

Rail Milling Solutions to Improve Network Performance at Irish Rail

Richard Stock, LINMAG Rail Services
Contributions by Tom Ruane, Irish Rail



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Overview

- Irish Rail – initial condition
- Milling technology
- Application of milling
- Benefits of milling
- Outlook and summary



Irish Rail – Key Data

- Operator of national railway network in Ireland
 - Connecting all major cities
- Gauge: 1600 mm (5ft 3in)
- 2733 km of track (1700 mi)
 - 53 km (33 mi) electrified - DART
- 362 km (225mi) of dedicated freight lines
- 2016: 42.8 Mio passengers



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Initial Condition

- By 2012 premature rail replacement rates had drastically increased
- Due to 1600mm gauge no access to existing rail maintenance technology
- Only options so far: arc weld repair or rail replacement



Damage Situation

- System wide eddy current and ultrasonic survey:
 - extensive RCF damage throughout the network
- Rail with a potential future life of 20 years had to be scraped for safety reasons (rail defects)
- Urgent action required



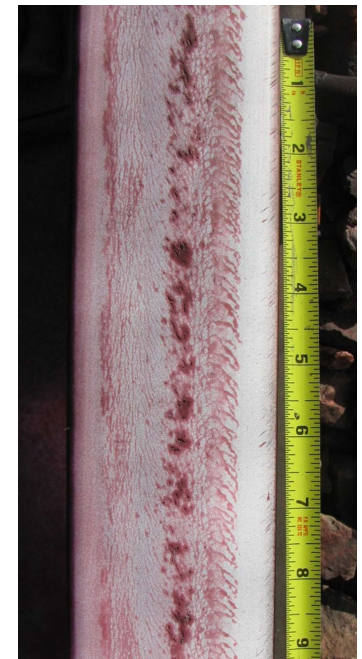
Results of Damage Survey

- Damage survey: most of cracks 5mm (0.2in) or less in depth.
- Result of wheel-rail contact and train operations
 - RCF
 - Wear
 - Wheel Burns



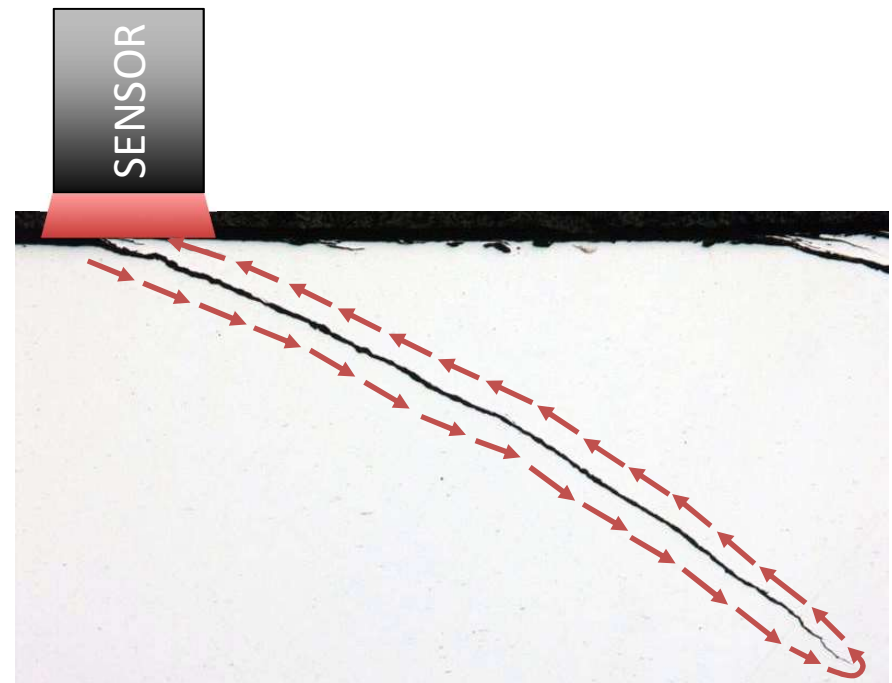
Gauge Corner Cracking (GCC)

- Head Checks: periodic cracks at the gauge corner (gauge corner cracking - GCC)
- Periodic cracks and crack networks also on the running surface
- Can cause detail fracture if not treated



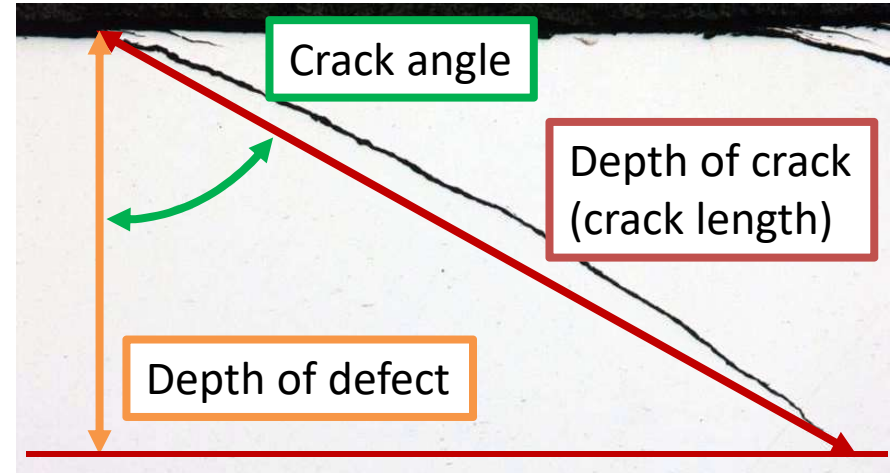
Principles of Eddy Current

- Sensor projects alternating electro-magnetic (EM) field to rail surface
- Alternating EM field induces in stray-current on rail surface
- Crack: stray current needs to bypass the crack



Eddy Current Measurements

- Eddy current measures length of crack (depth of crack)
- Defect depth:
 - Assumed crack angle
 - Degree of uncertainty and error



Spalling and Flaking

- Surface cracks (GCC) can combine causing material to break out of the rail surface.
- Defect named shelling by Irish Rail
 - Spalling or Flaking in NA



Corrugation

- Wave structure on the rail surface (tangent / curve)
- Short wave (25mm-80mm wavelength) or long wave (100-300mm) corrugation
- Multiple sub-classifications
- Combination of wear and plastic deformation
- Damage of other track components possible



Squats / Squat Type Defect

- Widening of running band / dip
- Typical kidney shaped
- Surface and subsurface crack(s)
- Classic Squat:
 - 100 MGT, strongly deformed material
- Squat type defect:
 - 10 MGT, no material deformation
- Singular or massed occurrence
 - Large scale surface break-outs



Other Defects



Example pictures



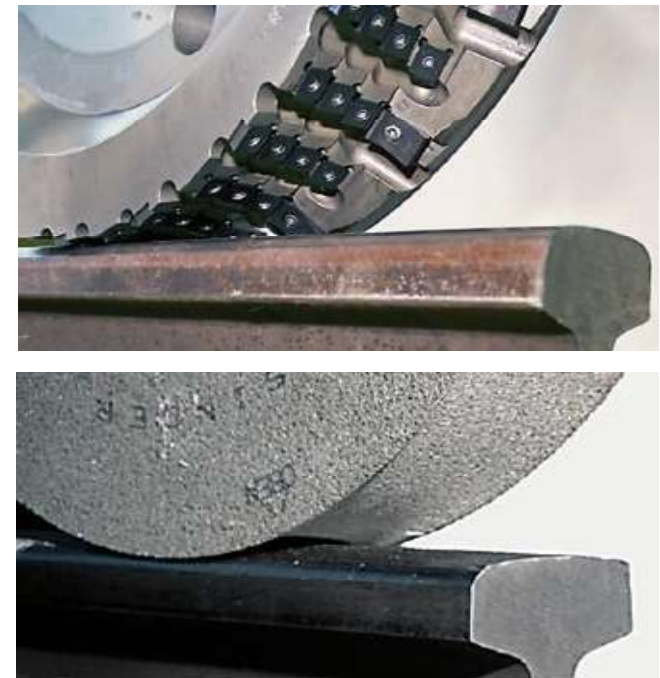
Decision Process

- Irish rail explored various options of rail treatment systems and possibilities
- Nature of damage situation:
 - Corrective with subsequent preventive/cyclic needs
- Rail milling was chosen as the most suitable process
- European tendering process
 - Award of 7 year contract to LINMAG



LINSINGER Milling Technology

- Rotational cutting process
- Generation of metal chips
 - Stored for later recycling
- Surface finish with offset grinding wheel
 - Polishing surface
 - Completely enclosed



Milling Technology

- Spark and dust free
- Metal removal per pass:
 - As low as 0.1-0.3 mm (0.004 – 0.01 in)
 - As high as 5 mm (0.2in)
- Processing speed up to 2 kph / 1.24 mph (dependent on machine size).



Milling Technology

- Highest profile precision
 - Longitudinal and transversal
- No damaging heat input into the rail material
 - No blueing or material transformation (Martensite, WEL) of rail surface
 - Process heat taken by chips and milling wheel



Milling Truck SF02W-FS “Erin”

- High Rail Truck – 80 km/h (50 mi/h) on roads, 35 km/h (21 mi/h) on rail
- Metal removal: 1mm (0.04in) on top of rail per pass (up to 5mm / 0.2 in at GC/GF)
- Processing speed (average) between 400-450 m/h (0.25 – 0.28 mi/h) of finished track
- Mainline track as well as switches & crossings



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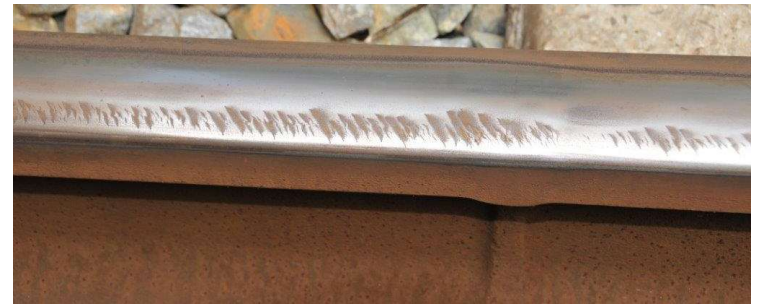
Milling Strategy

- Rail restoration
 - 100% defect removal
 - Longitudinal and transversal profile correction
- Dipped/high track joints, (Thermit/Flash Butt)
- Initial milling of new rails
- Preventive cyclical maintenance
- Anti noise / gauge widening / S&C



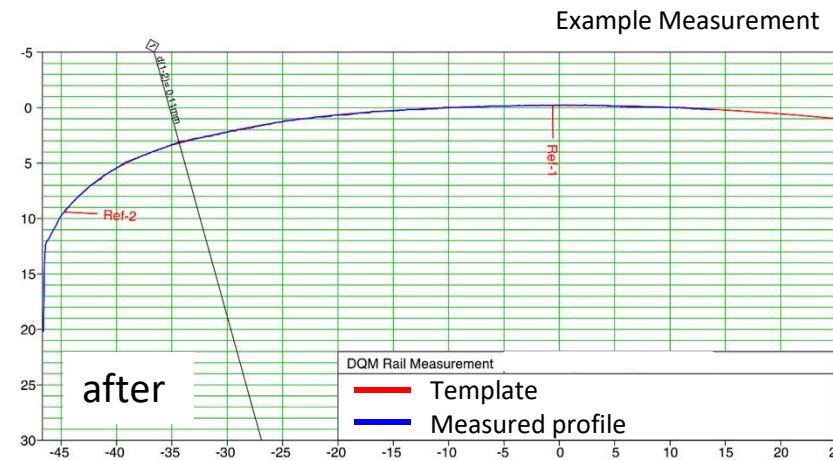
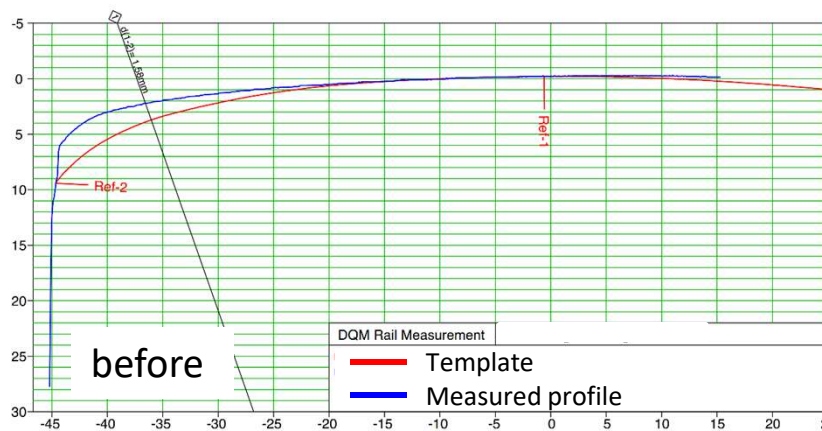
Rail Restoration

- Complete damage removal
- Restored rail profile
- Smooth and noise optimised surface finish
 - R_a typically below $5\mu\text{m}$



Transversal Profile

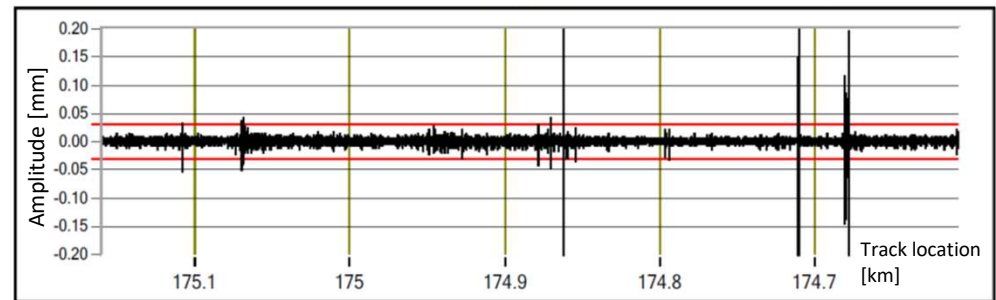
- Measurements before and after milling
- 100% transversal profile restoration (according to template) after 1 pass



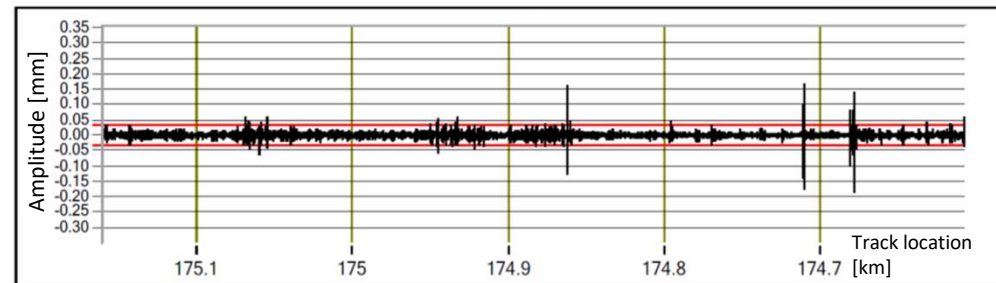
Longitudinal Profile

- Complete corrugation removal and restoration of longitudinal profile
- Spec. allows max. 5% of peak-peak values outside of bandwidth
- Results below 1% are easily achievable with milling
 - Perfectly smooth longitudinal profile

After Milling: Filter: 30 – 100 mm, Tolerance crossing: 0.30%



After Milling: Filter: 100 – 300 mm, Tolerance crossing: 0.95%



Example Measurements



Joints / Welds

- Correction of dipped or high joints and welds
 - Flash Butt / Thermite



Dipped Welds

Original rail surface with dipped weld area



After first pass: only partial / poor milling contact at dipped area



Second pass over weld: completely treated



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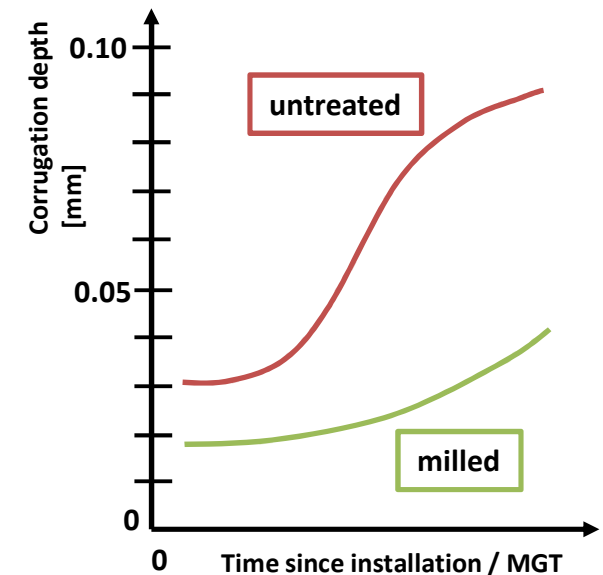


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Initial Milling of New Rails

- New rails to be cleared from defects such as:
 - Mill-scale and decarburized layer
 - Irregular welds
 - Non conforming rail profiles/inclination
- Delayed onset of corrugation
- Delayed need for tamping



Corrugation growth on mainline track, schematic drawing



Typical Shift

- Possession times 0045 – 0500 (4hrs 15mins)
 - Allow other vehicle to clear possession 20 minutes
 - Travel to start point (25-30 km/h) 30 minutes
 - Obstacles:
 - Breather Switch (expansion joint) 10 minutes
 - Level crossing 10 minutes
 - Travel back to stabling point 30 minutes
- 1 hr 40 mins**
- Available cutting time 2hrs 35mins
 - Machine Output = 425 meters/hours
 - **Total achievable output = 1,098 meters of restored rail**



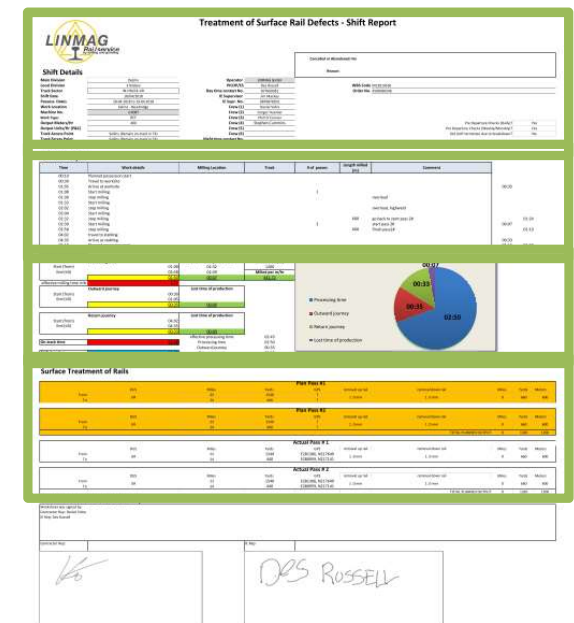
Shift Plan vs. Real Life

- Inputs from the Divisions, TRV, Ultrasonics, Eddy Current
- Through Clara Platform:
 - Defect depth \approx 3mm (0.12 in): 3 milling passes planned
 - After second pass (2mm / 0.08in) all cracks removed
- After Clara Platform:
 - Defect depth $<$ 2mm: 2 passes planned
 - Dipped weld (not identified during planing)
 - Poor milling contact after 2 passes
 - Third pass to full treat the weld



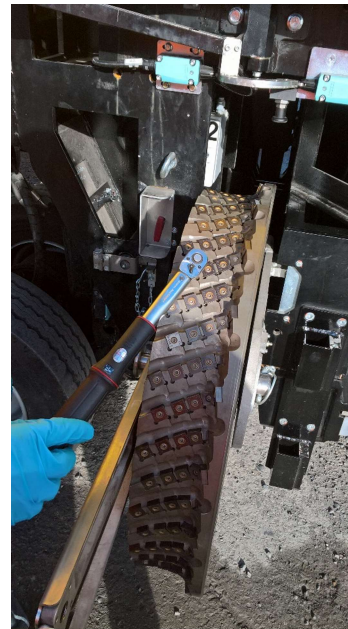
Detailed Shift Protocol

- After each shift a detailed protocol is provided to the customer
 - General info (crew, date, location etc.)
 - Detailed time stamped info: start / stop of milling, no of passes, occurrences, comments
 - Summary info: travel time, milling time, lost time, finished track length, processing rate, shift time, on-track time, etc...
 - Plan vs. actual shift comparison
- Electronic measurement protocols
 - Truck equipped with EC system (Sperry)



Milling Tool Maintenance

- If required the whole milling wheel will be changed during a shift
 - < 10min process
 - No tip changing during shift
- Off-shift: turning and changing of carbide tips



Daily Maintenance

- Maintenance and spare part container
 - Tools, metal tips, grinding wheels, general parts
- Turning / change of carbide tips during day shift
- Other machine maintenance
- Remote maintenance access by LINSINGER to solve problems



SF02W-FS Truck with spare part and maintenance container on route in Australia



Benefits of Rail Milling at Irish Rail

- Extended Rail Life
 - Rail replacement €150k per km vs. approx. €20-25k per km for milling
 - Milling can extend rail life up to 5-7 years
- Reduced rail breakages



Benefits of Rail Milling at Irish Rail

- Defect free rail head
 - Surface defects in close proximity to each other
 - Ultrasonic signal loss prevention
- Reduced track structure degradation
 - Less track maintenance/tamping
- Reduced impact forces and flanging improving fuel economy



Benefits of Rail Milling at Irish Rail

- Reduced CO₂ emissions by reduced rail exchange
 - 1.5 kg CO₂ per kg of new rail
- Reduced damage to rolling stock
- Less noise and vibration
- Increase passenger comfort
- Clean, low noise and spark free process



Milling machine working under single line possession



Outlook: S&C Treatment

- Planned for 2018
- All check rails can stay in place
- Complete switch processing in two treatment steps
- Continuous process without stops
 - Frog and points excluded



Example of switch treatment in Australia



Summary

- Rail milling to treat Irish Rail Network
 - 100% damage removal
 - Complete profile restoration
 - Cyclic preventative rail treatment
- Clear cost benefit by
 - Preventing premature rail exchange
 - Extension of rail life
 - Delay of other track and vehicle related maintenance activities



Thank you for your attention



Iarnród Éireann
Irish Rail

Tom Ruane
tom.ruane@irishrail.ie



Richard Stock
r.stock@linmag.com



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