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Slip-free speed testing with the Swiss Federal Railways (SBB)

In brake tests with critical adhesion conditions: slip-free speed testing

The train equipped with imc measurement devices.

The LUXACT sensor in operation

The inspection body of the Swiss Federal Railways (SBB) is specialized in the area of brake system testing on railway vehicles. For carrying out their tests on a steep-grade track section with critical adhesion conditions, the inspectors chose the LUXACT speed sensor to obtain slip-free distance and speed signals.

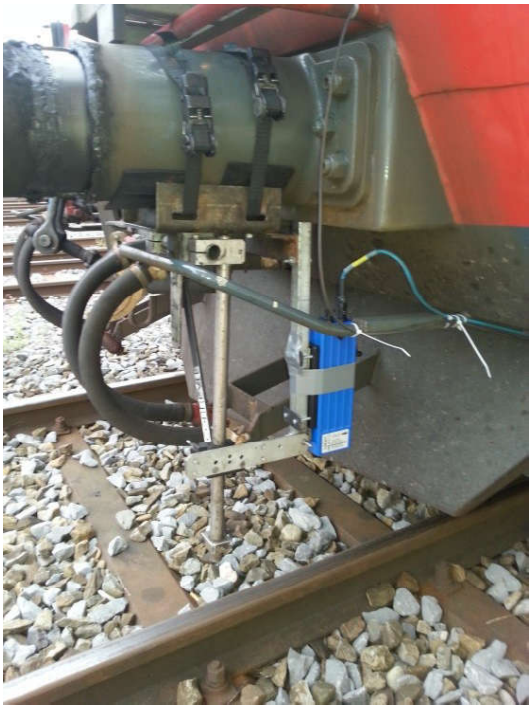
Compact & precise: the LUXACT speed sensor

Steel on steel

On the railway, steel wheels roll upon steel tracks. This combination results in a very low rolling resistance, thus making railway travel one of the most environmentally-friendly forms of transportation. However, this combination of steel on steel also has the effect of creating very low adhesion between the two surfaces. The coefficient of adhesion of a car tire on dry asphalt is approximately 0.6. On a railway vehicle, this coefficient is about 0.2 in dry conditions.

However, in cases where the tracks are wet or perhaps covered with debris or foliage, the coefficient of adhesion can sometimes decrease significantly to a level below 0.1. In these cases, the braking force is no longer transmitted directly to the track and the wheel is likely to slip. Passenger vehicles and locomotives are now employing an anti-slip protection system similar to ABS found in automobiles.

Inspectors from the SBB were commissioned to carry out tests regarding the braking and slipping of a trainset on a steep downhill grade. The test route ran largely through deciduous forests, where debris and foliage were frequently covering the tracks, especially in the fall months, thus placing high demands on braking performance.



The LUXACT speed sensor was mounted to the front of the train so as not to contaminate the optics with soapy water. © Photo: SBB

Requirements for speed testing

A quick look back: Previously, the optical speed sensors used by the inspection body had to be aligned directly over the railhead because of the low level of tolerance regarding the height acquisition. This resulted in frequent faulty speed signals, especially in tight corners or traversing over rail switches. In order to obtain a continuous speed profile, the measurement data had to be interpolated. Thus, the SBB was looking for a new solution

for measuring speeds – with the following requirements:

- Slip-free measurements (e.g., optically or by radar)
- Accuracy better than 0.5 %
- Not affected by height changes, e.g., at crossings, switches, etc.
- Insensitive to rain
- Possible to measure down to a standstill
- Also possible to test in tunnels
- $V_{max} \geq 230$ km/h

The inspectors from SBB opted for the LUXACT speed sensor since it can be used on all types of surfaces and over surface intervals, while still maintaining measurement accuracy in the parts-per thousand range. Thus, even when surface distances suddenly change at crossings, switches or safety stations up to 30 cm, it is not a problem.

Testing during low-adhesion conditions

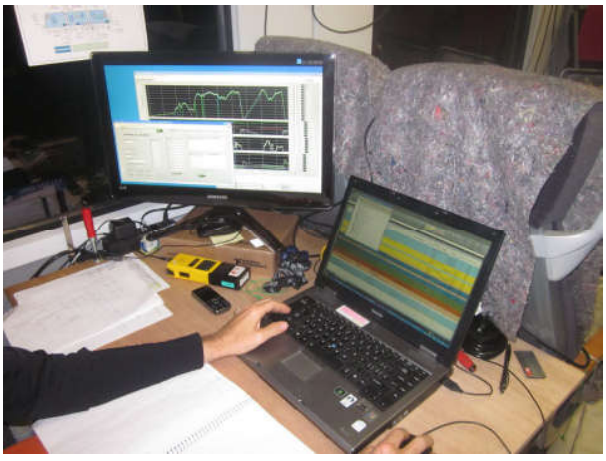
"Bad weather at the push of a button" thanks to the irrigation system directly before the front axle. © Photo: SBB

The first tests were carried out over dry rails. Then, the adhesion conditions were gradually deteriorated, for example, by spraying water or soapy water on the rail directly before the front axle. The braking axles exhibited partial slipping of up to 30%. That is, the wheels were turning at 70 km/h with the vehicle still moving at 100 km/h.

The aim of the slip-protection system is to keep the slipping within an acceptable range without increasing the stopping distance further than permitted (corresponds with ABS in a car). Thanks to the LUXACT speed sensor, a reliable speed signal was available throughout the entire measurement process.

To substitute for the weight of passengers, the trainset was outfitted with sandbags. © Photo: SBB

Together with other data such as brake cylinder pressures, brake power of the electrodynamic brakes (dynamo-operation), brake trigger signals coming from the safety system or train engineer, brake disc temperatures, etc., the overall braking behavior of the trainset could now be assessed.



Over 80 different variables throughout the trainset were measured and centrally monitored in the test wagon. © Photo: SBB

Further experiences with the LUXACT speed sensor

In addition to testing with low adhesion conditions at a maximum speed of 120 km/h, the LUXACT speed sensor has proven itself with further test runs at up to 200 km/h. The flexible mounting options have also proven to be quite practical, since the measurement equipment had to be moved several times from one vehicle to another.

In some individual tests, the measured speed from the LUXACT sensor deviated from the actual speed of the train. Thanks to the "health" signal, which is available via CAN interface, these occurrences can be easily identified and the measurement repeated. For additional precaution, the SBB used two reflectors attached to poles along the test track at known intervals that were picked up via beam sensors. This allows for errors, such as misaligned sensors, to be quickly and reliably detected.

Using reflectors and beam sensors, the speed and distance signals can be double-checked during the test runs, and errors, such as a misaligned sensor, can be detected. © Photo: SBB

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Ulteriori informazioni

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