



Sverige

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IWT4 - Instrumented Wheelsets

Fourth generation of wheelset technology

Instrumented Wheelsets

Instrumented wheelsets (IWs) are railway wheelsets that have been instrumented and calibrated so that they are capable of accurately measuring the dynamic contact forces at the wheel-rail interface.

Historically, they are primarily used to verify that new (or substantially modified) vehicles are not prone to derail and do not cause unacceptable levels of rail wear or damage to the infrastructure. Testing using IWs is required in Europe (Standard EN14363), the US (standard 49CFR-213) and is also common in China, Japan and India.

Our Heritage

Our heritage in building instrumented wheelsets spans over 60 years, with the first instrumented wheelsets being built in the 1950s. The third generation of the technology, IWT3, has been used since the 1980s and there are wheelsets from this decade that are still in use today. In 2004 the development of a groundbreaking new technology began, which would become the fourth generation of wheelsets; IWT4.

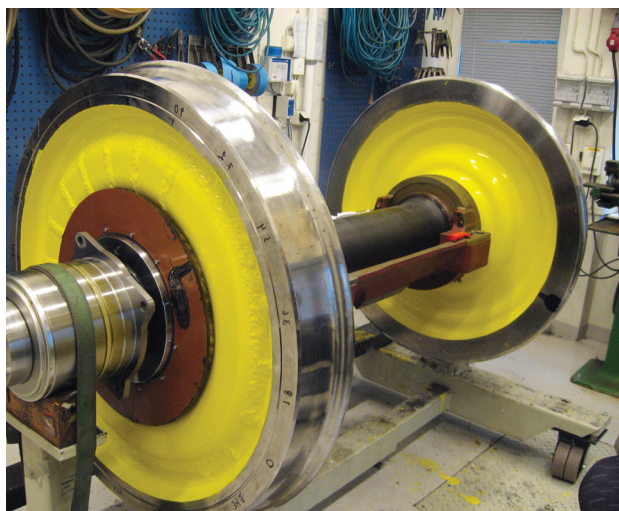
IWT4 – Fourth generation of wheelsets

IWT4 offers numerous advantages over traditional technology. It utilises the standard wheels fitted to the vehicle, meaning that no special 'test wheels' are required. This simplifies project logistics, reduces delivery time, and ultimately lowers costs.

The technology enables forces to be measured simultaneously in all three planes. Vertical and lateral forces are important for evaluating the vehicles dynamic performance and also track condition. Forces in the longitudinal direction can also be measured. Forces in this direction play a critical role in both the formation of wheel and rail rolling contact fatigue and wear. IWT4 can also measure the lateral position of the contact point; in other words, where the rail meets the wheel.

Only one side of the wheel disk needs to be fitted with measurement equipment, which simplifies the instrumentation process, and enables the system to be adapted to challenging bogie designs. The advanced telemetry system removes the need for slip ring devices, dramatically increasing reliability and simplifying installation of the system. By using an inductive telemetry

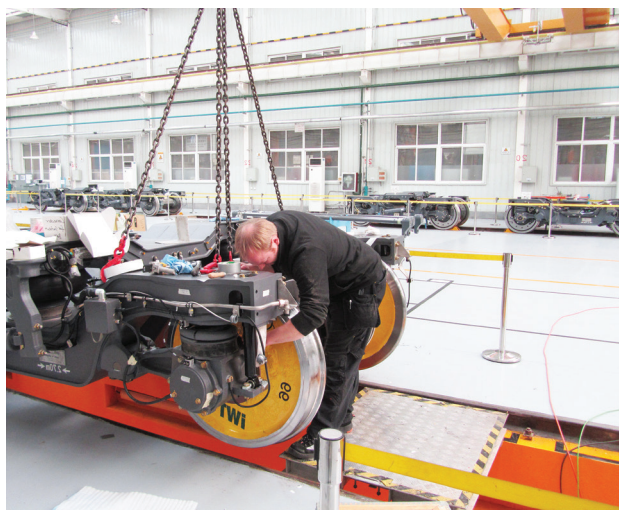
system specifically developed for the railway environment, the IWT4 system avoids the electromagnetic interference issues that are characteristic of radio based telemetry systems.



The technology doesn't require the wheel to be machined, so structural integrity is not altered. This removes the need for additional periodic ultrasonic inspection of the wheelsets. From a structural point of view, the wheelset is identical to the other "in service" wheelsets. An advanced inductive power transmission system removes the need for batteries, so as long as the vehicle is powered up, the IWT4 is as well.

A robust and field hardened technology

IWT4 is a robust and field hardened technology, with over 100 IWT4 wheelsets produced. The technology has been used in the field for over a decade.



IWT4 has been used by rolling stock suppliers such as Siemens, Bombardier, Alstom, Vossloh, Stadler, General Electric, Hyundai-Rotem, Talgo and PESA and in countries such as the USA, Brazil, Switzerland, Germany, Poland, Sweden, Austria, Finland, the United Arab Emirates, China, India and Norway.

The IWT4 technology has been extensively reviewed and accepted by the German Railway Authority and results from IWT4 have been accepted by the US Federal Railway Administration as part of the vehicle acceptance process.

Vehicle Approval

IWT4 was Siemens natural choice for testing the Sr3 locomotive in Finland. The non-invasive nature of the technology makes it ideal for high value locomotive wheelsets as the technology offers the potential to reuse the wheelsets in normal traffic after testing has been completed. Furthermore, the short leadtime offered by IWT4 makes it particularly attractive for time critical vehicle acceptance processes.

The broad gauge locomotive is part of the Vectron family of locomotives and was tested at speeds up to 220km/h on tracks spanning Finland. The Sr3 is one of four Siemens locomotives that IWT4 has been produced for. Siemens have chosen the IWT4 technology not only for European locomotives but also for approval of their Locomotives in the United States. For example, IWT4 was used onboard the "Vectron based" ACS64 delivered to Amtrak when testing the vehicle in accordance to US Standards.





Moving Boundaries

Vale's EFC is a mine to port iron ore transportation operation in an extreme environment, with the mine close to the Amazon and the port near Sao Luis in the north of Brazil. The measurement of wheel-rail forces played a crucial role in enabling Vale to increase the capacity of each ore wagon by 20 tonnes, resulting in an axle load of over 37.5 metric tons.

While it is easy to calculate the forces arising from the static axle load, the forces resulting from the dynamic interaction between vehicle and track are more difficult to determine. By using an instrumented wheelset the dynamic forces can be measured directly, which allowed VALE to understand the impact an increased axle load has both on vehicles and the track.

LKAB also move iron ore, but their operating environment is quite different. LKAB haul iron ore in the north of Sweden and Norway. An extreme environment positioned far north of the polar circle, where the ground remains frozen for large parts of the year.

But even here Instrumented wheelsets played a critical role in increasing wagon payloads, helping increase axle loads from 25 to 30 tons.

IWT4 is not only key when pushing axle load limits, it's also a key player when moving at speed. When Bombardier were setting Sweden's new speed record Instrumented Wheelsets played a critical role. With the IW's providing real-time measurement of the vehicles safety against derailment and stability, speeds could be stepped up in a structured and safe manner. Similarly when running at 420km/h on the Bombardier Zefiro, six IWT4's were onboard to measure safety critical parameters.

New Horizons - Track Condition Monitoring

IWT4 is unique in that it is capable of measuring at high frequencies using the vehicles original wheelset. By measuring at high frequencies it is possible to locate both singular and periodical irregularities, such as poor joints and worn switches or crossings and corrugations. Using the vehicles original wheelset makes it practical to use IWT4 on an in service train travelling at normal line

speeds. Collecting this data enables TÜV SÜD to clearly identify, quantify and classify areas of degradation of the infrastructure.

These areas may include sections where track or wheel wear is high, where corrugation has developed or poorly performing switches or crossings. While IWTs are not seen as a replacement for track geometry measurement, they do provide a direct measurement of what impact a particular set of geometry has on wheel rail forces. For example:

Q: "How dangerous is the rail dip we measured in curve X?"

A: "The IWTs gave us a L/V (Y/Q) value of 0.5, so we don't have an immediate derailment risk."

Q: "This switch is still within limits but it just feels wrong"

A: "We have measured the wheel rail forces in this switch since it was installed 3 years ago, and the forces have increased by X over the last Y months".

Regular monitoring of the infrastructure using IWT4 enables timely action to be taken when conditions degrade rapidly, while slower trends provide valuable information to aid in long term maintenance planning. In short, it supplies information to help you better manage your asset.

New Horizons - Friction Measurement

Effective management starts with measurement

Friction at the wheel rail interface is a critical parameter for an effective railway. By identifying areas of the network with low friction in real-time metro operators could potentially drastically reduce wheel flats on their fleet.

Wheel wear is typically the largest ongoing vehicle maintenance cost. If an operator could measure wheel rail friction they could actively manage their lubrication regime and significantly reduce their wheel wear.

We believe that there is an enormous potential for IWT4 in this area and have been actively working to find solutions. Together with the Stockholm Metro we have undertaken a prestudy to explore the potential of IWT4 as a "real-time friction measurement system" and the results are very positive. In cooperation with the KTH Royal Institute of Technology we further developed algorithms for friction measurement. Finally IWT4 played a critical role in the measurement of wheel-rail friction at Laser Precision Solutions test rig in Amsterdam.

Add value, Inspire trust

TÜV SÜD is a premium quality, safety and sustainability solutions provider specialising in testing, inspection, auditing, certification, training and consulting services. Represented in over 800 locations worldwide, we hold accreditations in Europe, the Americas, the Middle East, Asia and Africa. By delivering objective solutions to our customers, we add true value to businesses, consumers and the environment.

Technical Capabilities

Cut-off frequency for measurement of vertical and lateral wheel rail forces (Q, Y):
Up to 3kHz.

Typical measurement uncertainty of vertical and lateral wheel rail forces (Q, Y):
Typically better than 3% at 20Hz.

Measurement of longitudinal creepage forces (X):
Currently measured and soon will be supplied as a fully calibrated signal.

Cut-off frequency for X:
Typically in excess of 10Hz.

Measurement of contact point position:
Typically +/- 2mm accuracy is achievable. Accuracy is degraded during two point contact conditions.

Handling of two point contact:
Creates equivalent, global values for the contact forces. The individual contact forces for each of the individual points of contact are not measured.

Temperature:
-25°C to +50°C, may be increased after consideration of the specific application.

Special wheel disc design required:
No special requirements. Nearly all wheelsets can be used.

Modification of the wheelset:
No destructive modification of the wheelset is required, so the wheelsets fatigue life is preserved.

Signal and power transmission:
Wireless signal/power transmission, no modification to the axle or wheel required, no batteries required.

Approvals:
German Railway Authority, Eisenbahn Bundesamt (EBA).
Approved for use in the United States.

Permitted test speed:
5-400kph. Lower test speeds are possible for special applications.

Traction/Braking forces:
Traction and braking forces may be applied with the exception of tread brakes and wheel mounted disc brakes. Care should be taken in all cases to avoid wheel flats.

Delivery time:
Typically 6-8 weeks for two IWT4 wheelsets.

Note: As IWT4 uses the vehicles standard wheelset, geometry and hence wheelset characteristics vary between wheel types, the characteristics given above are typical values.