HIGH CAPACITY I PRECISION I RELIABILITY

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Rail Management Solutions for Slab Track applications and beyond

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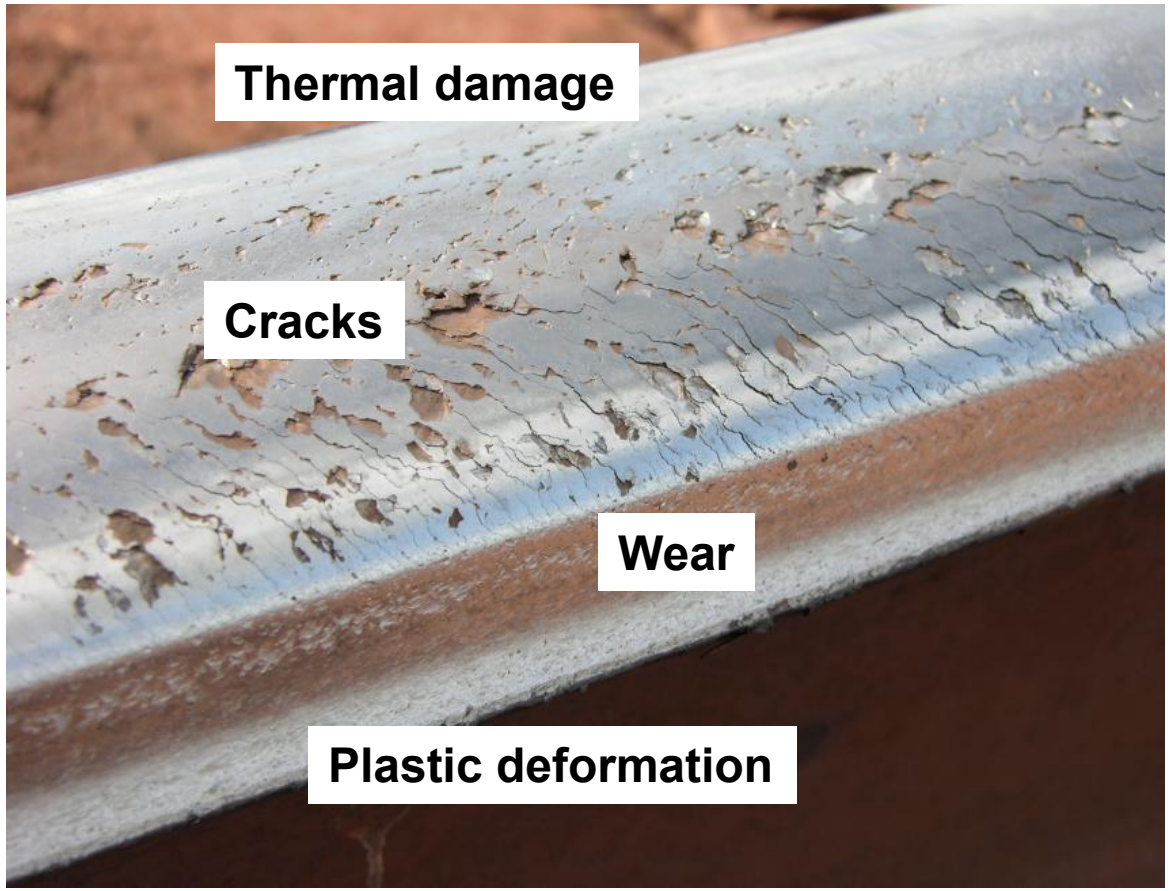
Why Rail Management

Rail Deterioration

Wheel/Rail Contact



Rail Management

Toolbox

1. Material and Joining
2. Profiles
3. Track Quality
4. Friction Management
5. Rail Profiling / Rail Maintenance
6. Measurement Technology
7. Data Handling Technology

Rail Grade Selection

Cornerstone for successful rail management

Rail grade selection as cornerstone

- Standard and heat-treated rail grades

Optimsed material structure for improved performance

Higher resistance against wear and rolling contact fatigue (RCF)

Extension of rail life

Photo by voestalpine Railway Systems

Joining of Rail

Rail Welding Technology

Every connection represents a discontinuity

Rail joint, isolated rail joint, welded rail connection

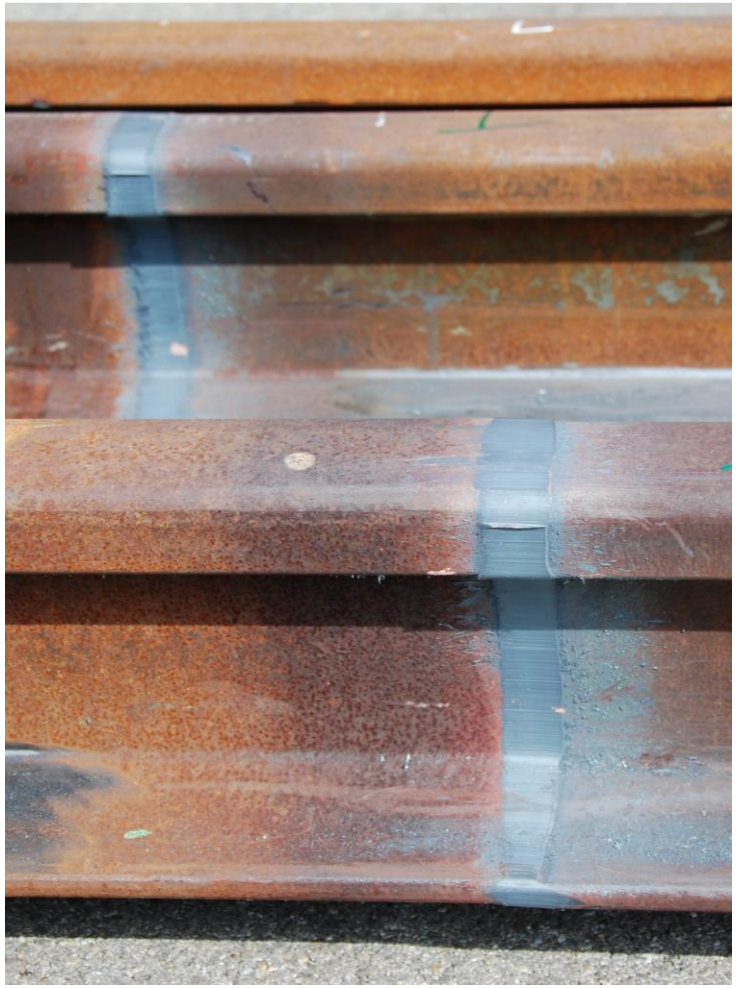
Welding technologies:

- Thermite welding, Flash butt welding, Gas Pressure Welding

Goal: long lasting rail connection that has similar / same material properties as the rail material

- Prevention of premature damage on welds
- Ideally: joint not “felt / seen” by passing train

Highest welding quality: Flash Butt Welding



Profiles

Manage rail/wheel contact

Improved steering (curves) and stability (tangent)

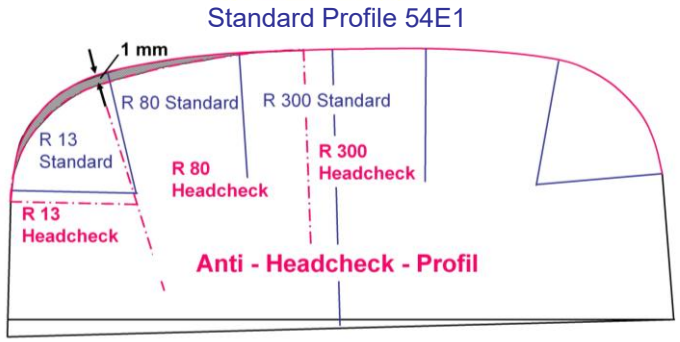
Reduced contact stresses

- Avoid 2-point contact or small contact patch
- Move contact to/from specific areas (e.g. AHC profile)

Delay rail degradation/damage

Different target profile strategies dependent on geographic location

- Europe: 1-2 target profiles per railway
- North America / Australia: multiple target profiles per railway dependent on tangent/curve



Track Quality

Extensive area – lower concern for slab track

Vertical and horizontal rail stability

High track quality

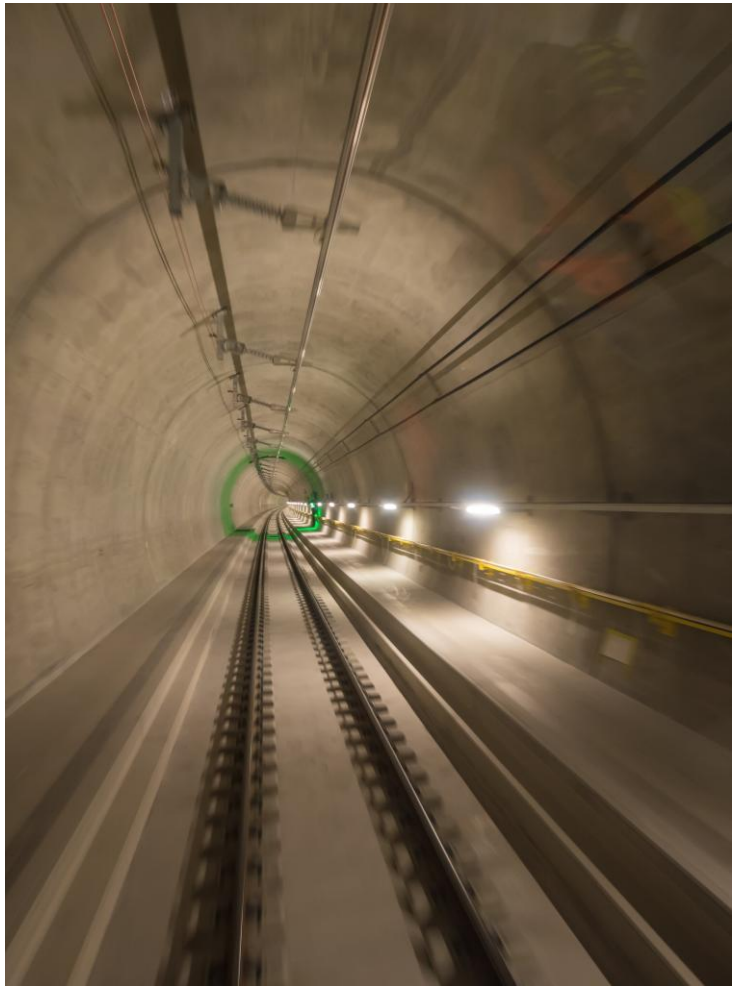
- Smooth vehicle running behavior und low dynamic forces (from track)

Low dynamic forces

- Delay in rail damage formation

Damage free rail

- Less dynamic forces (from rail) and reduced track degradation / damage



Friction Management

Optimal friction level

Adjusting friction at the right location to the correct level

- Avoid high friction – high contact stresses – high wear and damage
- Avoid low friction – safety (traction) issues and damage

Mitigate high friction

- TOR friction control and GF lubrication
- On-board and wayside solutions

Mitigate low friction

- Traction enhancer and rail cleaning

Rail Profiling / Rail Maintenance

Damage Removal

The only measure to remove existing damage

- Restoration / adaption of rail profile (longitudinal and transversal)
- Removal of surface damage
- Defined surface condition

Different maintenance strategies

- Preventive
- Corrective
- Regenerative

Maintenance Technologies

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Key Characteristics

Rail Grinding

Abrasive (dry) process with rotating grinding stones

Face grinding technology: Rotational axis perpendicular to rail surface

Rail Milling

Non – abrasive, dry cutting process with rotating cutter heads (carbides)

Peripheral milling: Rotational axis parallel to rail surface

Photo by Glucke, Wikipedia, CC BY-SA 3.0

Grinding and Milling

Comparability and Specific Properties

Resultant product looks similar, but details differ

Specific capabilities and properties for each technology

Example surface finish grinding

Example surface finish milling

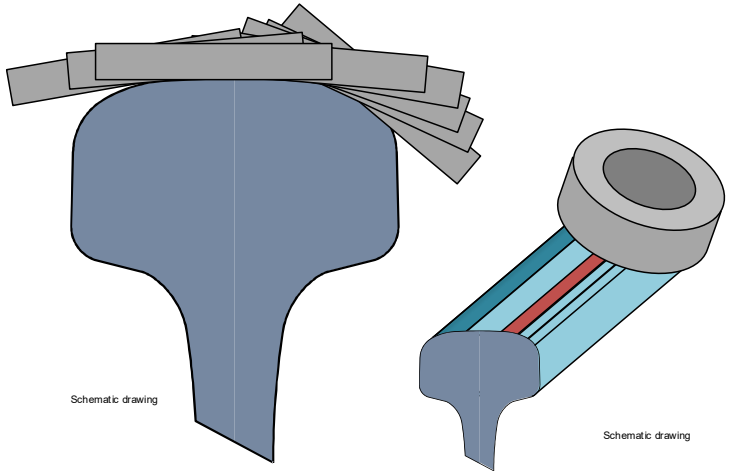
Grinding and Milling

Transversal Profile

Flexible profile adjustment through angular stone alignment

Flexible transition between profiles

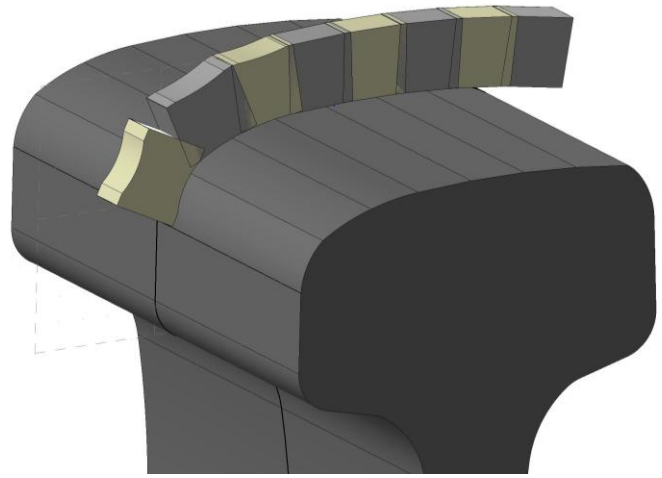
Accuracy +/- 0.3mm or less accurate



Profile defined by negative shape of cutter head (milling tool) with carbide inserts

Each individual profile requires own cutter head(s)

Accuracy +/- 0.1mm or less accurate



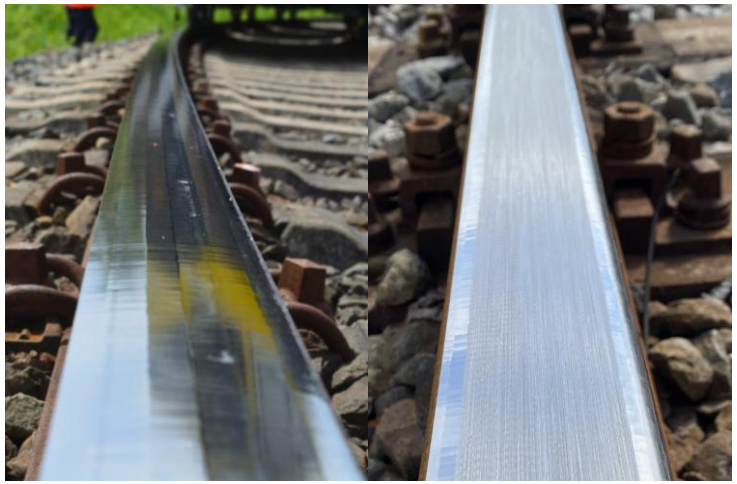
Grinding and Milling

Surface Condition

Transversal grinding marks (scratches) and resultant roughness

- Facets (stone traces)

Adjustable roughness (low to high).



Milling grooves require polishing (noise effect) – integrated in machine.

- Polishing: some kind of grinding process

Low surface roughness always achieved (longitudinal polishing structure)

Grinding and Milling: Productivity

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Speed per pass + metal removal + no. of required passes

Speed up to 32 km/h per pass (bi-directional)

- Average speeds between 5 km/h and 15 km/h per pass

Metal removal per pass between 0.1mm and 1.0mm (uniform profile)

- Dependent on machine size

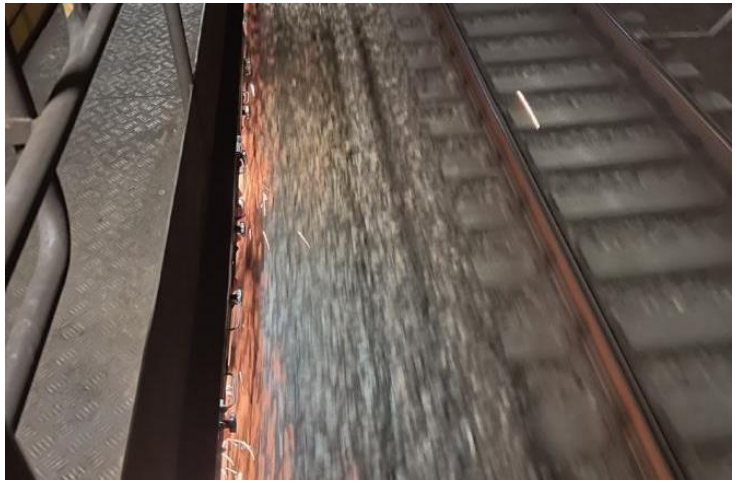
Speed up to 3 km/h per pass (directional)

- Average speeds between 0.4 km/h and 2 km/h per pass

Metal removal per pass between 0.3mm and 2mm (TOR) per milling tool

Grinding and Milling

Process By-Products



Omnidirectional spark streams

- Shielding to keep sparks mostly between rails
- Fire fighting equipment

Dust collection systems to minimize dust exposure

Milling process is spark and dust free

- Milling chips collected and recycled

Polishing process: limited, directional spark stream

- Housing/suction system to collect limited sparks and dust

Grinding and Milling

Additional Aspects

Process heat absorbed by rails, stones and sparks

- Can lead to material transformations (White Etching Layers – WELS)
- Also other sources of WEL / controversial topic

Wide variety of track conditions / qualities treatable

Process heat absorbed by milling tool and chips, no WEL

- Polishing process can result in limited, fragmented WELs

Certain level of track quality required

Technology Analysis

Grinding

Strengths

- Full profile flexibility and bi-directional process
- Low to medium metal removal per pass
- High productivity in initial and preventive scenarios (speed/pass)
- Established and integrated process
- Adjustable surface quality
- Low impact by rail and track condition

Limitations

- Dust development
  - Filter system
- Spark development
  - Shielding / fire prevention measures
- Heat input into the rail
  - Controllable by process parameters
- Reduced productivity in corrective scenarios

Technology Analysis

Milling

Strengths

- Low to high metal removal per pass
- Spark and dust free milling process
- By-product collection system
- High productivity in corrective / regenerative scenarios
- High surface quality (polishing)
- Clean and low noise operation

Limitations

- Reduced productivity in preventive scenarios (speed/pass)
- Low profile flexibility
  - Cutting tool change
- Unidirectional process
- Polishing: limited sparks and dust
  - Collection system required
- Cutting-insert lifetime
- Track condition sensitivity

Additional Technologies

Urban Application

ATMO – Automatic Track Machine Oscillator

Technology

- Block stones (oscillating-, slide-mode)

Preventive maintenance of TOR

- Keep rail surface in good condition
- Low metal removal
- No reprofiling

Corrugation removal (multiple passes)

Trailer to be towed with any rail-bound or hi-rail vehicle (up to 30 km/h)

Measurement Technology

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Without quantification no effective management possible

Transversal Profile

- Metal removal determination

Longitudinal Profile

Surface crack condition

Ultrasound testing for internal defects

Surface video for damage / feature detection

GNSS location tagging

Data analysis

Generation of measurement protocol

Photo by trackopedia

Data Handling

Smart decisions with smart data

Requirements

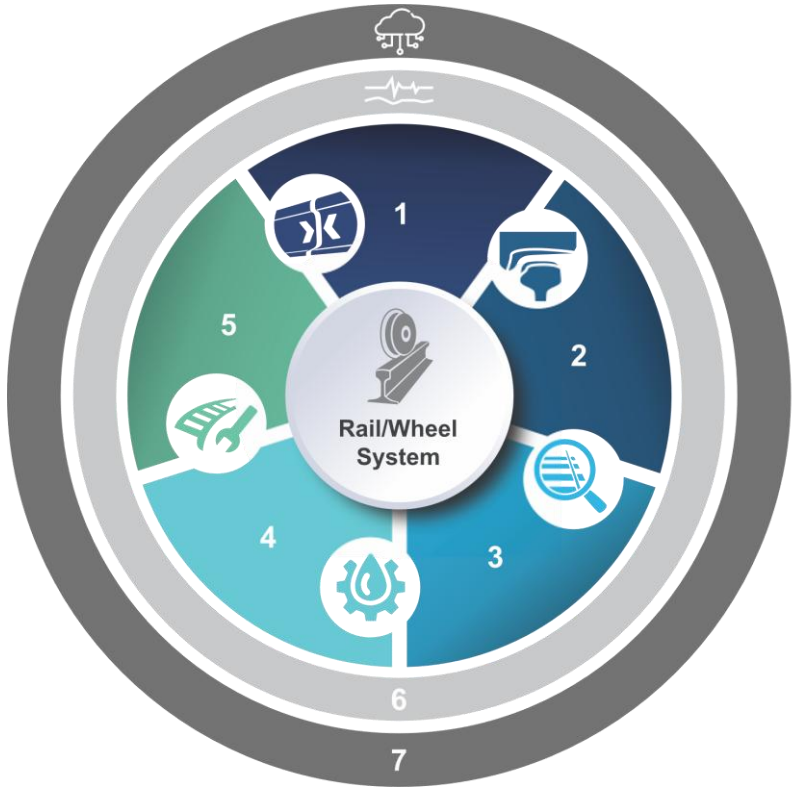
- Import data from various data sources
- Check / ensure integrity, link and process data
- Data synchronisation across machines and devices
- Data and machine cyber security

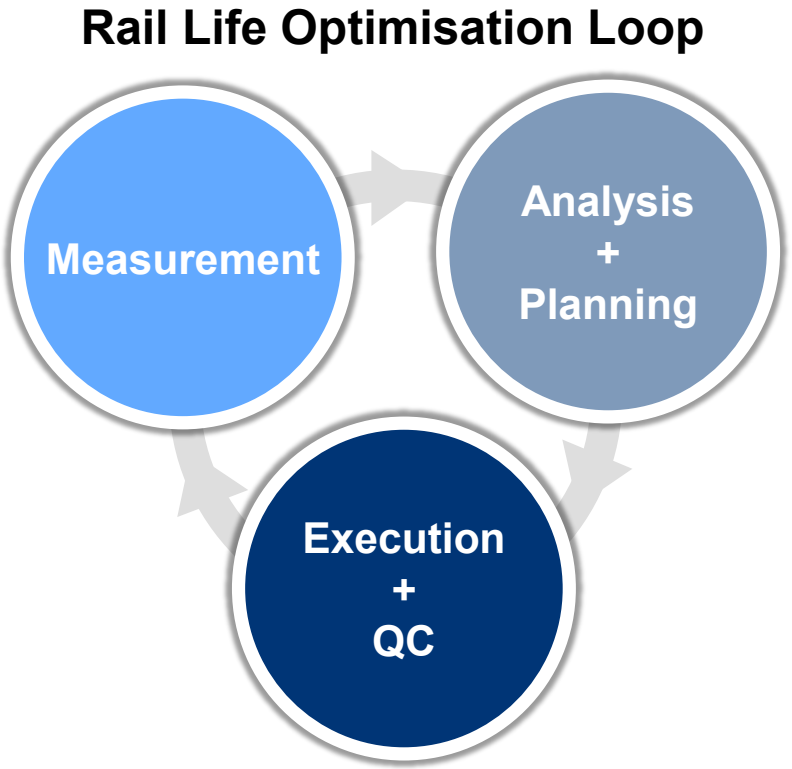
Data visualisation and reports

Data transfer to treatment machine(s) for work execution

Rail Management

From individual tools to an integrated process





Small Scale Process

Automated spot repair - ROBOT

Automated local defect repair for rail and switch frog maintenance

“Box in box” system placed on standard flat wagon

Hybrid power supply: Battery pack and diesel generator

Integration of whole process:

- Scan + analysis – mill – preheat – deposit weld – grind – QC scan + documentation

Safe workplace – no person on track

From the Past to the Present

Rail Management on a large scale

Visual Inspection

Some Measurement Technology

- Hand tools or vehicle-bound

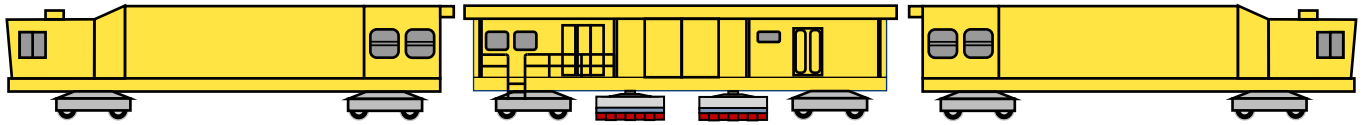
Some individual measurement reports

Cyclic maintenance strategy based on experience

Workforce experience

Decision to maintain

Grinding Train Work Program



Experience of crew

On-site subjective adjustment

A shiny rail surface

No or limited QC

Rail condition?

From the Present to the Future

Data Sync | Data Sync | Data Sync

Regular rail condition assessment

Data analytics, decision making and work preparation

Live assessment

Live adaption of work execution

QC Measurement

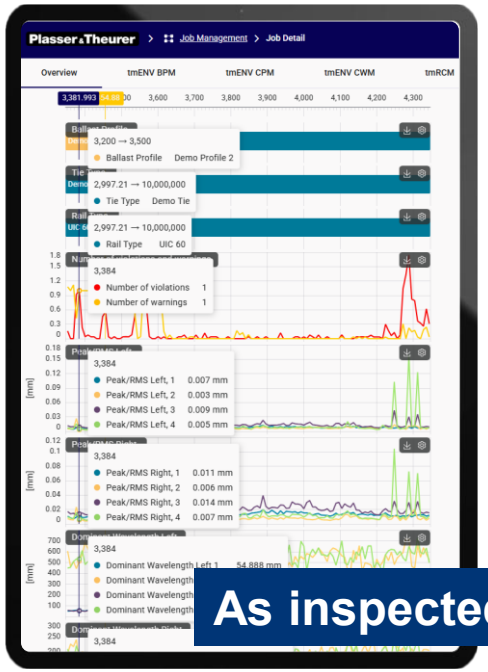
Transparent Documentation

Defined rail condition

Rail-bound

High-rail

Trolley



As inspected

Grinding

Milling

ATMO

As maintained

Summary

Rail Management Solutions (slab track and beyond)

Toolbox for rail life extension

Measurement Technology:

- Rail condition assessment

Rail Maintenance Technology:

- Restore rail condition
- Grinding, Milling, ATMO, ROBOT

Data Handling throughout the whole process

Integrated Rail Management Process for maximum rail-life benefit

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Thank You for Your Attention!