

# **Acoustic Rail Grinding**

—

## **Definitions, Applications and Specifications**

**Dr. Wolfgang Schöch**  
**SPENO INTERNATIONAL SA**



# Contents

**Introduction – Railway & Noise**

**Wheel – Surface Conditions**

**Rail – Surface Conditions  
Irregularities / Corrugation**

**Grinding**

**Basics – Applications - Specifications**

**Noise Issues**

**Rail Surface Conditions**

**- Examples After Grinding**



# Introduction

- **Freight traffic only (heavy haul)**  
RCF / Wear / **Noise**
- **Mixed passenger and freight traffic**  
Wear / RCF / **Noise**
- **High-speed passenger traffic only**  
Equivalent conicity / RCF / **Noise**
- **Mixed High-speed passenger and freight traffic**  
Wear / RCF / **Noise** , Equivalent conicity
- **Passenger only**  
**Noise** / Wear / RCF



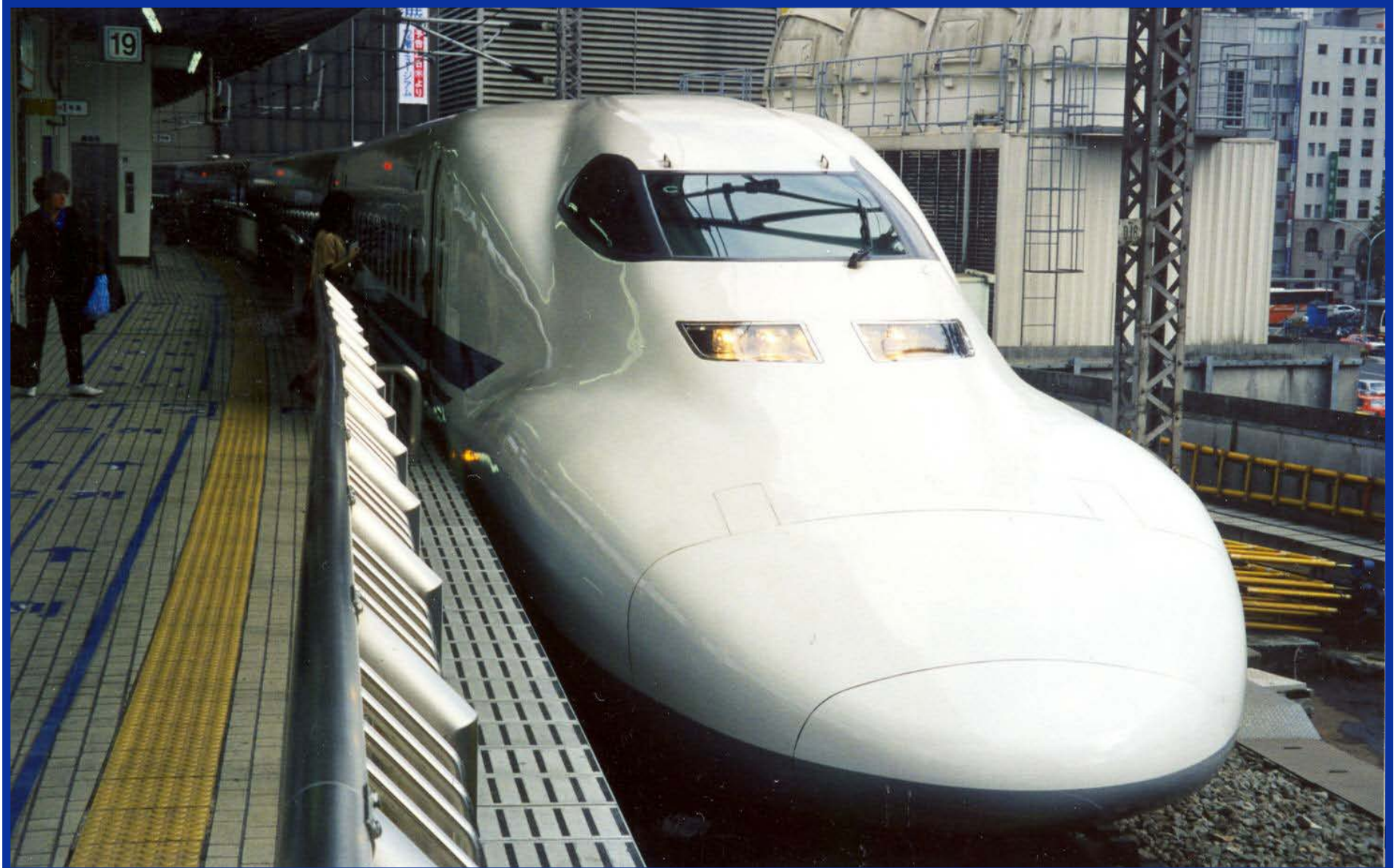


# Down Town





# High Speed

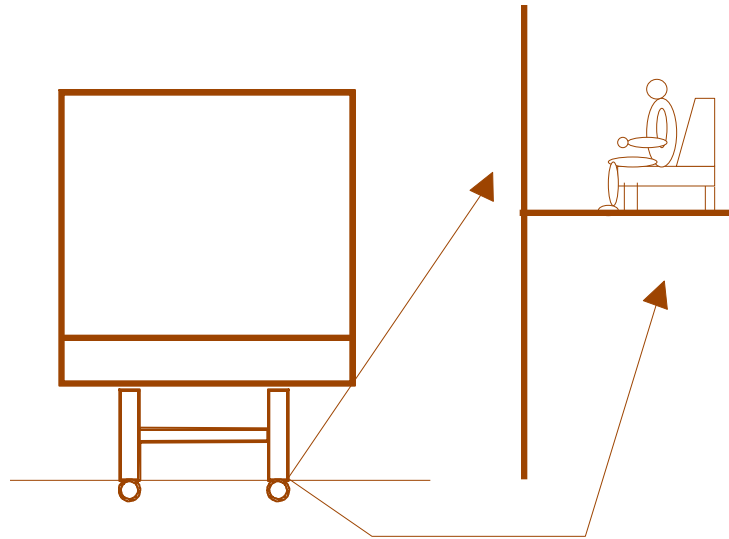




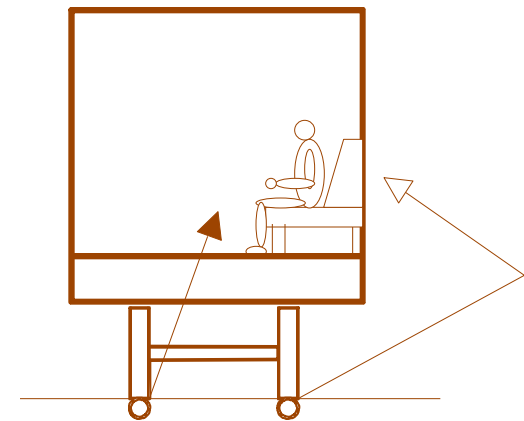
# Urban Systems



# Nuisance



**External: Environmental Conflict**



**Internal: Revenue Loss**



# *Factors affecting railway noise*

Wheel

Speed

Aerodynamic Noise

Engine Noise

Wagon, Bogie and Brake Noise

Roughness of the Wheels

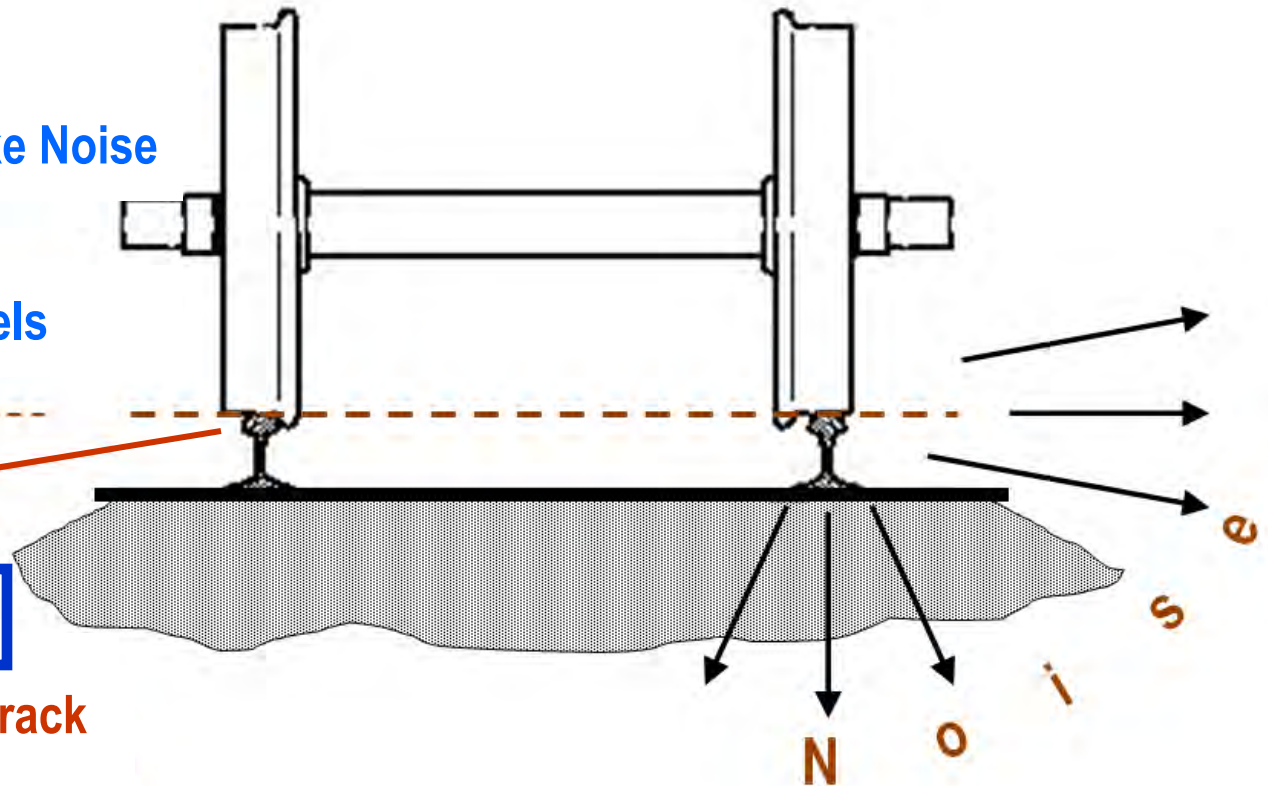
Contact

Rail

Roughness of the Rail

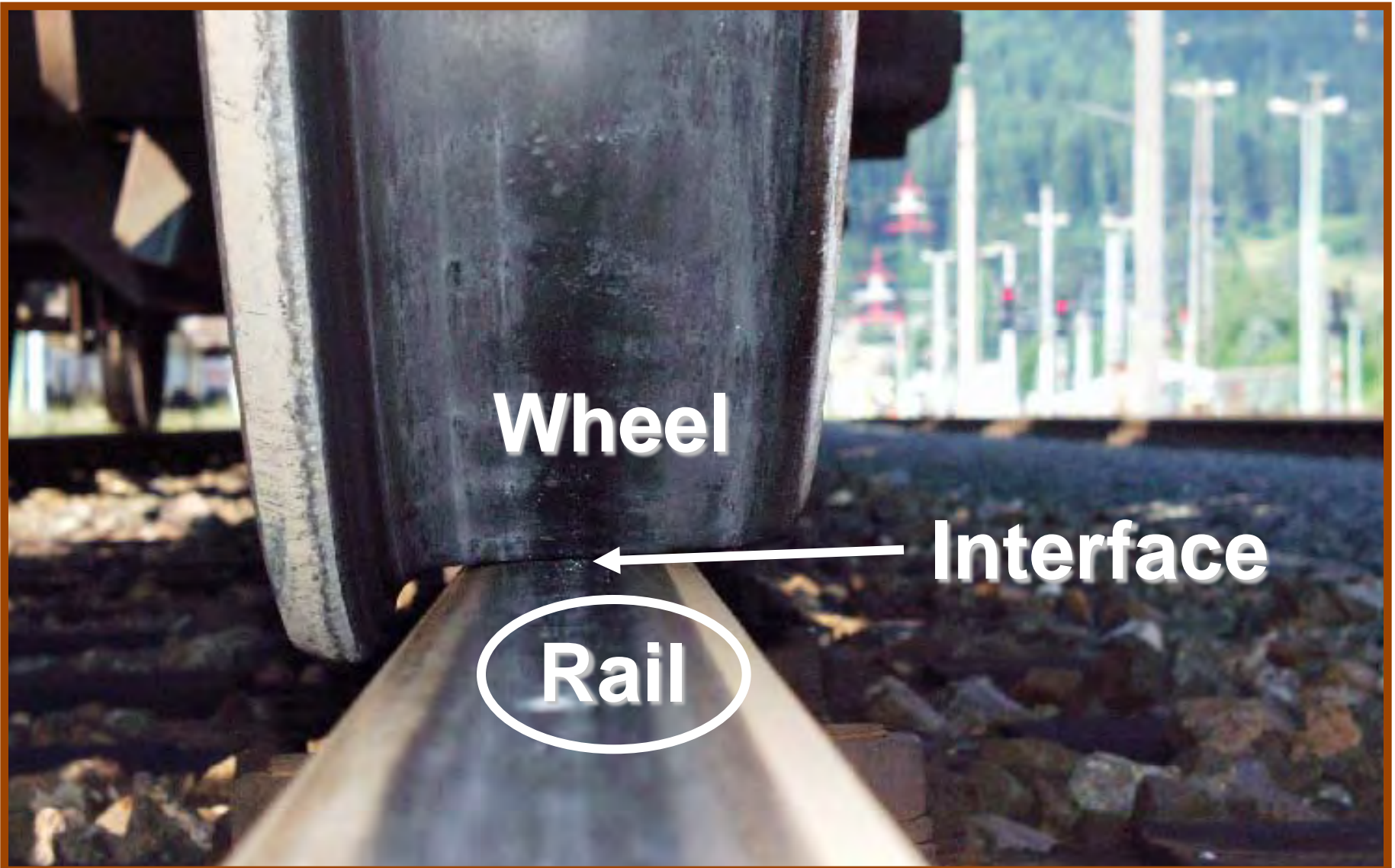
Characteristics of the Track

Nature of the Ground





# Wheel / Rail Interface



# Contents

Introduction – Railway & Noise

**Wheel** – **Surface Conditions**

Rail – Irregularities / Corrugation

Noise Recording

Grinding

Basics – Applications - Specifications

Rail Surface Conditions

- Examples After Grinding

Conclusion - Summary



# Profiled Wheel





# Worn Wheel





# Worn Wheel Surface Condition





# Wheel Flat

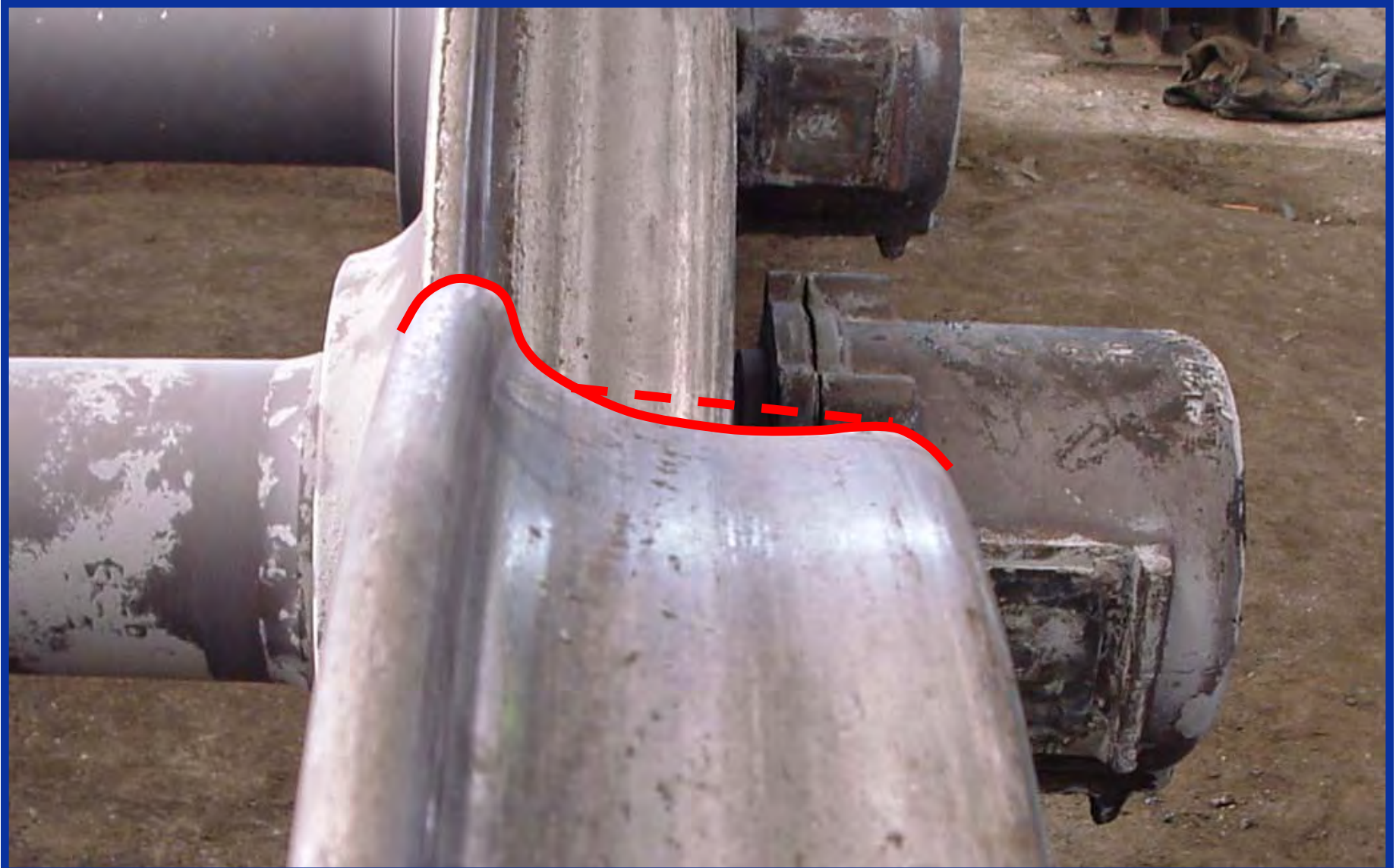




# Skid Marks



# Wheel Shape - Hollow Worn Wheel





# Wheel Rectification





# Contents

Introduction – Railway & Noise

Wheel – Surface Conditions

**Rail – Irregularities / Corrugation**

Noise Recording

Grinding

Basics – Applications - Specifications

Rail Surface Conditions

- Examples After Grinding

Conclusion - Summary



# Wheel burn



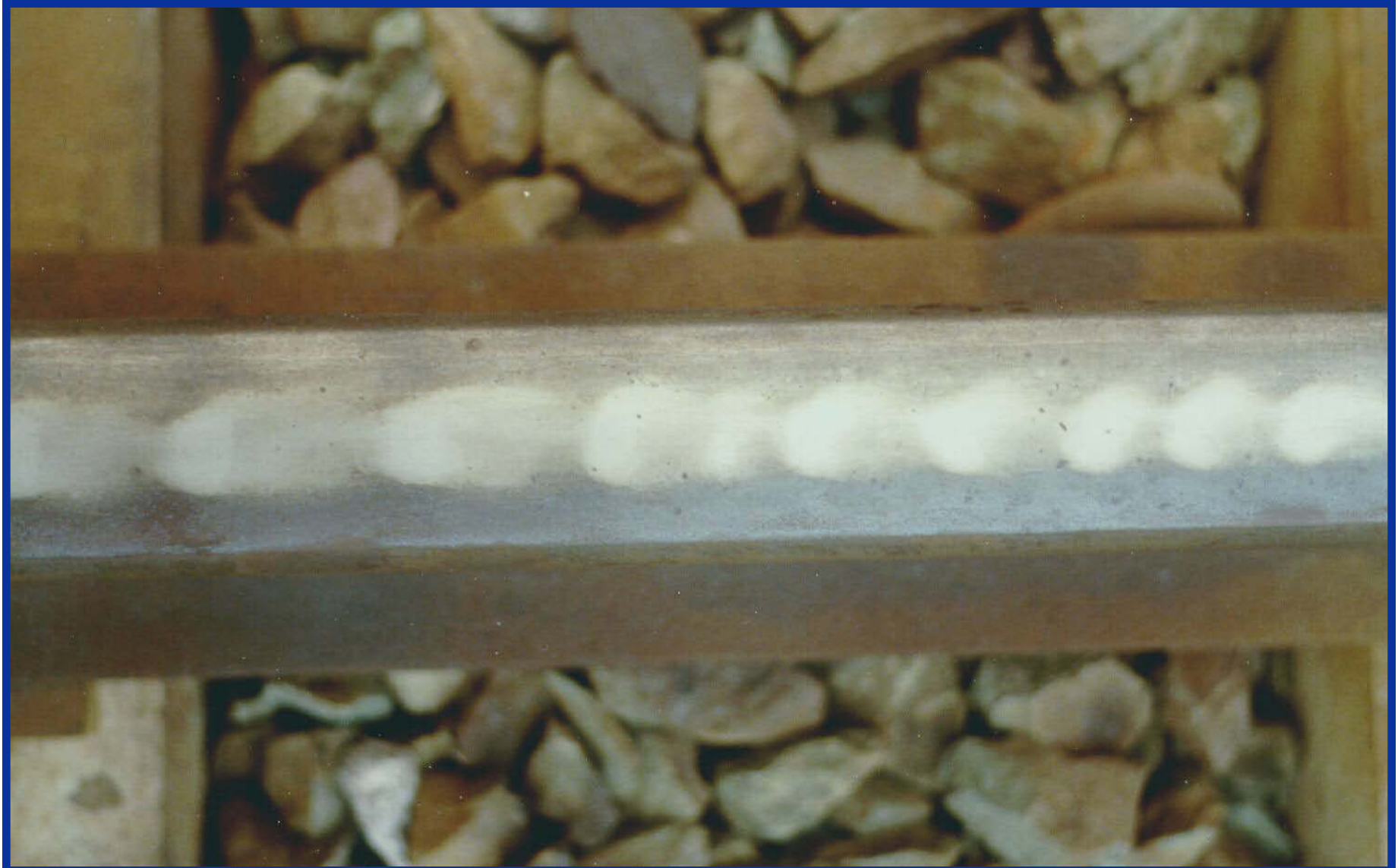


# Wheel burn (Detail)





# Short Pitch Corrugation (Tangent)





# New Rail - 1



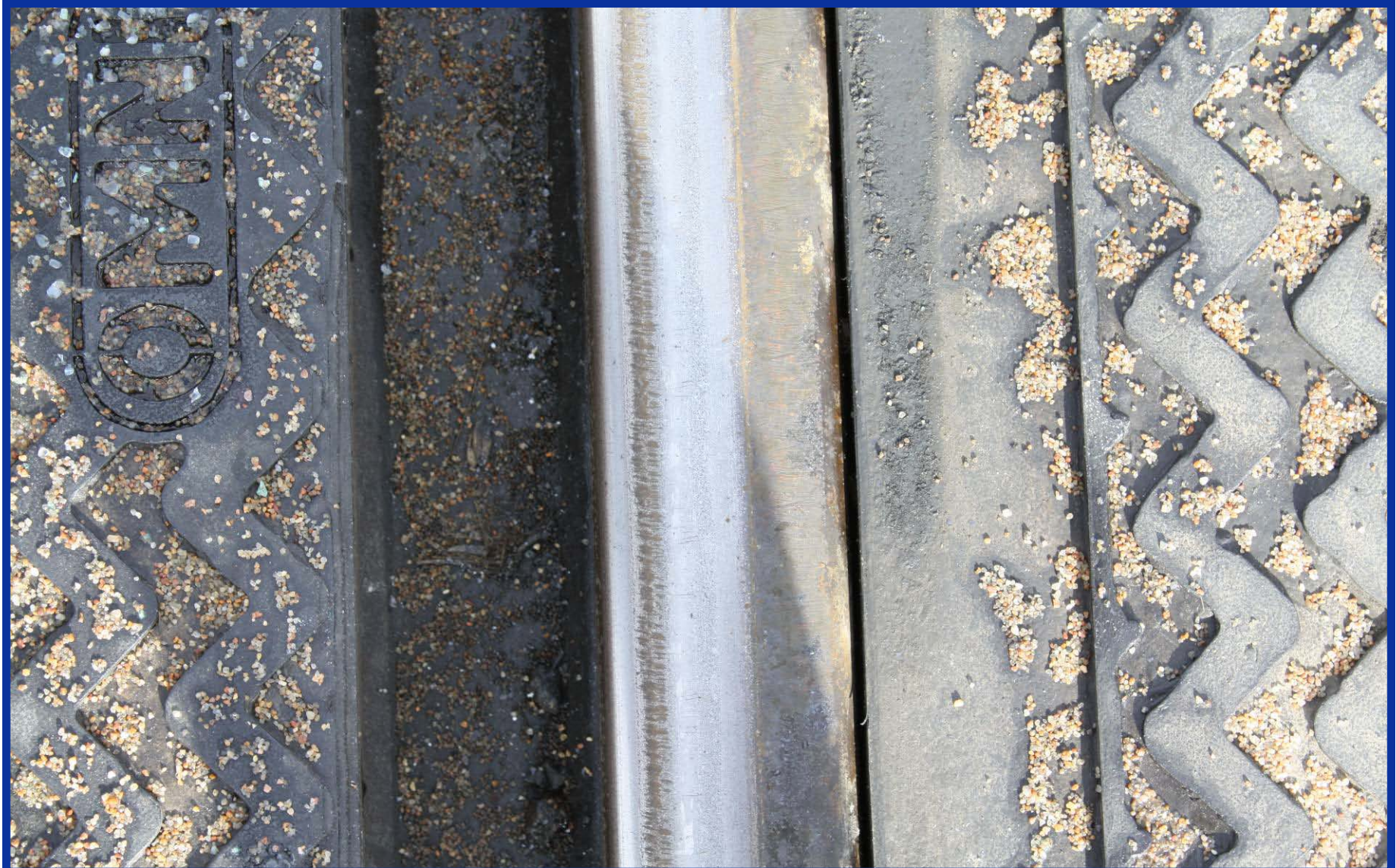


# “New Rail” - 2





# Ambient Conditions





# Short Wave Corrugation -1





# Short Wave Corrugation - 3





# Periodic Longitudinal Irregularities



# Longitudinal Irregularities - Detail





# Corrugation – Example 1



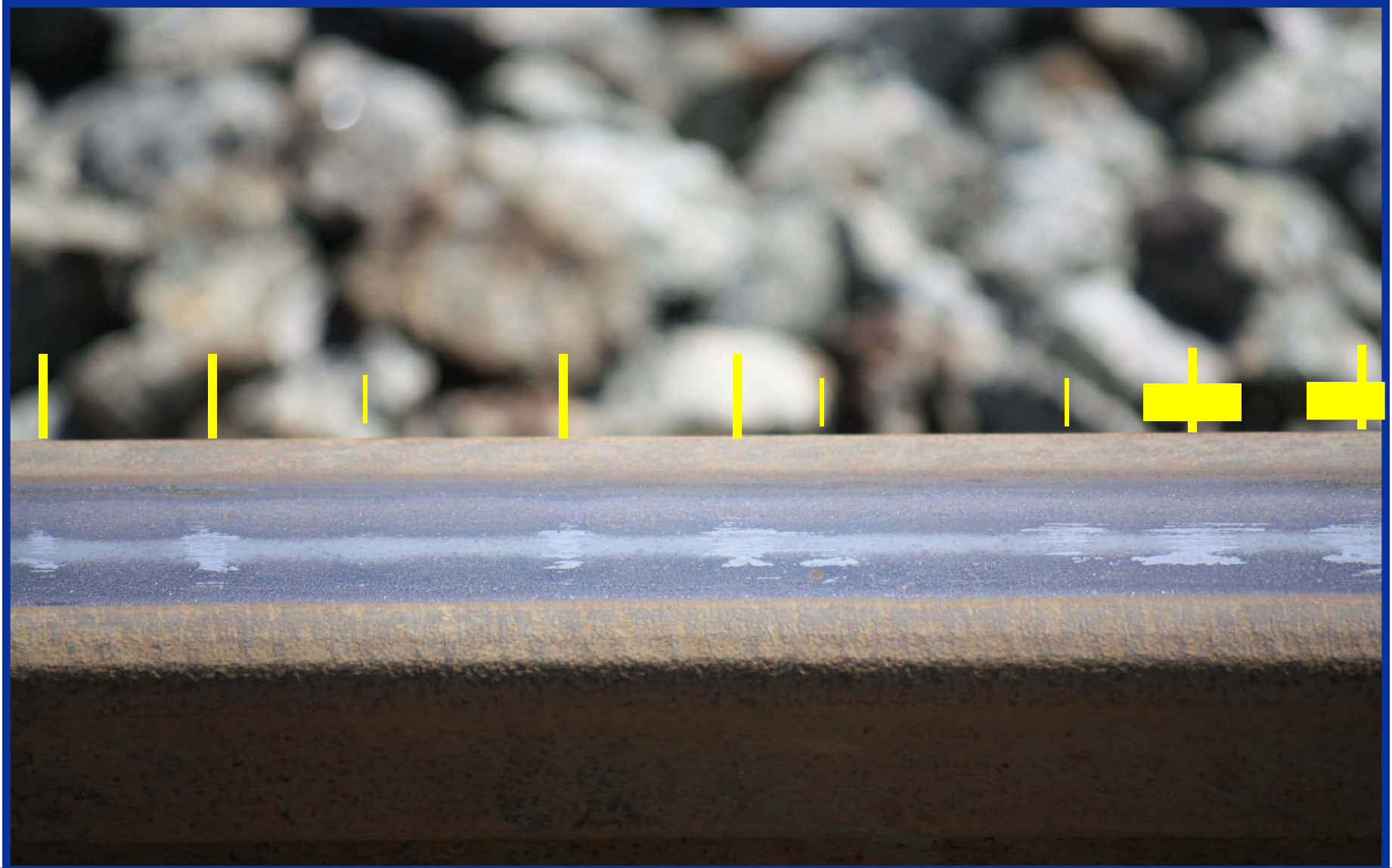


# Corrugation – Example 2

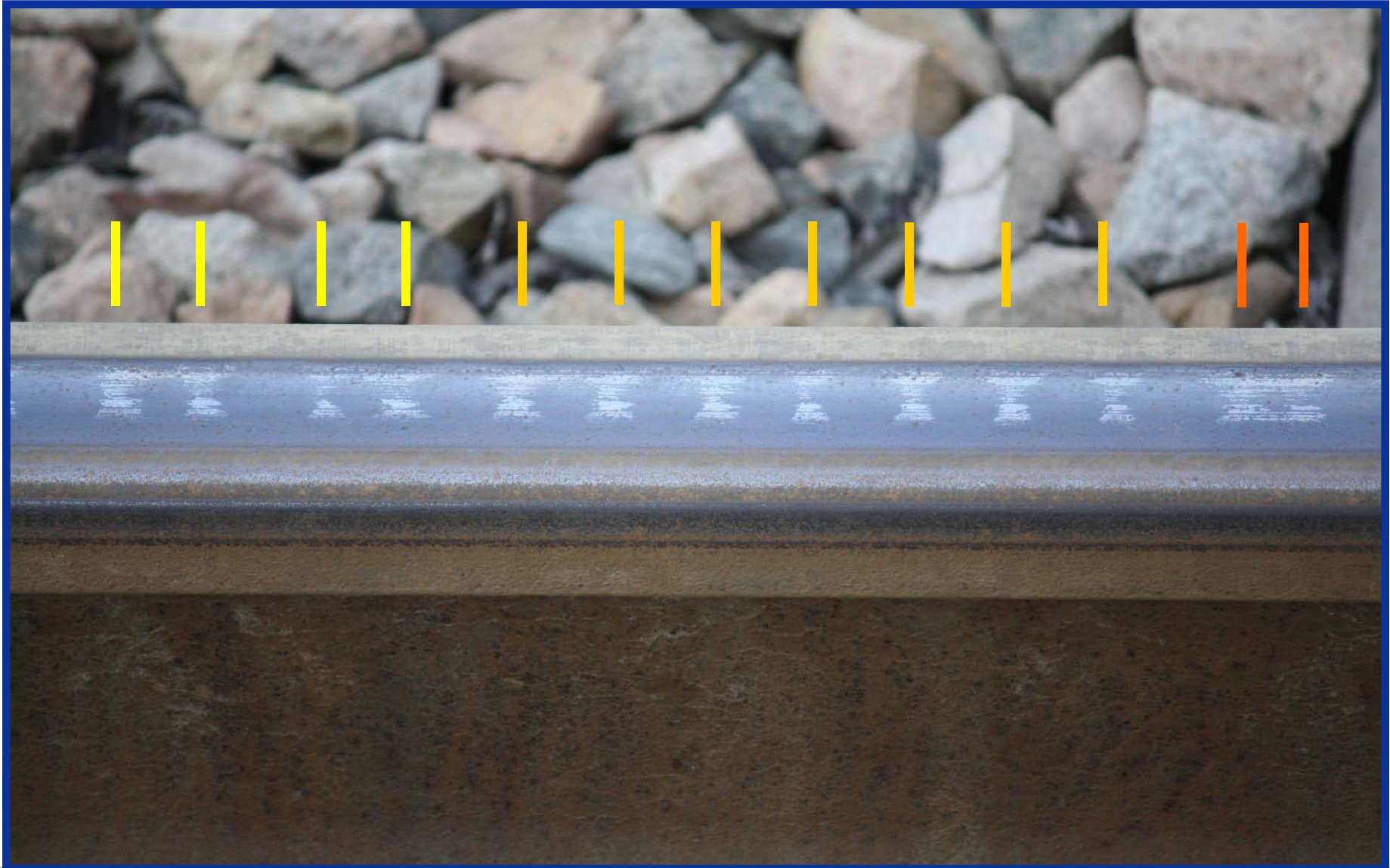




# Corrugation– Example 3



# Corrugation – Example 4





# Corrugation – Example 5





# Embedded track and Corrugation - 1





# Embedded track and Corrugation - 2



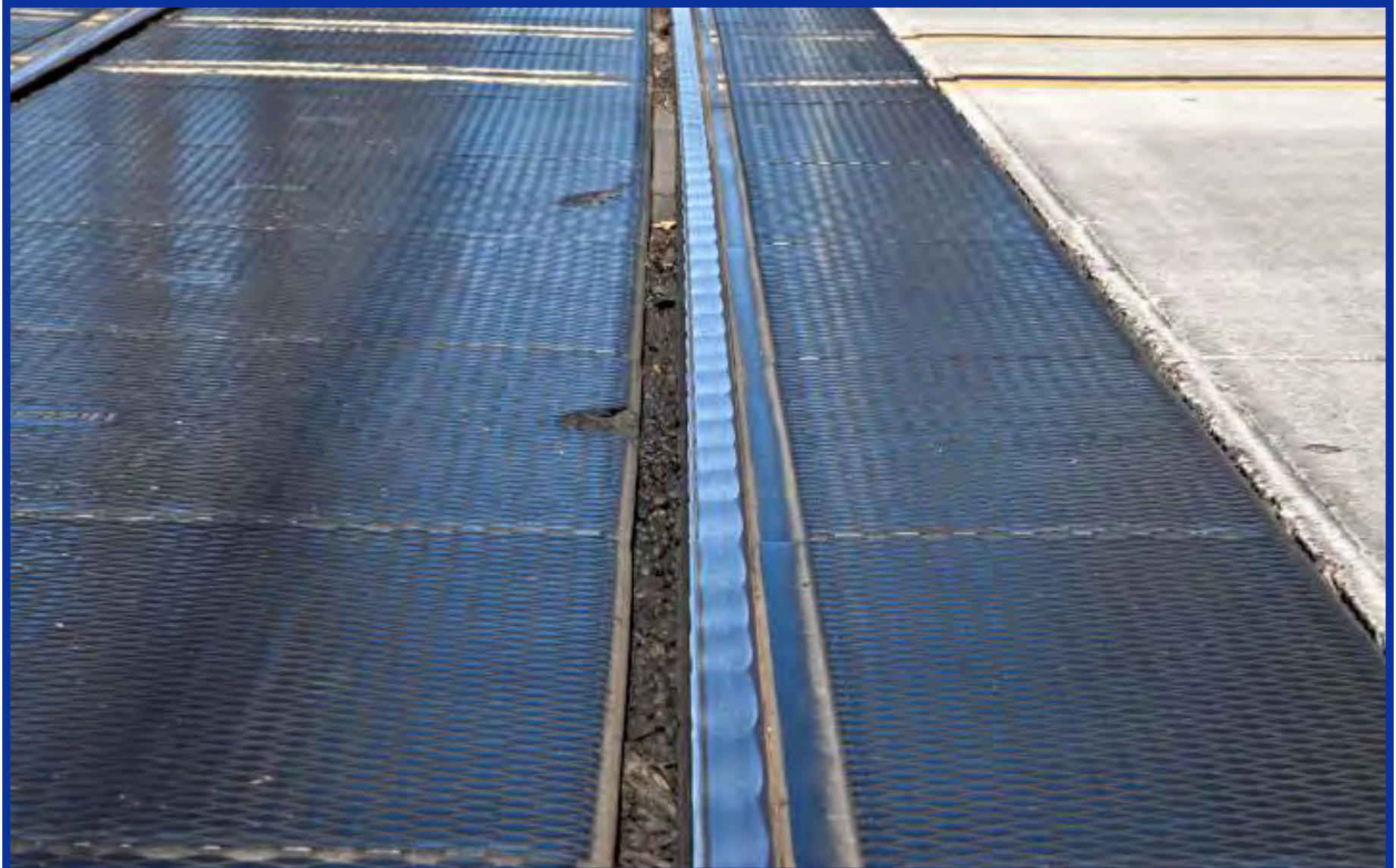


# Embedded track and Corrugation - 3





# Embedded Track – Short Waves





# Head checks at Gauge Corner





# Contents

Introduction – Railway & Noise

Wheel – Surface Conditions

Rail – Irregularities / Corrugation

**Grinding**

**Basics – Applications - Specifications**

Noise Recording

Rail Surface Conditions

- Examples After Grinding

Conclusion - Summary



# Grinding - Basics

**Providing best possible contact and running conditions**

**Minimizing dynamic loads**

(Longitudinal profile Corrugation removal)

**Reduction of noise!**

**Minimizing contact stresses**

(Target profile selection and production tolerances)

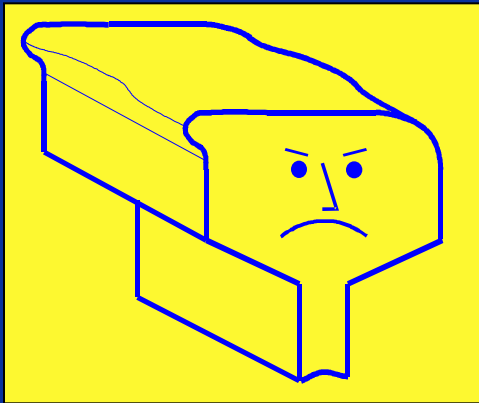
**Elimination of surface damage**

(Metal removal – Rolling Contact Fatigue)

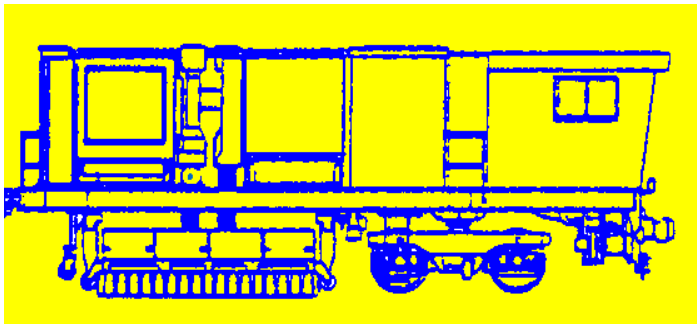




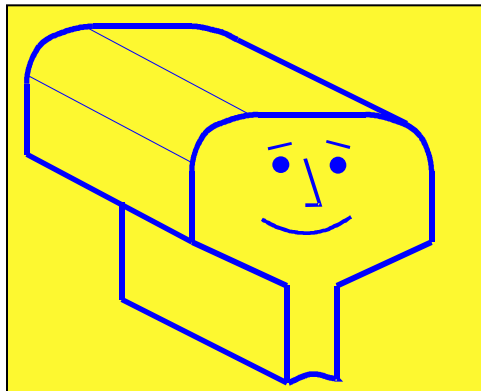
# Rail Maintenance



Rail condition  
(before grinding)



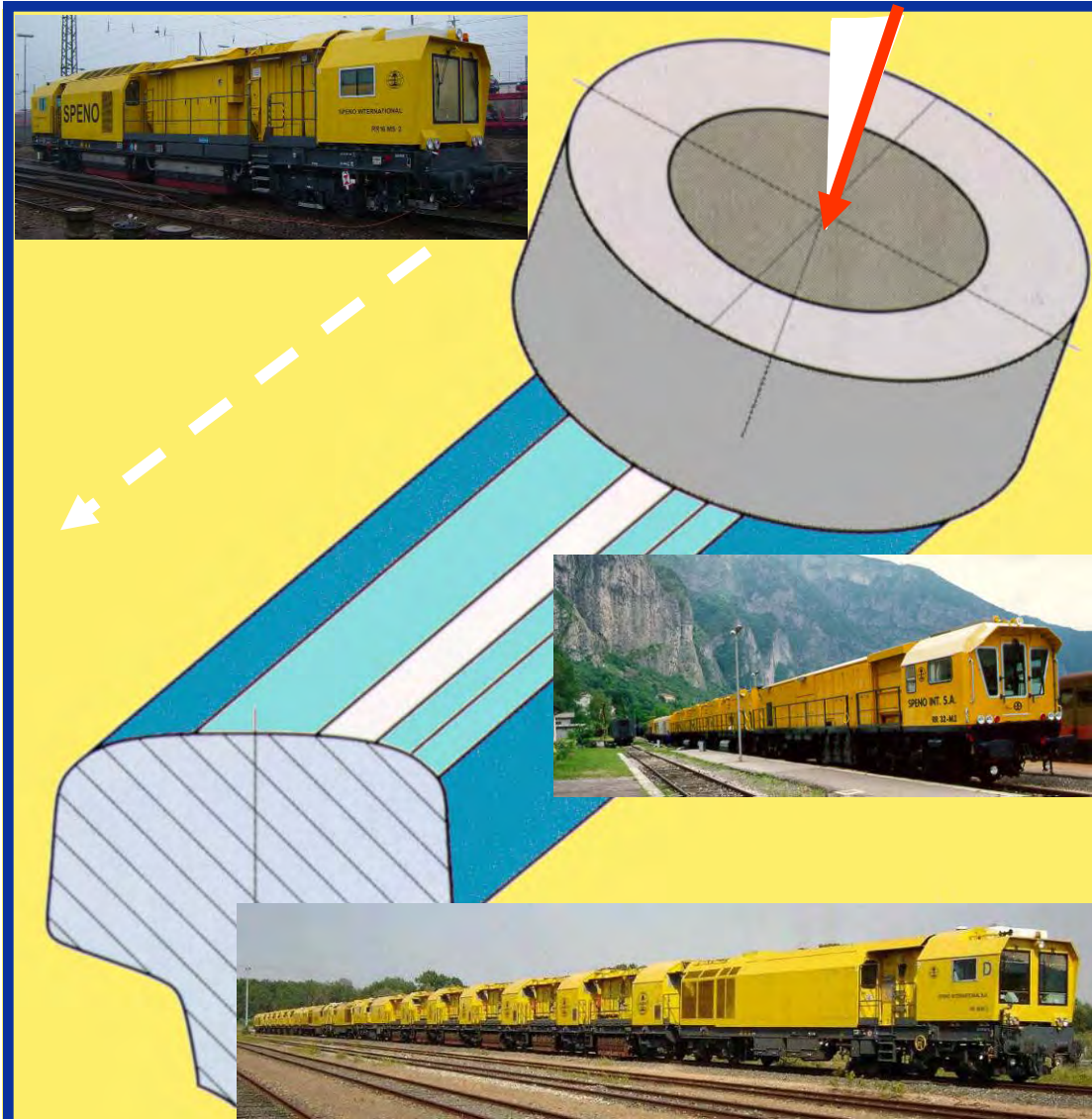
Grinding train  
(execution of work)



Target condition  
(after grinding)



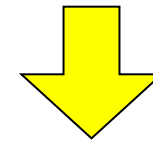
# Grinding Process



Motor inclination

Stone pressure

Working speed



**Specified Product**

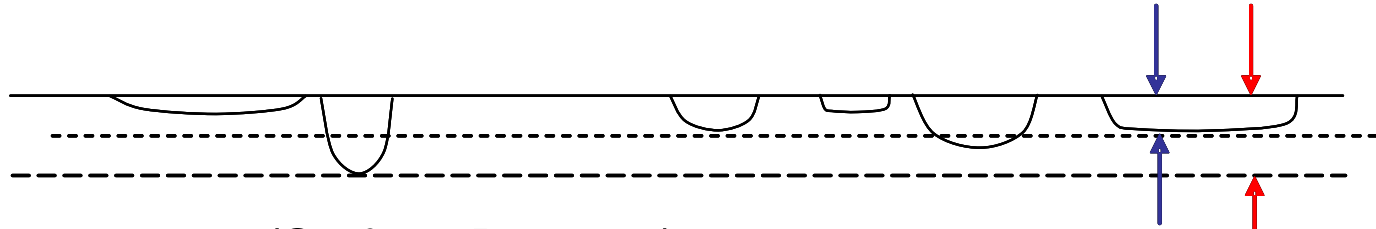




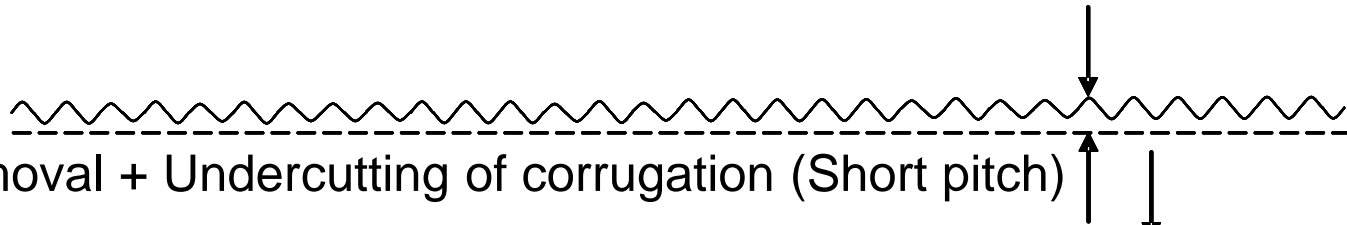
# SRR 16M-1 for special applications



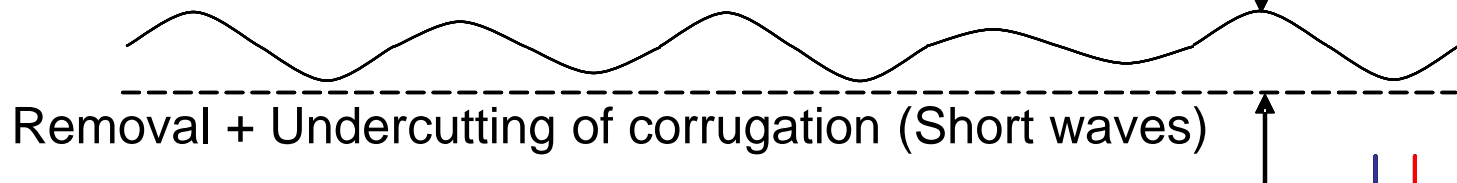
# Specs - Metal Removal - Longitudinal



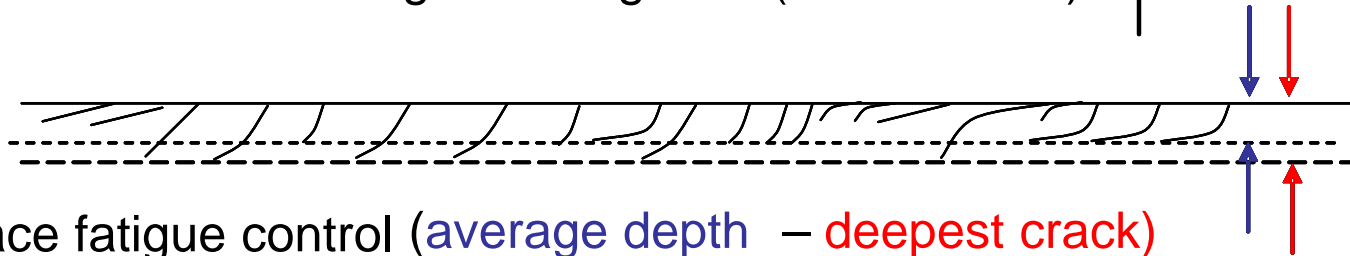
a) Metal removal (Surface Damage) in steps - complete



b) Removal + Undercutting of corrugation (Short pitch)



Removal + Undercutting of corrugation (Short waves)

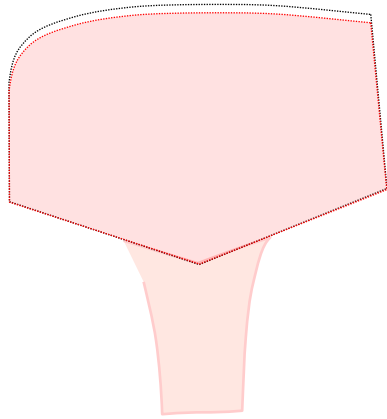


c) Surface fatigue control (average depth - deepest crack)

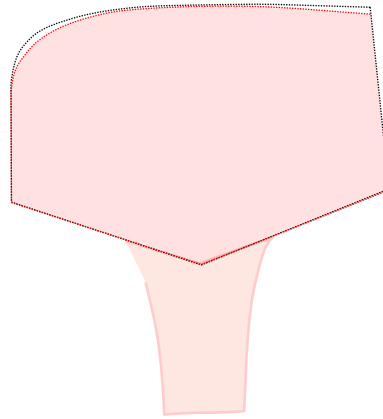




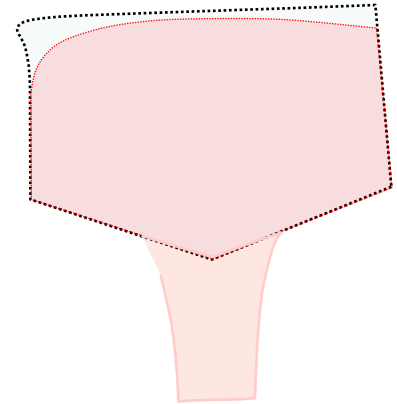
# Specs - Metal Removal - Transverse



a) Initial grinding,  
Damage removal  
(Consistent metal  
removal)



b) Cyclic grinding  
(Anti-head check-profile)



c) Corrective grinding  
(Profile correction &  
short wave removal)



# Specifications for Grinding Work

## = CRITERIA FOR QUALITY CONTROL

|                             |                               |
|-----------------------------|-------------------------------|
| <b>Longitudinal Profile</b> | <b>(Continuous Recording)</b> |
|-----------------------------|-------------------------------|

|                           |                               |
|---------------------------|-------------------------------|
| <b>Transverse Profile</b> | <b>(Continuous Recording)</b> |
|---------------------------|-------------------------------|

|                           |                            |
|---------------------------|----------------------------|
| <b>Surface Conditions</b> | <b>(Visual Inspection)</b> |
|---------------------------|----------------------------|

|                      |                     |
|----------------------|---------------------|
| <b>Metal Removal</b> | <b>(On Request)</b> |
|----------------------|---------------------|

|                            |                              |
|----------------------------|------------------------------|
| <b>Metal Removal - RCF</b> | <b>(HC Grinding Scanner)</b> |
|----------------------------|------------------------------|



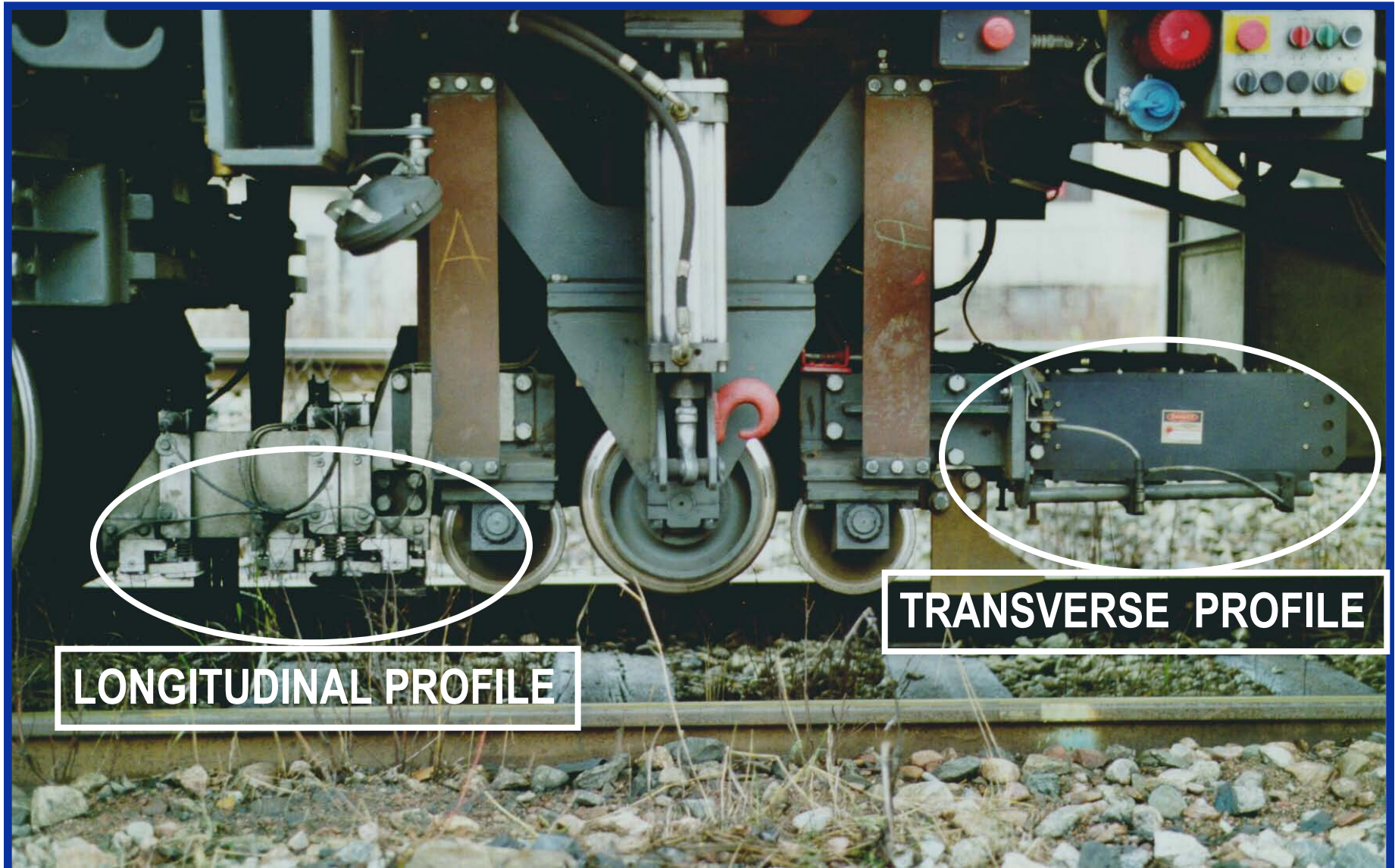


# Longitudinal Specs - Example CEN

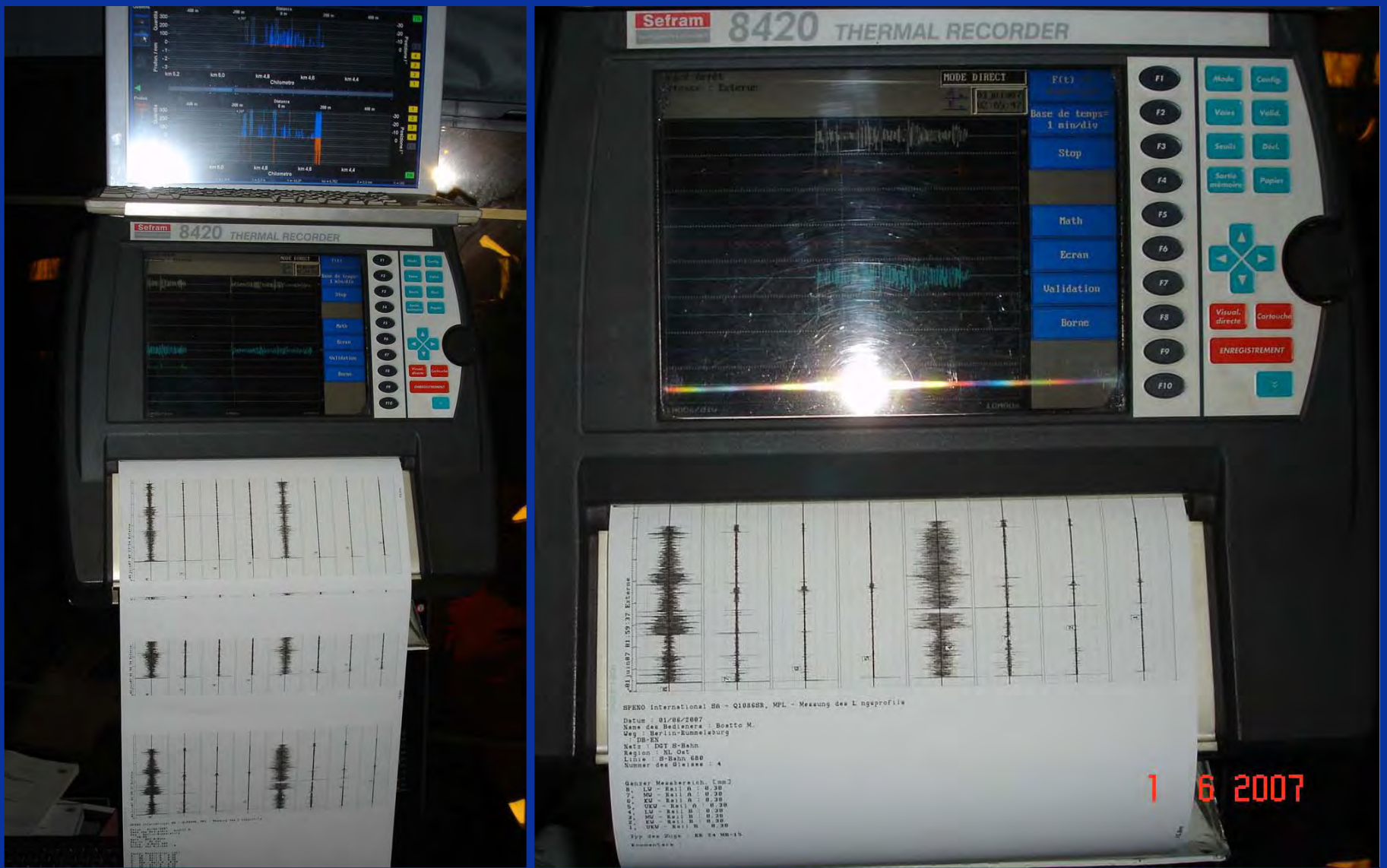
| Wavelength range<br>[mm]                       | 10 – 30<br>(1/2" - 1") | 30 – 100<br>(1" - 4") | 100 – 300<br>(4" - 12") | 300 -1000<br>(1' - 3') |
|------------------------------------------------|------------------------|-----------------------|-------------------------|------------------------|
| Limit of peak to<br>peak amplitude<br>[mm]     | +/-0.01<br>(0.4 thou)  | +/-0.01<br>(0.4 thou) | +/-0.015<br>(0.6 thou)  | +/-0.075<br>(3 thou)   |
| Percentage of Permissible Length Outside Specs |                        |                       |                         |                        |
| Class 1                                        | 5%                     | 5%                    | 5%                      | 10%                    |
| Class 2                                        | -                      | 10%                   | 10%                     | -                      |



# Recording Trolley







# Other criteria (prEN 13231-3:2010)

## Facet width:

- 4 mm on gauge corner
- 7 mm on the shoulder
- 10 mm on the rail crown

Maximum variation of width: 25 %

## Coloration:

No continuous blueing





# Roughness (prEN 13231-3:2010)

- Recording Frequency not specified, typically once a shift
- One measurement point consists of six contiguous measurements each rail after grinding
- No more than 16 % of the measured lengths (or 1 in 6, if only 6 measurements are made) shall exceed the limit of 10  $\mu\text{m}$ .



# Roughness Meter (e.g. Hommel)





# Situation After Grinding



# Contents

Introduction – Railway & Noise

Wheel – Surface Conditions

Rail – Irregularities / Corrugation

Grinding

Basics – Applications - Specifications

**Noise Issues**

Rail Surface Conditions

- Examples After Grinding

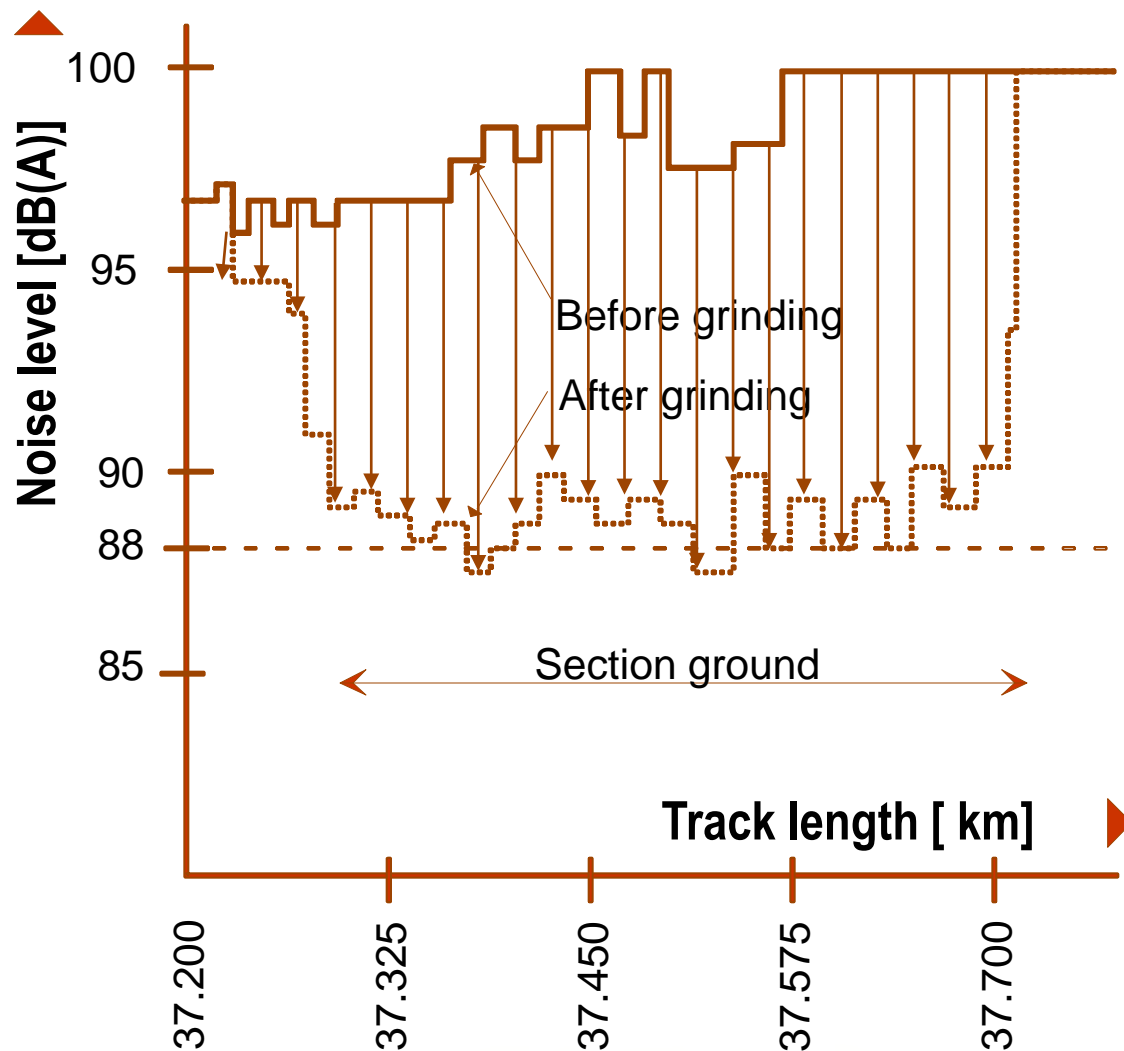
Conclusion - Summary



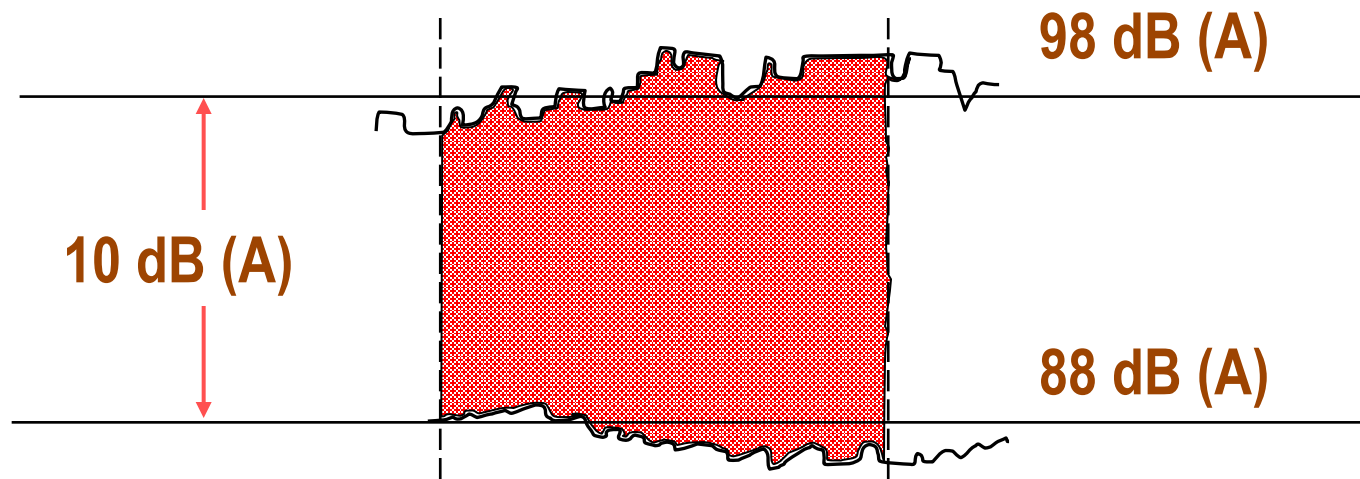


# Noise Reduction - Example

Result of  
measuring car  
from DB AG  
on high speed track  
(max speed 200 kph)



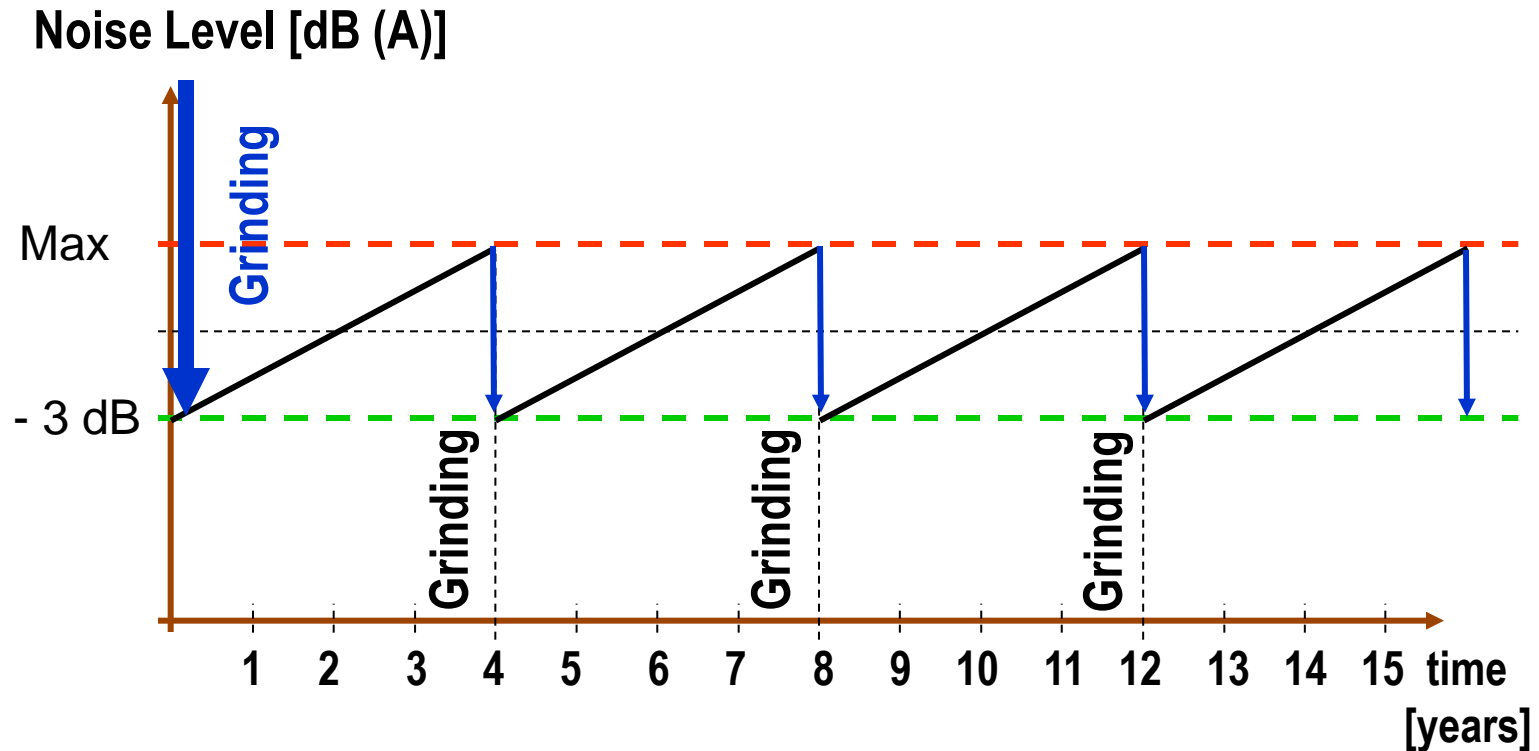
# Reduction of noise level by grinding



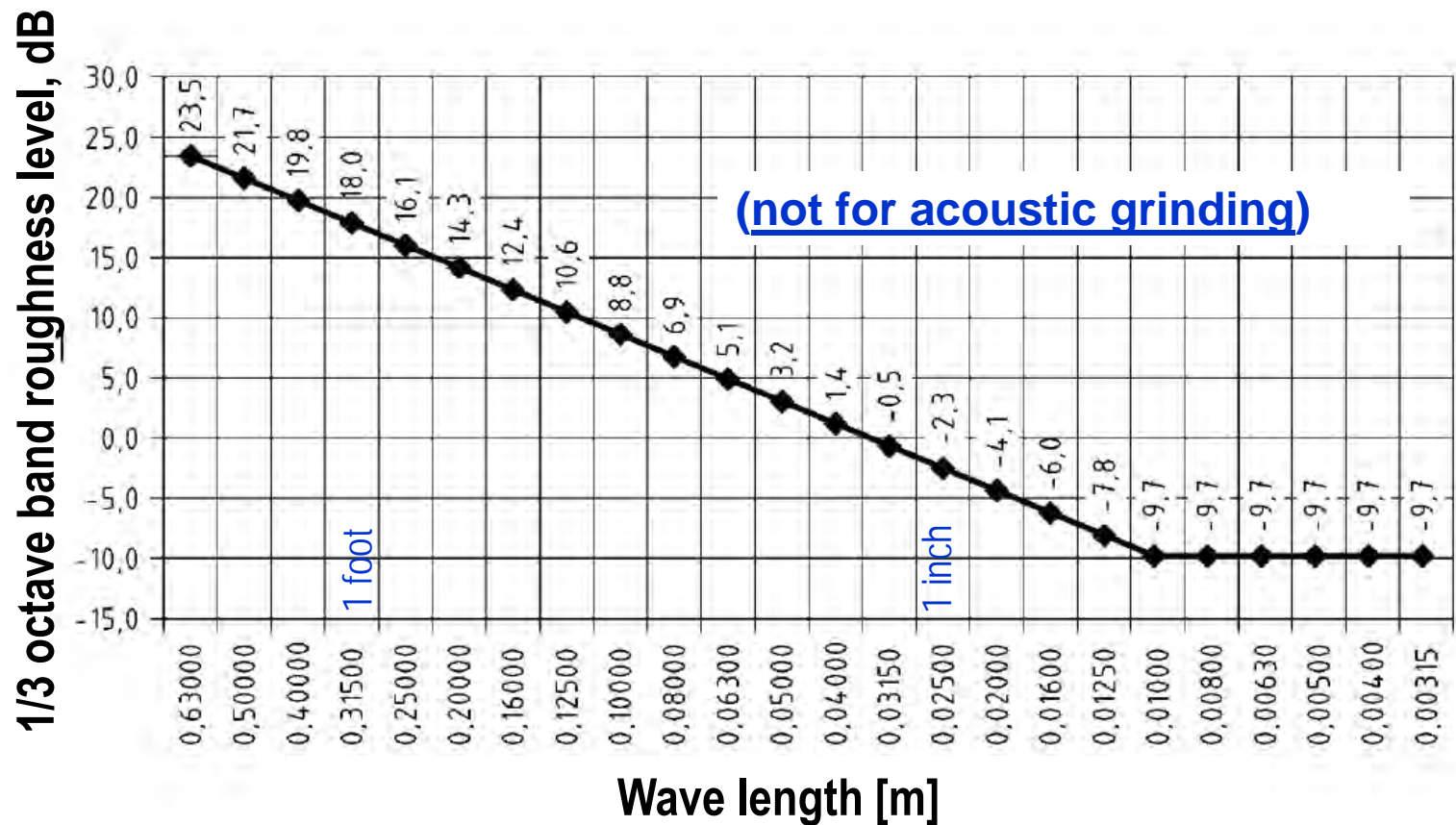


# Especially noise controlled lines – DB AG

## Change of noise over time and grinding strategy



# Roughness Specification EN 3095 (2006)



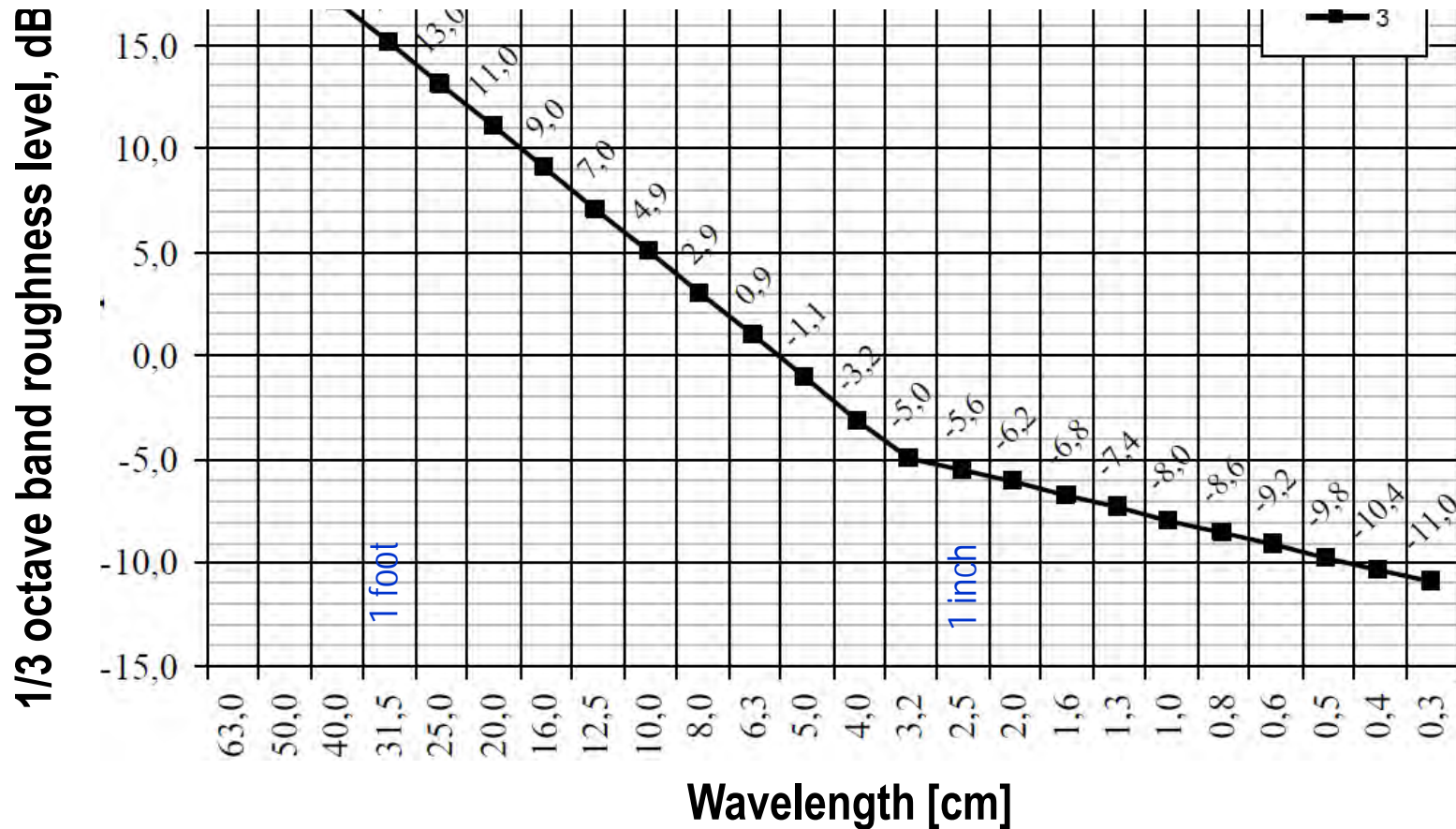
Roughness Requirements for Vehicle Acceptance Tests





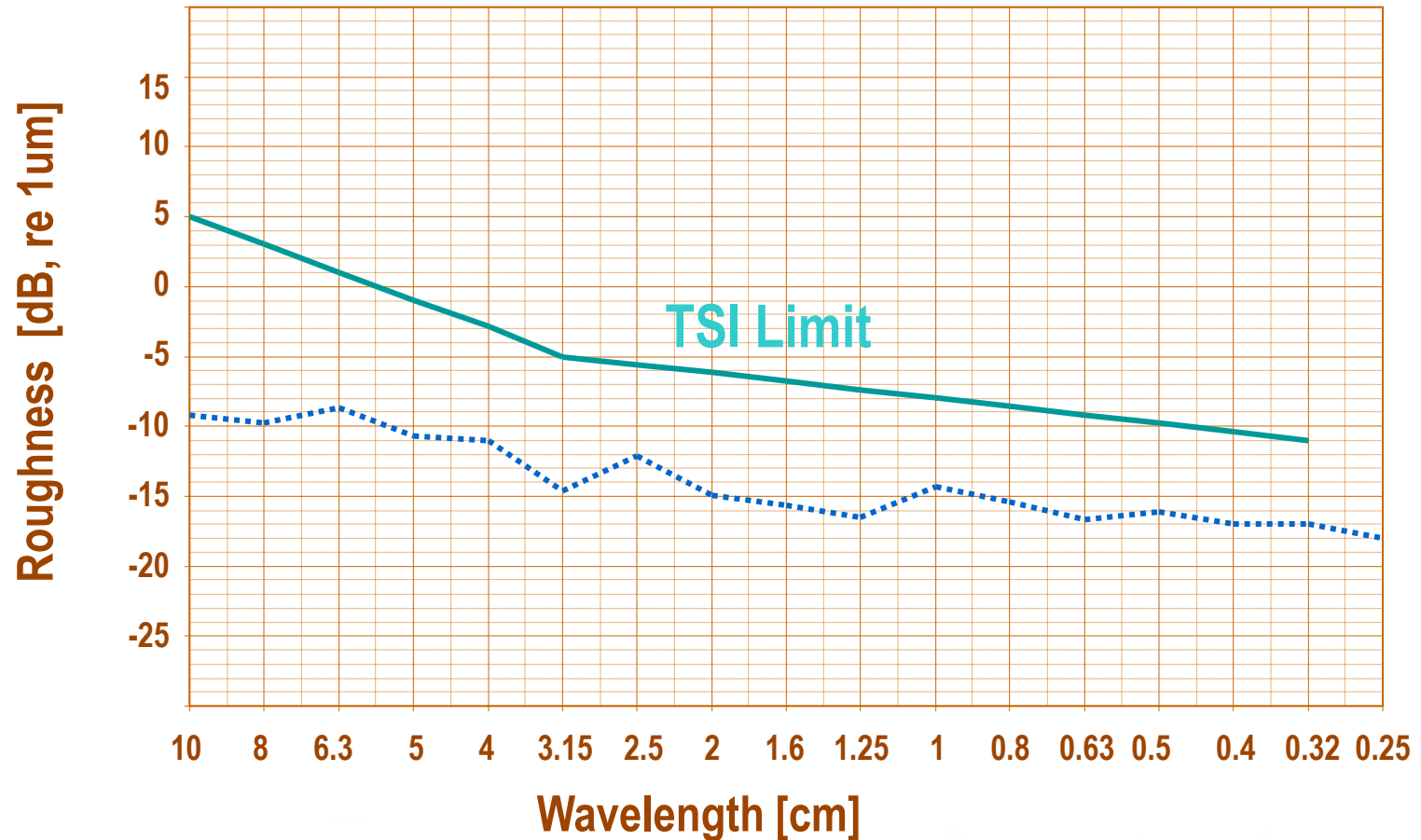
# Roughness Specification TSI (draft 2010)

## Roughness requirements for Vehicle Acceptance Tests (not acoustic grinding)



# Noise Recording After Grinding

RM 1200 Recording Line Augsburg – Donauwörth DB AG  
(6 weeks after Speno – Grinding - 16.12.2004)





# Contents

Introduction – Railway & Noise

Wheel – Surface Conditions

Rail – Irregularities / Corrugation

Noise Recording

Grinding

Basics – Applications - Specifications

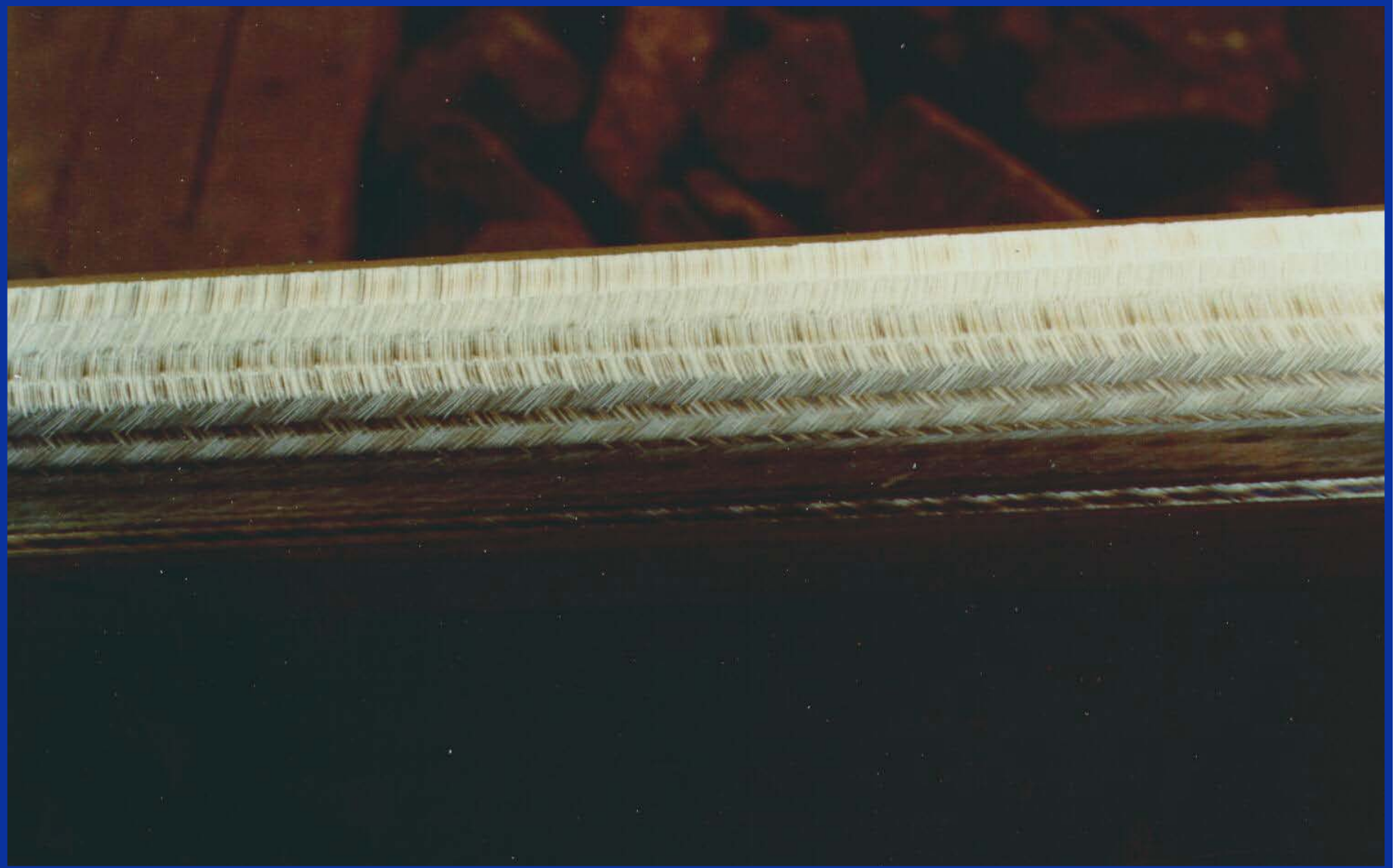
**Rail Surface Conditions**

**- Examples After Grinding**

Conclusion - Summary



# Production Grinding

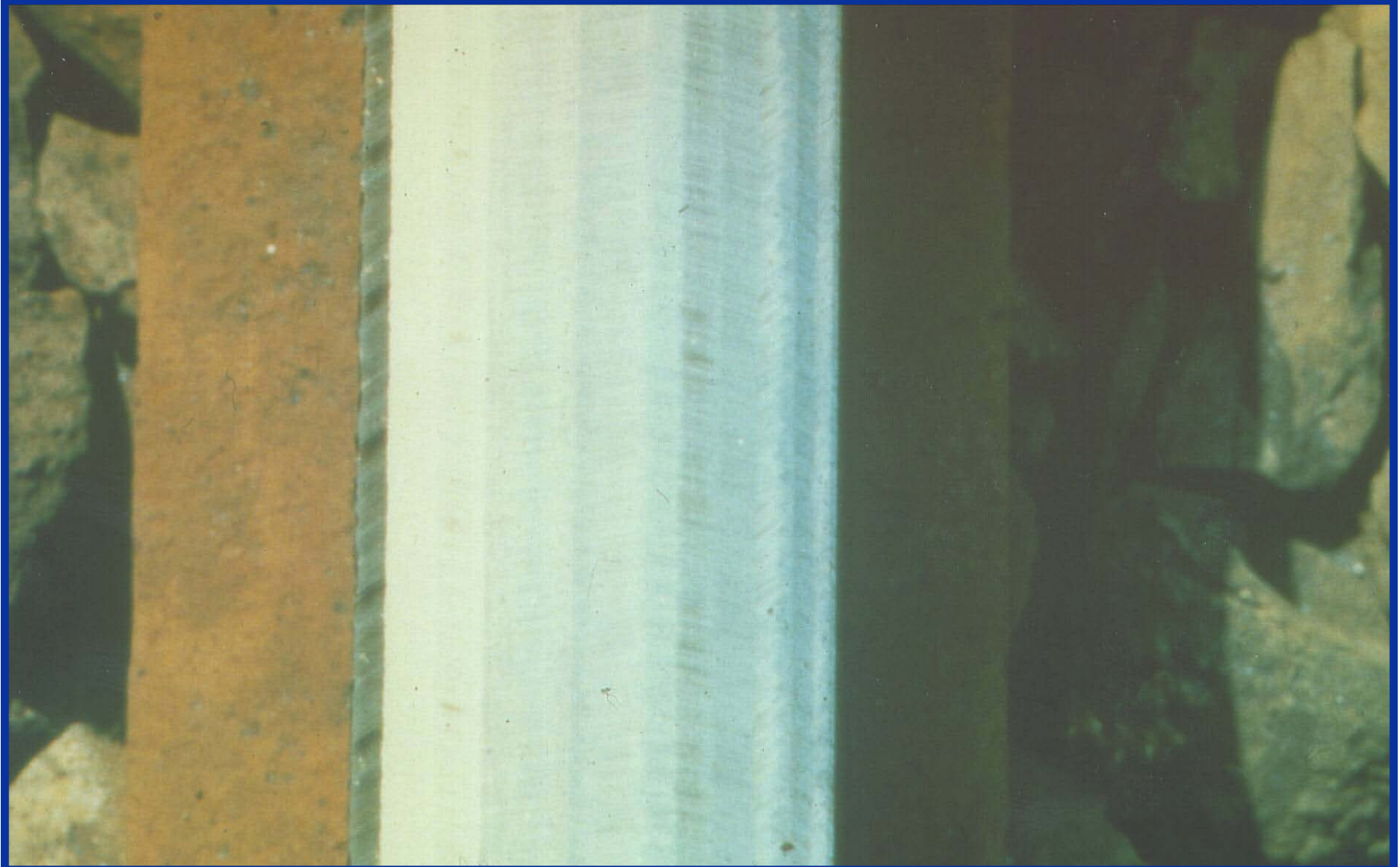




# Aggressive Grinding



# Acoustic Grinding (Fine Finish)





# Surface after grinding - 1

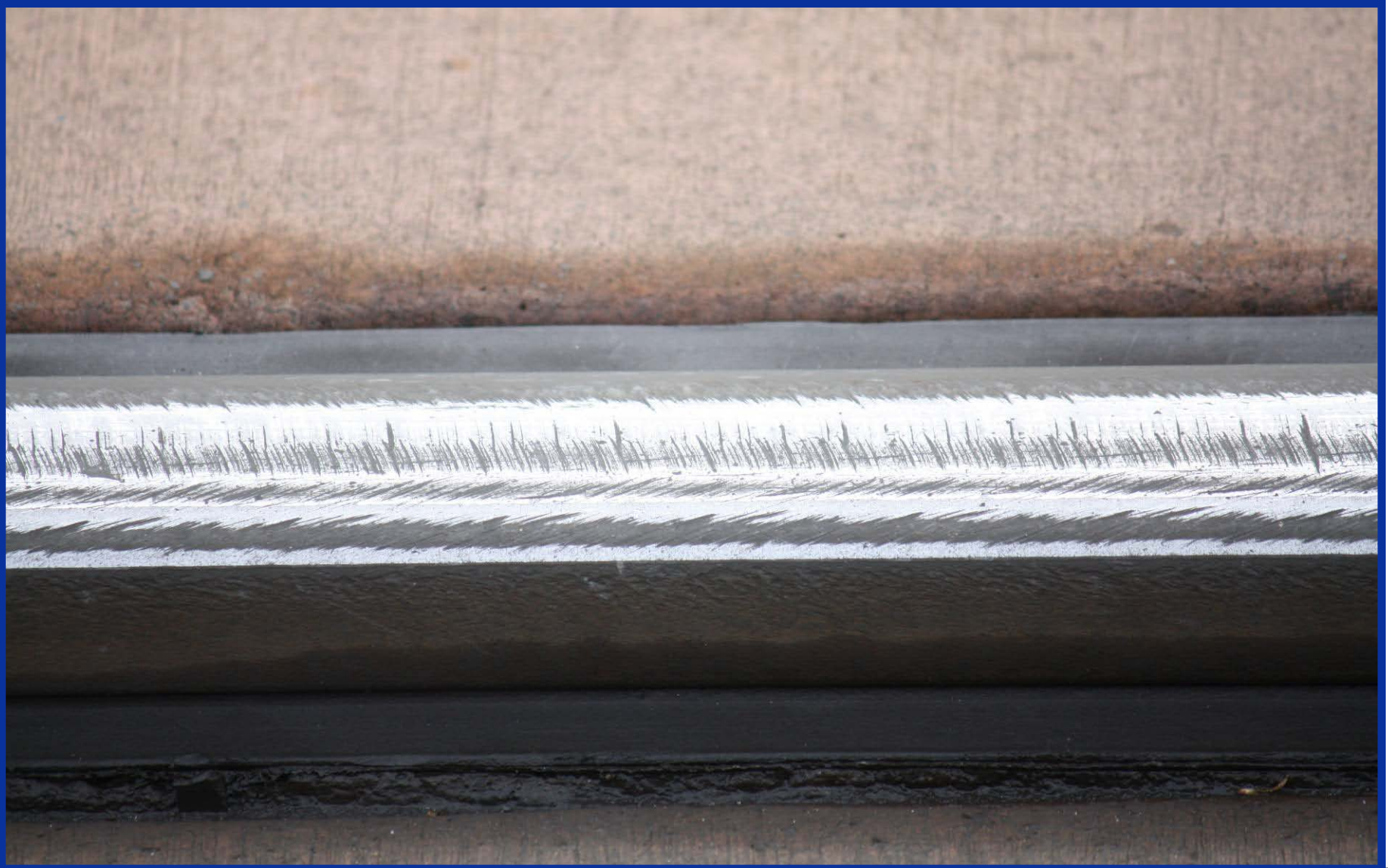


# Surface after grinding - 2





# Surface after grinding - 3





# Surface after grinding - 4





# Corrugation Re-start - 1



# Corrugation Re-start - 2





# FINISHED RAIL



# Acoustic Rail Grinding

—

## Definitions, Applications and Specifications

**Thank You For Your Attention!**

Dr. Wolfgang Schöch

SPENO INTERNATIONAL SA

