinding of the rails, which helps to solve many RCF problems in a plain track, cannot be widely applied due to complicated rail configuration in the switch and due to limited thickness of the rails. Therefore other alternatives must be found for the treatment of the wear and RCF problems in switches.

3 RESEARCH ON POSSIBLE SOLUTIONS AND CURRENT PROJECTS

At present moment a number of projects aimed to improve switches are already running under supervision of ProRail:

1. Monitoring of RCF and wear in switches.
2. Monitoring of cyclic grinding (track and switches).
3. Test and implementation of AntiHeadCheck rail profile in curves and switches.
4. Repair welding process in switches for HC and squats.
5. Regulations of profiles and new rail steel grades.
6. Wheel/rail contact optimisation by modelling.
7. Prediction models RCF to control budget.

To extend the current knowledge ProRail is initiating a research programme on train/switch dynamic interaction. Within the research programme five main projects must be conducted:

1. Monitoring of a number of switches.
2. Dynamic interaction of train and switch (macro-level modelling).
3. Dynamic interaction of wheel and switch rail (micro-level modelling).
4. Damage development and material improvement in railway switches.
5. LCC and RAMS of railway switches.

The research programme aims to provide a fundamental basis for the development of railway switches which permit longer inspection intervals, have fewer faults at inspection, involve lower maintenance costs and cause less disruption in rail traffic.

A large number of important questions to be answered within the research programme, between others:

1. Influence of the elasticity of the switch structure on RCF occurrence.
2. Influence of the switch layout and irregularities on wear and RCF.
3. Influence of the lateral and longitudinal geometry of the rails in switches on dynamics.
4. Improvement of the rail steel to have less wear and RCF.
5. Influence of vehicle speed, axle load and suspension parameters on dynamics in the switch.

Current results, implementation of the results in practice and need for the future research will be discussed during the presentation.