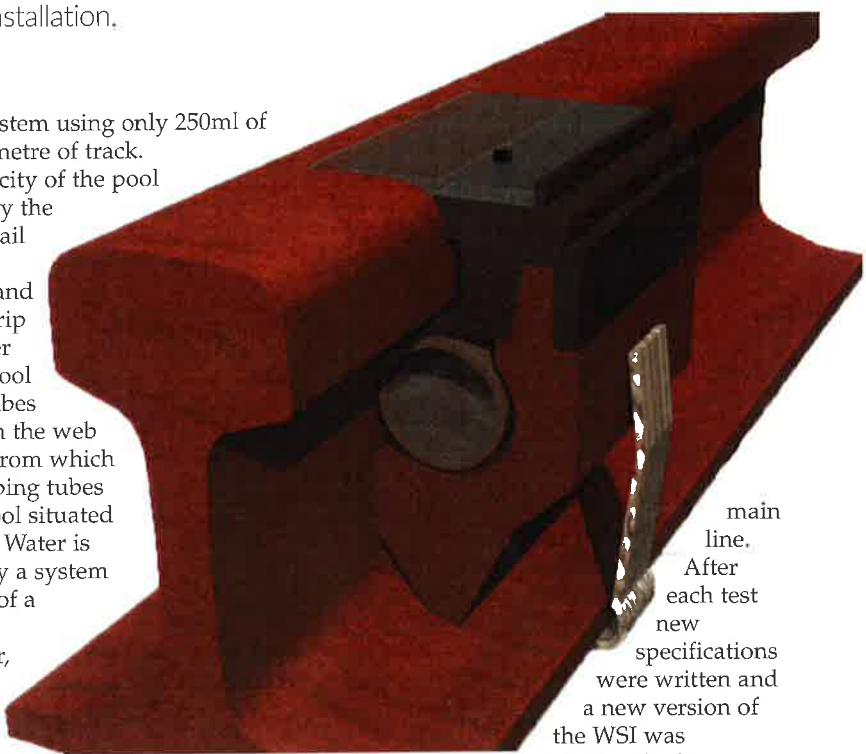
Combating leaves on the line

A new water-based system developed in the Netherlands has undergone tests to prove its effectiveness at overcoming poor railhead conditions caused by leaf fall. **Margreet Beuving,** consultant at Dekra Rail, which carried out the tests, profiles the Water Spray Installation.



DURING the autumn months, the combination of falling leaves and the moist environment contributes to significant degradation in railhead conditions, potentially causing unwelcome delays to services. Several measures have been deployed in a bid to tackle the issue over the years, but with no real success at offering a dependable answer to this significant problem.

However, the observations of a Dutch train driver may now have inspired a viable solution. The driver noticed that the slipperiness experienced in humid morning conditions disappeared after a heavy rain shower.

As a result, he came up with the idea for the Water Spray Installation (WSI) which is designed to clean the rail running surface using a small amount of water which prevents the adhesion of tree leaves. The method has been developed in cooperation with Rail Road Systems and QEP Holland and supported by Netherlands Railways (NS), with tests carried out by Dekra Rail.

The system utilises a tank of water situated a few metres from the track from which tubes carry the water to a pool on the rail head before each train arrives. The train wheels subsequently disperse the water over the rail head with the goal to break up the leaf layer, with the system using only 250ml of water per metre of track.

The capacity of the pool is limited by the top of the rail head at the inner side and a rubber strip on the outer side. The pool is fed by tubes mounted in the web of the rail from which small dripping tubes feed the pool situated on the rail. Water is supplied by a system consisting of a pump, a compressor, control and software which is situated in a box next to the track. The tubes are frost-resistant with a thermometer in the rail head along the main line monitoring the local temperature. In instances where the temperature drops below 0°C, the system software switches off the water supply and blows air through the pipes.

Testing of the equipment was carried out consecutively in the lab, on a 10m test track, in a freight yard and on a main line. After each test new specifications were written and a new version of the WSI was developed. This iteration was repeated five times with Dekra Rail aiming to answer the following research questions during the trials:

- to what extent do water and wheels remove the leaf layer?
- is the system maintainable and robust?
- is the WSI effective in a train service?
- what are the risks and conditions for application of the WSI?

In each the comparison was made between situations with and without leaves, and with and without water with real leaves used in each test phase. The main line test was carried out in autumn 2014 and used several measurement techniques (see panel) to provide the necessary empirical information.

Results

The water and wheel cleaning principle was initially tested on the two-disc machine. A leaf layer was created by feeding real leaves to the disc-to-disc interface. When water was added the adhesion μ first dropped to

Measurement techniques

Two-disc machine: This machine consists of two motors which drive two touching discs. The slip and friction coefficient between the discs are derived from pressure, speed and torsion measurements [3].

Rail Tribo Meter: The railhead conditions can be measured manually using a Rail Tribo Meter (RTM). A measuring wheel is pressed on the rail head and by pushing the equipment, slip is provoked. The braking force necessary to create slip is the RTM-value.

Onboard measurement equipment: Acceleration measurement equipment was installed on board an NS SGM II Sprinter EMU for tests conducted at the railway yard and on the main line. The driver was instructed to use the maximum traction and braking settings to trigger wheel slip, forcing the train's Wheel Slide Protection (WSP) to take over traction or braking activity achieving maximum acceleration/deceleration, which is directly proportional to adhesion.

0.02. After 25 turns of the discs the slipperiness disappeared and a clean surface with only the water resulted ($\mu = 0.6$).

This first version of the WSI was then tested on a separate 10m section of test track. A test car with small wheels (designed to feature a realistic contact pressure) ran back-and-forth automatically over the track. The wheels created a running surface with adhesion values comparable with the track on the main line.

In the tests a slippery black leaf layer was created using five leaves per metre of track and approximately 1000 wheel passages. The Rail Tribo Meter (RTM) values were 37 µRTM on the dry leaf layer and 15 µRTM on the moisturised leaf layer. Following the application of water, only a few wheel passages were needed to make the leaf layer fall apart and for the clean metallic colour of the running surface to become visible. To remove the leaf residue and enhance the RTM value to approximately 30 µRTM, 200 wheel passages were needed. This slow increase of the adhesion compared with tests conducted in the railway yard and on the main line is due to the large amount of leaves and the low speed of the wheels on the test track.

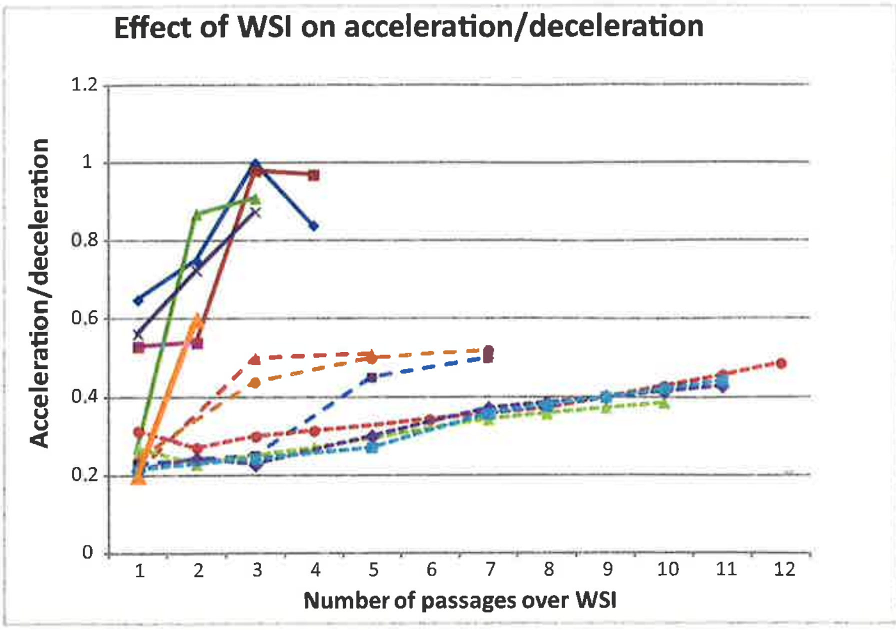


Figure 1: Results of four test stages. The two-disc machine (thick orange line), 10m track (dotted lines), railway yard (dashed lines), main line (solid lines).

Robustness tests of the second WSI design on the test track resulted in specifications for the third version at the yard. Here low adhesion levels were created by applying leaves to the railhead, again about five leaves per metre of rail. After activation of the WSI and three train passes the adhesion had improved. The RTM values increased from 20 to 35 µRTM, and the acceleration from 0.2 to 0.5 m/s^2 at 50% traction power (Figure 1).

Following the railway yard tests a fourth version of WSI was tested to guarantee robustness for application on the main line.

The WSI's running surface, dripping tube and limiting strip fits seamlessly with the rail profile.

	Clean track [m/s²]	350m WSI [m/s²]	200m WSI [m/s²]	Reference locations [m/s²]	WSI off [m/s²]
Traction	0.68 +/- 0.09	0.67 +/- 0.09	0.53 +/- 0.07	0.45 +/- 0.13	0.45 +/- 0.05
Braking	0.86 +/- 0.14	0.93 +/- 0.07	0.88 +/- 0.07	0.47 +/- 0.19	0.41 +/- 0.01

Table 1: Average acceleration values of the main line tests.

In autumn 2014 two Water Spray Installations with a length of 350 and 200m were installed at Veenendaal Centrum station on the Maarn - Rhenen main line in the Netherlands.

The results of the tests show acceleration values of 0.8 to 1.0m/s² on the 350m WSI. In figure 1, all tests are compared.

Figures 2 and 3 show the main line results in more detail. The acceleration values of 0.8 to 1.0m/s² are representative values for clean track with these reference values accumulated in the summer. The reference locations without WSI show low adhesion with values down to 0.2m/s².

The acceleration values on the 200m WSI are somewhat lower than on the 350m WSI, which is probably due to its shorter length and the nearby road crossing. The track of the 200m WSI remains slightly polluted. The fact that this reduction is only visible at traction, and not at braking, is explained by the slower response time of the WSP at traction, resulting in longer slip periods.

> WSI improves adhesion in slippery conditions and the main line tests show a 70-86% improvement in the rate of acceleration in autumn conditions.

In addition with only 80% of the measurement train wheels using powered axles, versus 100% at braking, the traction values are 80% of the braking values.

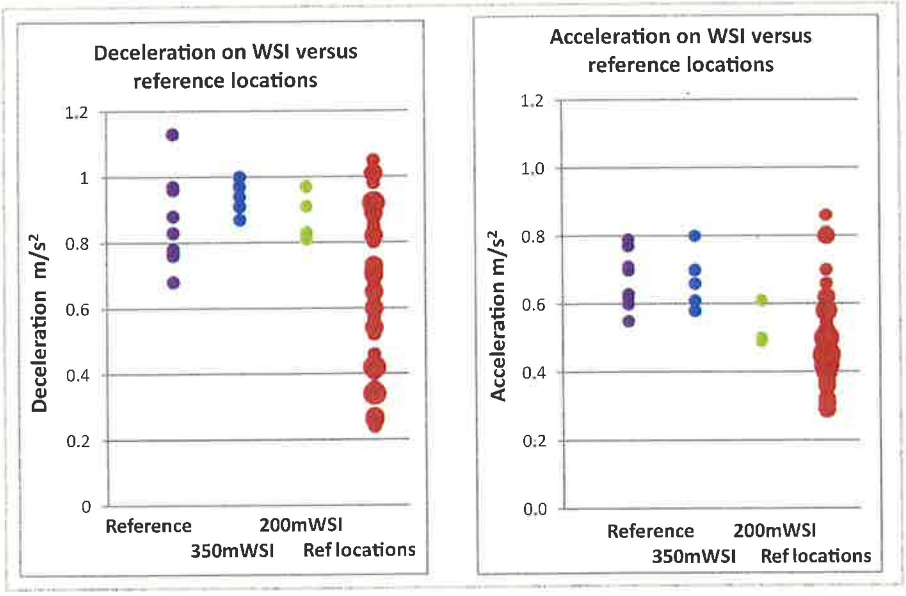
The results of the main line tests are summarised in Table 1.

WSI has proven to be reliable and sustainable during testing. The anti-frost system functioned as intended and the system was watertight for more than 80% of the three-month autumn period which was sufficient to reach the described results. In two cases a 5cm section of the equipment was damaged by maintenance works.

In all test stages the results were comparable: the leaf layer is broken down by small volumes of water and is removed by the wheels. WSI improves adhesion in slippery conditions and the main line tests show a 70-86% improvement in the rate of acceleration in autumn conditions if a WSI of sufficient length is installed, potentially improving operational reliability. The system is robust, while its sustainability and reliability has been proven and is most effective when it remains activated throughout autumn. Level crossings are a source of dirt and further tests with water on crossings are foreseen to identify a solution to this problem.

The project set up - with iterative steps moving from lab tests to mainline tests - allows a good comparison of the results of the various methods. The three-way cooperation between NSR, Dekra Rail and RRS, where each step in the project led to new specifications and an improved WSI system, proved to be an effective and transparent approach.

The next step for the WSI project is to conduct tests on a section of track where trains operate at 120km/h. Plans for these tests have been submitted to ProRail and NS, which are currently deciding whether and when testing can take place. It is hoped that it could happen in autumn 2016. **IRJ**



Figures 2 and 3: Deceleration and acceleration at 100% power. Reference measurements on clean track (purple dots), measurements on the 350m WSI (blue dots), on the 200m WSI (green dots) and on other reference locations without WSI (red dots). The size of the dots indicates the number of measurements with this value.

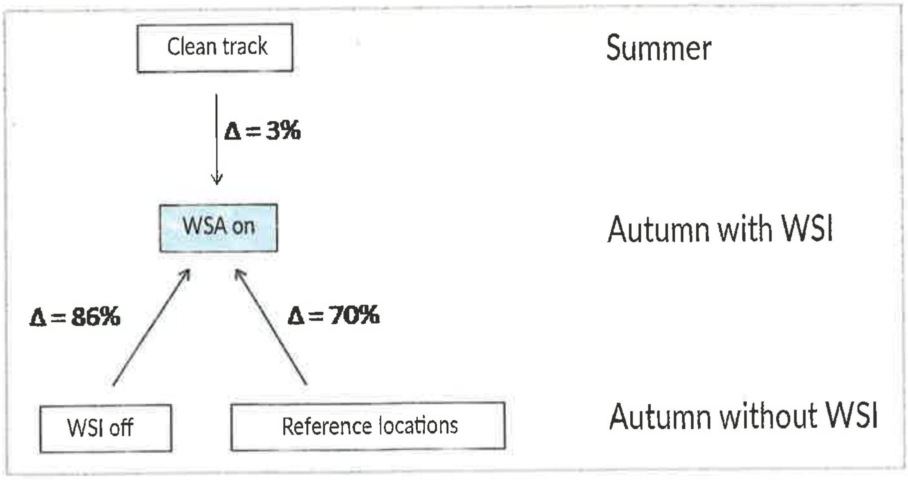


Figure 4: Increase of acceleration/deceleration by the WSI compared with three reference situations. To determine the percentage, the reference situations are set to 100%.