APTA 2011
Noise based grinding intervention

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Overview

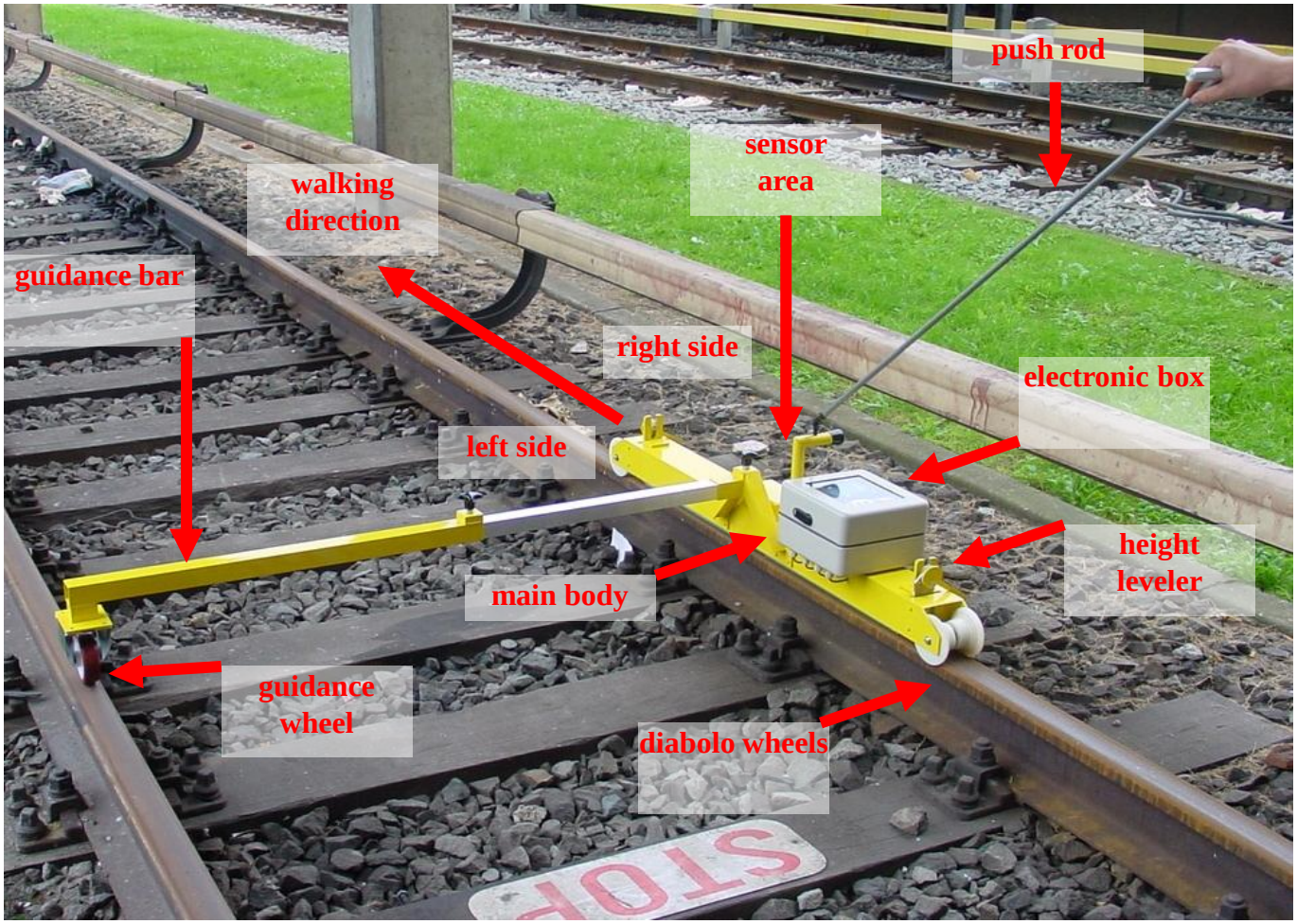
- Rail roughness measurements
- Relationship: Rail roughness – Noise & vibrations
- Relationship: Grinding – Rail roughness
- Conclusions

Rail roughness measurements

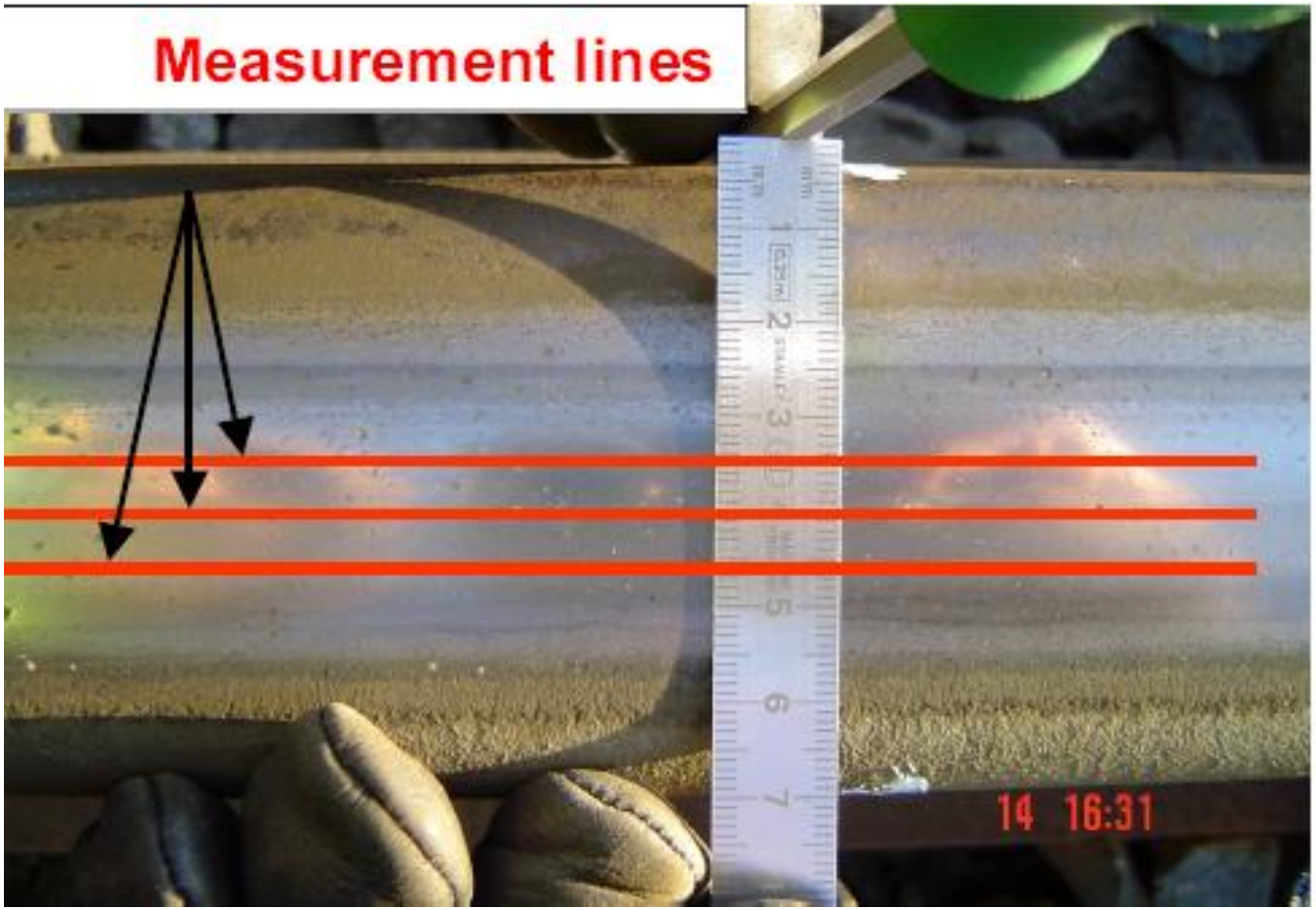
Content

- Measurement equipment: Rail Surface Analyser (APT-RSA)
- Data processing

Measurement equipment: Rail Surface Analyser (APT-RSA)

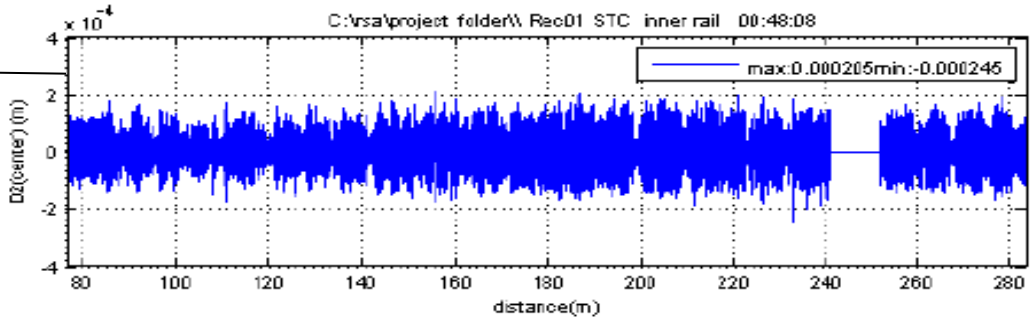


Measurement equipment: Rail Surface Analyser (APT-RSA)

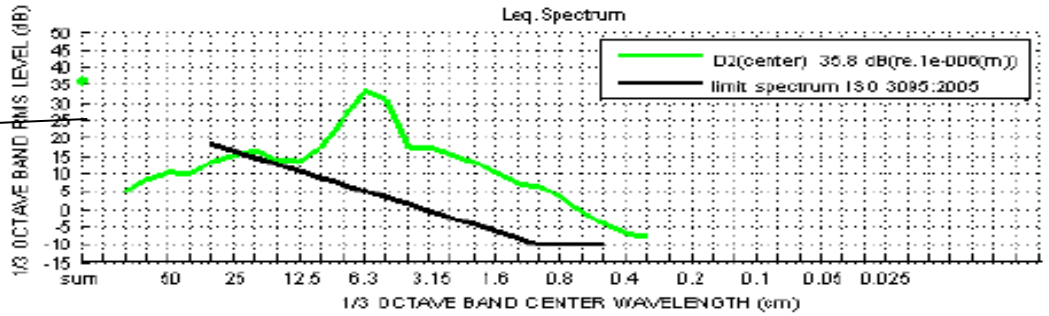


Data processing

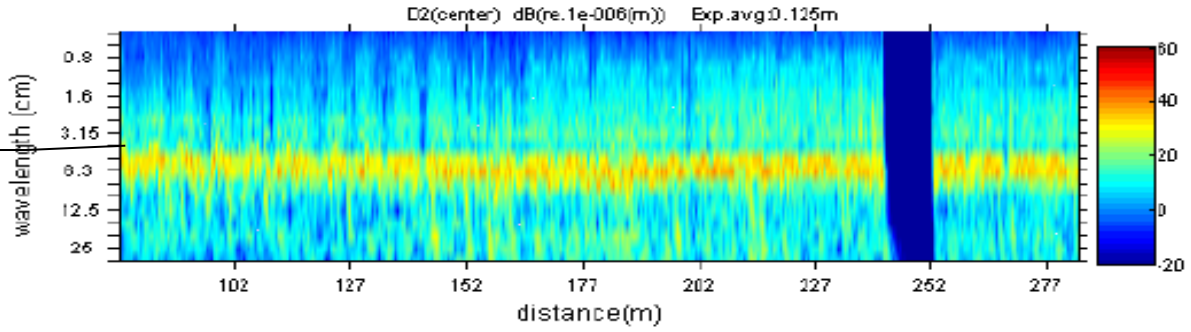
Roughness level (one rail) in function of distance



Roughness RMS spectrum



Waterfall diagram (spectrum in function of distance)

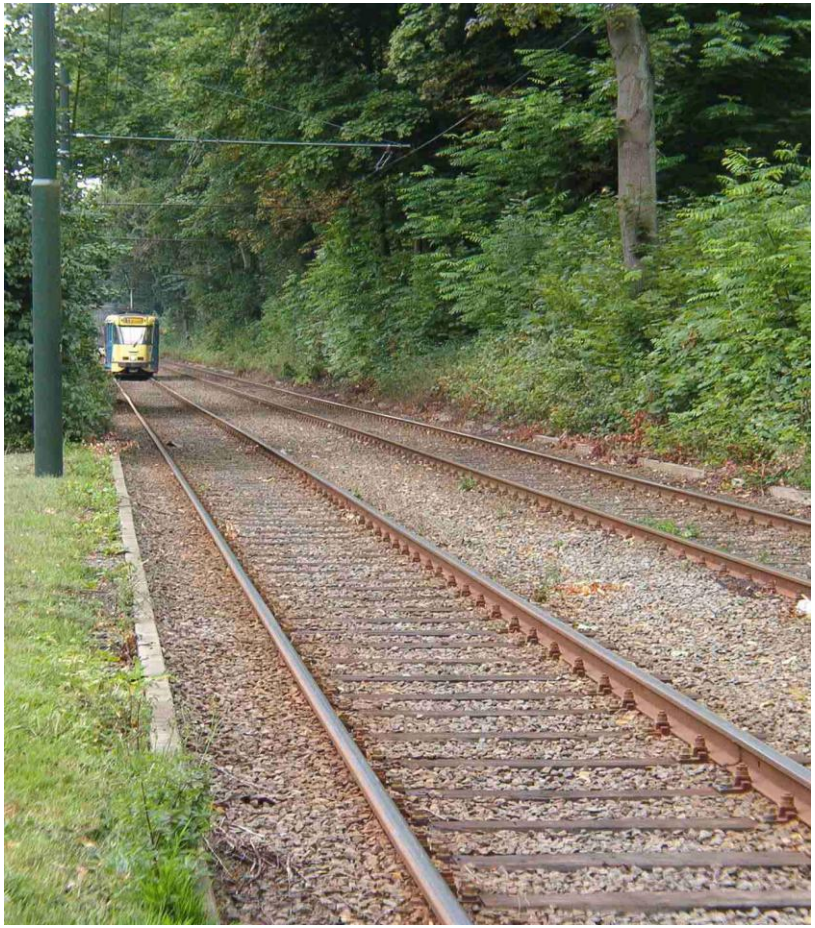


Relationship: Rail roughness – Noise & Vibrations

Content

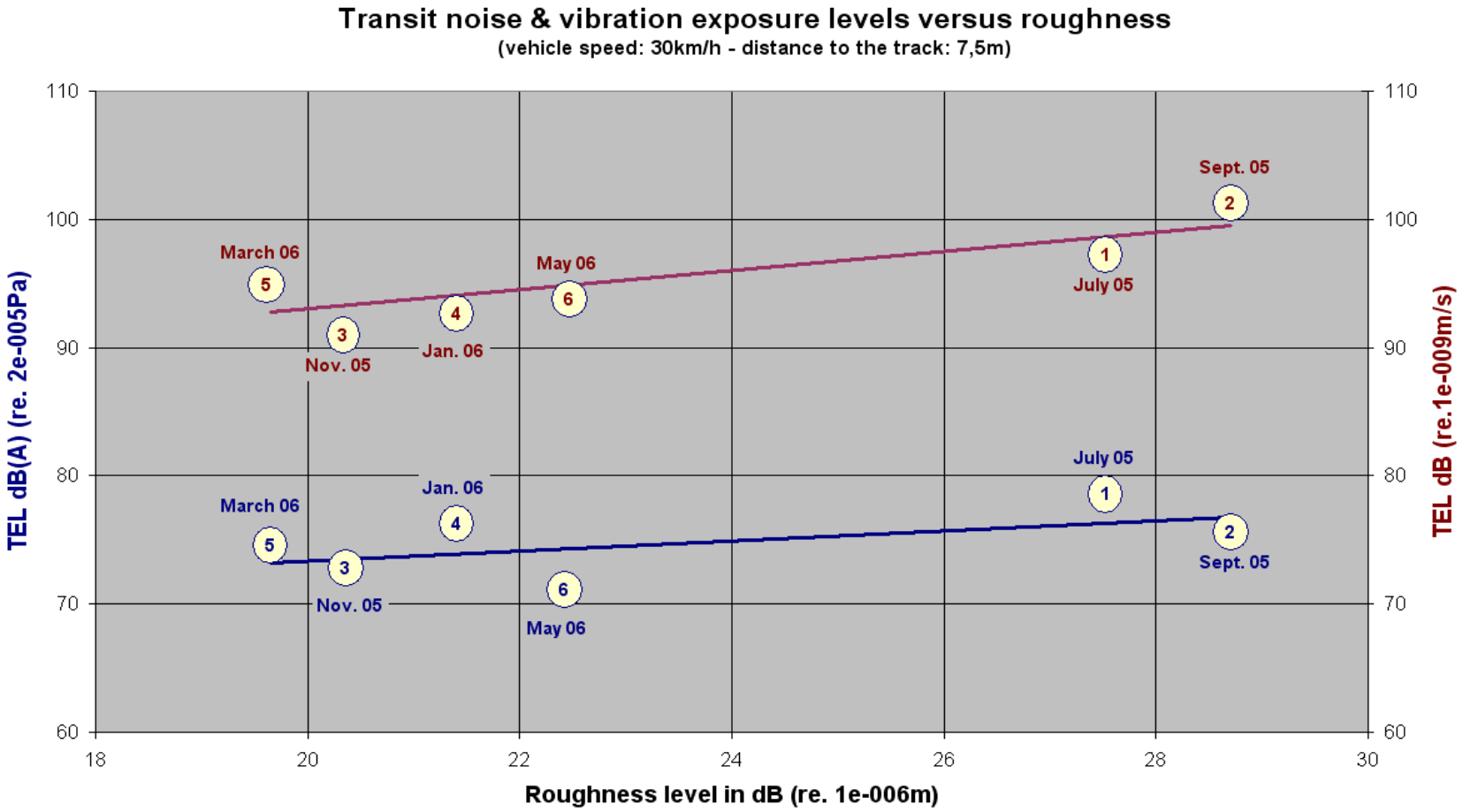
- Long term measurement campaign
- Results

Long term measurement campaign

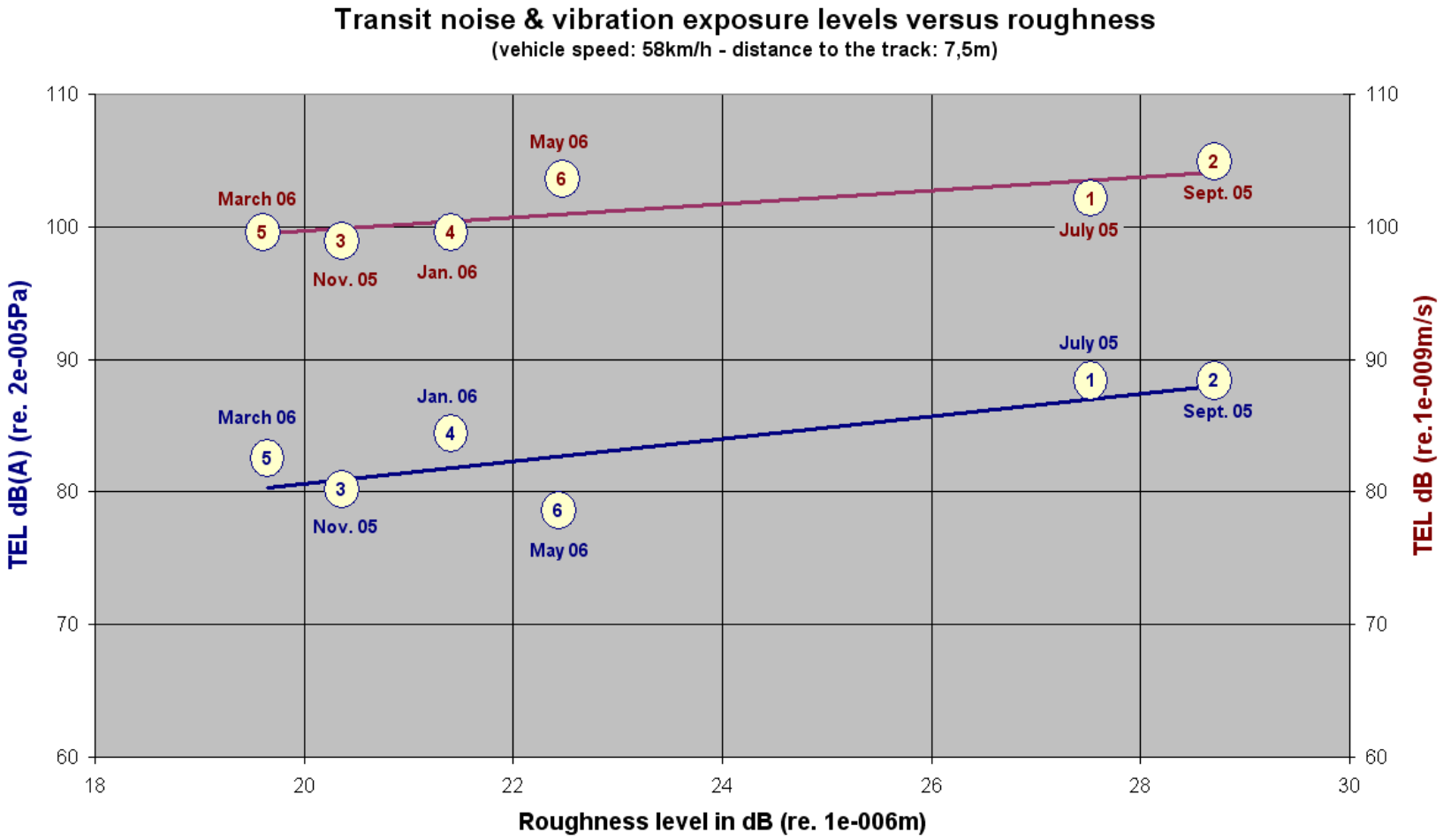


- Test site in Brussels
  - Tangent track with low inclination
  - Dedicated test vehicle (with low roughness wheels)
  - Speeds: 17 km/h - 58 km/h
  - Measurements at 7.5 m, 20 m and 25 m of:
    - pass-by noise
    - vibration levels
  - Track roughness measurements with APT-RSA

Long term measurement campaign: Noise/Roughness measurements @30 km/h



Long term measurement campaign: Noise/Roughness measurements @58 km/h



Long term measurement campaign: Results

- Noise increases significantly at higher rail roughness
  - 10dB increase in rail roughness ➔ 4dB(A) at 30 km/h
  - 10dB increase in rail roughness ➔ 8dB(A) at 58 km/h
- Vibrations increase significantly at higher rail roughness
  - 10dB increase in rail roughness ➔ 7.5 dB at 30 km/h
  - 10dB increase in rail roughness ➔ 5 dB at 58 km/h
- ➔ Solution:
  - Grinding to control rail roughness / noise / vibrations
- ➔ Questions:
  - When is it necessary to grind?
  - Is the result after grinding satifactory?

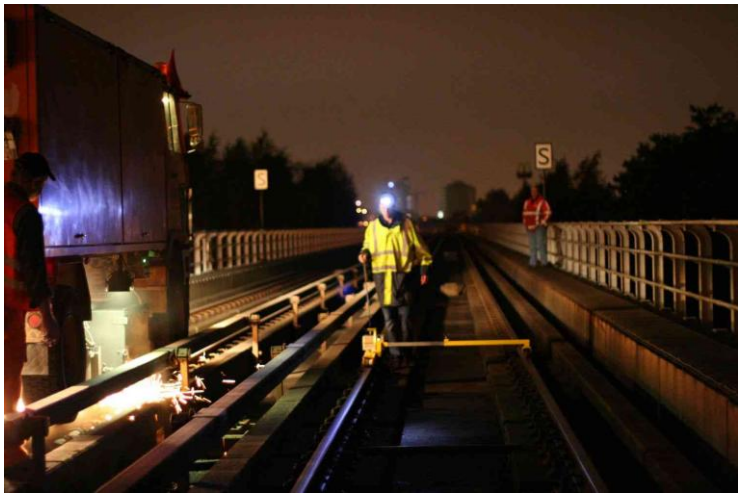
Relationship: Grinding – Rail roughness

Content

- Grinding and importance of rail roughness measurements
- Timing
- Standards
- Quality of grinding
- Case study: Metro network RET Rotterdam (NL)
  - Necessity to grind
  - No necessity to grind

Grinding and importance of rail roughness measurements

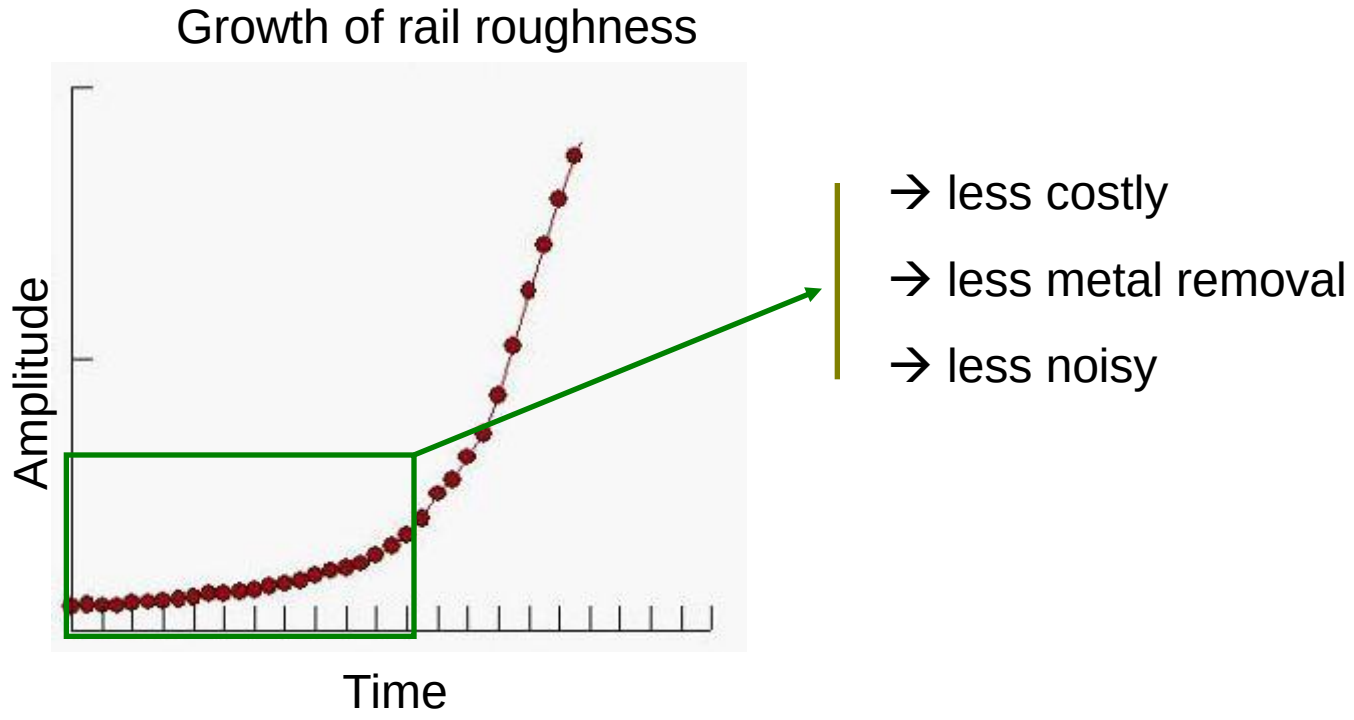
- Dificulties / Particularities
  - Timing is of great importance
  - Quality of grinding: It is critical to remove all corrugation patterns completely



- Timing? → Intervention limit (rail roughness)
- Quality of grinding? → Acceptance limit (rail roughness)

Timing

- Defining optimal grinding moment



Timing

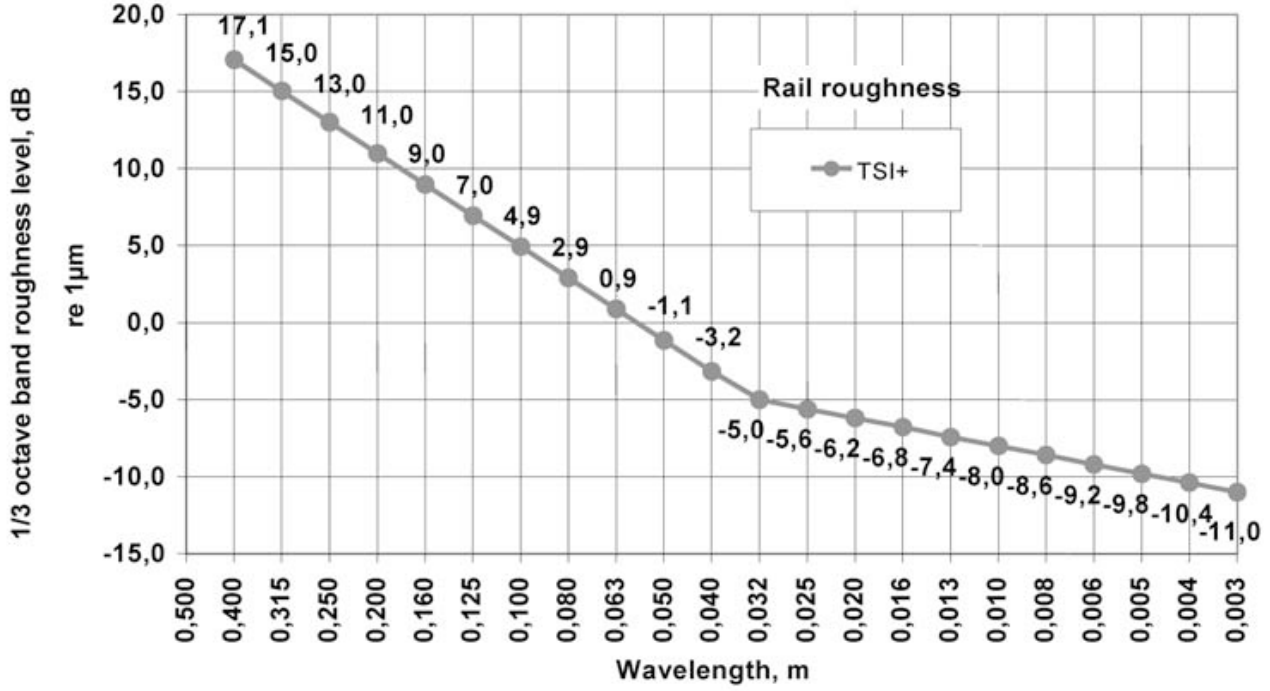
- Subjective criteria
  - Noise complaints
  - Visual inspection
  - Experience with track history
  - Specific time intervals
- Objective criteria
  - Example: Prorail (NL) Intervention Levels
- Importance of timing
  - Too Late ➔ Depths are there
    Noise is there
  - Too early ➔ Unnecessary metal removal
    ➔ Higher costs
    ➔ Early rail replacement

Standards

- Roughness specification for vehicle acceptance tests
  - ISO 3095
  - TSI (2005)
- Roughness specification for grinding acceptance
  - CEN

Standards: Roughness specification TSI (2005)

- roughness requirement for Vehicle Acceptance test (not for acoustic grinding)



Standards: Roughness specification ISO 3095 (2005)

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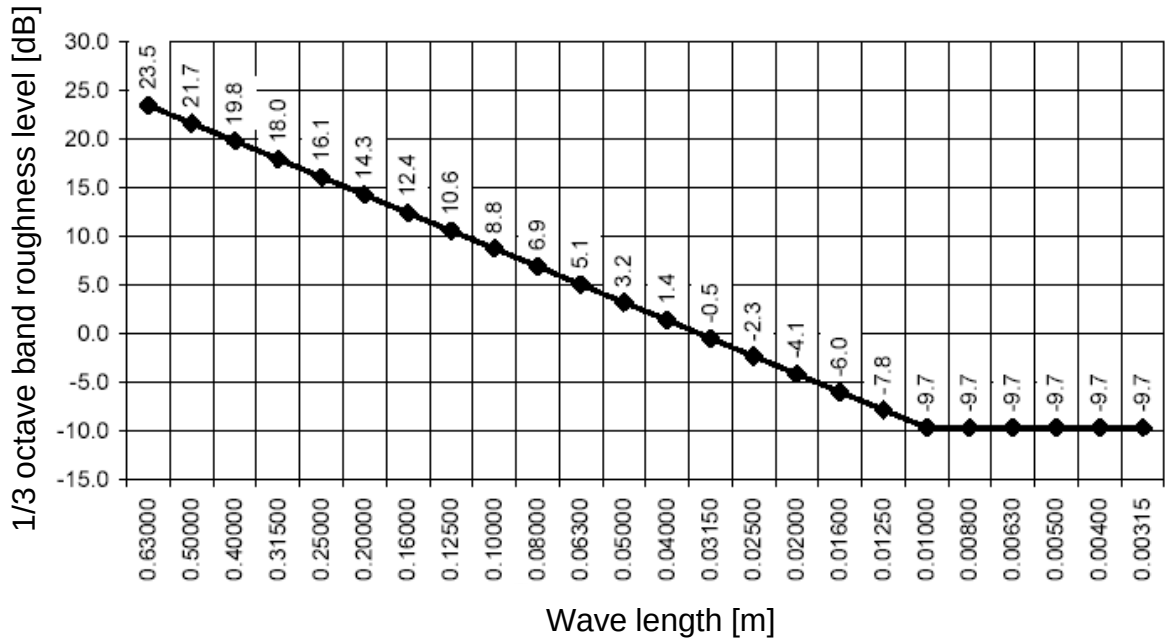


Standards:
Longitudinal Specs – Example CEN

Wavelength range [mm]	10 – 30 (1/2” - 1”)	30 – 100 (1” – 4”)	100 – 300 (4” – 12”)	300 – 1000 (1’ – 3’)
Limit of peak-to-peak amplitude [mm]	±0.01 (0.4 thou)	±0.01 (0.4 thou)	±0.015 (0.6 thou)	±0.075 (3 thou)
Percentage of Permissible Length Outside Specs				
Class 1	5%	5%	5%	10%
Class 2	-	10%	10%	-

Standards: 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 µm

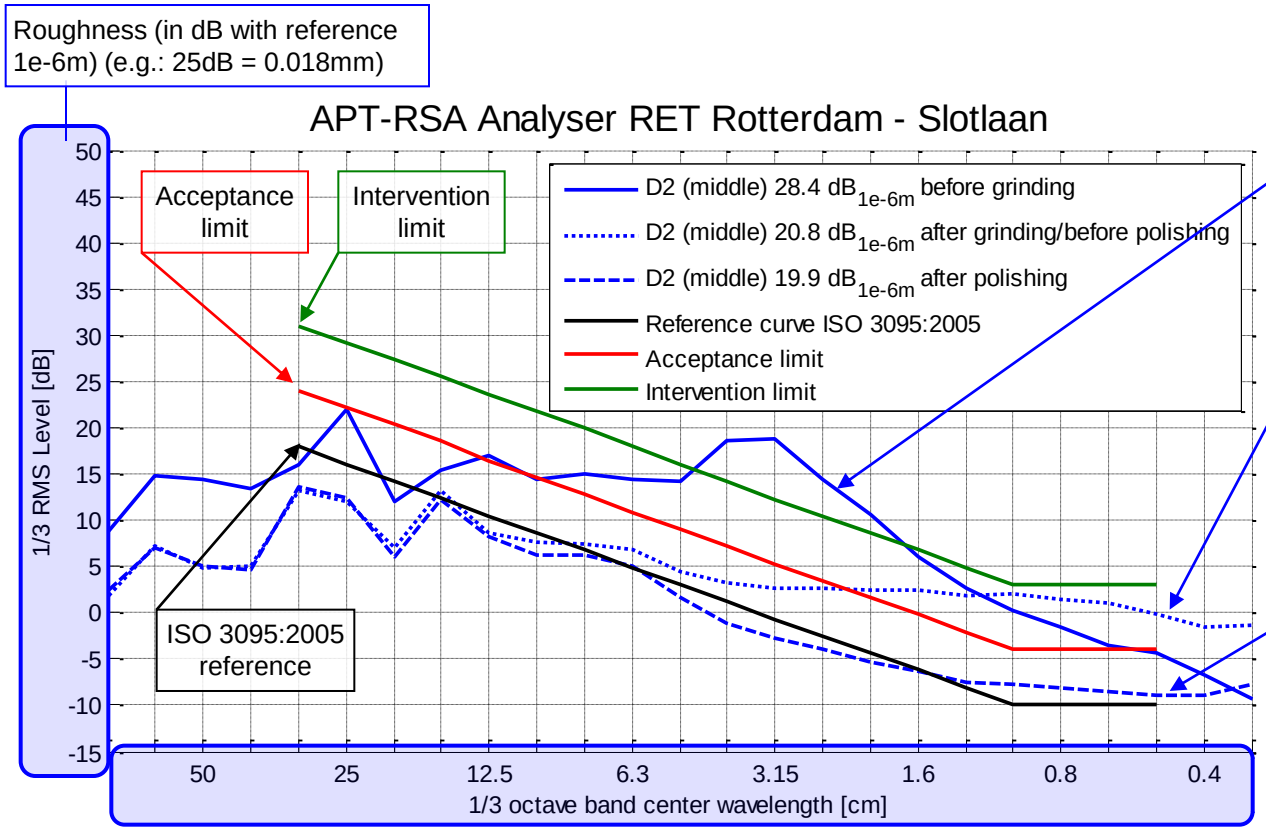
Quality of grinding

- Corrugation completely removed?
- Roughness sufficiently low?
- Need for Quality Control
  - Verification of different grinding passes → Measuring Rail roughness
  - Corrective actions during the grinding process
  - Acceptance of the works

Case study: Metro network RET Rotterdam (NL)

- Identify noise problems related to roughness = is the noise problem caused by roughness
- Grinding works
- Measurement campaign
  - Rail roughness measurements
    - Before grinding → Intervention limit
    - After grinding
    - After polishing → Acceptance limit

Necessity to grind



1. Measurement before grinding

➔ **Higher than Intervention limit**

➔ **Grinding**

2. Measurement after grinding / before polishing

➔ **Higher than Acceptance limit**

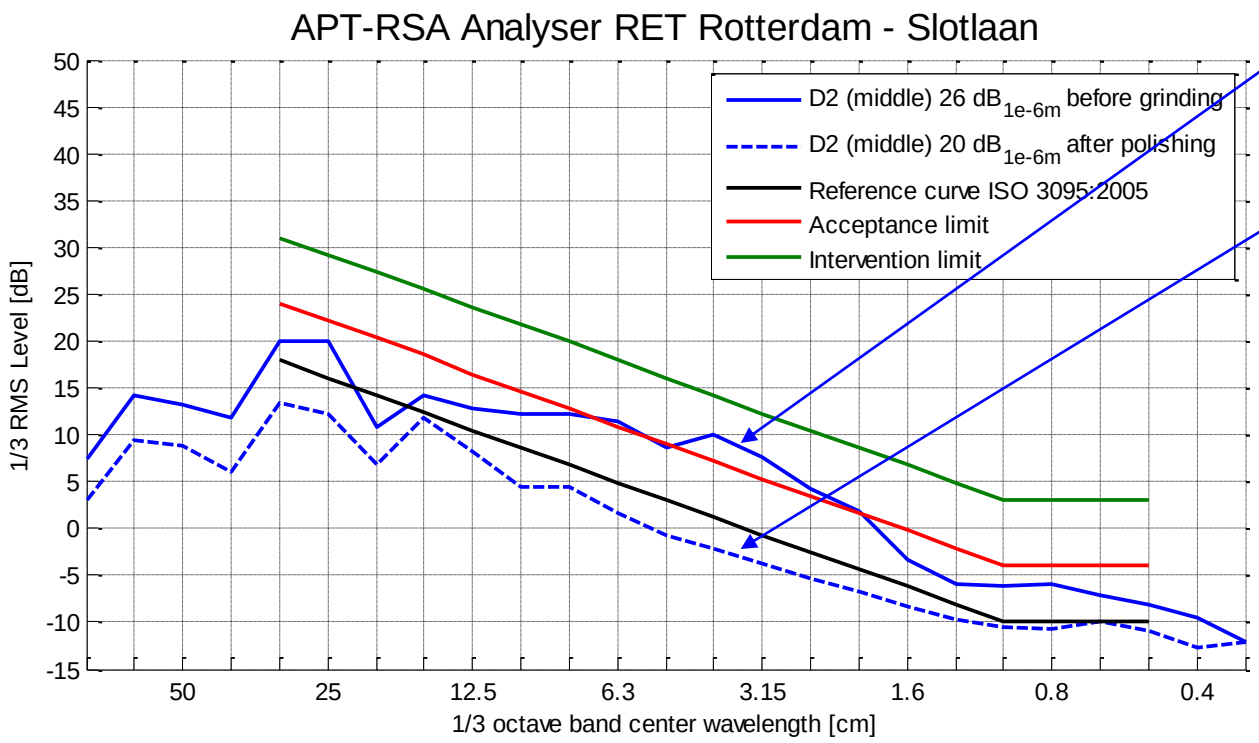
➔ **Polishing**

3. Measurement after polishing

➔ **Lower than Acceptance limit**

➔ **Acceptance of work**

No necessity to grind



1. Measurement: Before grinding
➔ Lower than Intervention limit
➔ To early to grind

2. Measurement: after grinding/after polishing
➔ Lower than Acceptance limit
➔ Acceptance of work

Conclusions

Conclusions

- High rail roughness levels cause high noise and vibration levels
- SOLUTION: Noise based grinding
- IMPORTANT: Timing and quality control
- TOOLS: APT-RSA (Rail Surface Analyzer)
  - Determining intervention moment
  - Quality control → acceptance of work

Conclusions

- Advantages of this work method:
  - Cost effective (Timing of intervention)
  - Guaranteed effectiveness regarding noise/vibration problems (Acceptance)