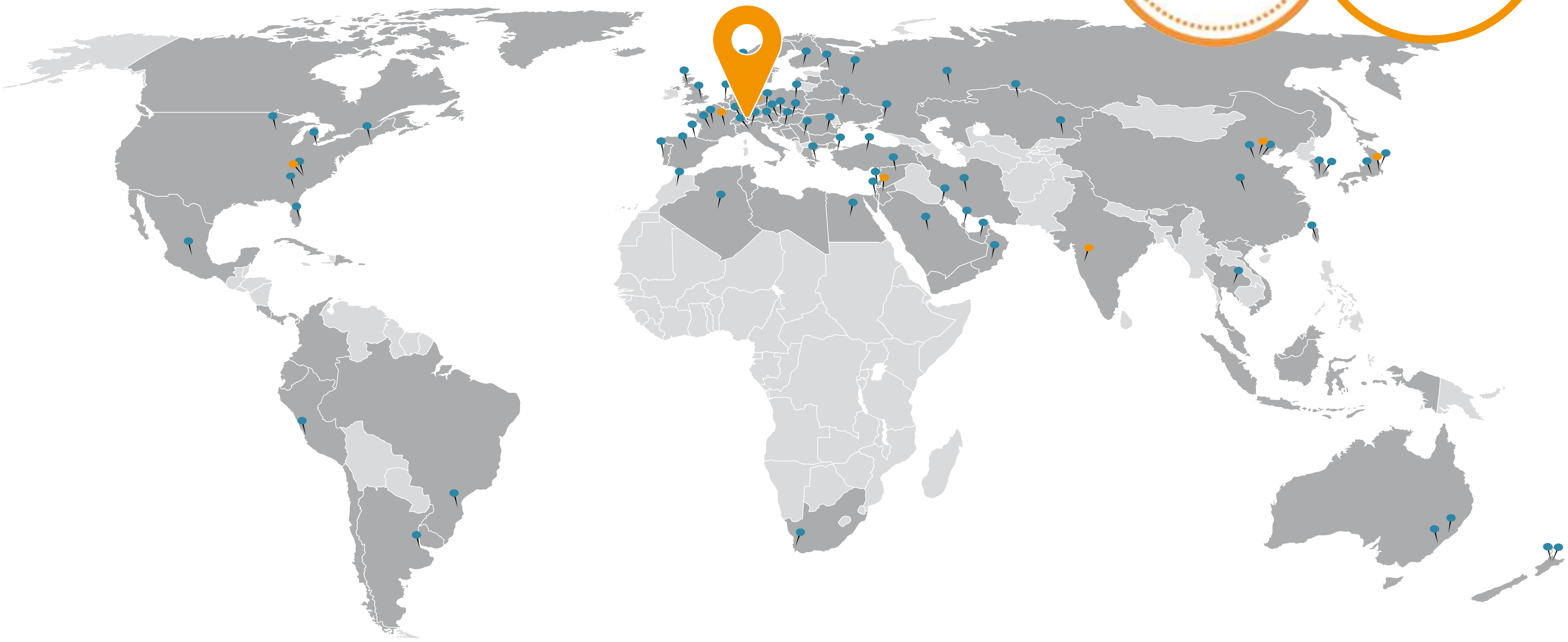
OPTIMIZATION OF TRANSITION ZONES

SIGNIFICANTLY INCREASES THE EFFICIENCY OF RAILWAY LINES

7 November 2025, Naples
Harald Steger / Product Manager

getzner

OPTIMIZATION OF TRANSITION ZONES



TRANSITION ZONES

1.440 km
Length of track

Bridge **#883**

Tunnel **#201**

Turnout **#1.108**

HOW DO BROKEN COMPONENTS „WEIGH“ IN TRACK?

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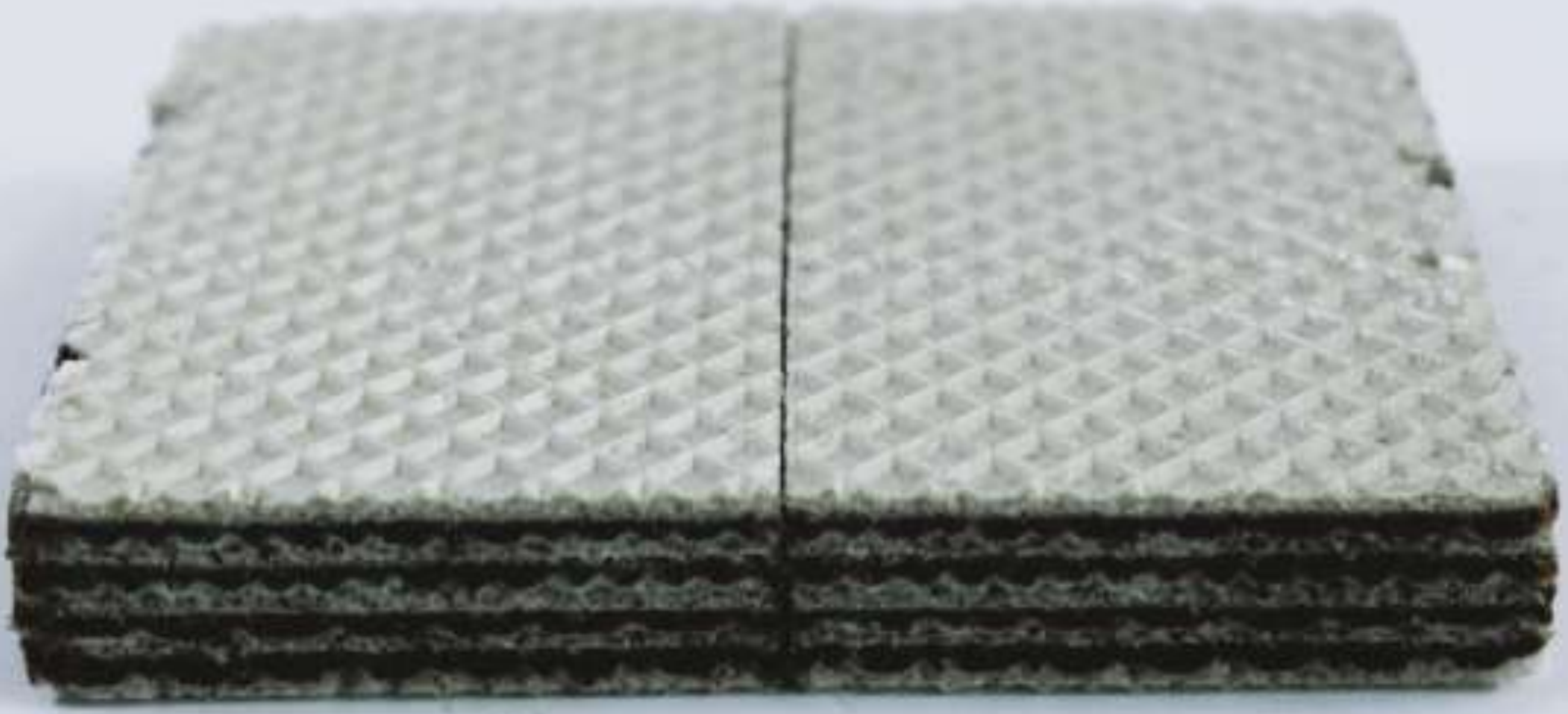
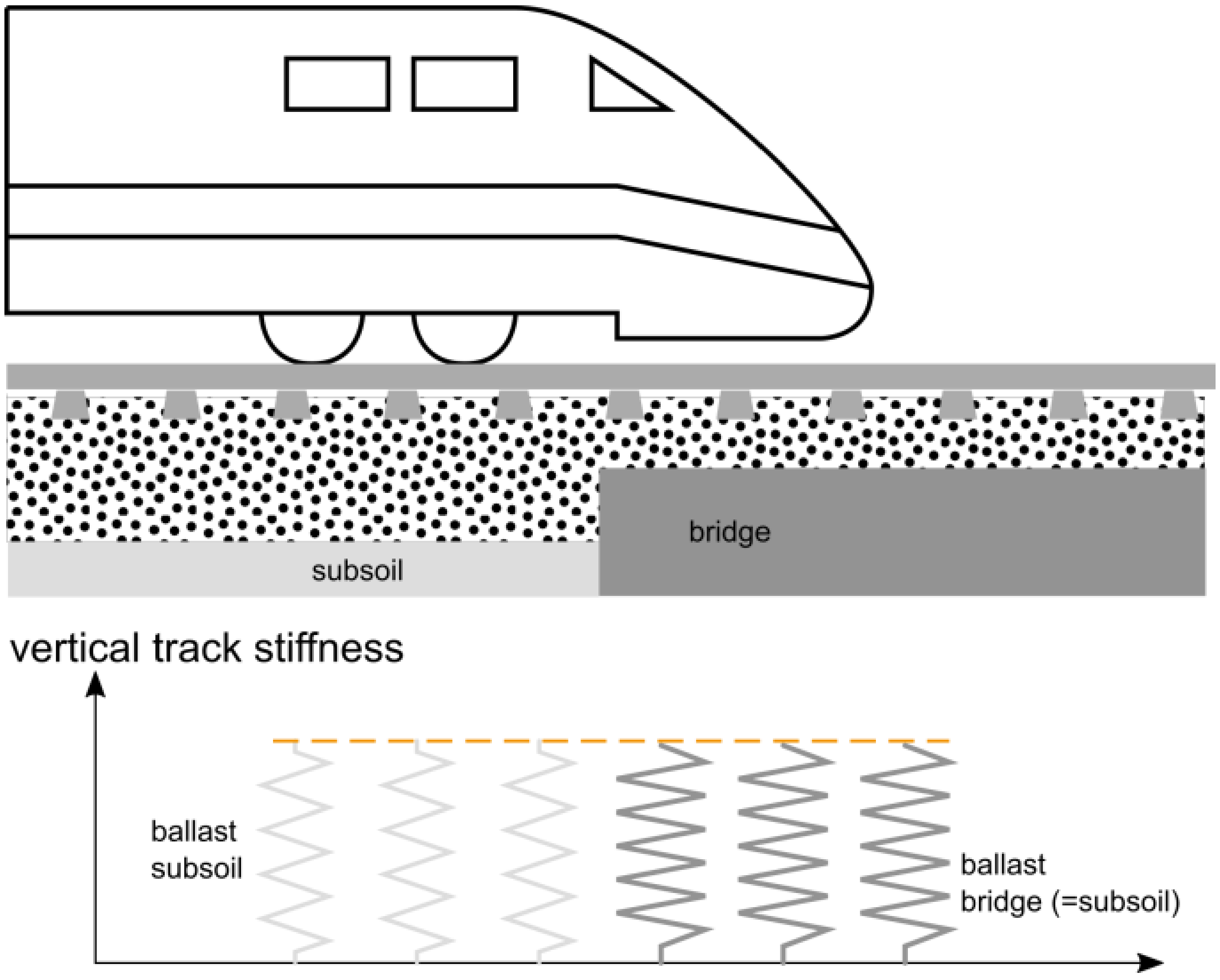
What if „wafers“ transit rough?



What if „wafers“ transit rough?

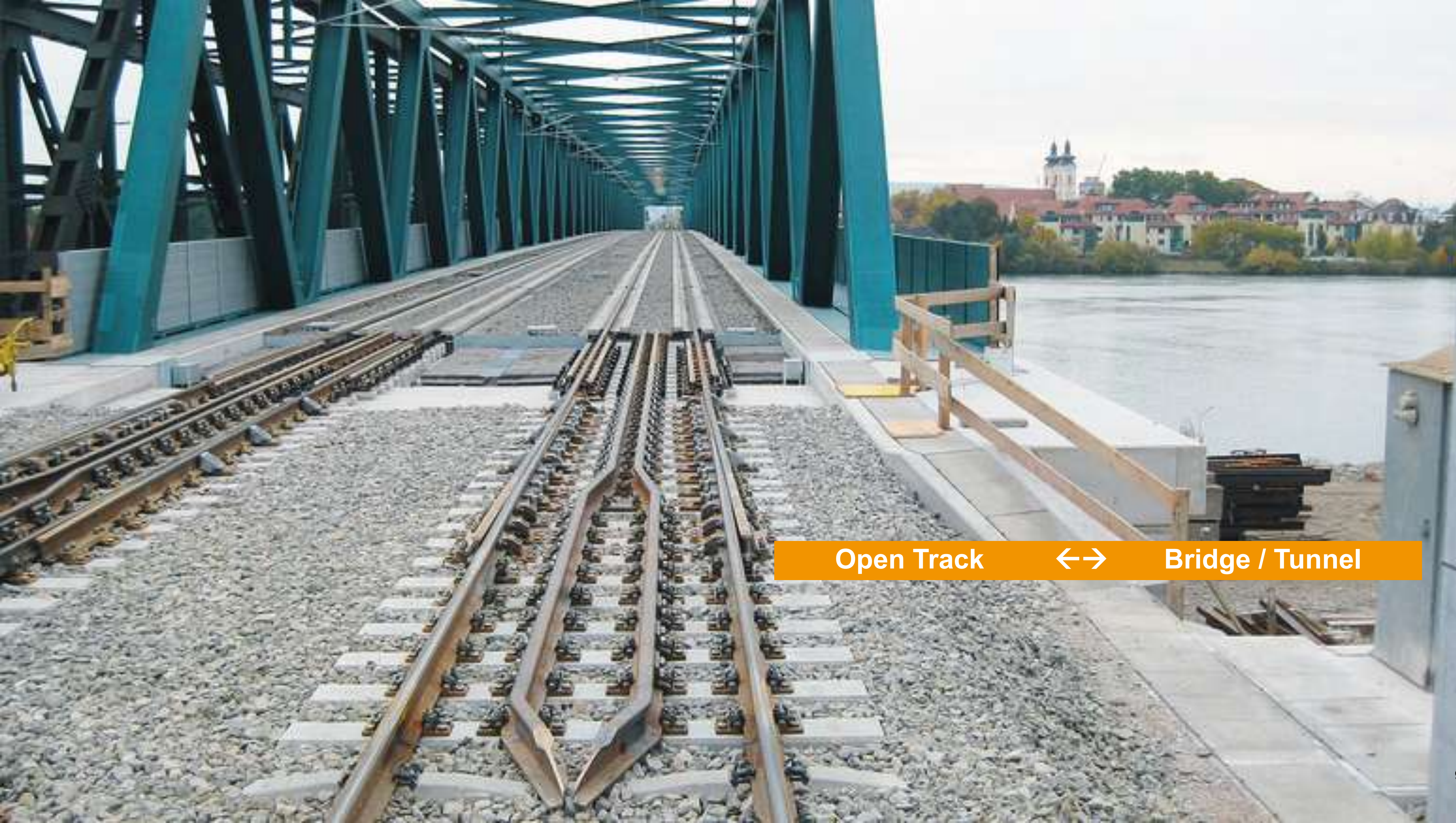
TRANSITION ZONES

WHAT ARE TRANSITION ZONES?



Any area where a change in superstructure design occurs

→ sudden change in vertical track stiffness


Open Track ←→ Bridge / Tunnel


Ballasted Track ←→ Slab Track


Regular Track ←→ Turnout


Slab track
←→
Different designs

CHALLENGES


Ballast wear ←→ „White spots“


High dynamic forces ←→ Broken clips


High dynamic forces ←→ Cracks in sleeper


Change in stiffness ←→ Track settlement

SOLUTIONS

DESIGN APPROACH?

Guard Rails

Advantage

additionally integrated stiffness

Disadvantage

high tensions within the sleeper

Ballast Bonding

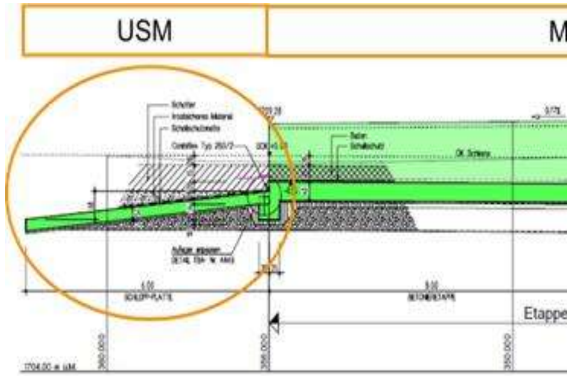
Advantage

Fixation of ballast

Disadvantage

Tamping is a challenge

Transition Slab



Advantage

no settlement before bridge or MSS

Disadvantage

costs

Ballast trough

Advantage

No ballast flow

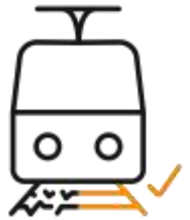
Disadvantage

Costs

WHAT CAN WE DO ABOUT IT?

Effective & simple Solution

ELASTIC SOLUTIONS FOR RAILWAY SUPERSTRUCTURE



Ballasted track

Slab track

DESIGN RULES

DESIGN RULES

„as long as necessary“
Benefit

\+

„as short as possible“
Costs

→

Ideal length

DESIGN RULES

Minimum length

Bogie – center-distance (e.g. 10m)

Rules

v	0,5 sec	0,7 sec	1,0 sec
80 km/h	11 m	16 m	22 m
125 km/h	17 m	24 m	35 m
160 km/h	22 m	31 m	44 m
200 km/h	28 m	39 m	56 m

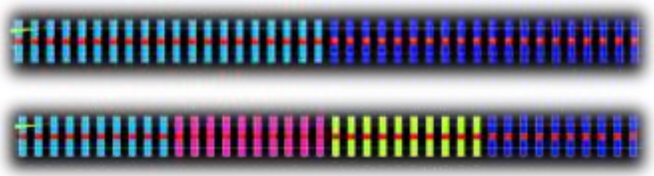
CALCULATION MODEL

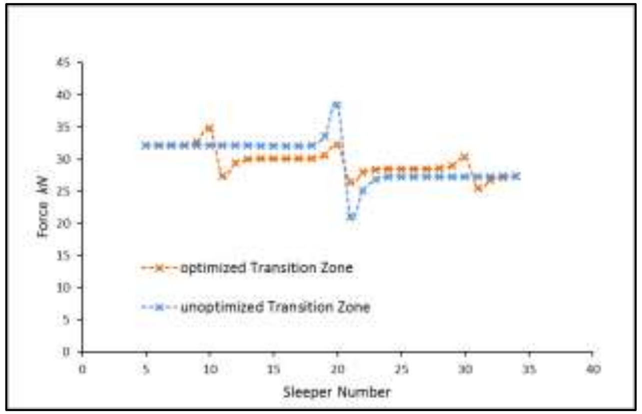
FEM model allows to compute the Transition Zone as a whole

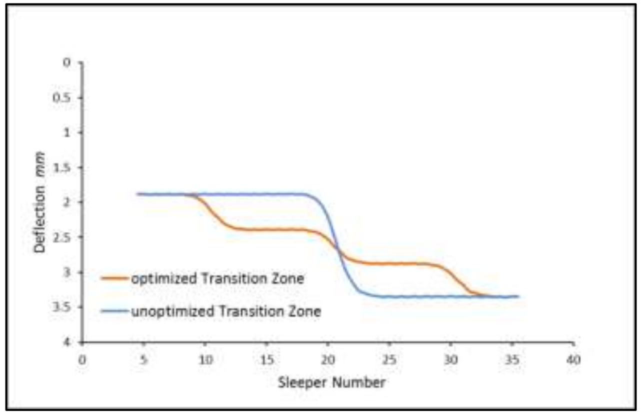
Different superstructure

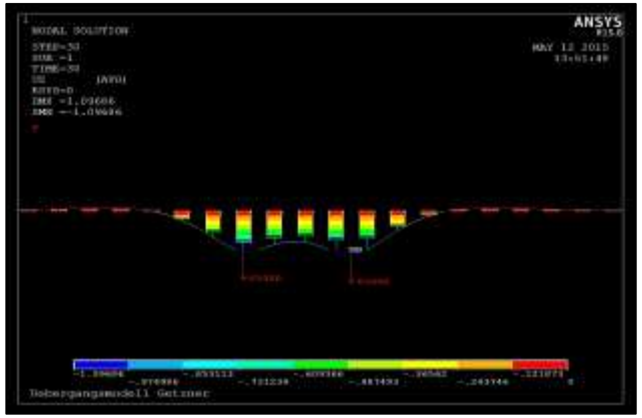
Various elastic layers

Multiple parameters

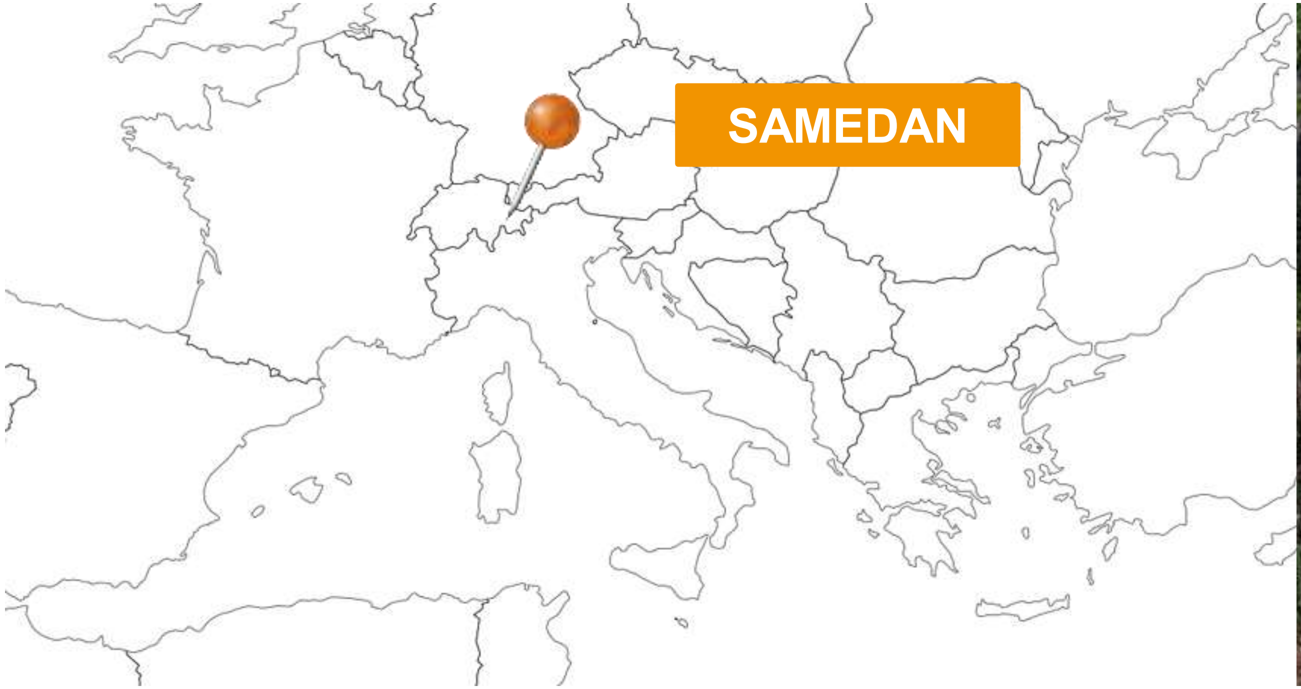








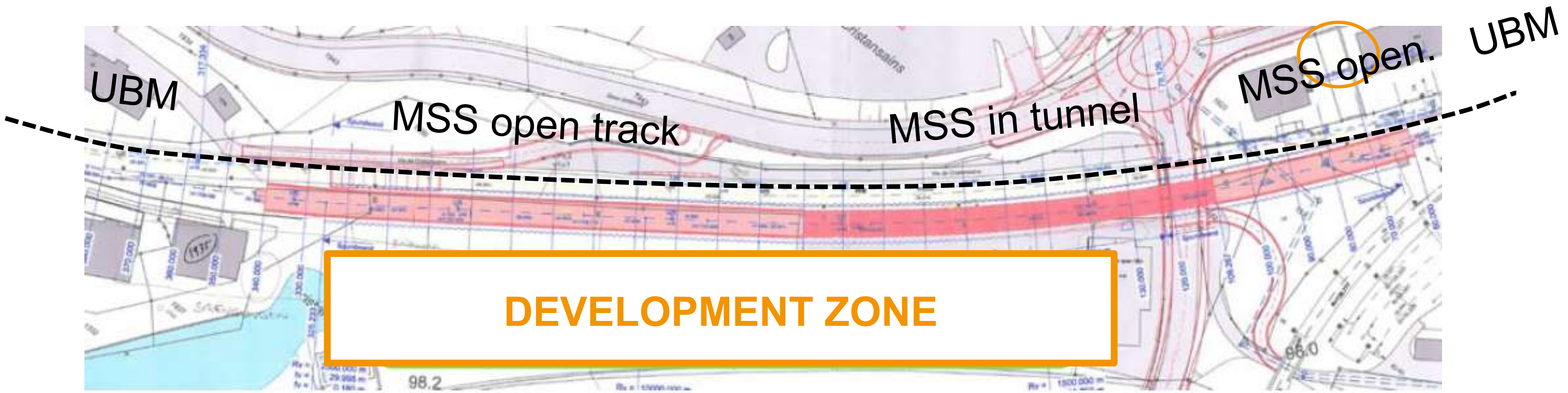
SAMEDAN, CH – TUNNEL REFERENCE



SAMEDAN, CH – TUNNEL REFERENCE

REQUIREMENTS

- Vibration isolation in residential area
- MSS f0 < 20Hz
  - Axle Load 18to / v ≤ 65km/h
  - Material: Sylomer® 25mm
- UBM f0 < 27Hz
  - USM Sylomer® D1519 for the transition zone

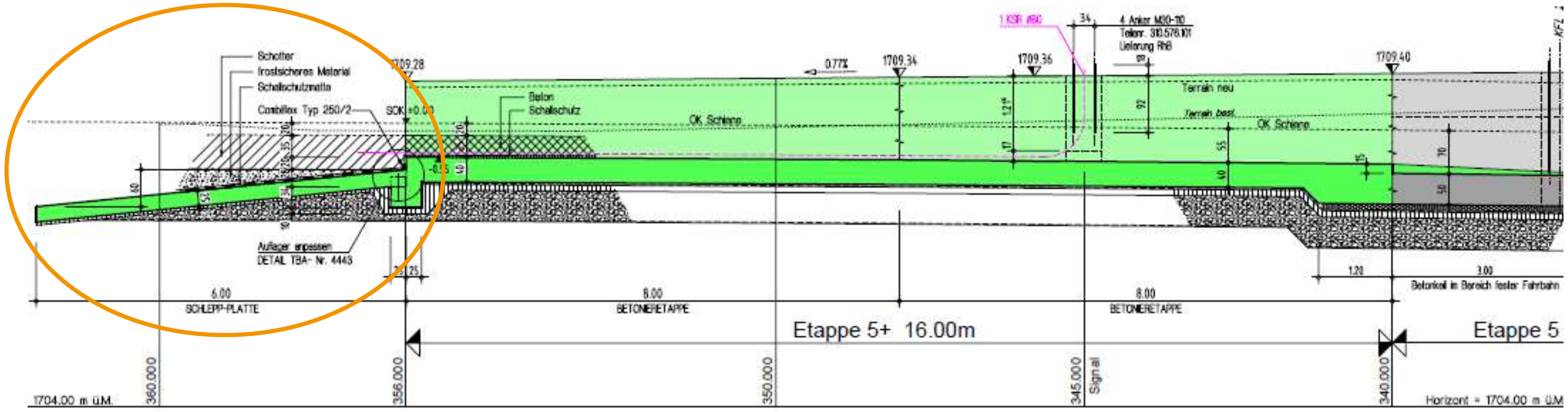


SAMEDAN, CH – TUNNEL REFERENCE

TRANSITION ZONE

- Concrete Transition slab with Under Ballast Mat (UBM)
  - Min. stiffness difference
  - Deflection difference slab track to ballasted track < 1 mm („running train“)

UBM | **Mass spring system**

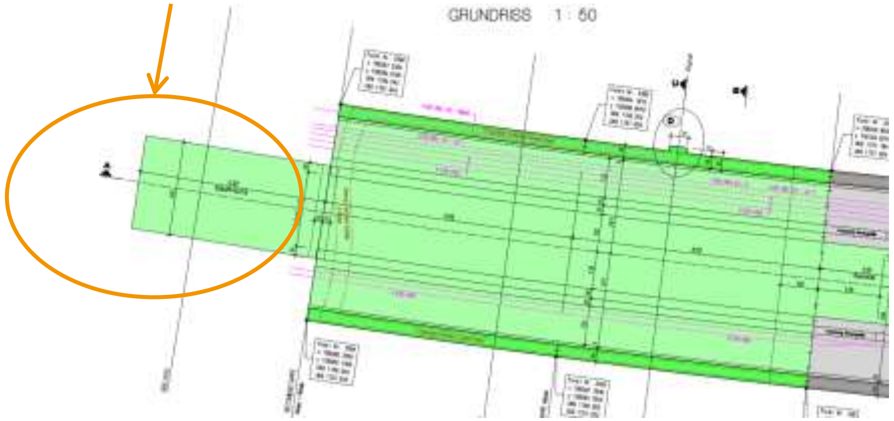


SAMEDAN, CH – TUNNEL REFERENCE

TRANSITION ZONE

For transition zone slab track to ballasted track:

- Drag panels of of ~ 8m length
- Sylomer® UBM D1519
- Homogeneous transition – no sudden stiffness changes



CHALLENGES IN TURNOUTS

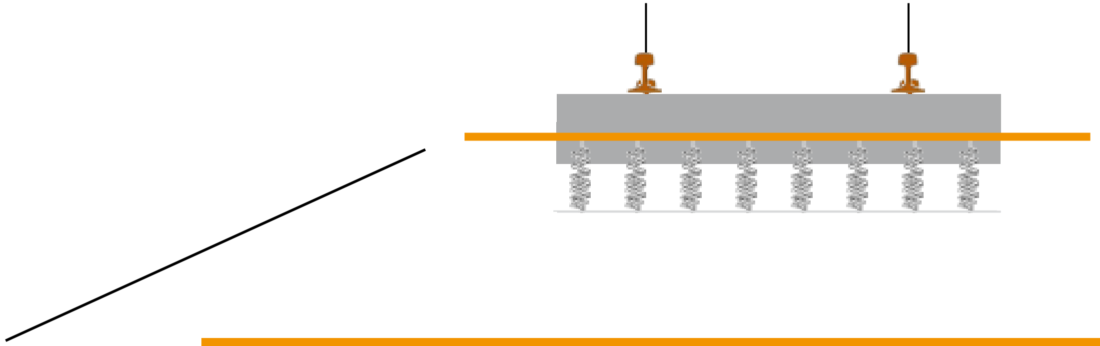
- Turnouts make the network
- They define the operating efficiency and service capability of the whole system (e.g. availability / speed)
- The investment cost of a turnout is on average 4 times higher compared to the regular track
- Turnouts cause much higher maintenance expenses

For investment 1% of the total costs arise for turnouts, but …

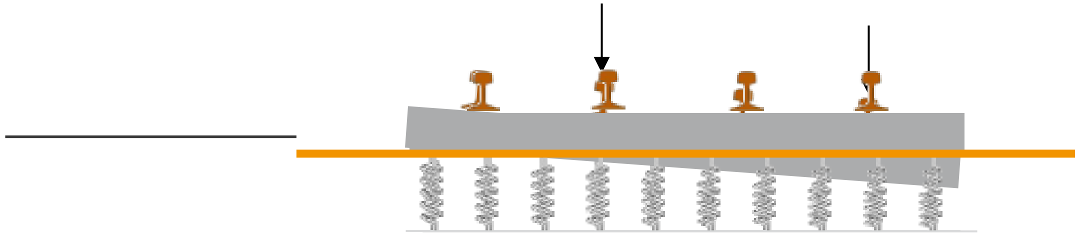
….for maintenance > 25% of total costs

Number of Turnouts in …	
Germany	~ 78.000
Austria	~ 13.400
Switzerland	~ 14.000
Italy	**~ 37.400**

CHALLENGES IN TURNOUTS

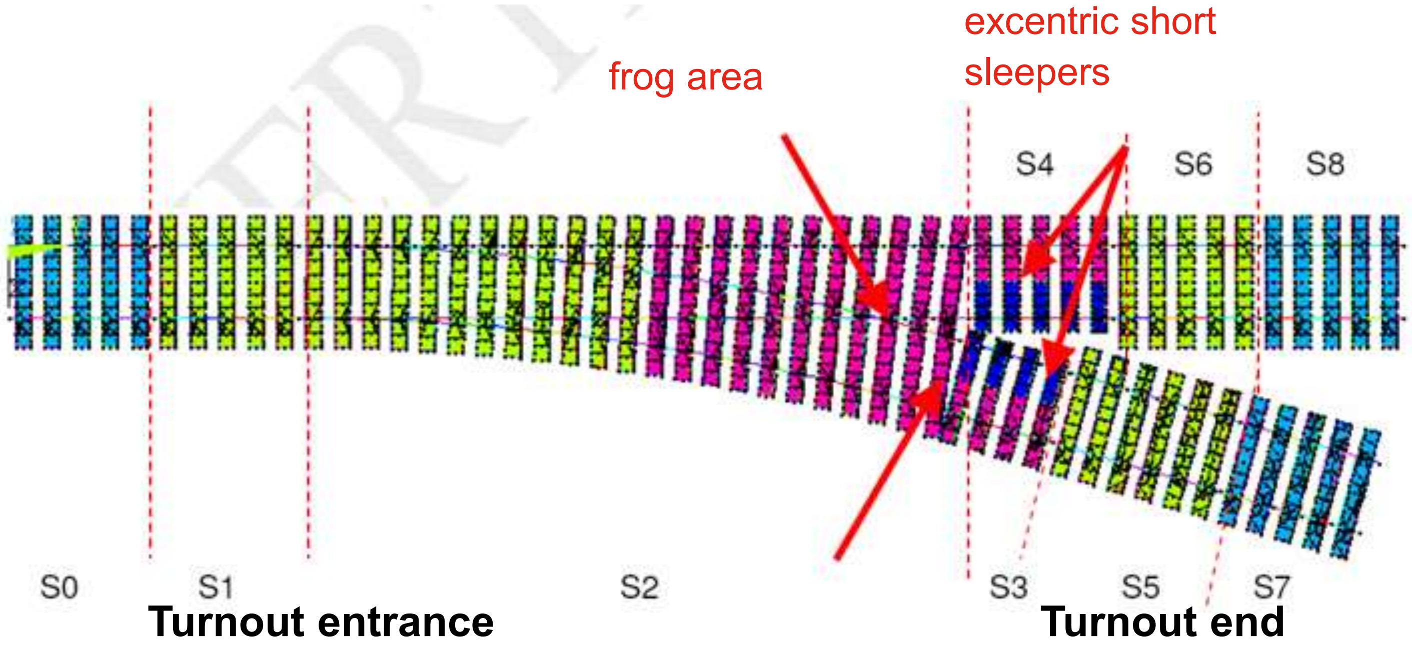


Area of discontinuity in the track
….different support conditions of the bearers



CALCULATION MODEL / FEM

TURNOUT MODEL FOR SLAB TRACK



- Excentric load impact and tilting
- Variation of base plates in fastening for excentric load distribution

ST. GOTTHARD, CH – TURNOUT REFERENCE

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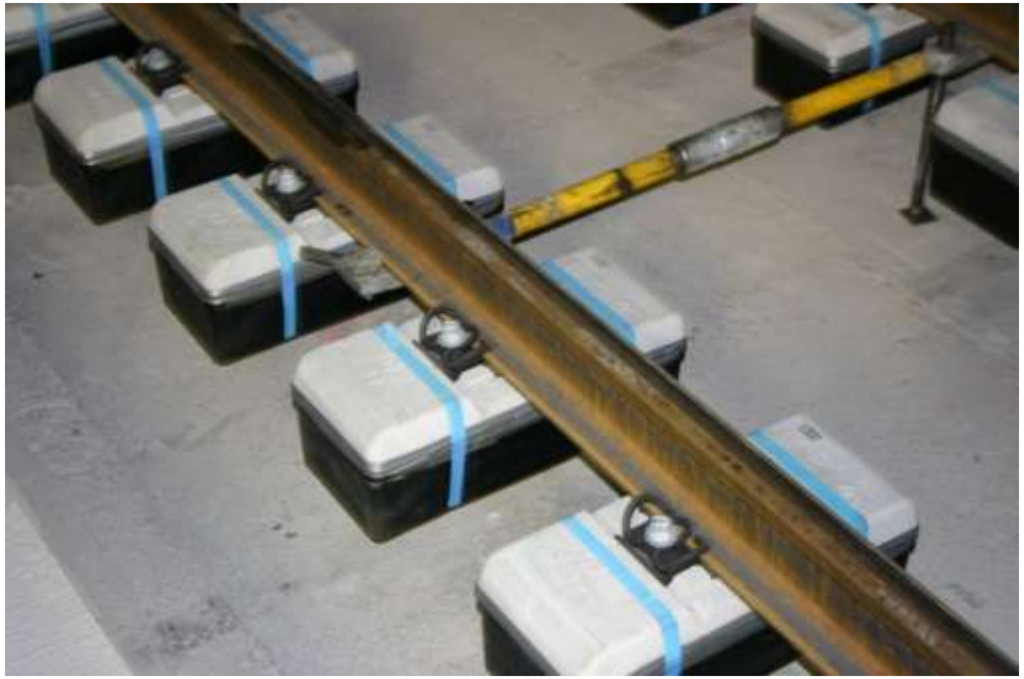
LONGEST RAILWAY TUNNEL IN THE WORLD

- Client: ARGE Transtec Gotthard
- Operator: SBB
- Construction of railway: 2009-2016
- Length: 2 tunnels à 57 km

> 400.000 pcs. of LVT system

10 slab track turnouts of VAE



SERVICES

FEA based prognosis

installation

ST. GOTTHARD, CH – TURNOUT REFERENCE

PREREQUISITE CONDITION

- Axle Loads of 25 tons
- Speed of 250 km/h → turnout crossing time ~1 s

DESIGN GOALS

Differences in rail deflection along the entire switch < 0.5 mm required

Transition LVT – long sleepers considered …..

…..and optimized (static rail deflection in LVT straight track section of ~1.2mm)

Optimized stiffness graduation in turnout area

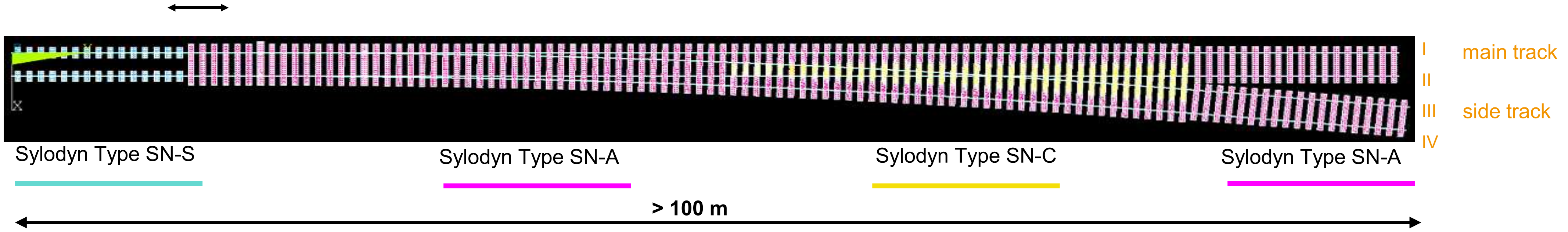
with different sleeper boot insertion pads

ST. GOTTHARD, CH – TURNOUT REFERENCE

SOLUTION

Compensation of geometric discontinuities via a special arrangement of different **Sylodyn® sleeper boot insertion**

Transition LVT – long sleeper **long sleepers with sleeper boot**



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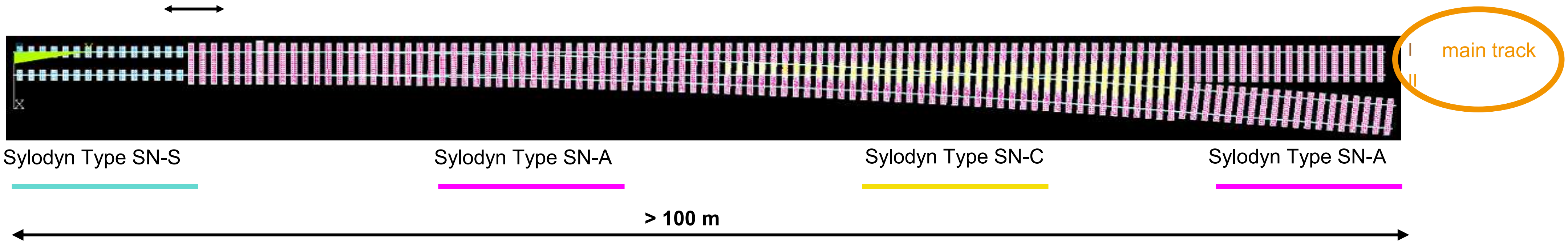
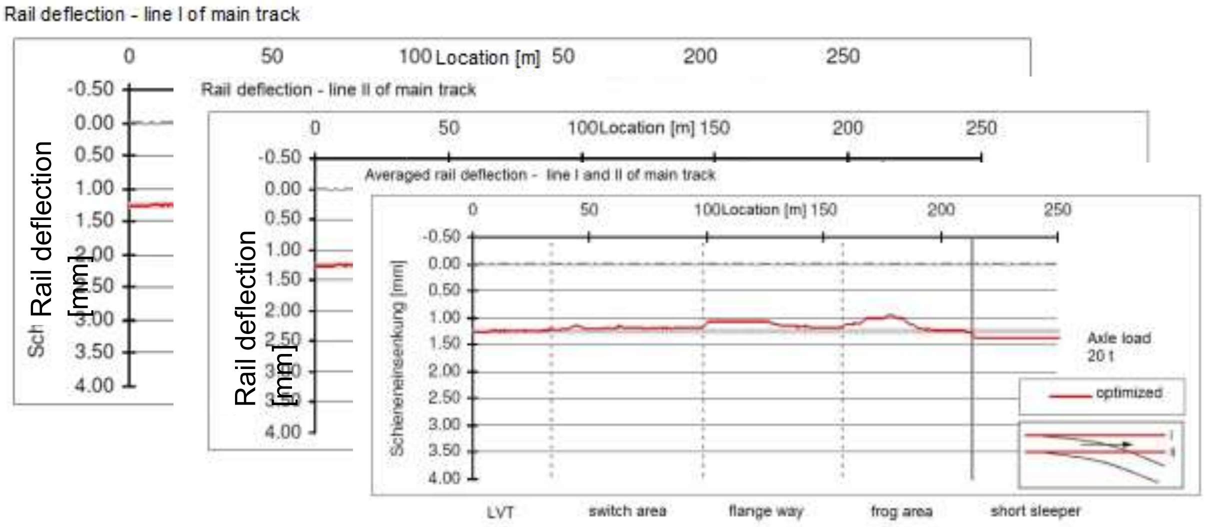
Transition LVT – long sleeper

long sleepers with sleeper boot





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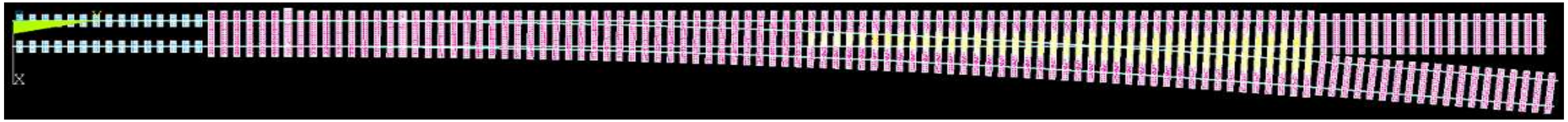
Transition LVT – long sleeper

long sleepers with sleeper boot



III side track
IV

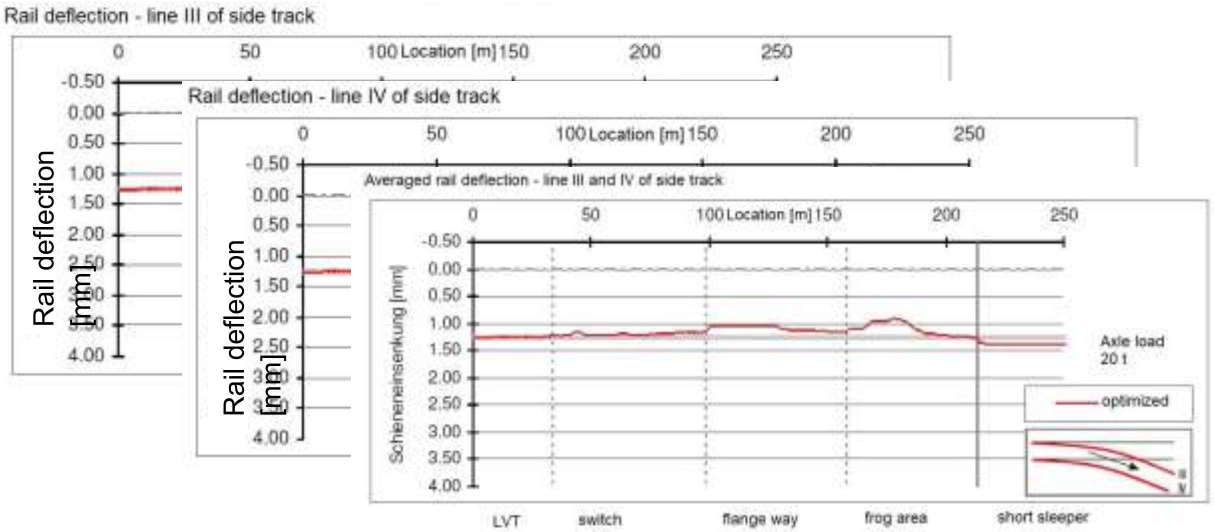
Sylodyn Type SN-S

Sylodyn Type SN-A

Sylodyn Type SN-C

Sylodyn Type SN-A

> 100 m



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MEASUREMENTS

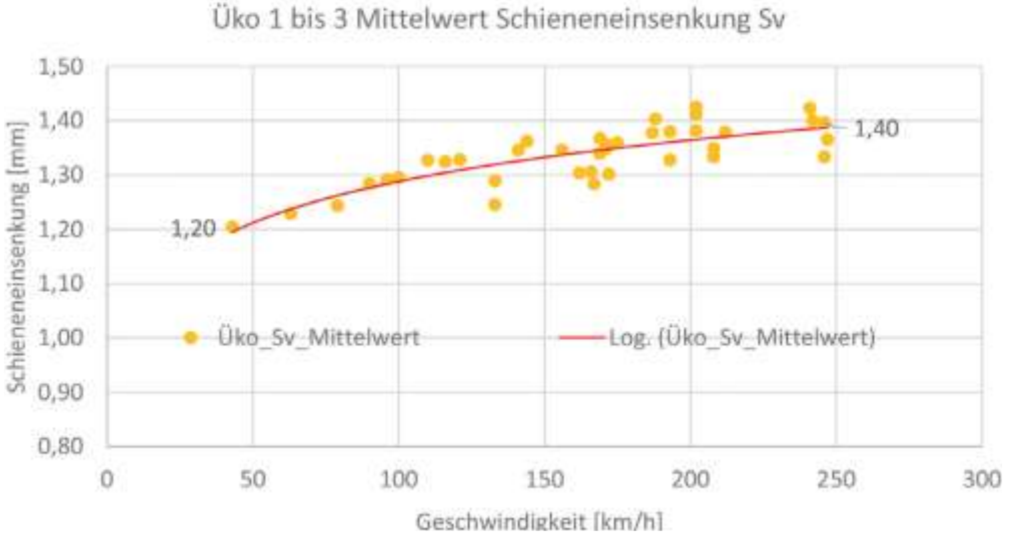
in the area of perspective turnout in Erstfeld;
Measurements conducted by **Technical University Munich**

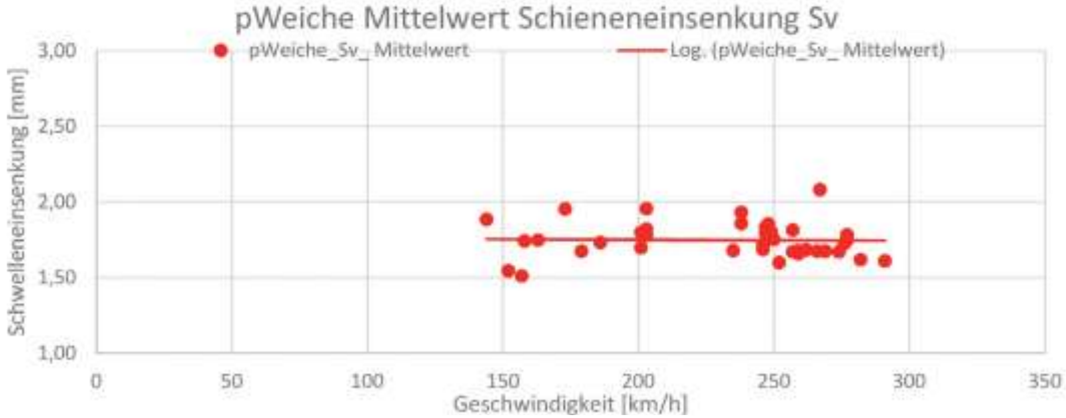
- Measurements with train IC-S / axle load 19.8 tons
- v= 250km/h – averaged vertical rail deflection
- special circumstance in the turnout:
  - Each measuring cross section was located under a sleeper with different length (pW1/ l=2.6m; pW2/ l=2.8m; pW3/ l= 3.0m)

Source: Stahl.W.; TUM- Dynamische Einsenkungsmessungen im Gotthard-Basistunnel; EI- Der Eisenbahningenieur, August 2016, S.12-14.
www.eurailpress.de/archiv/gotthard-basisitunnel/

ST. GOTTHARD, CH – TURNOUT REFERENCE

MEASUREMENTS





v= 250km/h – averaged vertical rail deflection

- ~1.4 mm in transition zone
- ~ 1.75 mm in turnout

Δ rail deflection ≤ 0.5mm

Source: Stahl.W.; TUM- Dynamische Einsenkungsmessungen im Gotthard-Basistunnel; EI- Der Eisenbahningenieur, August 2016, S.12-14.
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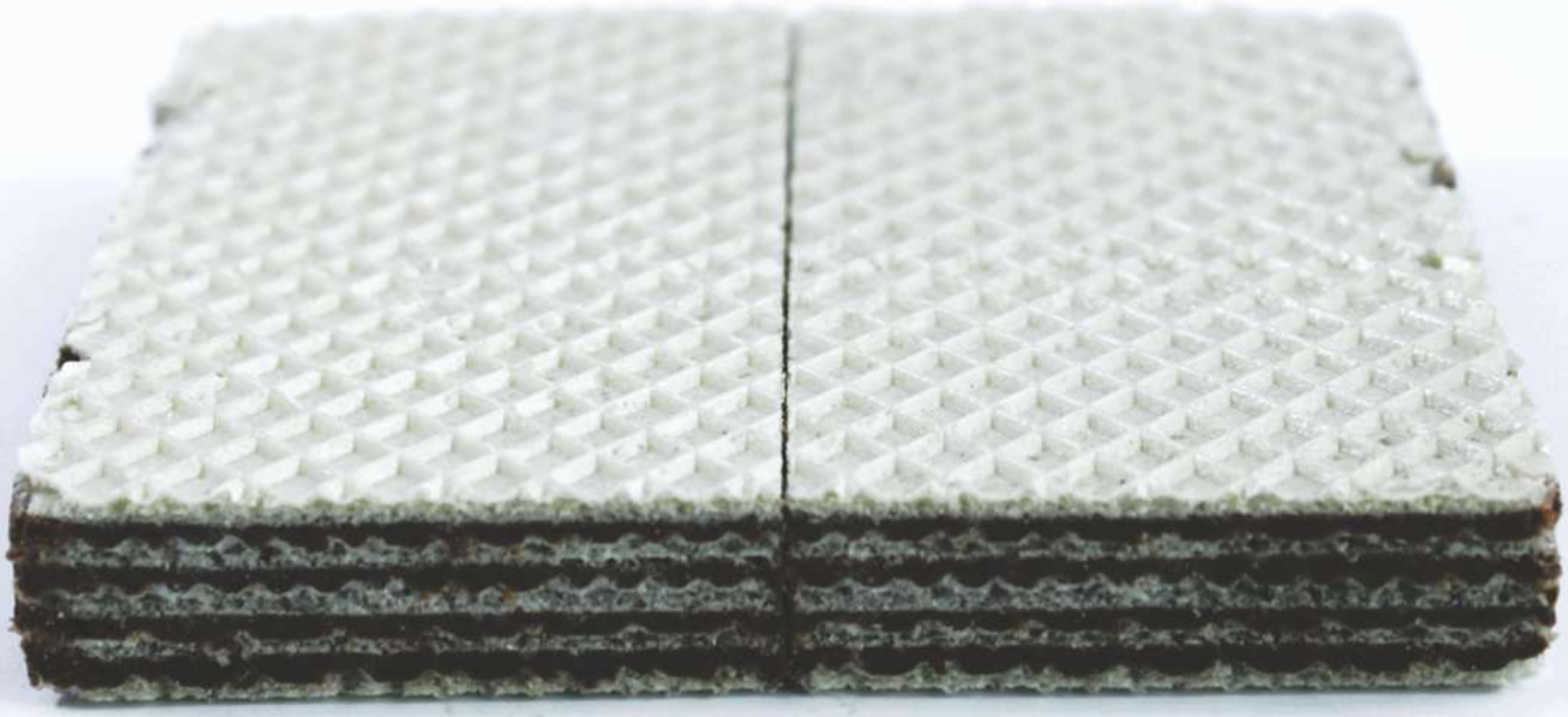
What if „wafers“ transit smooth?

BENEFITS

What if „wafers“ transit smooth?



BENEFITS

OPTIMIZATION OF TRANSITION ZONES

Track availability

- Improved operation reliability
- Higher profitability

More safety

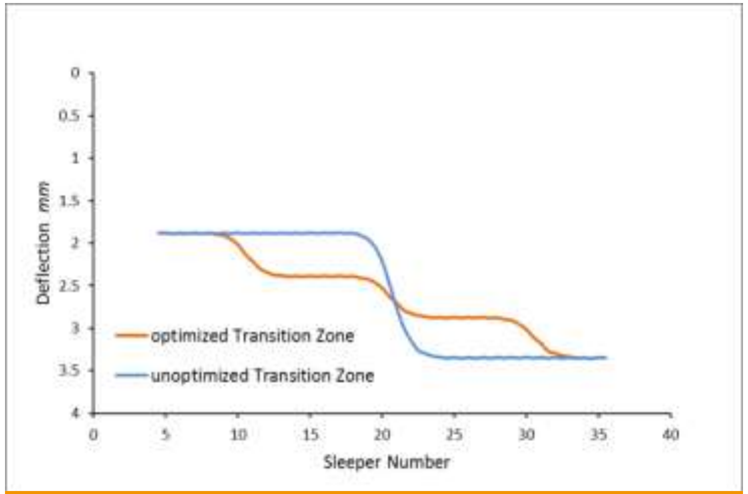
- Improvement of track quality

Reduction of maintenance & life cycle costs

- Improvement of track quality & elongation of maintenance cycles
- Less track possessions

KEY TAKE AWAYS

High Impact



Smart Solutions

Optimized Resources

KEY TAKE AWAYS

OPTIMIZATION OF TRANSITION ZONES

Harald Steger

Product Manager
+43 5552 201- 1428
harald.steger@getzner.com
getzner.com

getzner engineering a quiet future