Enhancing Maintenance Efficiency and Safety in Heavy-Haul Railway Operations through On-Route Measurement of Wheel Out-of-Roundness

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Introduction

Maintaining both safety and operational efficiency in heavy-haul railway systems is increasingly challenging due to rising axle loads and service demands. Wheel out-of-roundness (OOR) induces adverse dynamic wheel-rail interactions that accelerate wear, propagate rolling-contact fatigue and increase derailment risk. Older, conventional trackside systems like the widely used WILD (Wheel Impact Load Detection) have some disadvantages. These include their frequent inability to detect early-sta ge irregularities, and the fact that measured values are speed-dependent and not directly connected to the geometric failure size. We propose a continuous, on-route OOR-monitoring paradigm using rail-mounted acceleration sensors. Under in-service conditions, this system captures high-resolution, wheel-longitudinal profile data, bridging the gap between fault inception and maintenance intervention. Real-time alerts enable predictive scheduling, reducing lifecycle costs and extending wheelset and infrastructure lifespans.

Comparison with other approaches

On-board systems
× High hardware cost, power supply, complex maintenance and limited data integration

Acoustic and optical methods
× Susceptible to environmental conditions; limited accuracy, vehicle type dependencies

WILD
× Detects only larger defects, indirectly over impact force; influenced by track stiffness, axle load and speed
× Exhibits speed-dependent reading artefacts and calibration challenges

Advantages of the Argos® OOR System
✓ Sub-0.01 mm (0.0004 in) measurement resolution
✓ Direct wheel defect size
✓ Proven field performance under real-world conditions
✓ Low system complexity and maintenance cost

Results

The study highlights the effectiveness of the Argos® OOR system in comparison to traditional maintenance methods. It enables early detection of wheel irregularities, allowing for proactive maintenance interventions before defects escalate. This is a significant advantage over WILD, which can only detect larger defects and is influenced by variables such as speed, track stiffness, and axle load, resulting in speed-dependent artefacts and calibration issues. Additionally, by providing more comprehensive and consistent data, integrating this information into predictive analytics enables better maintenance scheduling. This approach reduces lifecycle costs and enhances operational efficiency. Proven field performance under real-world conditions further establishes the system as a robust and reliable solution.

Conclusion

Real-time, on-route measurement of wheel out-of-roundness delivers a validated, cost-efficient strategy for proactive maintenance on heavy-axle railroads. Its sub-0.0004 in resolution, robust repeatability and environmental immunity enable earlier interventions, extend wheelset service life, reduce lifecycle costs and elevate overall network safety and fluidity.

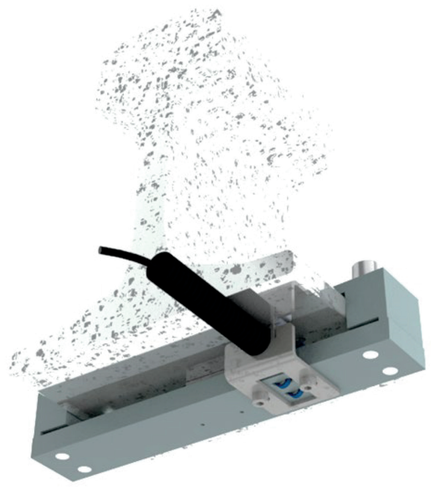

Figure 1. Clamp on sensors

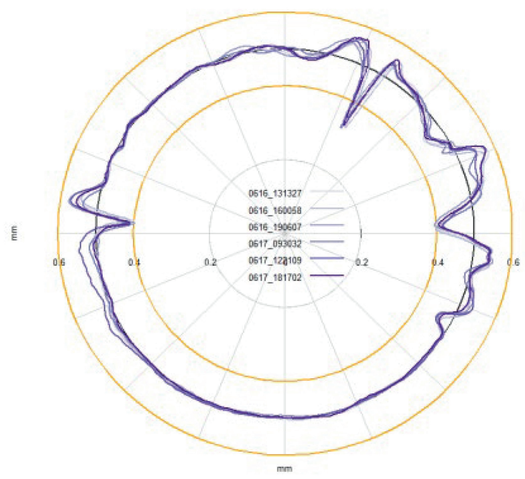

Figure 2. Multiple measurements of the same wheel with multiple defects

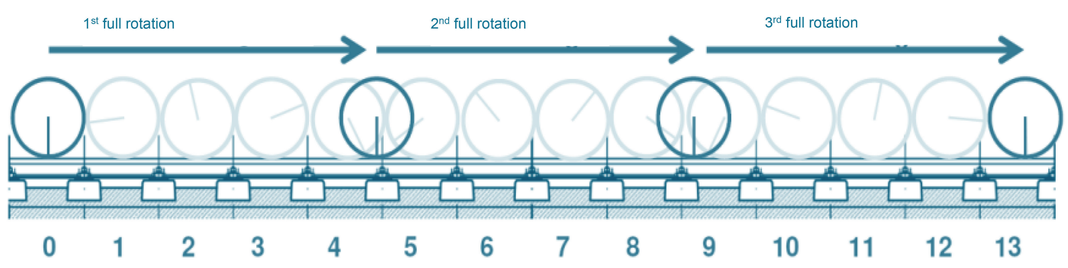

Figure 3: Three full overruns are measured

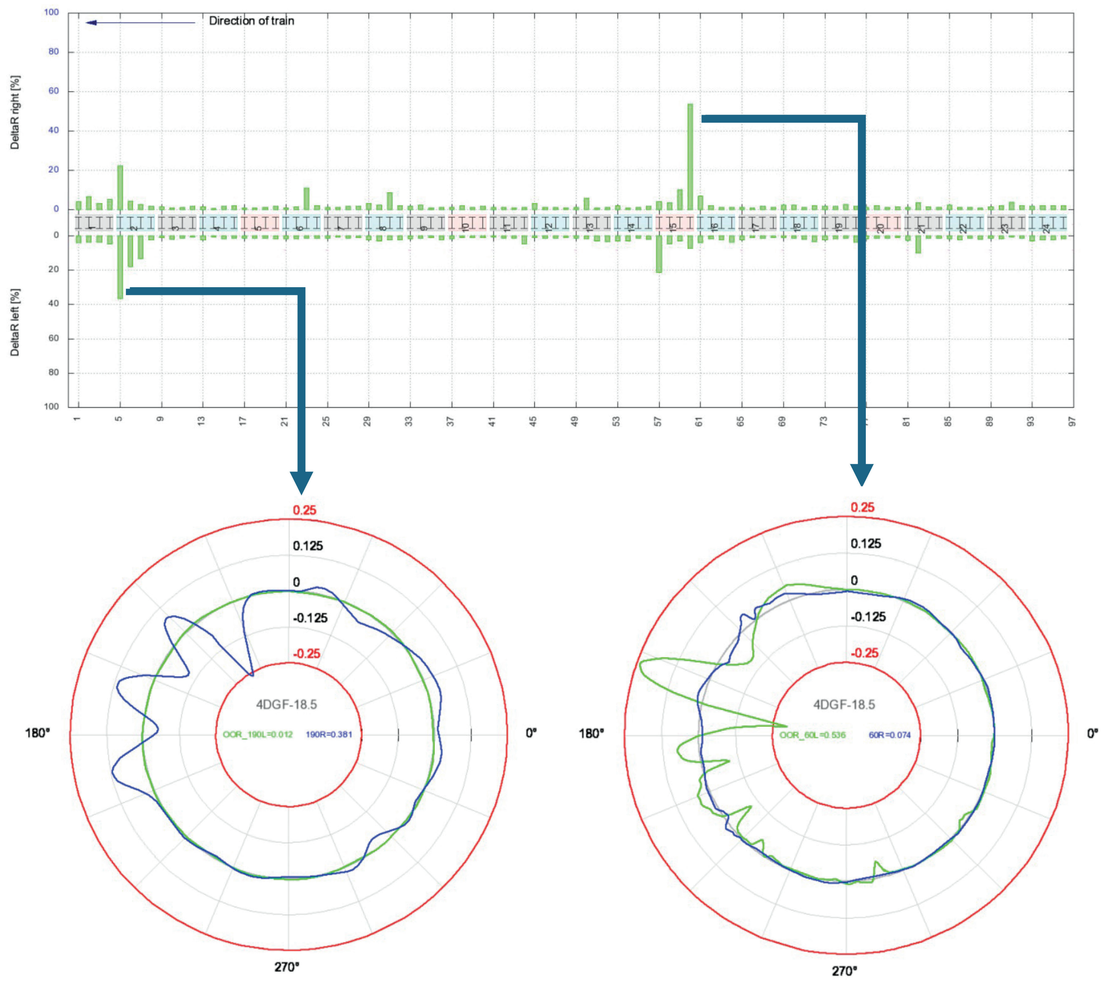

Figure 4: Example of freight train wheel defects

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