Using Rail Grinding to Remedy and Prevent the Negative Effects of Wheel/Rail Interaction

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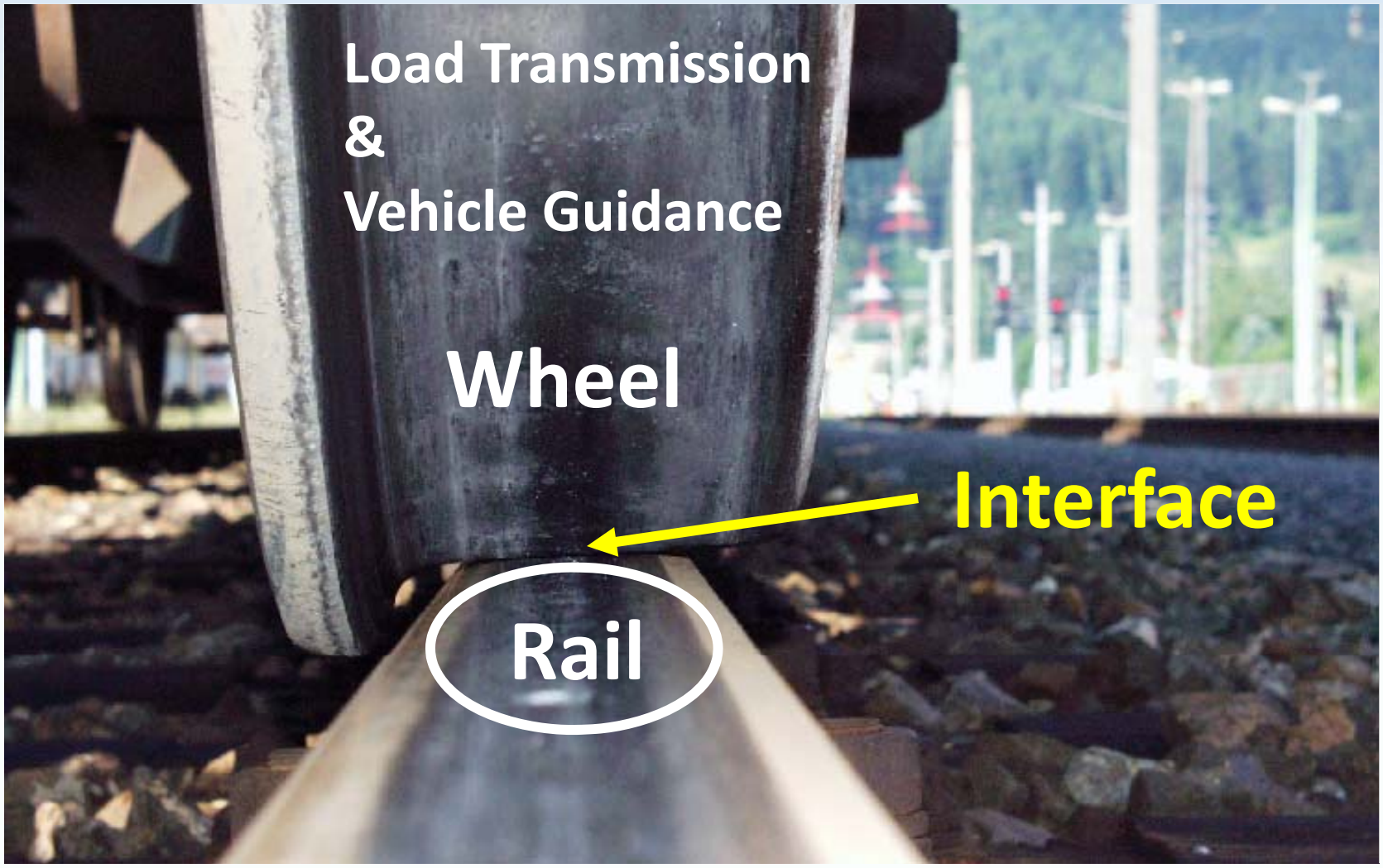
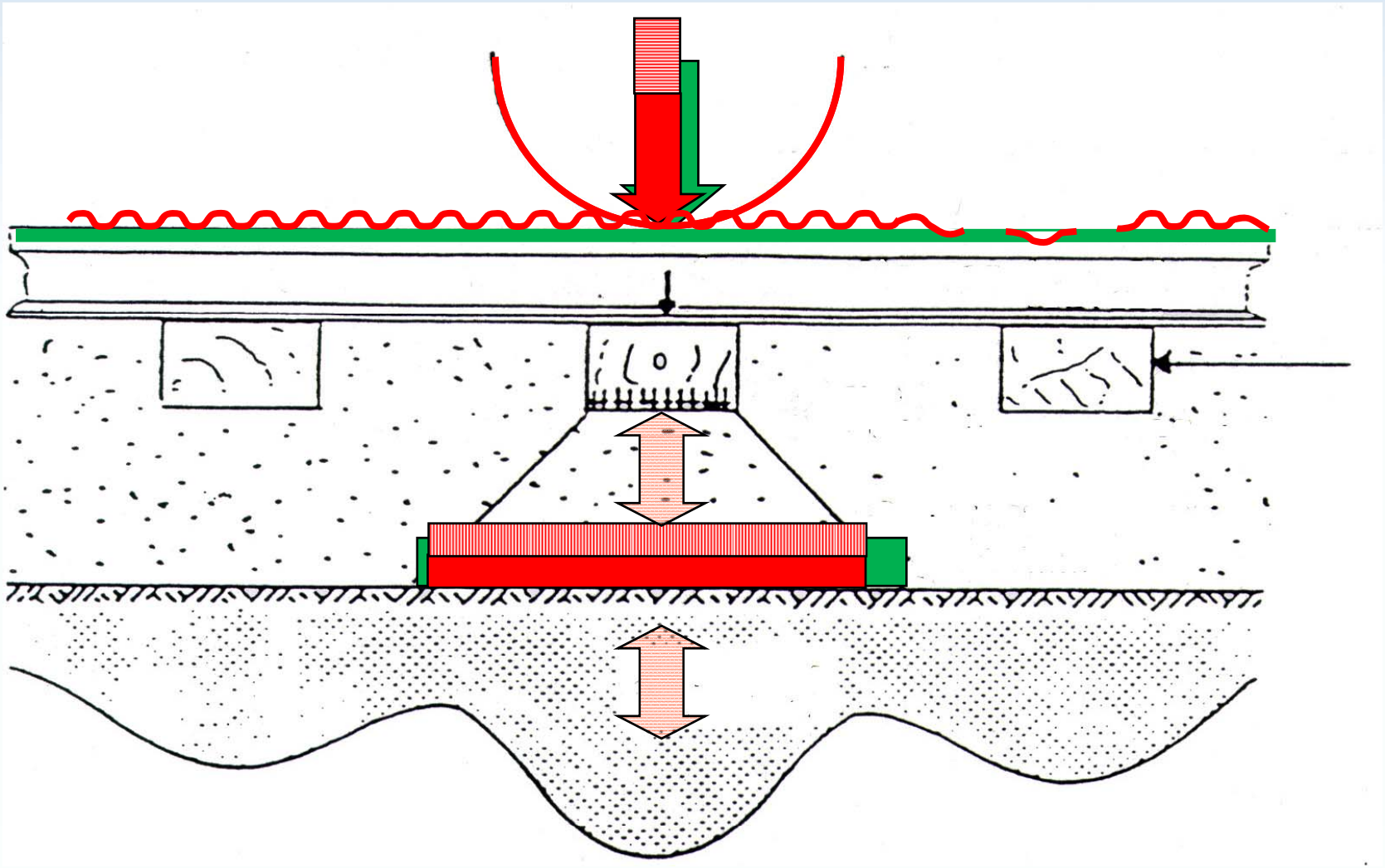
Rail maintenance in general

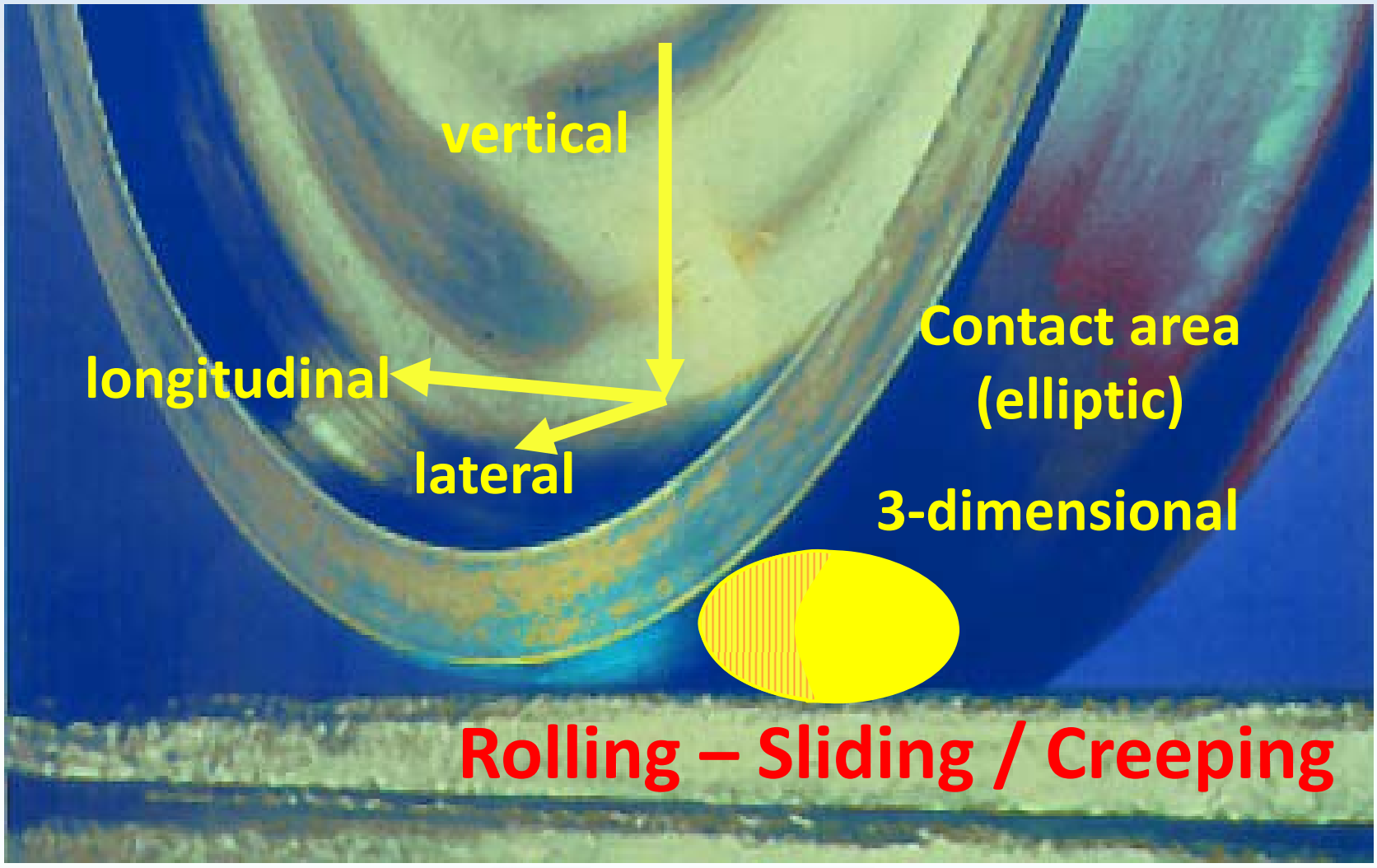


Vehicle – Track Interaction

Dynamic Forces & Vibrations

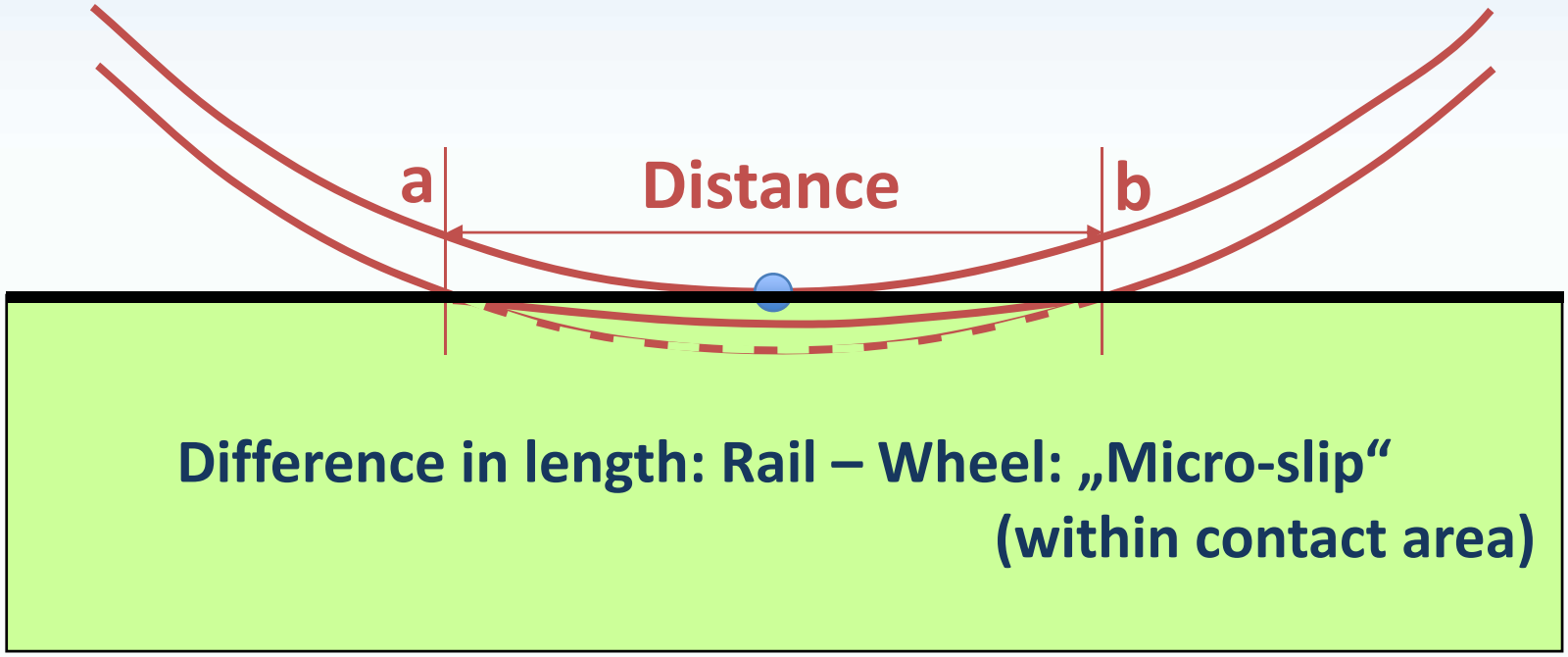


Load Transmission



Elastic Bodies in Contact

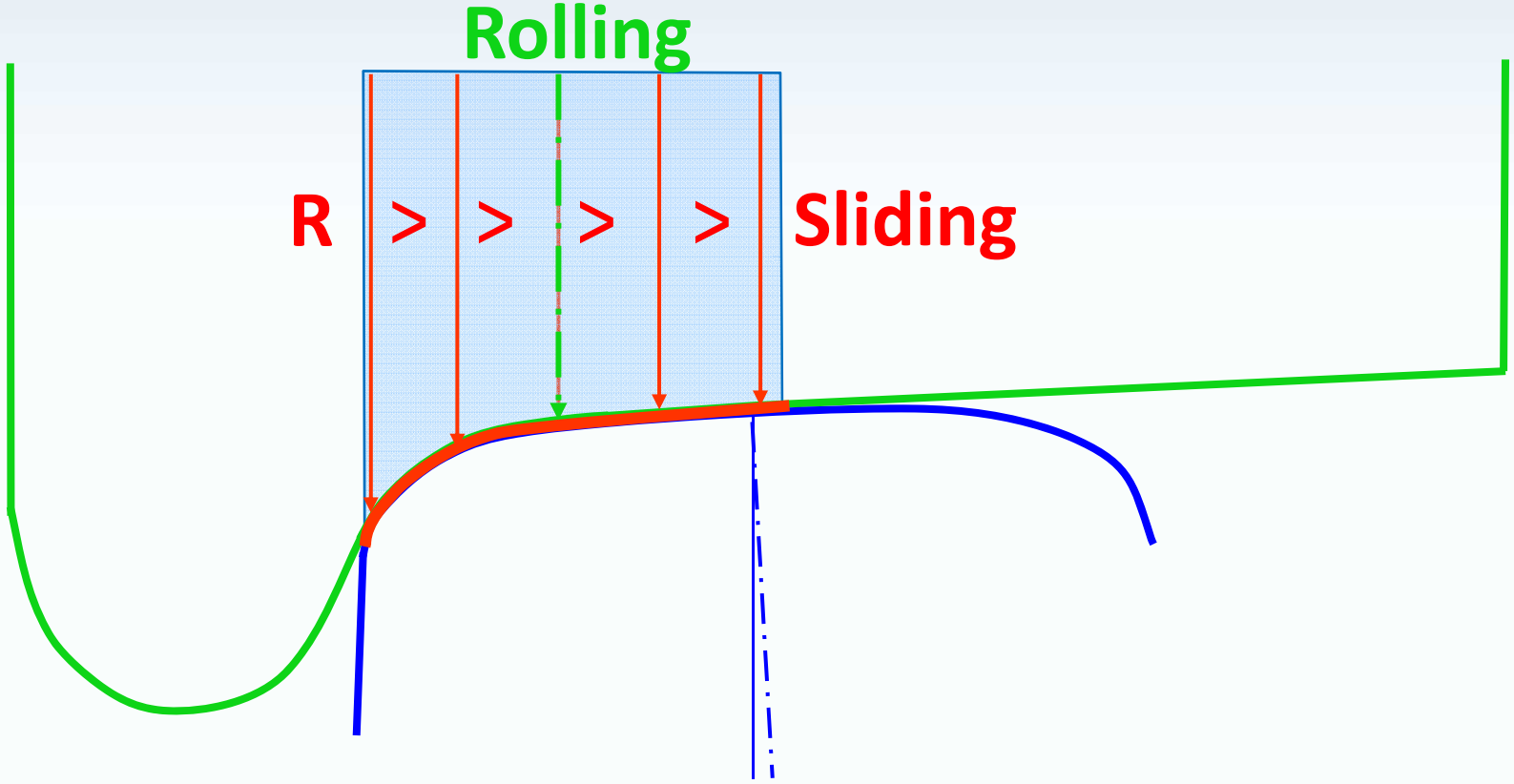
Rolling and Sliding



Difference in length: Rail – Wheel: „Micro-slip“ (within contact area)

Three-dimensional Bodies in Contact

Wide-zone-contact



Rail Maintenance by Grinding

Metal Removal (Artificial Wear)

Corrugation
Profile deformation
Damage
Fatigue

Defect Elimination – Longitudinal Profile & Vertical

Contact Geometry – Transverse Profile & Vertical

Applications for Rail Grinding

Longitudinal profile correction	Short pitch corrugation removal (tangents)
	Short wave formation removal (curves)
Transverse profile correction	Flat railheads, lips
	Improvement of contact conditions (WAP)
Surface damage removal	Ballast stone imprints, other imprints
	Irregularities at welds
Surface fatigue control	Head checks (gauge, centre)
	Squats, Studs, Flaking, Spalling
Noise reduction	Corrugation removal, Fine surface finish
Special profiling	Reduction of lateral wear
	Equivalent conicity, gauge widening
	Reduction of fatigue

Grinding Strategy - Definition

Regularly programmed (pre-scheduled) or repeatedly executed maintenance work

- **When should the grinding action take place? (Intervention threshold)**
- **What should the grinding process achieve?**

  (Defect correction = Metal removal)

  (Contact Geometry Correction = Target profile)

Maintenance Strategies

- Corrective grinding
  - Symptom related grinding
  - Cyclical grinding
- Preventive grinding
  - Initial grinding (new rails)
  - Cyclical grinding

Corrective Grinding

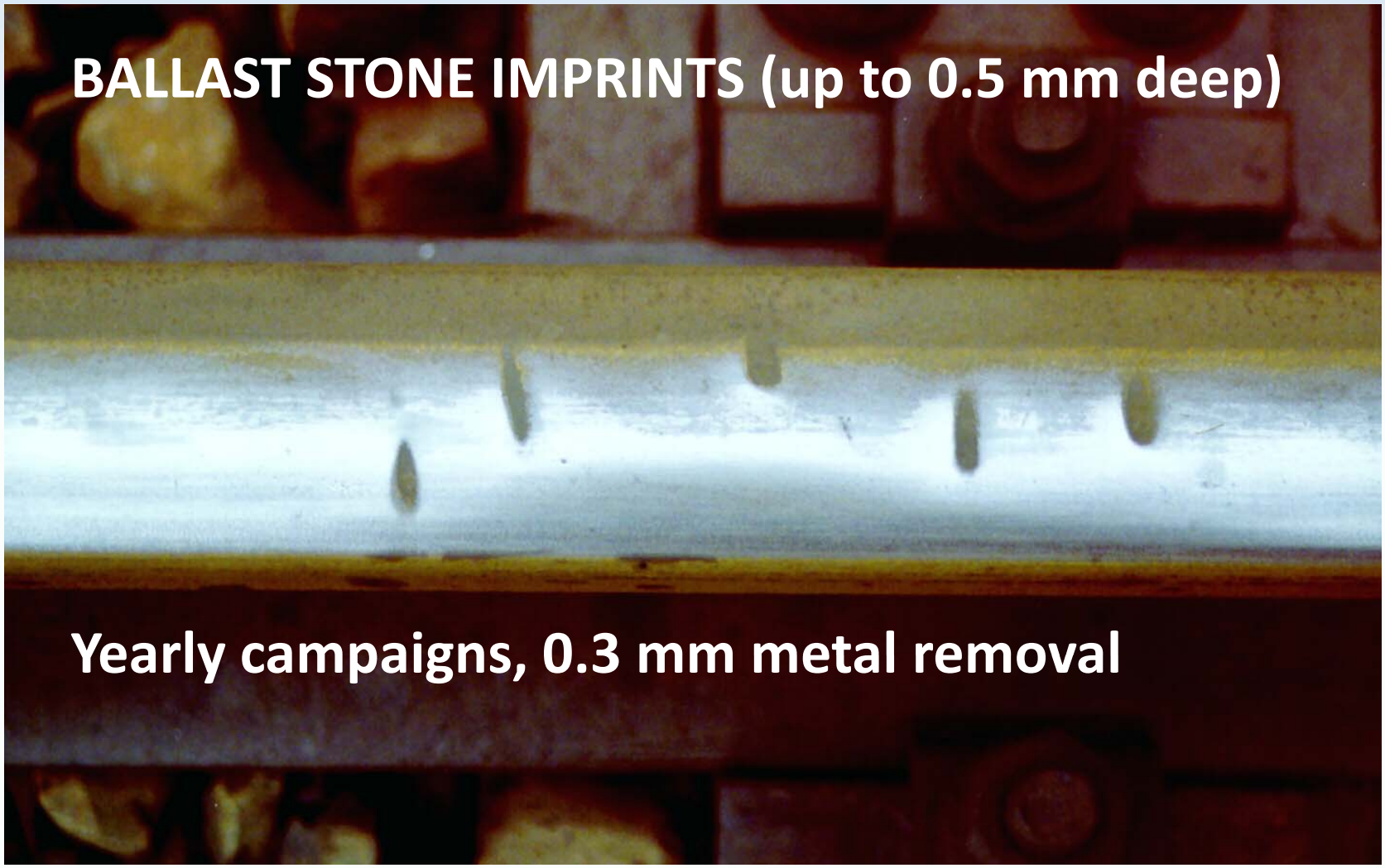
Removal of (severe) defects such as:

Corrugation, Plastic deformation,
Surface damage, Surface fatigue

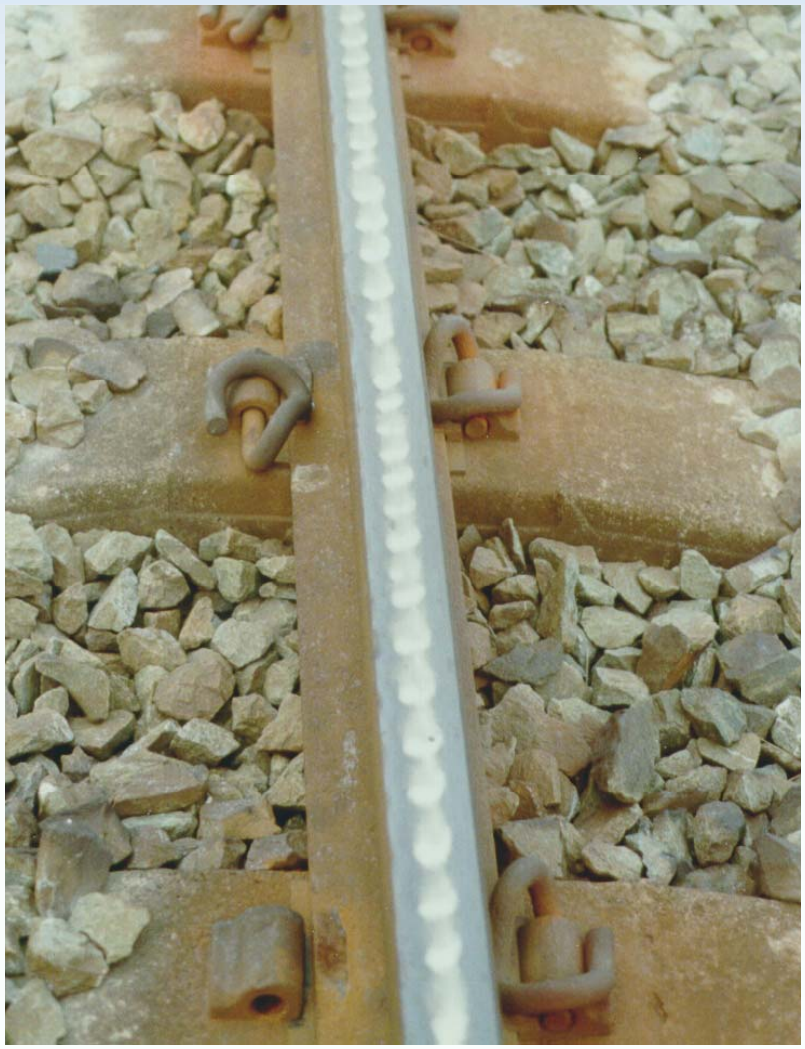
Restoration of optimal conditions

Metal removal:
Small defects (< 0.1 mm) - Severe defects (> 1 mm)

Example - Surface Damage



Example - Corrugation



Symptom based grinding

Corrugation removal when passing a pre-set threshold

Choice of threshold with respect to economic and technical considerations

Surface damage / Fatigue - Visual detection, recording

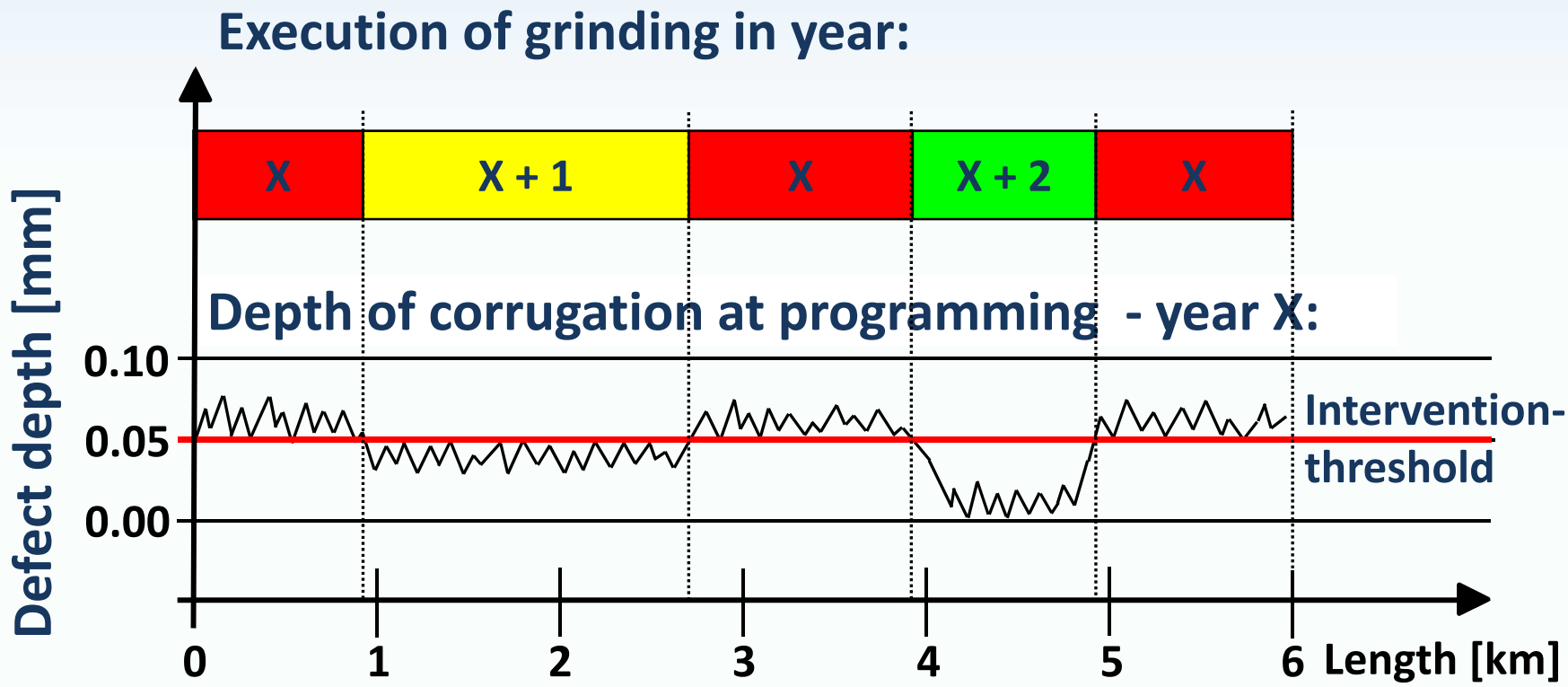
Example

Intervention Thresholds DB Netz AG

Line Speed V [km/h]	Defect Type	Wave length [mm]	Planning Depth [mm]	Execution Depth [mm]
< 120			0.07	0.10
120 - 160	Short pitch corrugation	10 - 100	0.05	0.07
160 - 200			0.03	0.05
> 200			0.02	0.03
	Short waves	30 - 300	0.10	0.20
	Long waves	300 - 1000	0.40	0.50

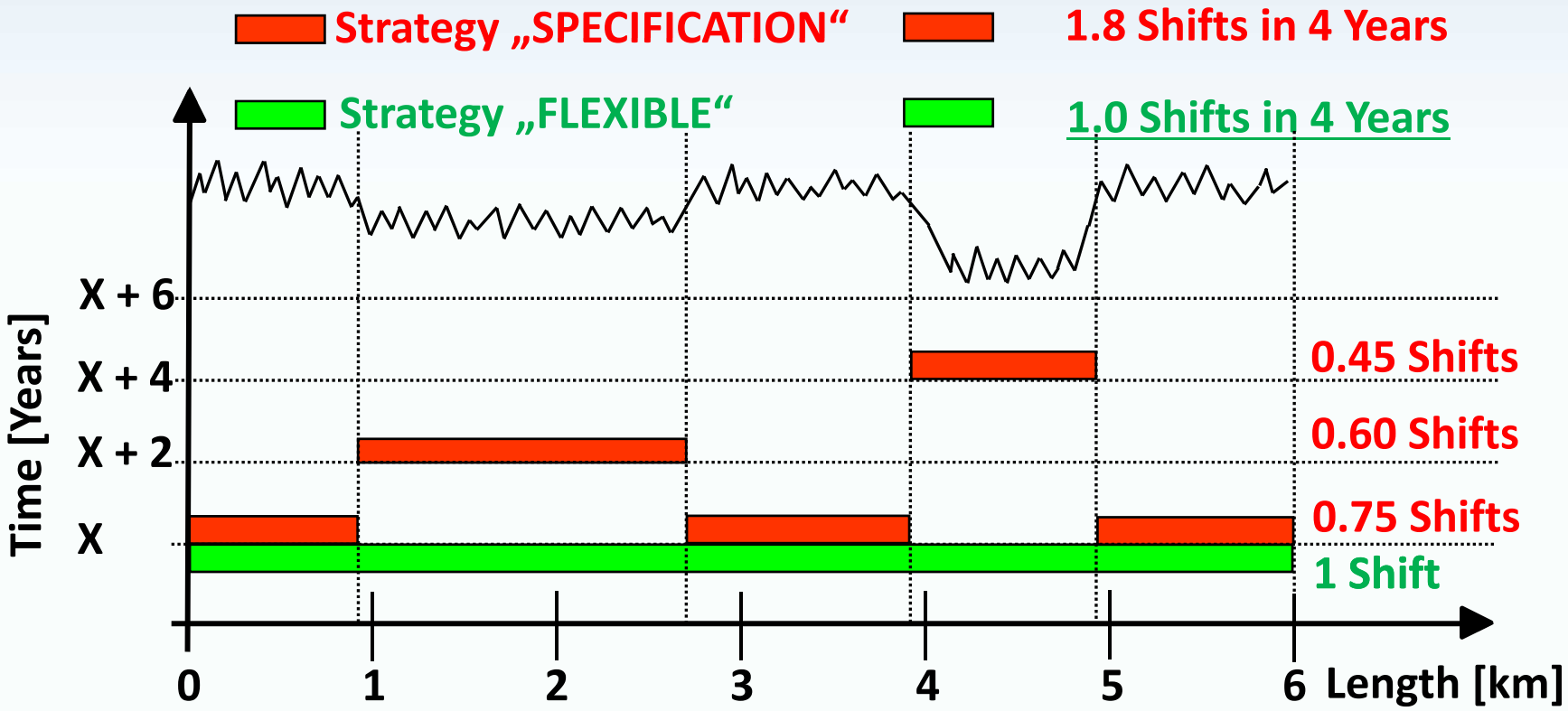
Execution - Fixed Threshold

Symptom-based periodic maintenance (example corrugation)



Optimized Threshold

Grinding work in the course of time
(Corrugation growth: 4 years until intervention threshold)



Preventive grinding

Treatment before
measurable / significant defects appear

Removal of usually small quantities of metal,
Minor transverse profile corrections

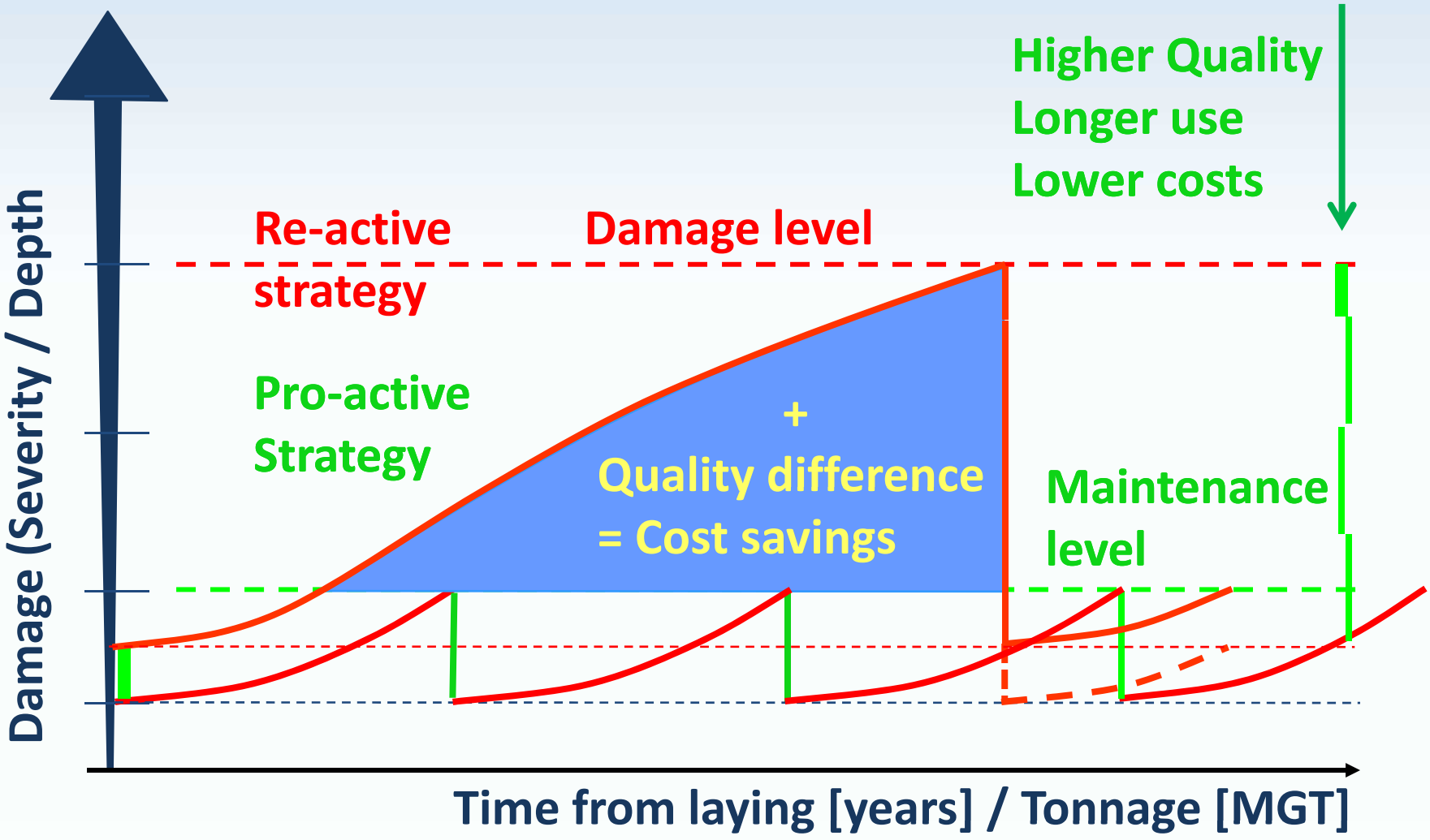
Metal removal: 0.1 – 0.3 mm / intervention

Cyclical grinding

Repeated removal of the top surface layer,
minor correction of transverse profile

Intervention cycle depending on damage development
(mainly experience, in future recordings)
(e.g. 15 – 150 MGT, 0.1 – 0.3 mm metal removal)

Alternative Grinding Cycles



Initial grinding

Providing of best possible contact and running conditions

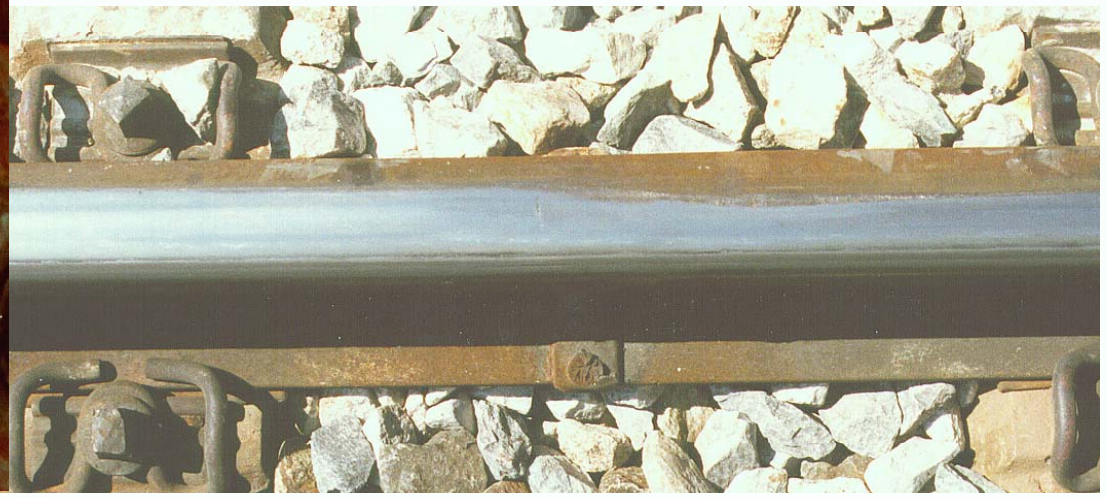
↓

Minimizing the dynamic forces

↓

Maximum delay of damage formation and development

New Rails



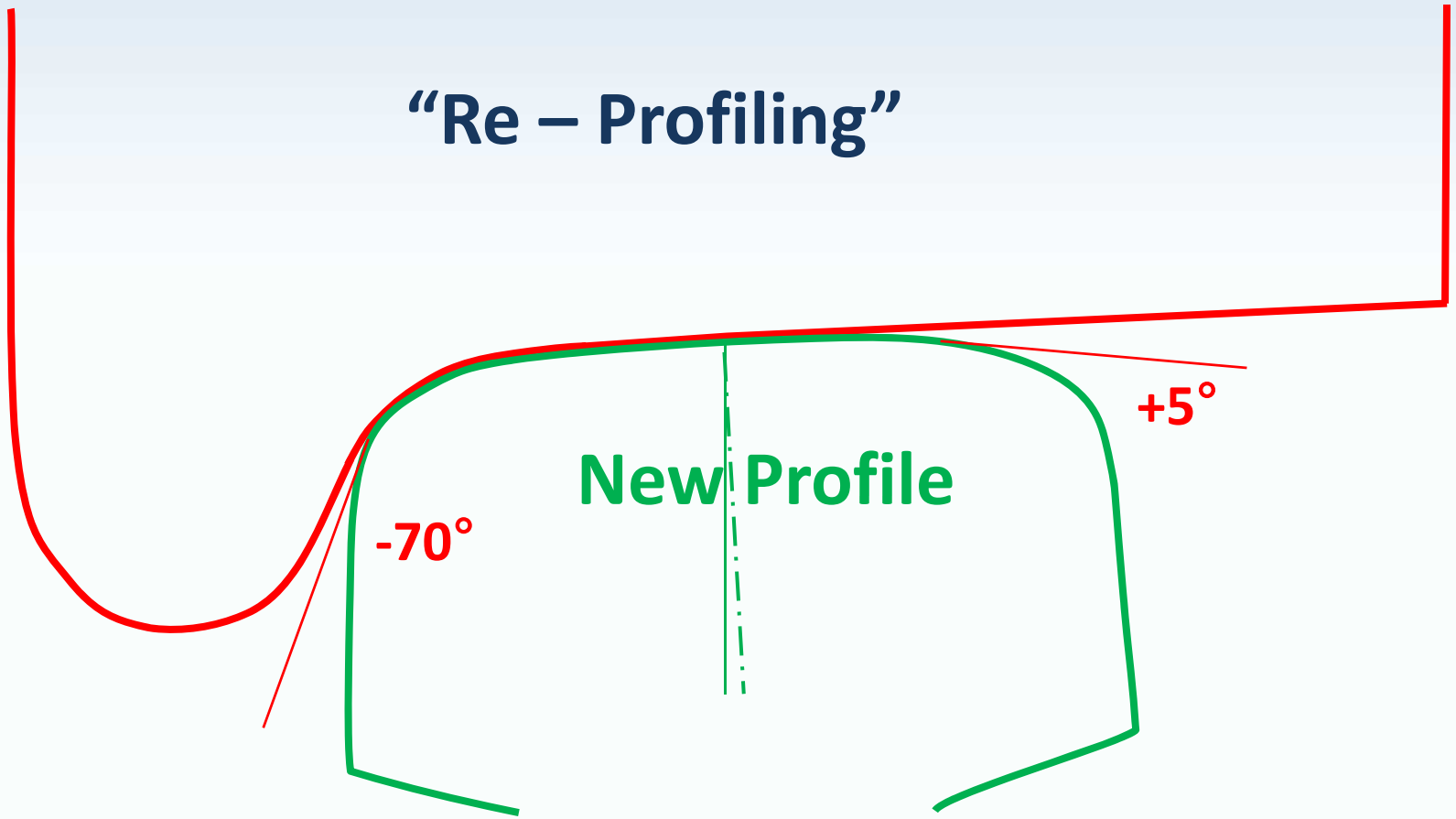
Application of Initial Grinding

All major European Railroads

Newly constructed lines (particularly high-speed)

After re-railing in main tracks (sometimes up to 6 months later)

Target Profile



Special Profile Grinding

Wear Reducing Profiles
("Asymmetric Grinding")

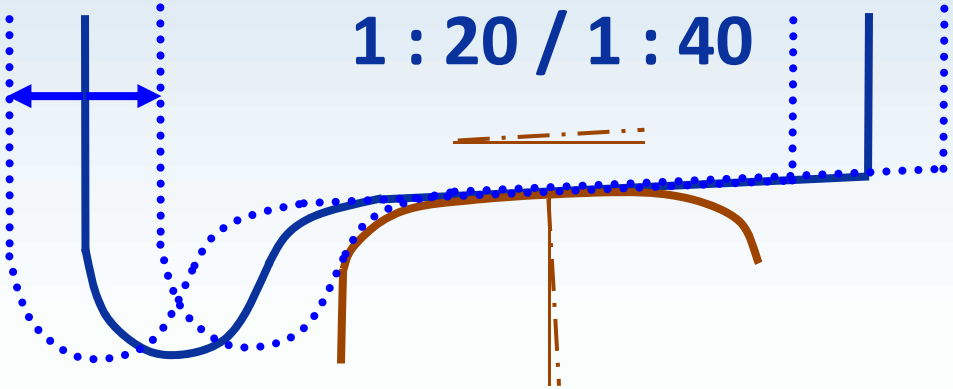
Vehicle Behaviour Improving Profiles
("Gauge Widening Profiles")

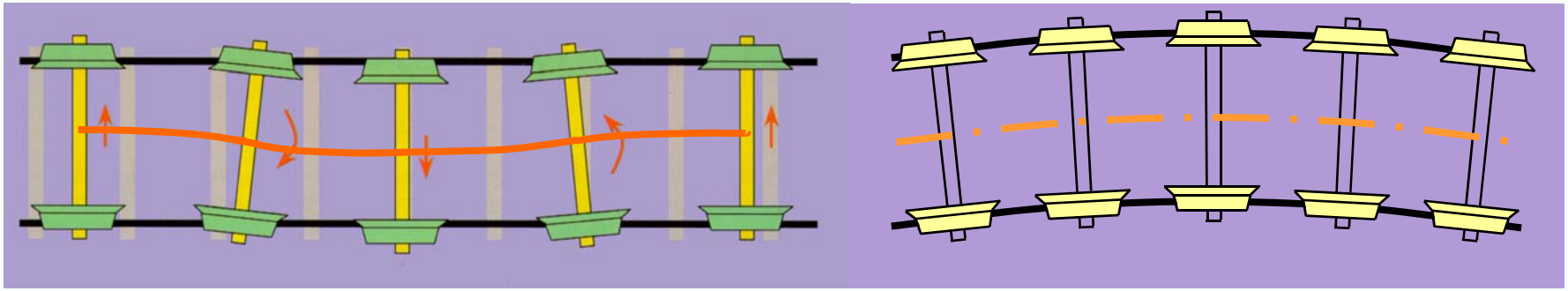
Fatigue Reducing Profiles
("Anti-Head Check Profiles")

(Sometimes combined with other applications)

Conicity and Self - Centering

Lateral movement

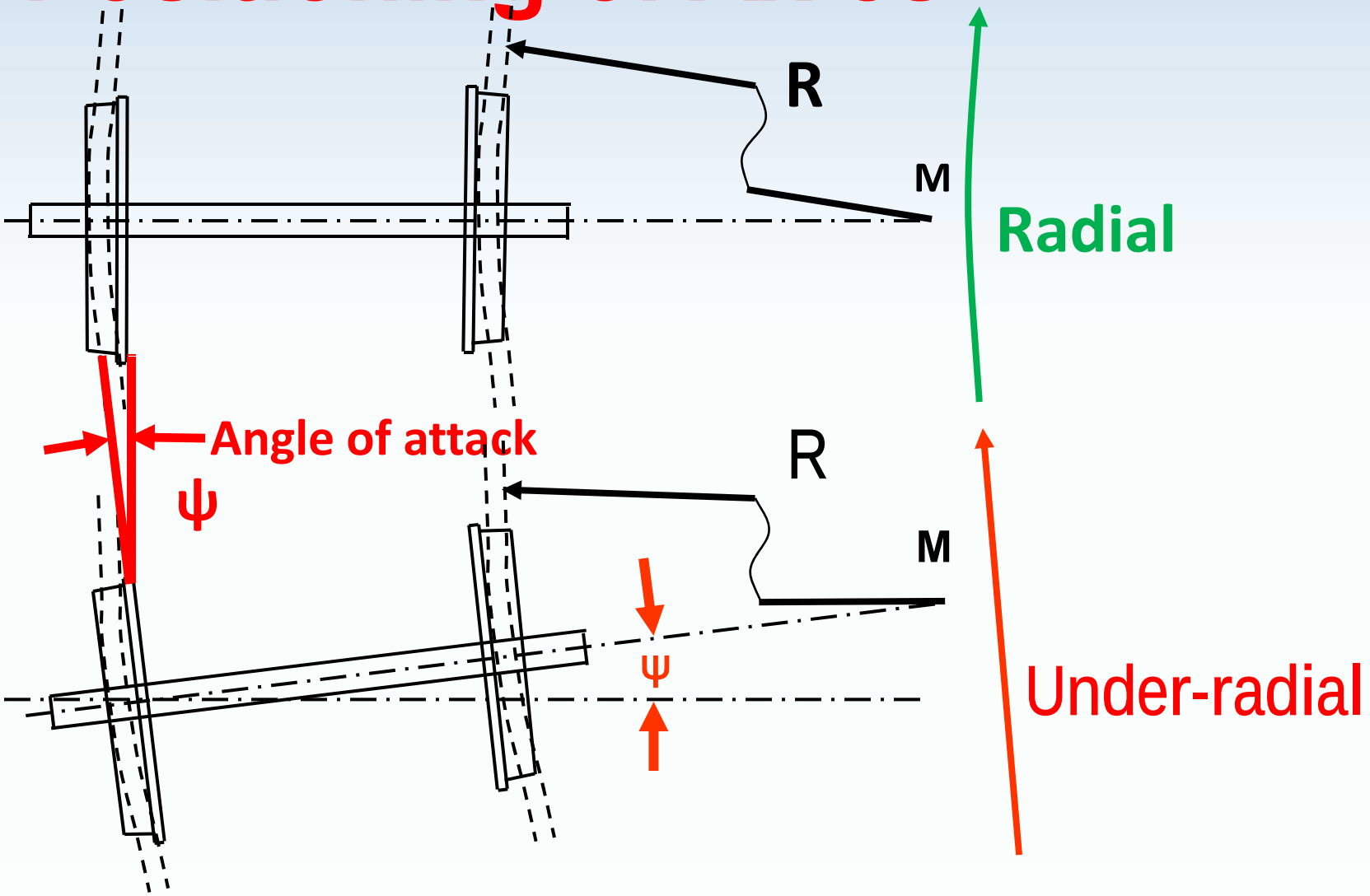




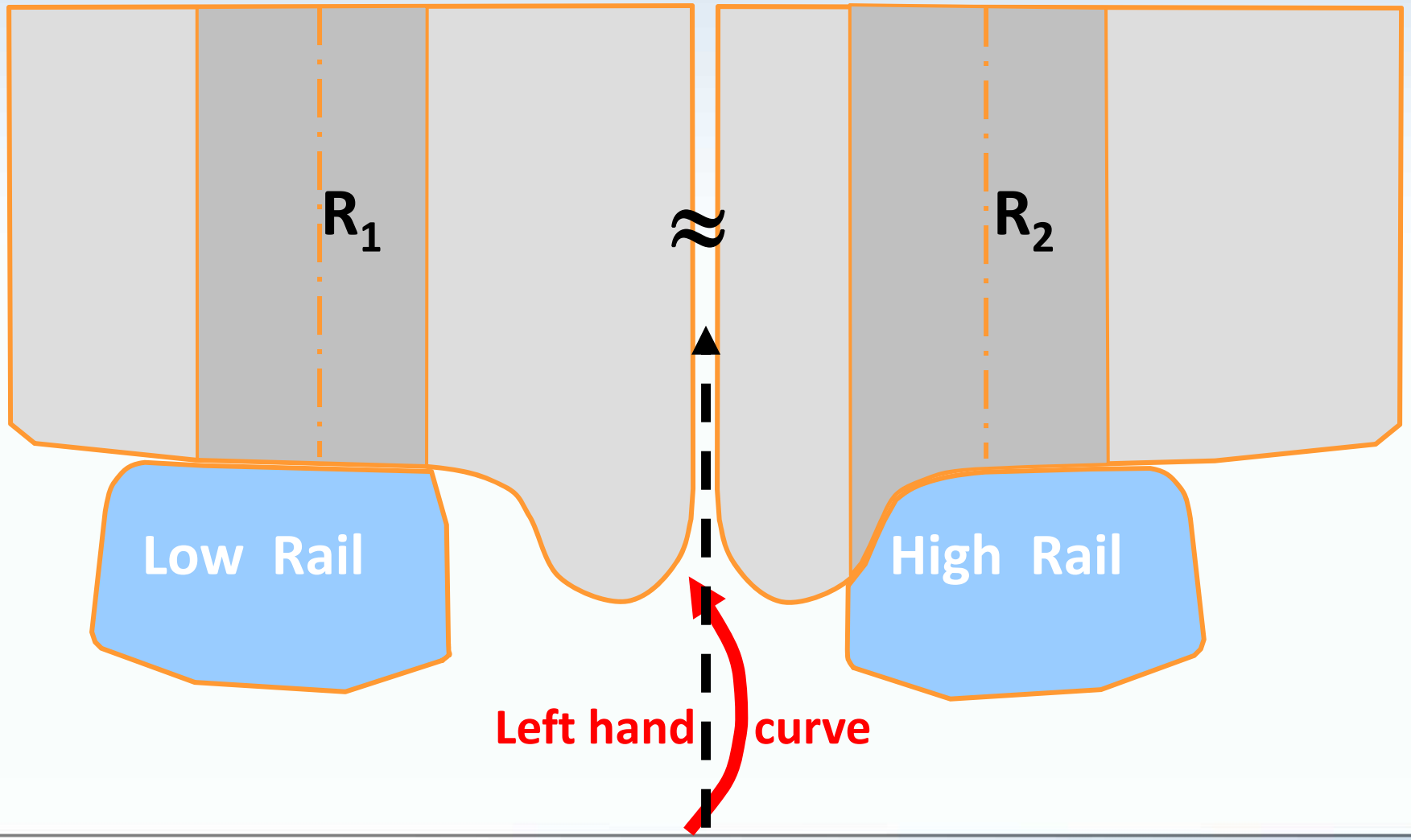
Self - centering (Tangent)

Radial positioning (Curve)

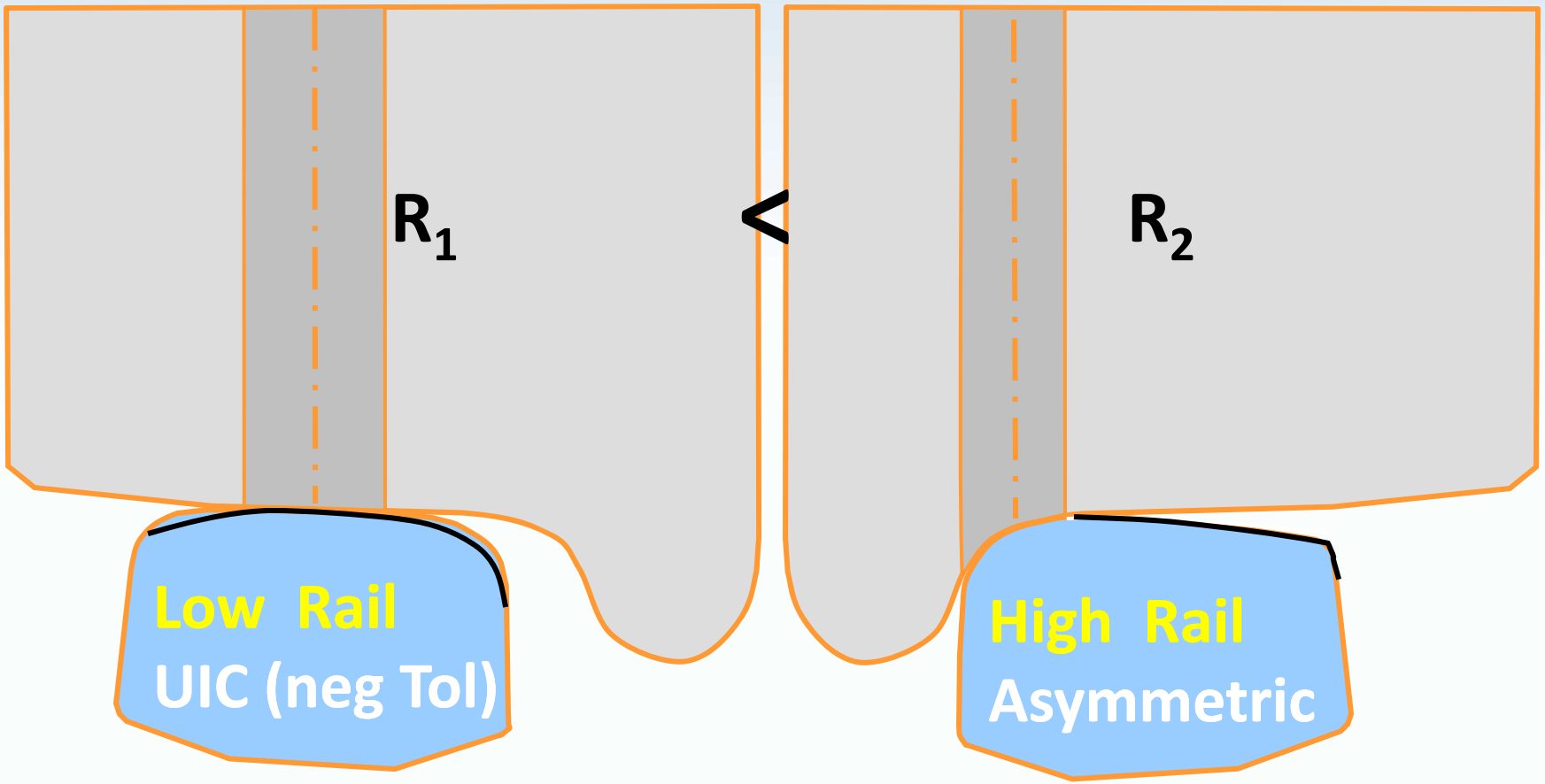
Positioning of Axles



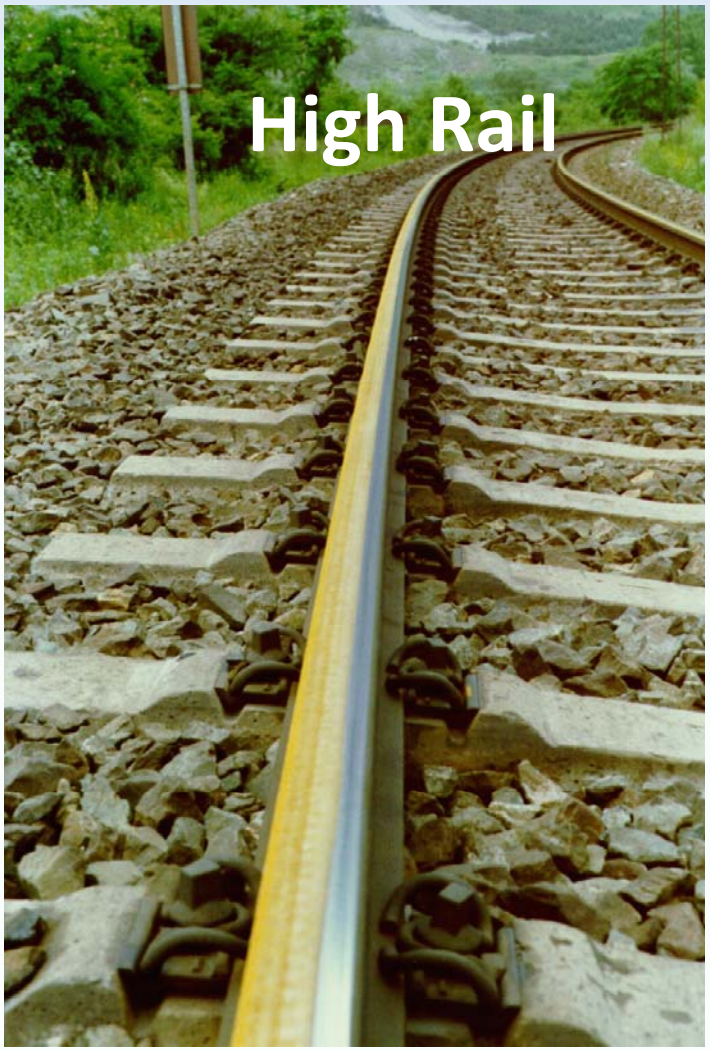
Typically Worn Rail Profiles

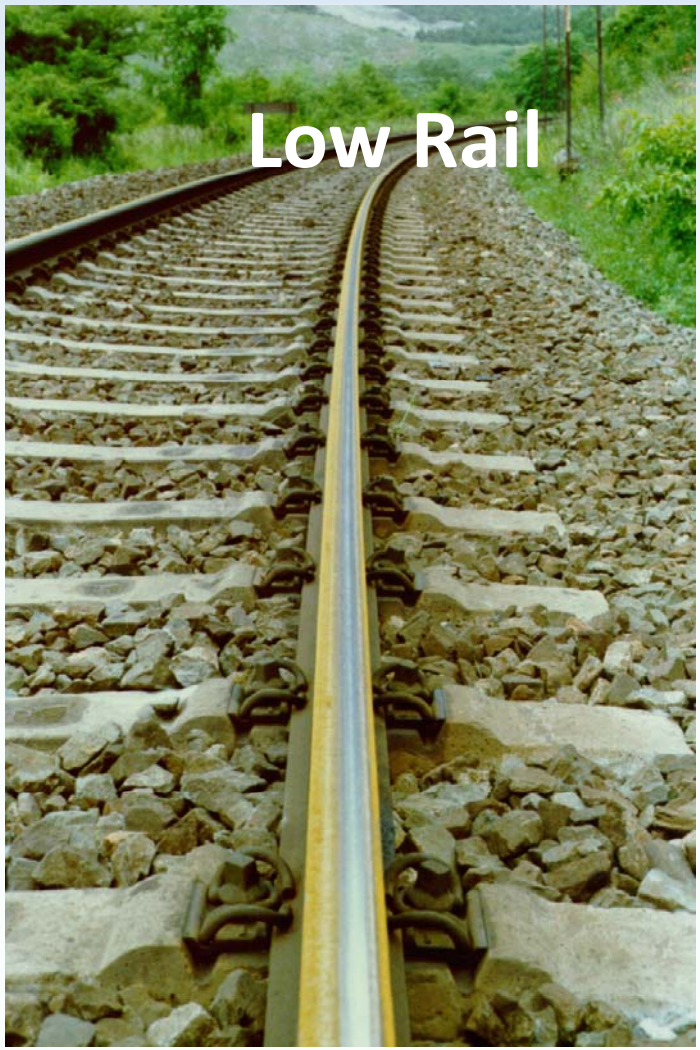


Specific Profiles ÖBB

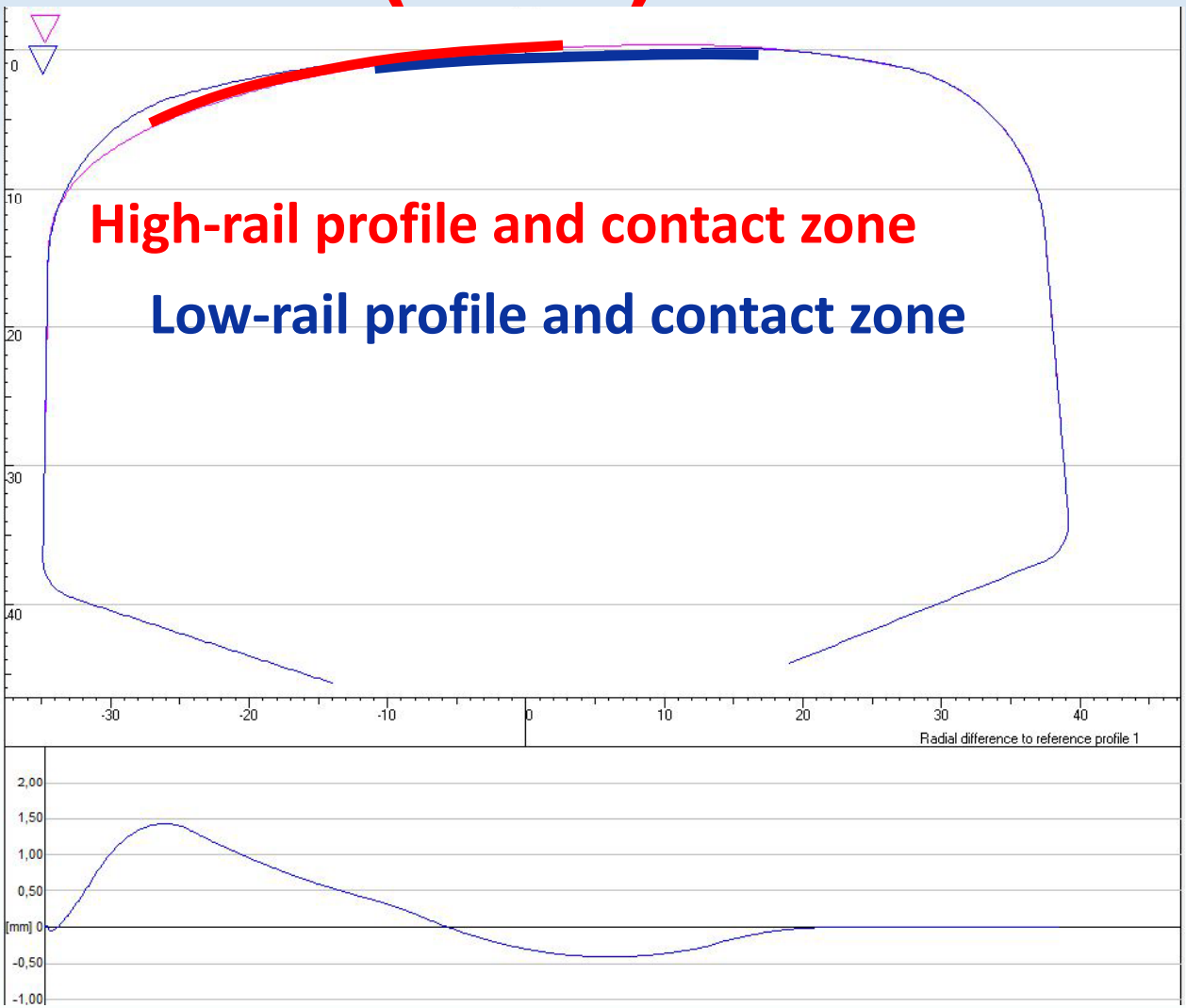


Specific Asymmetric Profiles

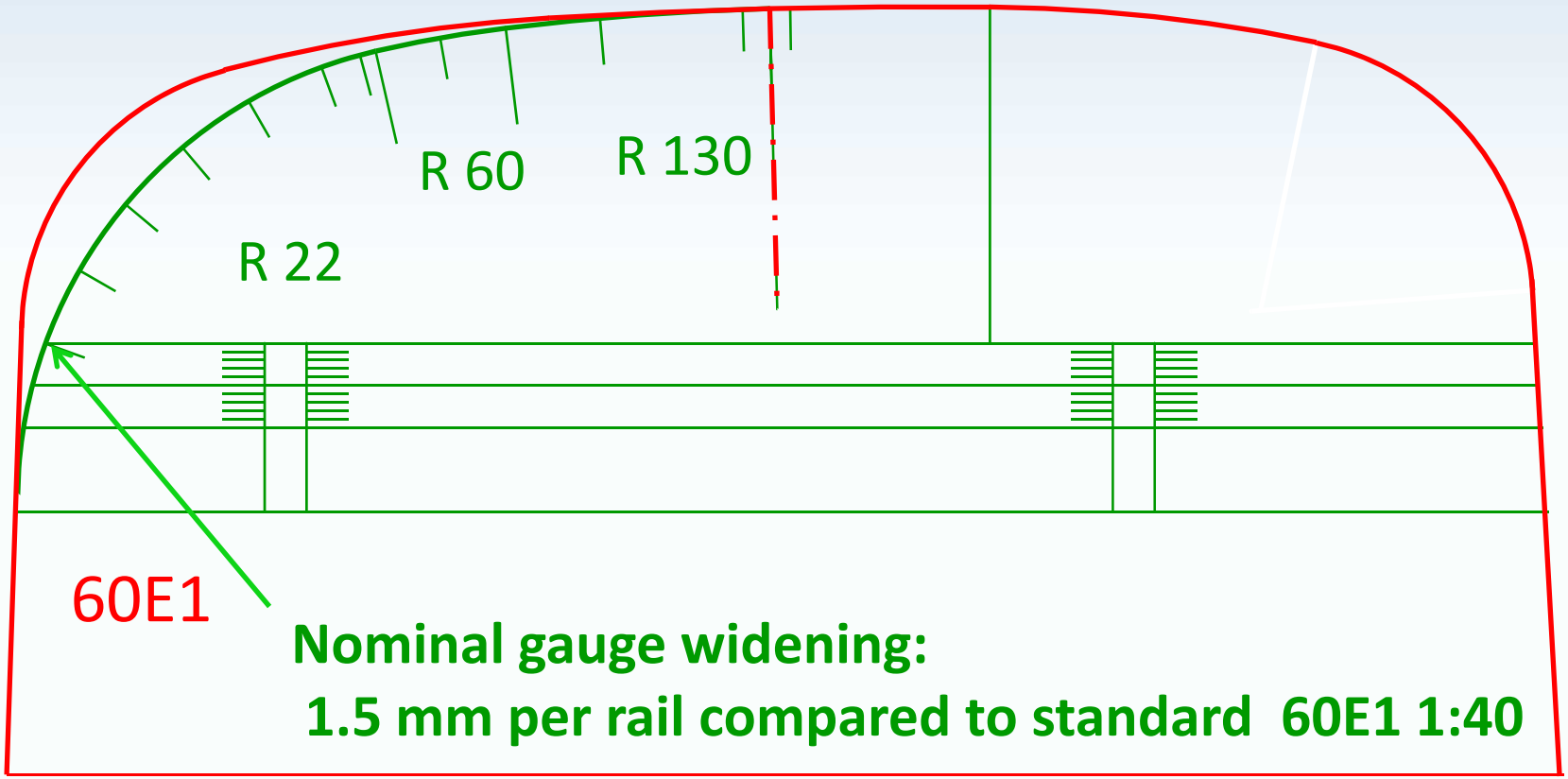




Ofotbanen (JBV)



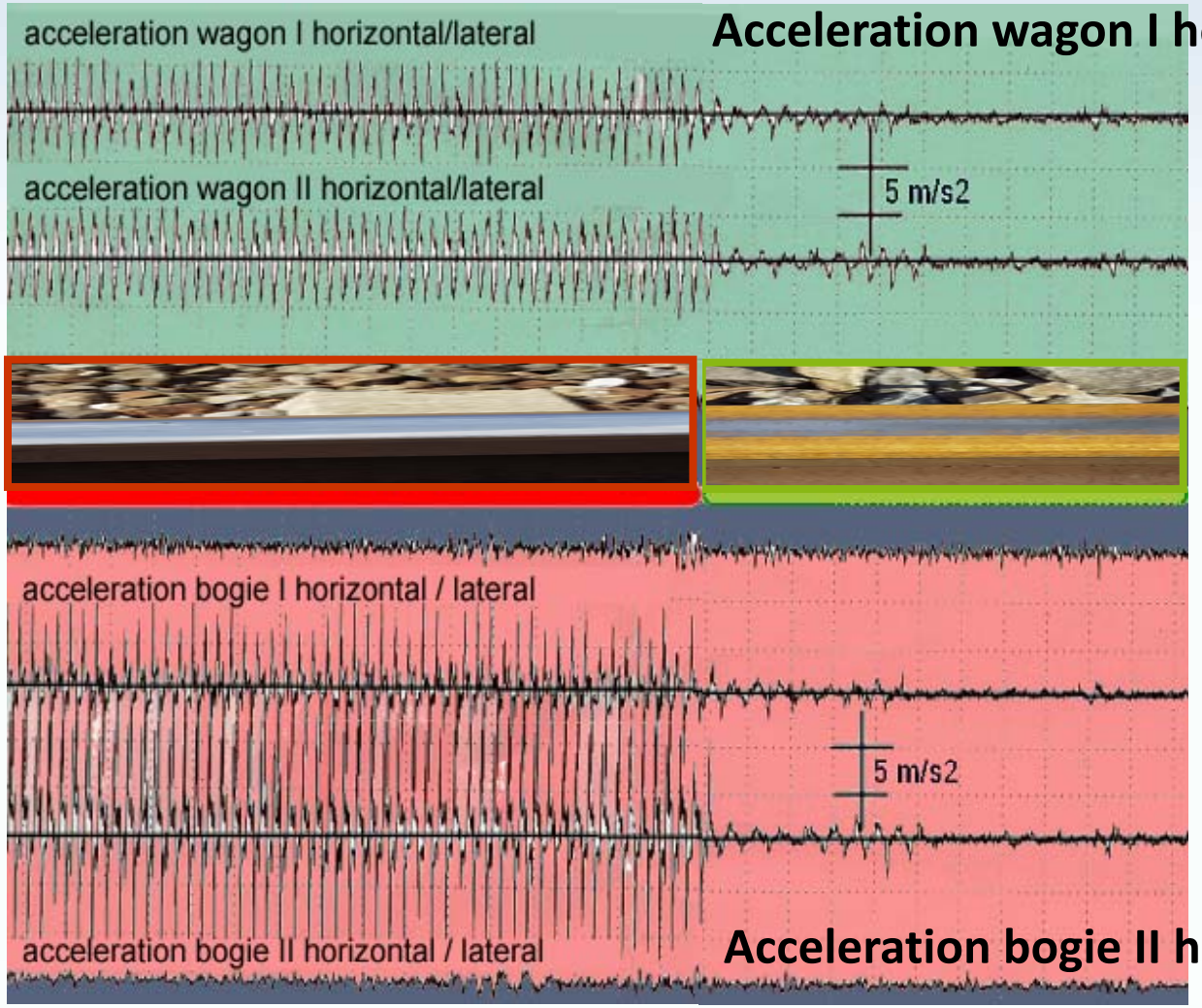
Convex Profile ÖBB



Profile design by Austrian Railways (ÖBB)

Different Profiles

Effects: Before / After Grinding



Acceleration wagon I horizontal

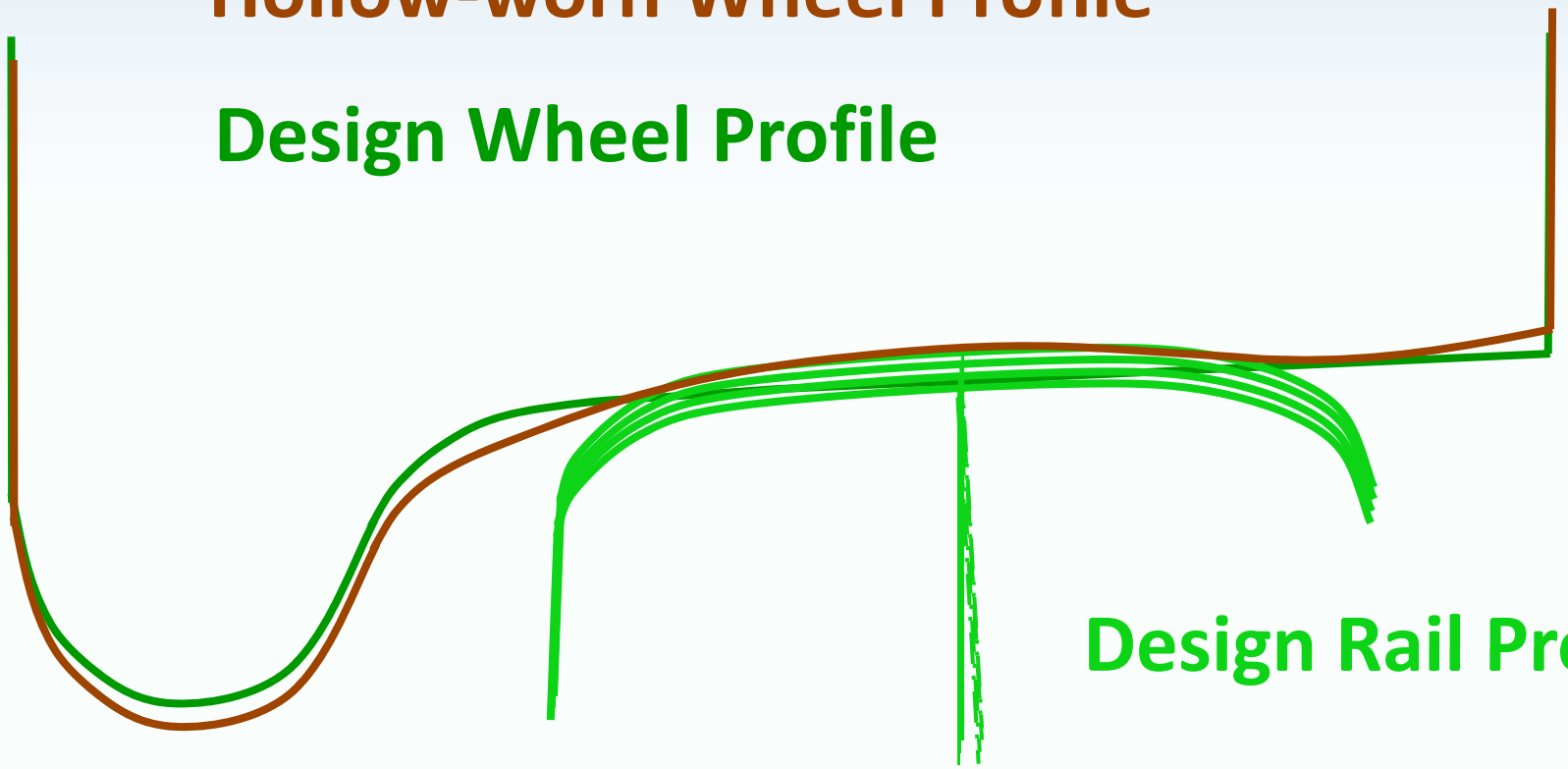
Track Ground

Track Not Ground

Convex Profile ÖBB

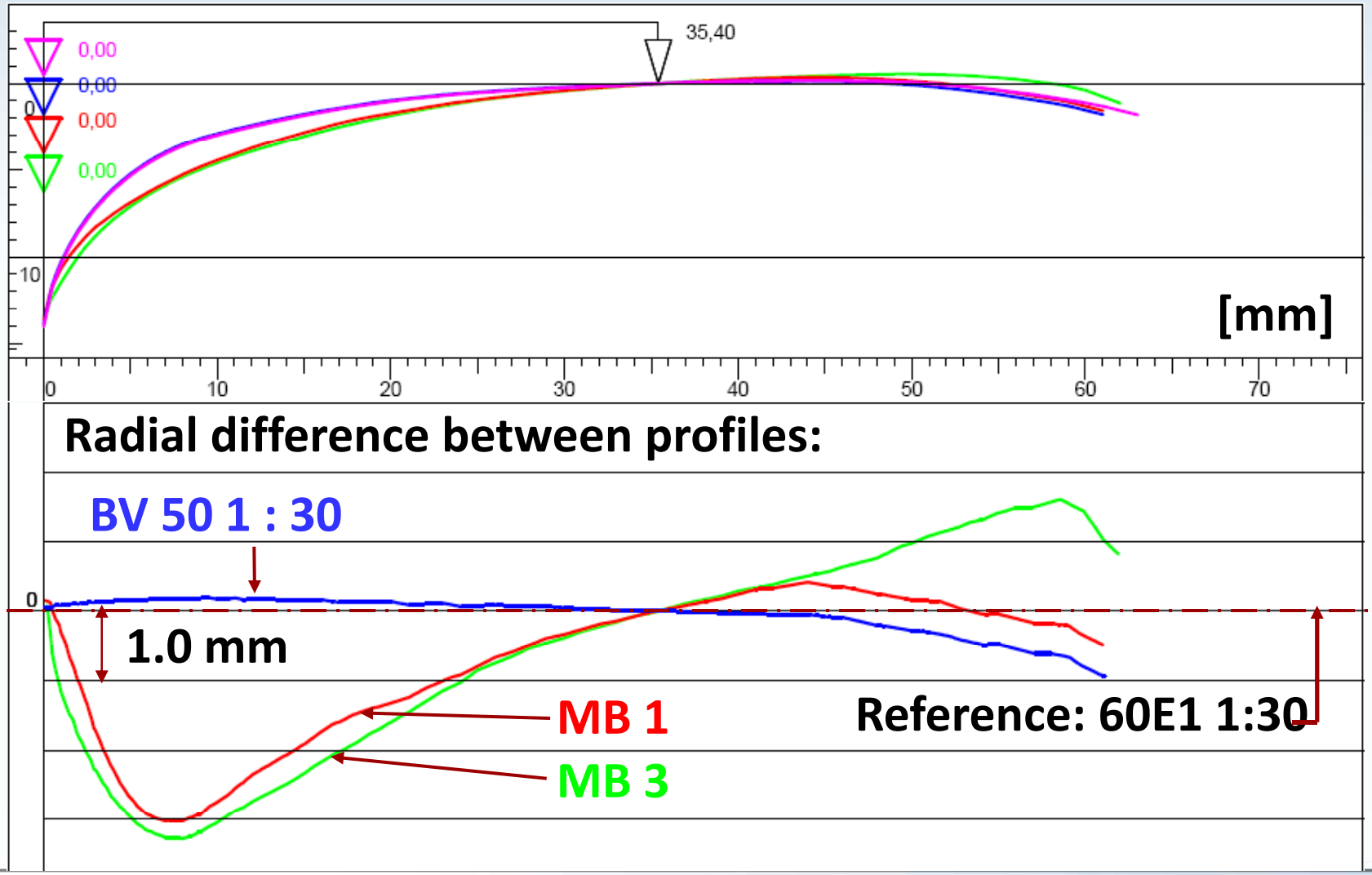
Acceleration bogie II horizontal

Profile Changes - Wheel



Contact Area Changes

WAProfile – Example TRV (2000)

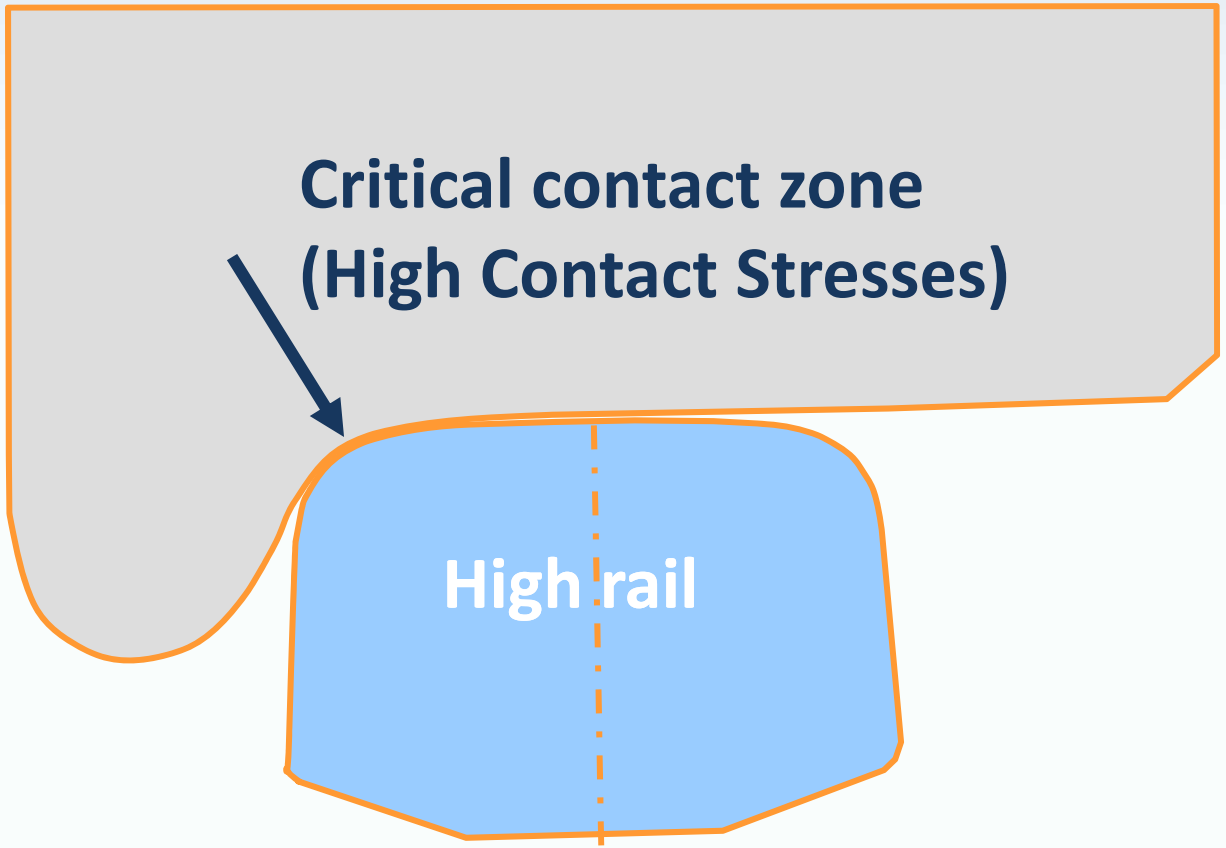


Squats, Studs & Belgrospi

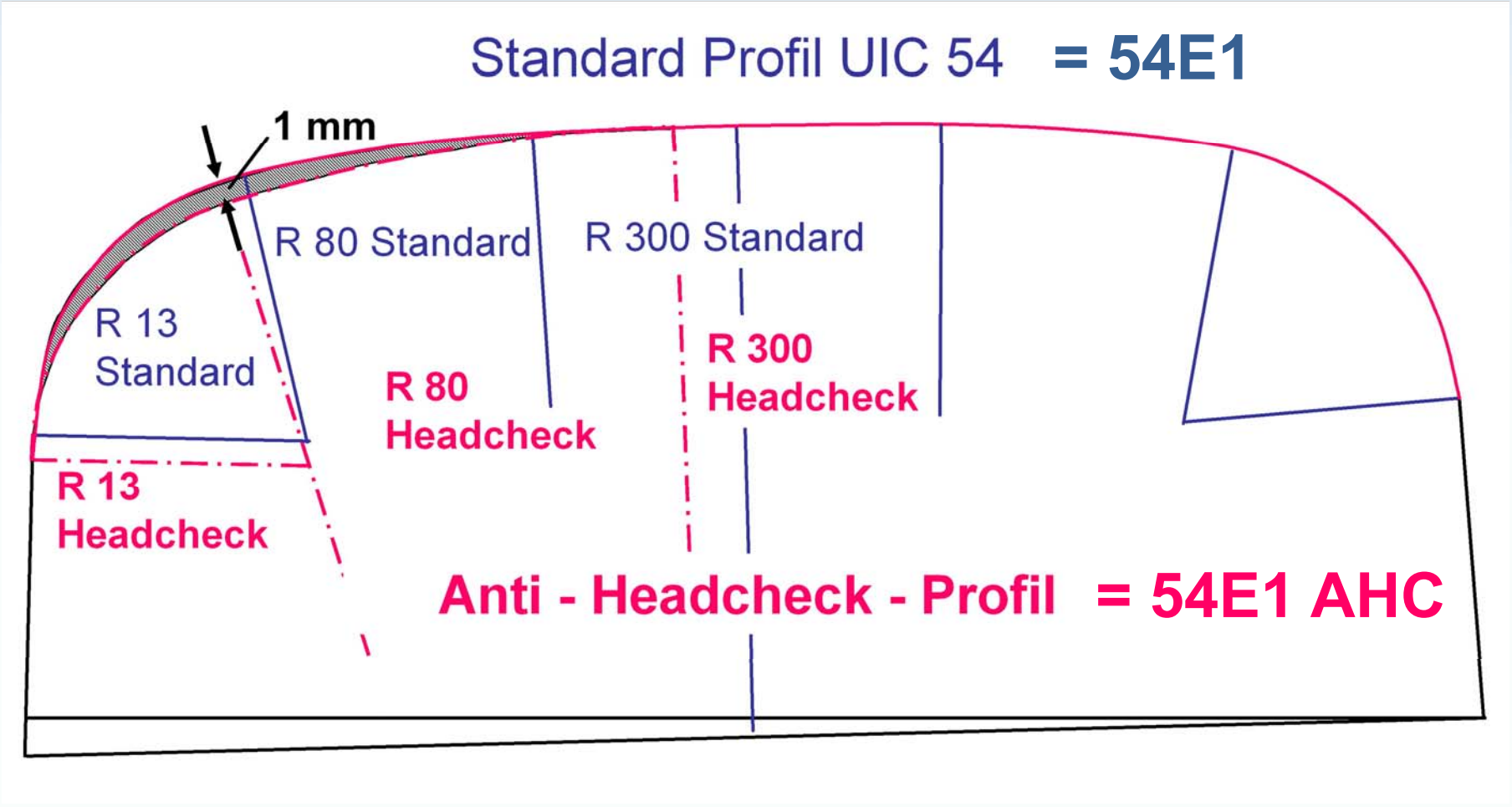
Head Checks

Typical Contact Conditions - HC

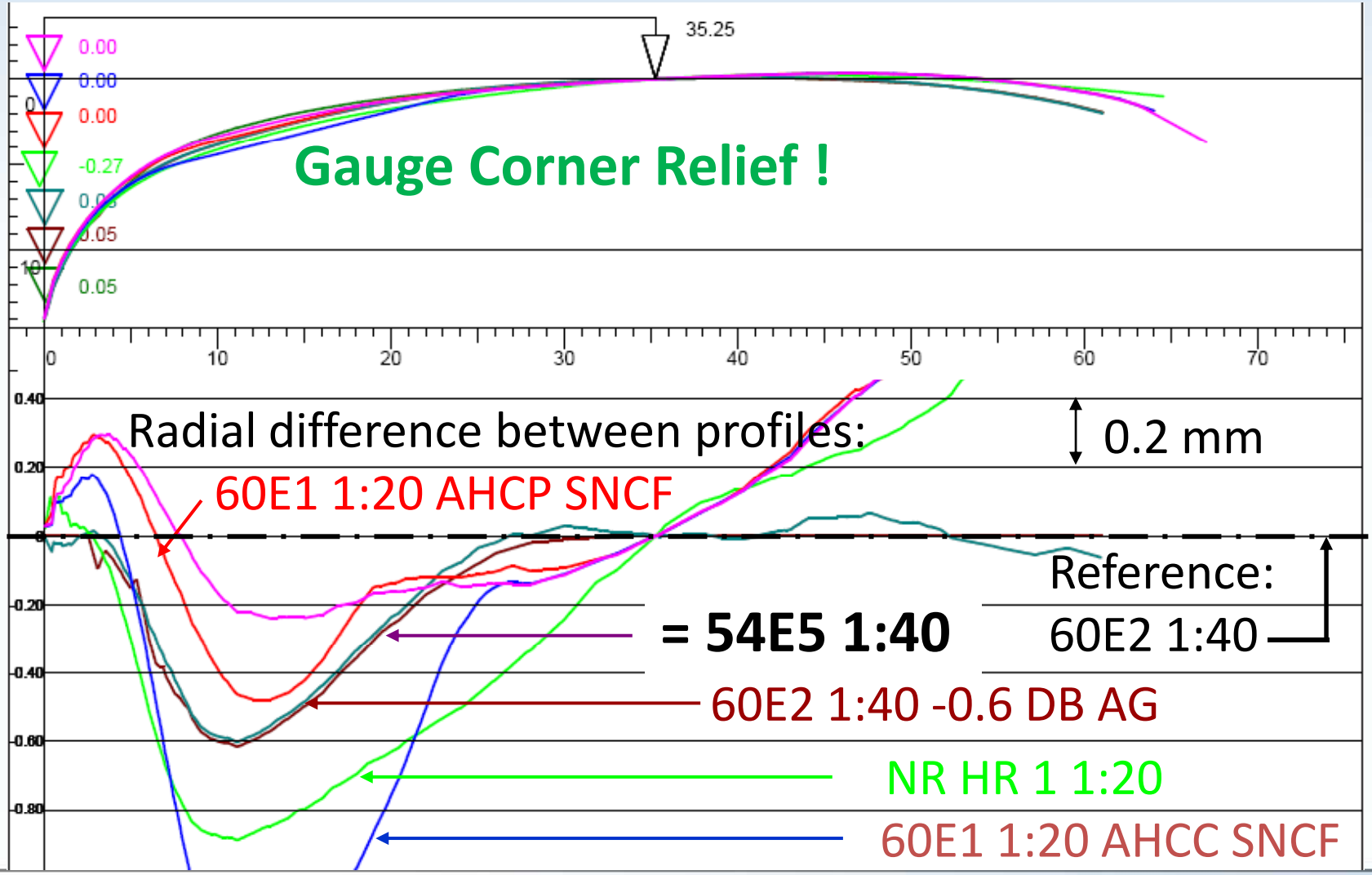
Important: Target Profile and Production Tolerances



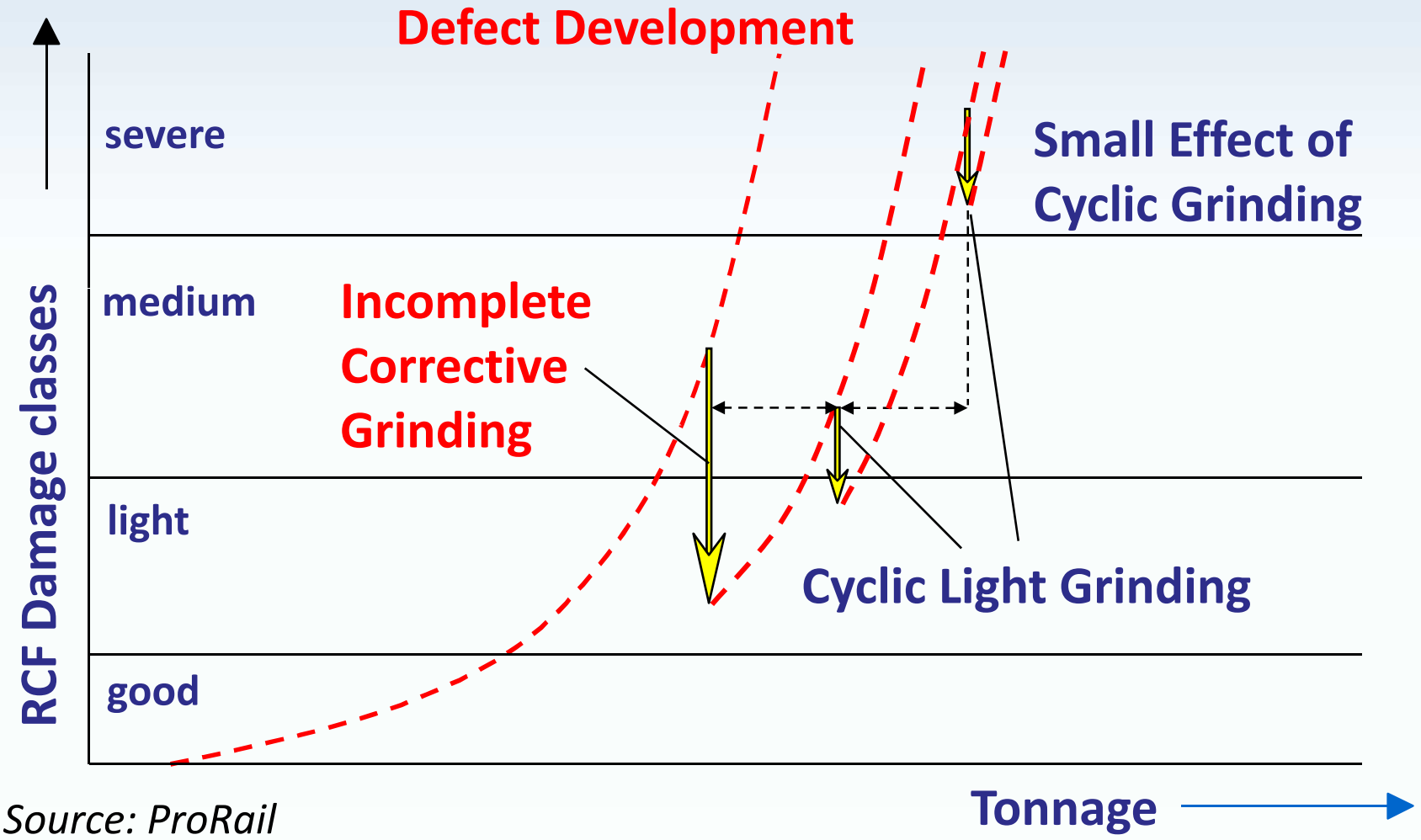
AHC - Profile (Example ProRail)



AHC-profiles (“Innotrack”)

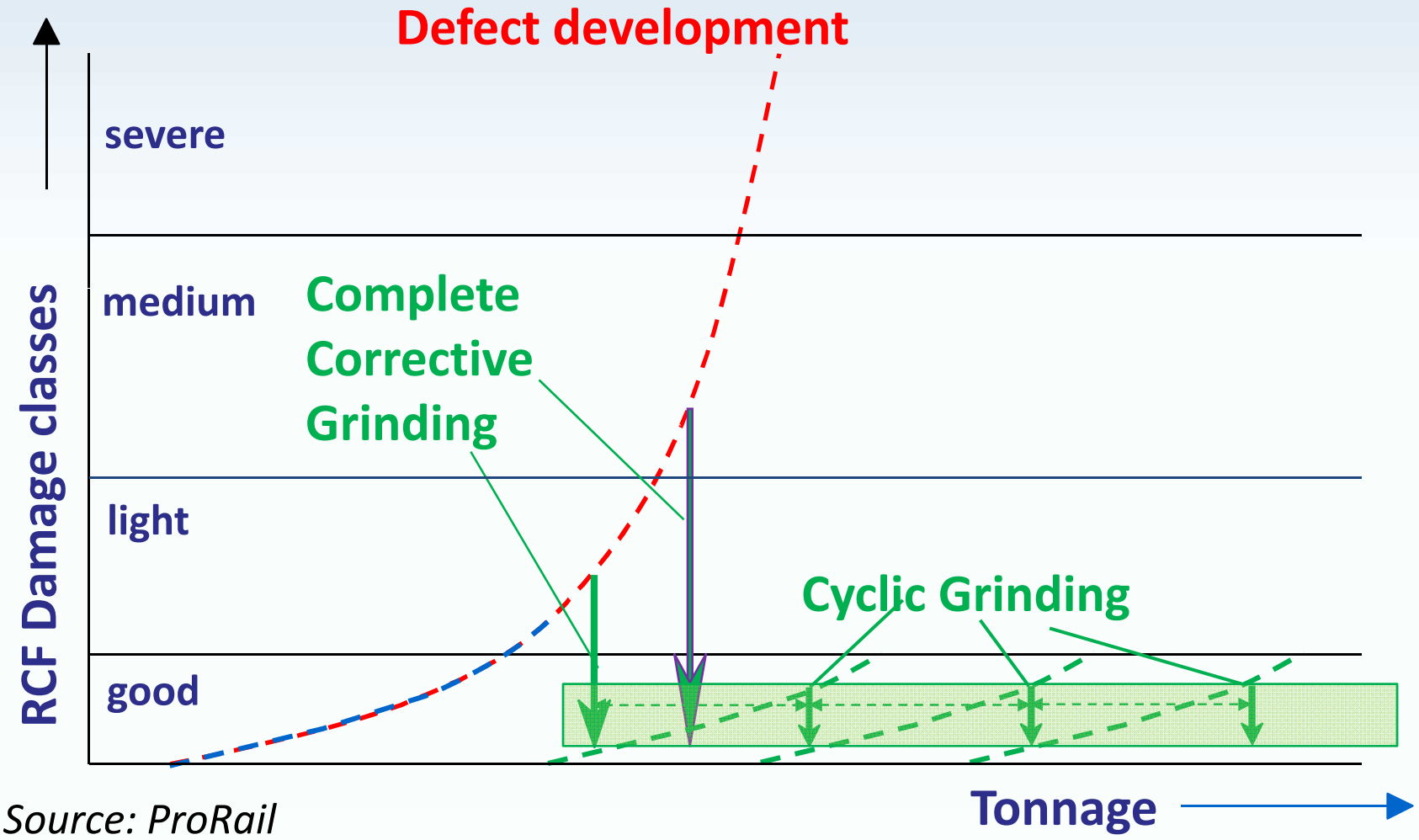


Incomplete Corrective Grinding



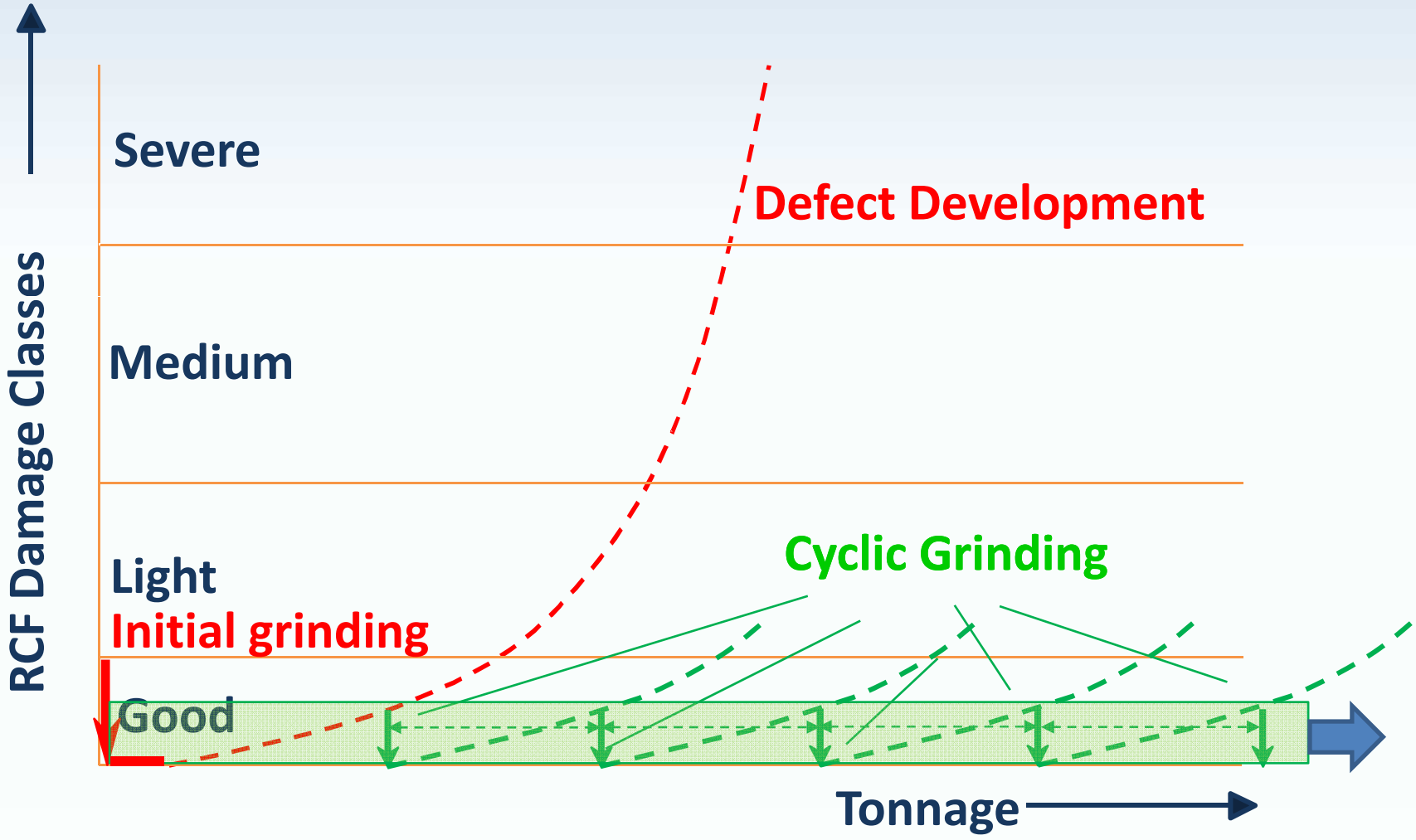
Source: ProRail

Complete Plus Cyclic Grinding



Source: ProRail

Initial & Preventive Grinding



Special Target Profiles

Routine Operation

Interaction
Wear – Fatigue – Running behaviour

Maintenance Strategy
Initial / Corrective / Preventive / Cyclical

Other Maintenance Strategies

- Special Profile grinding
- Acoustic Grinding (Noise Reduction)
- Switch grinding (Grinding Rail in S & C)
- Integrated grinding campaigns
  (Combination with other work,
  e.g. tamping)

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Thank you for your attention

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