



# Materials science research at ProRail: *How it contributes to track performance*

Bart Schotsman, M2i Conference, 2020

**ProRail**

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# Introduction



Bart Schotsman

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Steel grade and rail profile selection

Grinding and milling

Inspection

Research

Materials science research at ProRail: How it contributes to track performance

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- ProRail, infrastructure manager
- Research, applied and scientific
- Rail defects and inspection
- Fundamental study of contact fatigue of rails after grinding

# ProRail, infrastructure manager

## Our mission

We connect people, cities and companies, now and in the future. We make pleasant travel and sustainable transport possible.

ProRail Connects. Improves. Makes sustainable.





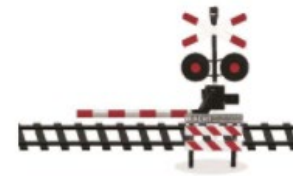
#### Spoorlengte (km)

2019: 7.097 | 2018: 7.114



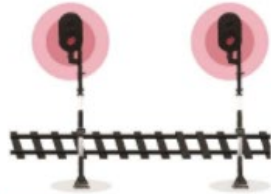
#### Wissels

2019: 6.560 | 2018: 6.795



#### Overwegen\*\*\*

2019: 2.477 | 2018: 2.519



#### Seinen

2019: 11.586 | 2018: 11.751



#### Stations

2019: 400 | 2018: 399



#### Tonkilometers (in miljarden)

2019: 57 | 2018: 55



#### Treinkilometers (in miljoenen)

2019: 165 | 2018: 164



#### Aantal spoorweg- ondernemingen

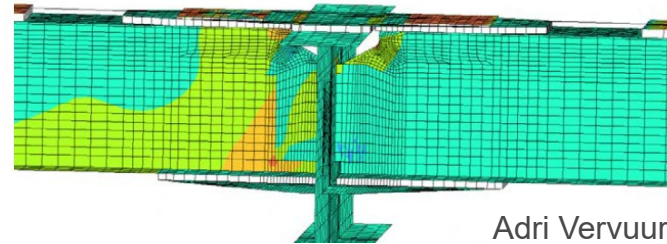
2019: 27 | 2018: 29

# Research, applied and scientific

- TU Delft
  - Railway Engineering
  - Materials science and engineering
- TUE / TNO
  - Structural reliability
- And more partners



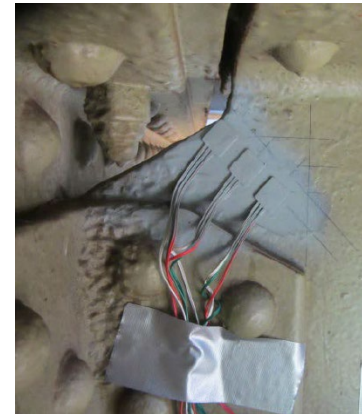
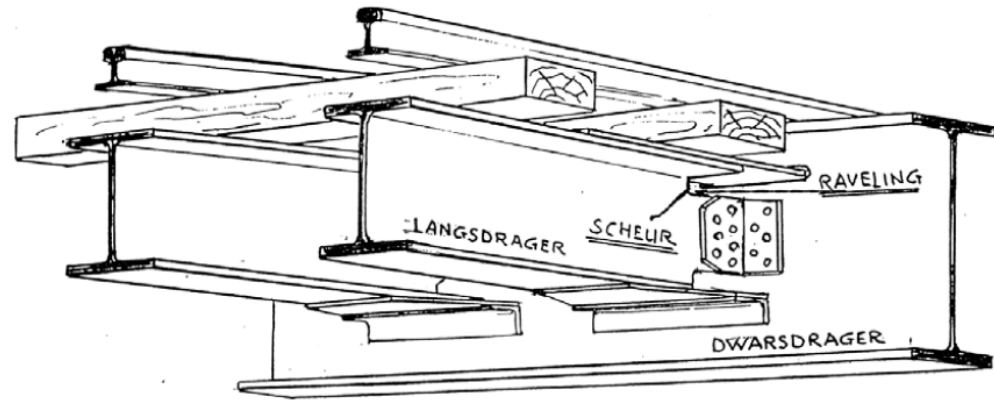
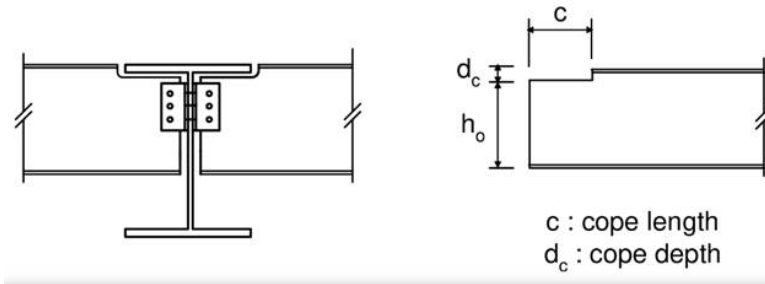
Speno RR64MS2, Bart Schotsman



Adri Vervuurt, TNO

# Applied research, TNO

- Determining the inspection interval of steel railway bridges
- Project objective: to determine the inspection interval of the coped beam.



Adri Vervuurt, TNO



# Scientific research, TUE.

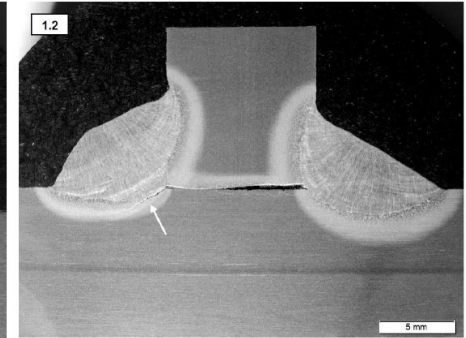
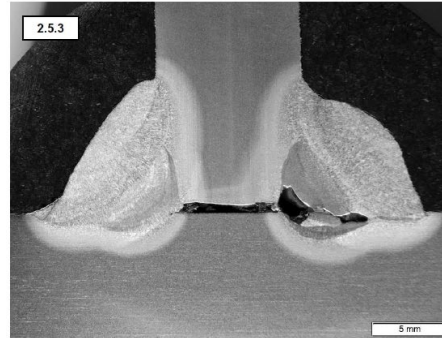
- Assessment method for the (remaining) fatigue life of steel bridges with weld imperfections
- The objective is to arrive at an accurate determination of the remaining life of weldments.



**TU/e** Technische Universiteit  
Eindhoven  
University of Technology

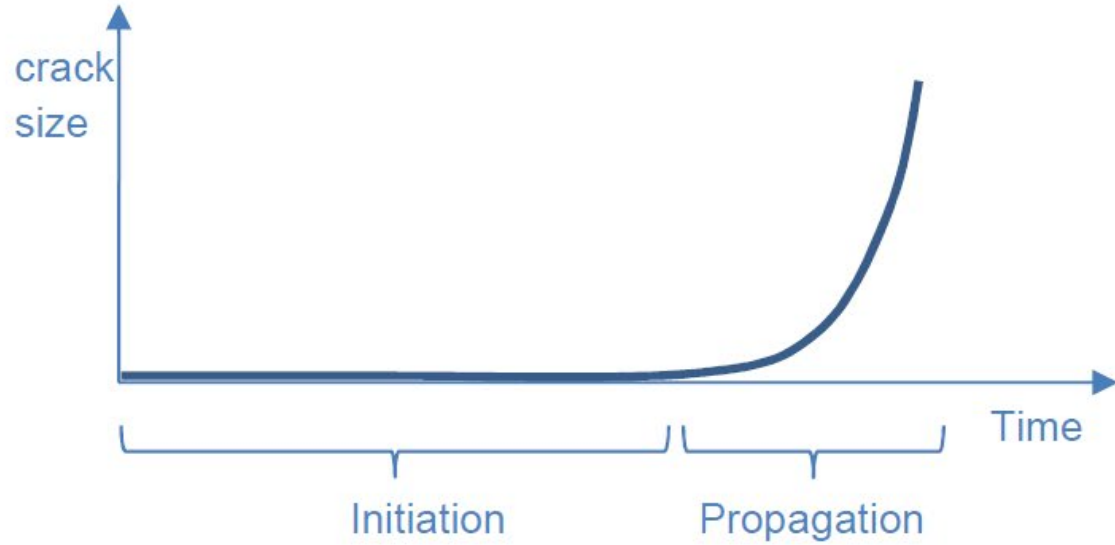
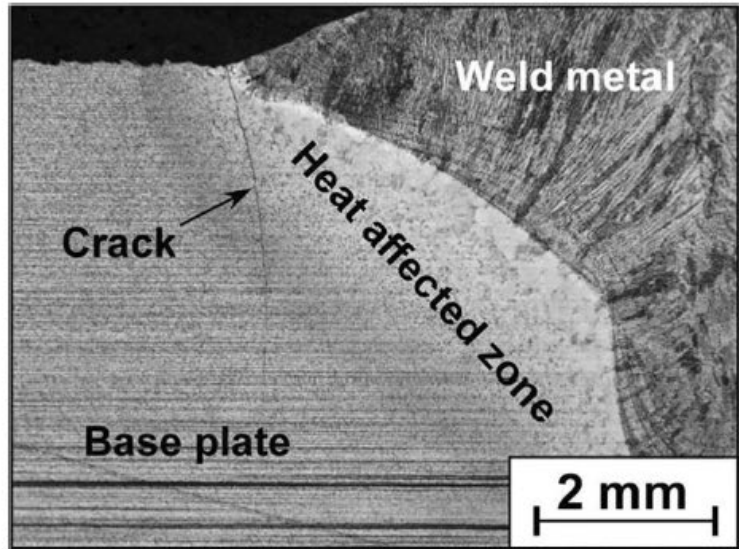
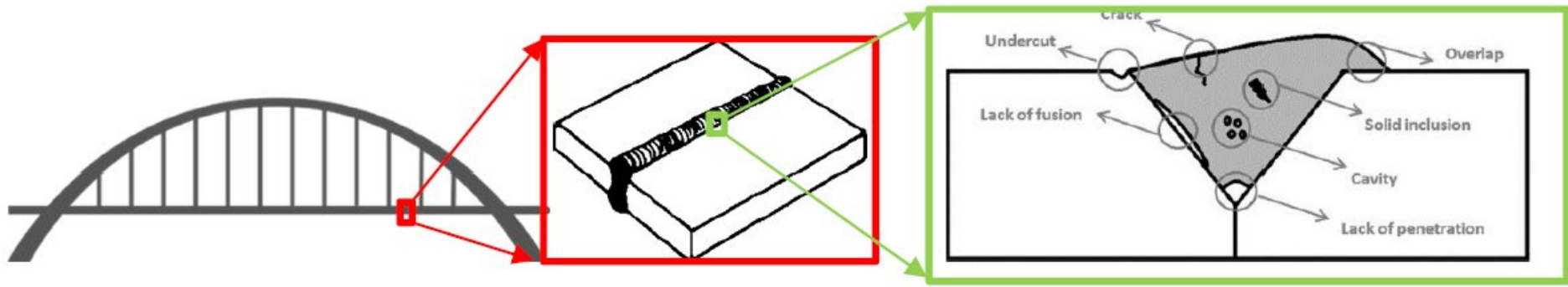
**ProRail**

**TNO** innovation  
for life



Hagestein bridge, Frank van Dooren

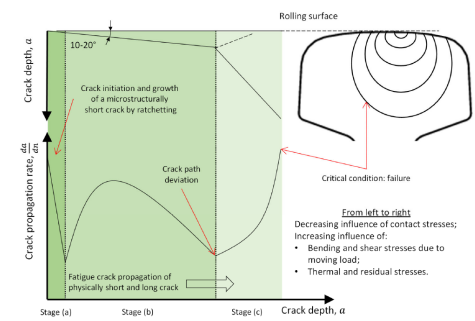




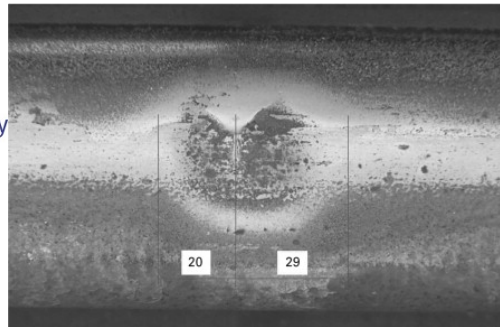
Fatigue in weldments (J. Maljaars)

# Scientific research, TUE.

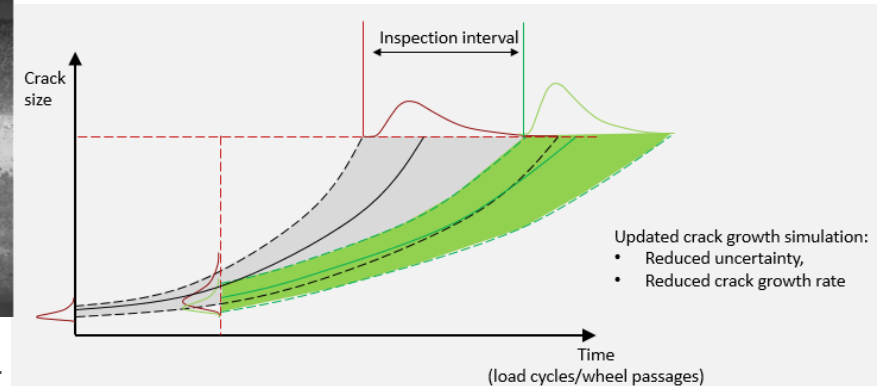
- Fatigue crack growth of squat defects in rails
- The objective is to develop a probabilistic fatigue crack growth model applicable to squat defects in rails.



Squat growth, Zerbst (2009)



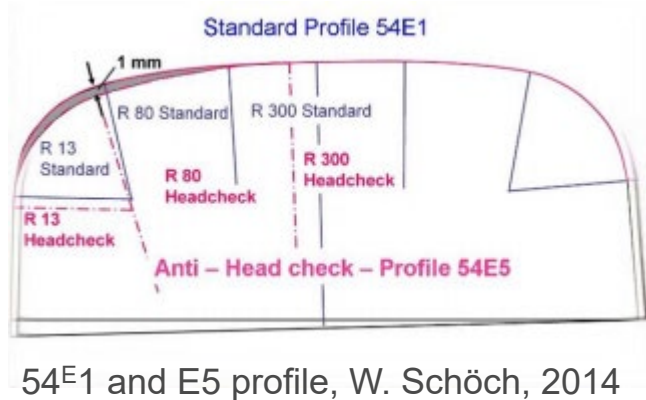
Li, Z. (2009). Squats on railway rails.



Determining inspection intervals after squat detection, D. Leonetti

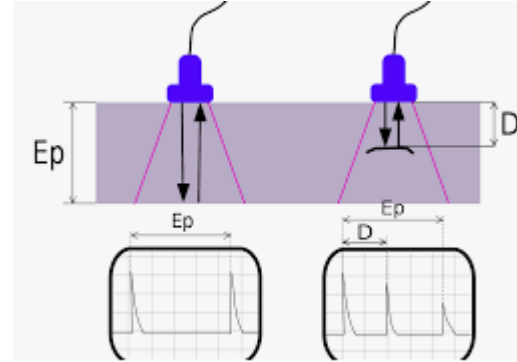
# Rail defects and inspection

- Gauge corner cracking



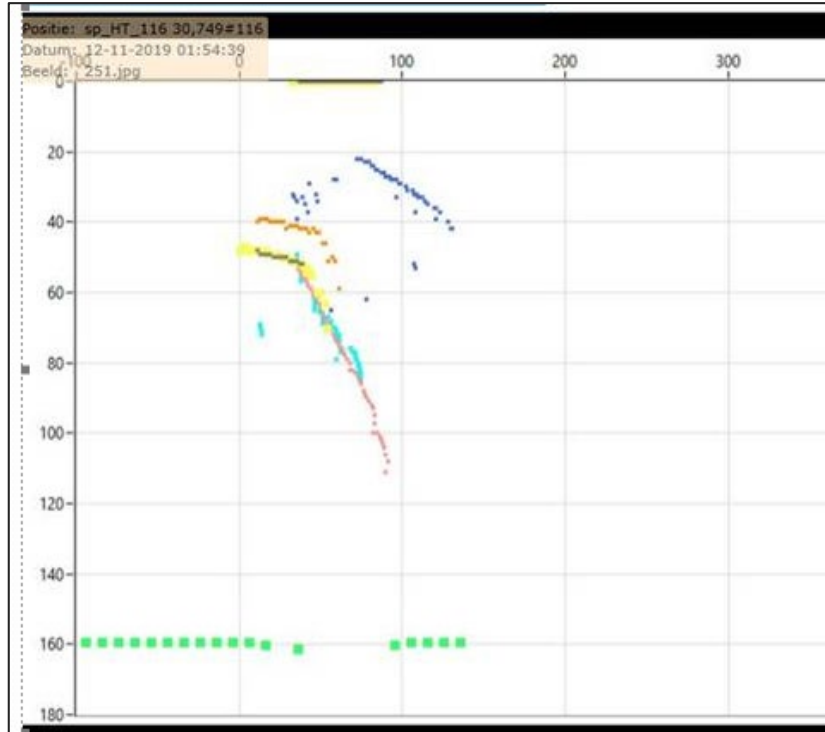
Gauge corner cracking, S. Grassie

# Rail defects and inspection





# Rail defects and inspection



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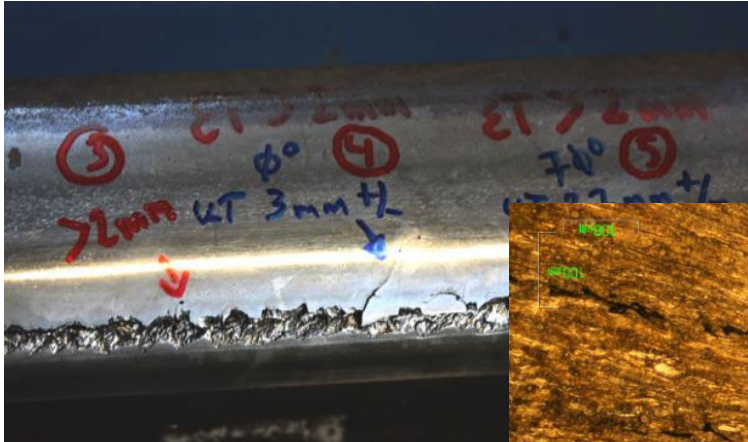
1. Not degraded, unaffected
2. Severely degraded, looks and smells burned



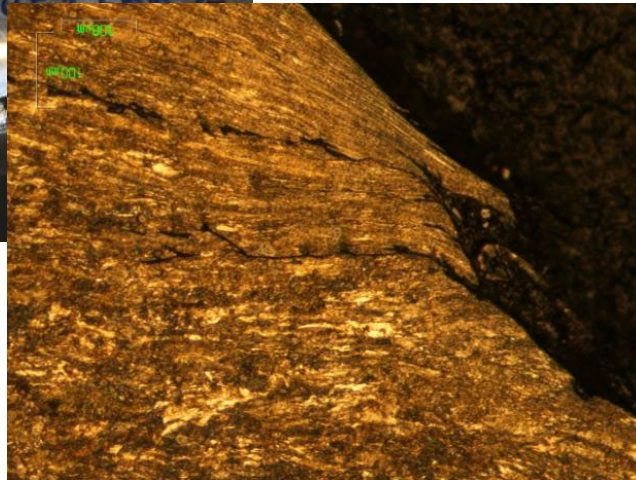
3. Damage by stray current



# Rail defects and inspection



Overlubrication, switch  
1133B, Breda, J. vd Stelt,  
2019



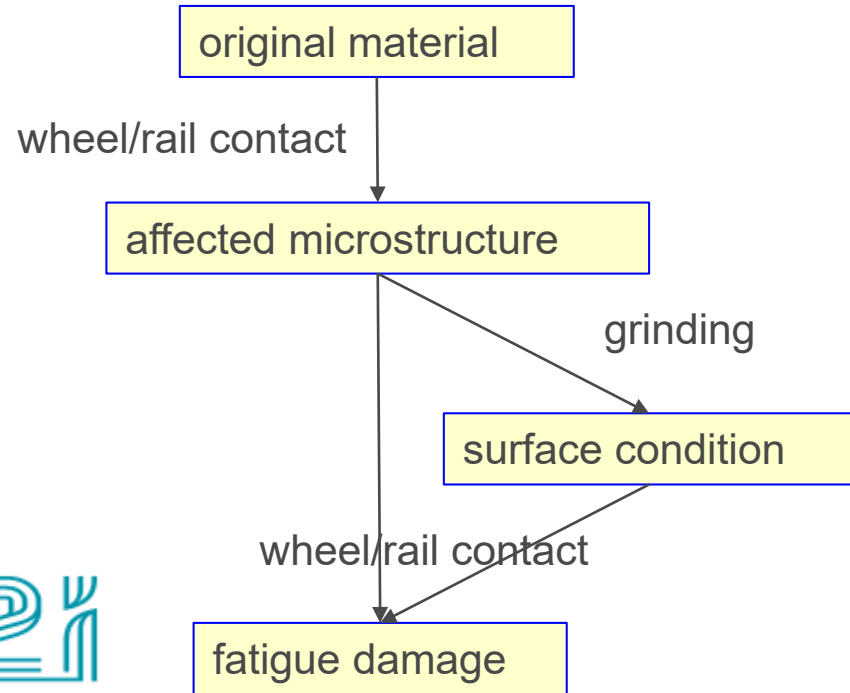
Pitting corrosion, Hemtunnel, J.vd  
Stelt, 2020

# Fundamental study of contact fatigue strength of rails after grinding

- Prof.dr.ir. Jilt Sietsma,
- prof.dr. Maria Santofimia,
- prof.dr.ir. Roumen Petrov,

Department of Materials Science and Engineering at the Delft University of Technology

The project objective is to understand the surface condition damage relation.

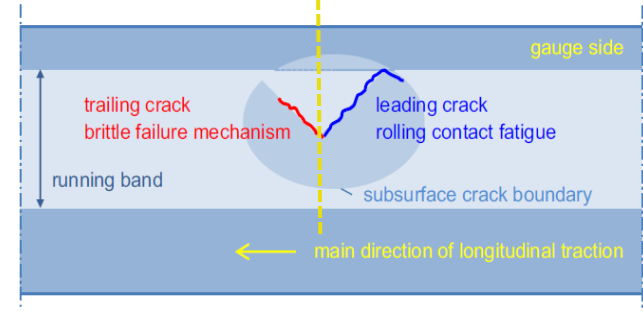
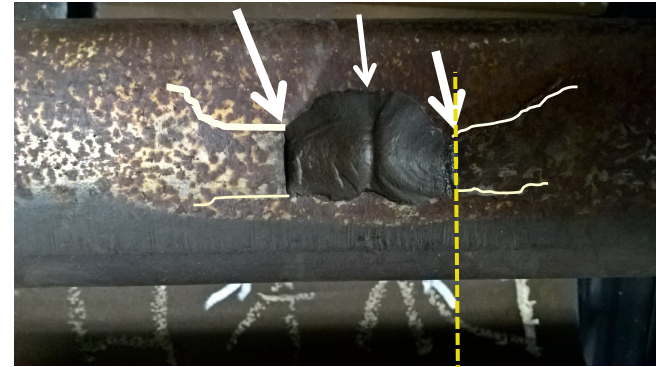




# Fundamental study of contact fatigue strength of rails after grinding



MHH rail, BE, km 5.2, Blauwkapel, 20151002



MHH rail. Training material VolkerRail field staff. Origination unknown.

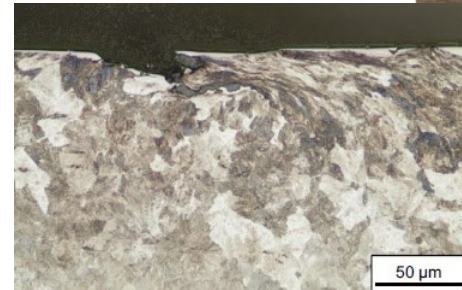
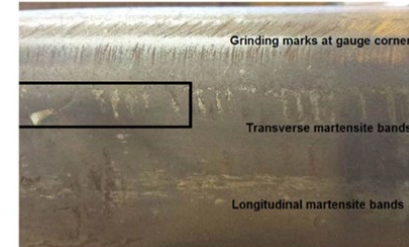
# Fundamental study of contact fatigue strength of rails after grinding

- New defects are associated with the high frequency and high powered rail grinding
- Empirical evidence but no full understanding of the mechanism of fatigue crack initiation after grinding; and
- Of the individual contribution of aspects of the surface condition: roughness, thermal stress, white layer



Typical spalling in MHH steel after grinding, (Dekra Rail, 2016)

Worn 350HT rail with transverse martensitic bands associated with grinding (Rasmussen, 2017)

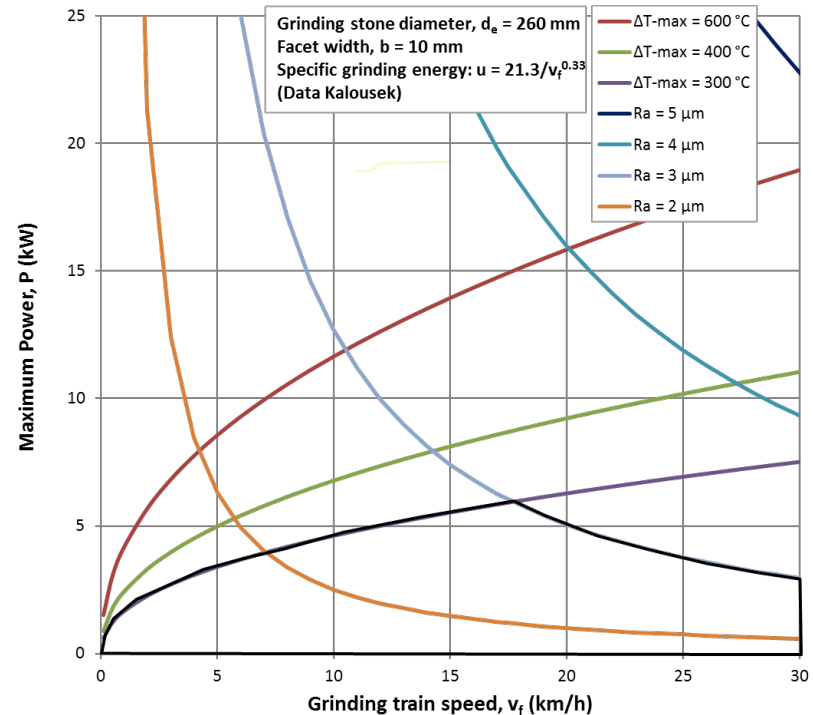


Defect initiation, several days after grinding. (Steenbergen, 2016)

# Fundamental study of contact fatigue strength of rails after grinding

Based on literature this model has been designed avoiding the detrimental aspects of grinding.

Temperature rise and surface roughness as a function of grinding power and feed speed (Slot, TNO, 2015)



# Fundamental study of contact fatigue strength of rails after grinding



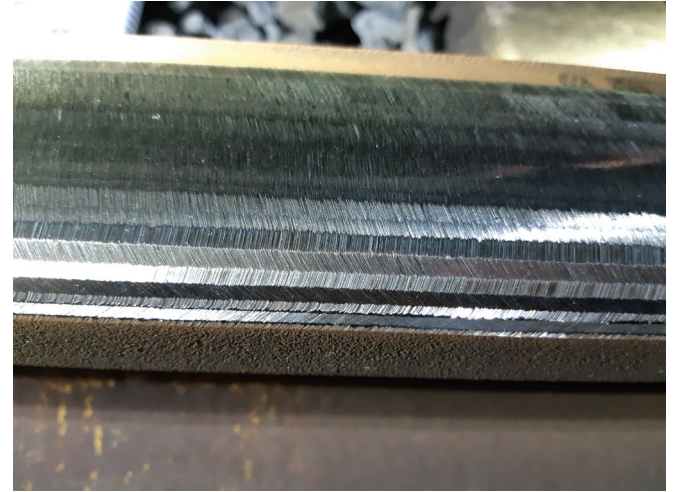
*Freshly ground rail surface of a British Steel R370CrHT rail. Surface roughness and ground facets are clearly visible [Schotsman2017].*

*Surface roughness*

*Waviness*

*Facet width*

*Martensitic phase at the surface*



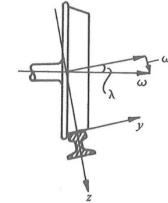
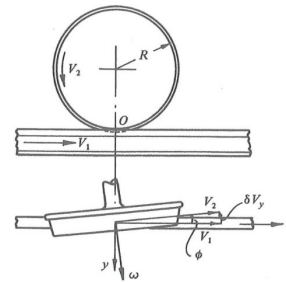
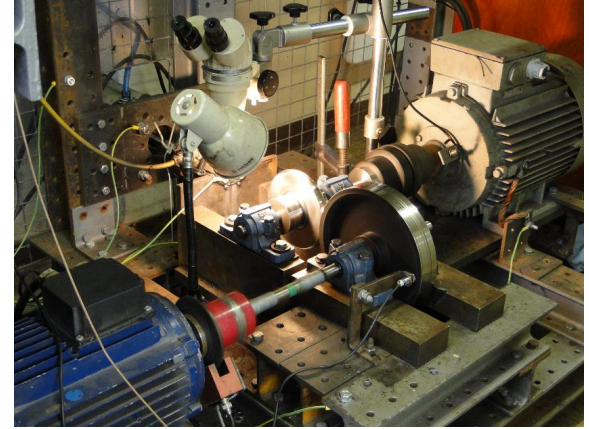
*Freshly ground rail surface of a R350HT rail. [Schotsman 2019].*

# Fundamental study of contact fatigue strength of rails after grinding

Next to these in-situ project small experiments are designed to study the evolution of the ground surface.

A two disc experiment on surfaces applied with technology having different specific energy.

To study running-in behavior of surfaces.

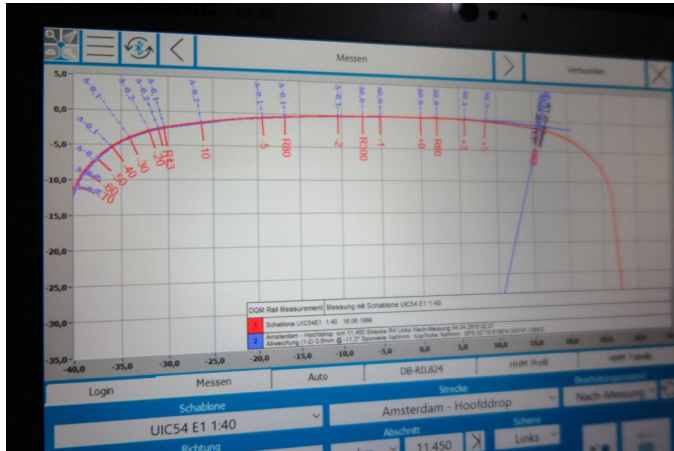


Sources of slip and spin in the wheel-rail contact (Johnson, K.L., 1985)



# Resume on Materials Science Research at ProRail

- It is part of daily operation
- New rail defects and rail breaks are examined
- Close cooperation in research becomes more and more the standard



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