

Optimisation of Transition Zones



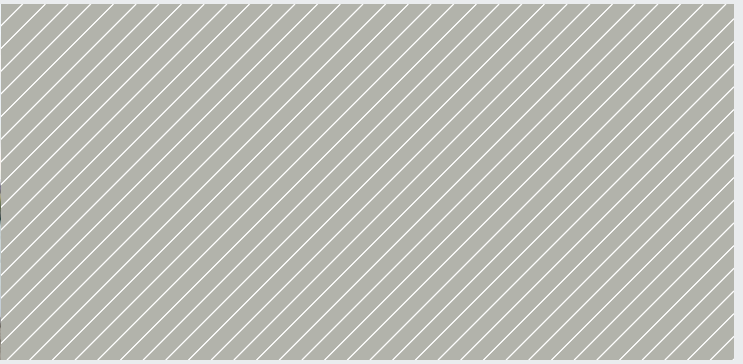
» Significant reduction in the maintenance costs of susceptible track sections

» Reduced wear in all superstructure components

» Extended service life and thus increased availability of track

1 | Significant Reduction of Maintenance Costs





Transition onto a bridge

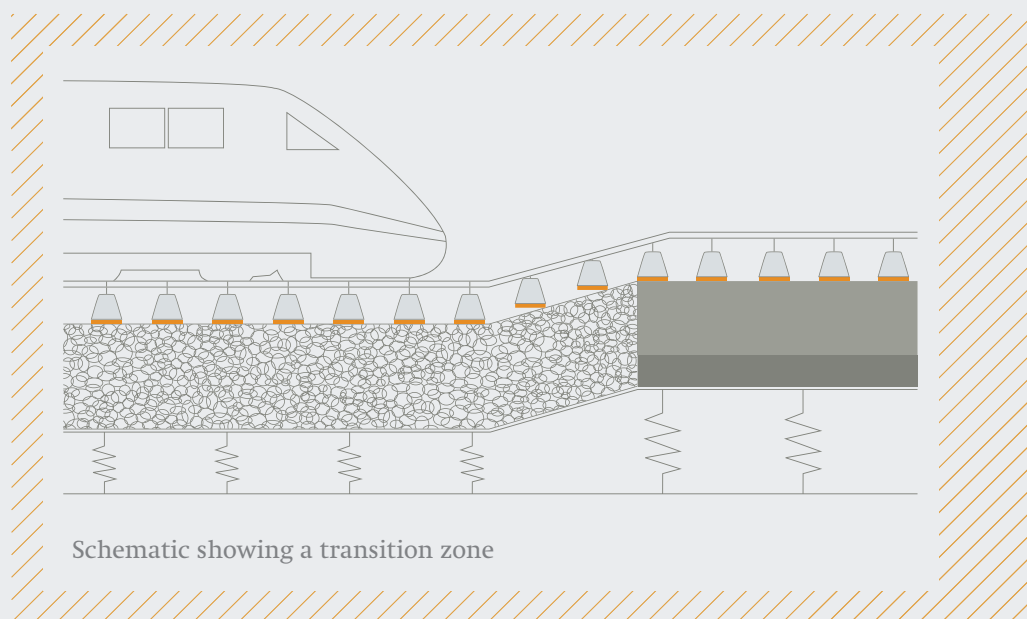
Transition zones: Areas of railway tracks that require high levels of maintenance

When changing from one type of superstructure to another, the variations in stiffness produce a greater stress on the components, which consequently require more maintenance. Solutions offered by Getzner help to significantly reduce this stress and the resulting maintenance costs.

Transition zones are sections of track where the stiffness of the bedding changes considerably over a short distance. When there is an abrupt change in the superstructure construction, the variations in stiffness and resulting rail deflections cannot be avoided. Sudden changes can, for example, occur in the transition from a ballasted track to a slab track, from open track to a bridge or when crossing over a turnout.

Even where the superstructure system is similar, a change in the substructure or subsoil can cause increased levels of maintenance. In the case of transitions to bridges for example, the difference in subsoil stiffness and uneven settlement can result in increased dynamic loads on the components.

➤➤ *Optimisation of the susceptible transition zones can significantly change the cost-benefit ratio of a line.*



Schematic showing a transition zone

2 | Compensating for Deflection Differences



Ballast wear

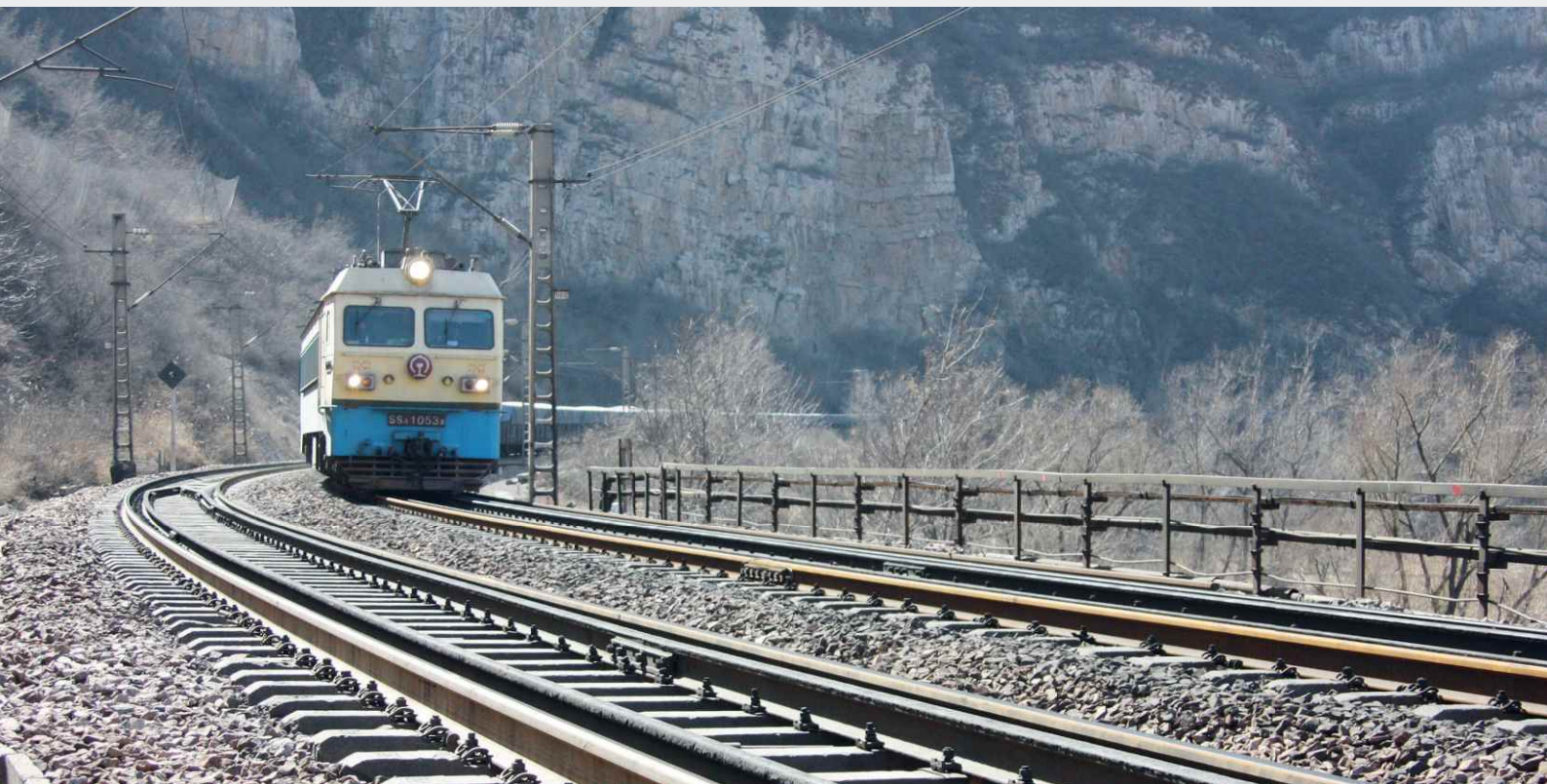
Counteracting increased wear

Because of the design, there is a stepped change in the superstructure stiffness in transition zones. High static and dynamic loads can cause wear of the superstructure components, even after a short period of operation. Elastic products by Getzner can provide the necessary protection for components and make a valuable contribution to reducing loading levels.

In transition zones where there is no optimised stiffness graduation, components may be damaged by the high dynamic loads as a train passes over:

Ballast movement and overloading lead to ballast wear and hollow areas between the sleeper and ballast. Ballast wear is often identified by the white spots caused by the resulting abrasion. Increased rail seat forces produce a high stress on the ten-

sion clamp until it eventually breaks. Tension clamp breakages often occur around guardrails. Cracks and breaks in sleepers are also caused by high loads. In addition, irregular settlement is caused by variations in stiffness and changes in subsoil properties.





Broken tension clamp



Broken sleeper



Settlements



Variations in settlement

The increased load on the superstructure is also caused by the varying settlement behaviour resulting from the different structural designs. The longer the track is in use, the greater the unevenness along the line. As a consequence, the forces being exerted on the superstructure construction steadily increase. Furthermore, settlement variations lead to defects in the track geometry, which in turn increases the dynamic load.

Dynamic loads

Differences in deflection as the train passes over result in increased rail-wheel forces and dynamic loading of the entire superstructure. This increased loading leads to more maintenance work and reduces passenger comfort.

Getzner has the answer

Installing elastic elements reduces the impact loads and the vibrations that are transferred as the train passes. The defined use of highly elastic Sylomer® and Sylodyn® components compensates for the undefined variations in stiffness in the transition zone. The improved load distribution ensures that movement within the ballast bed is reduced and has a positive influence on settlement behaviour. A targeted graduation of the rail deflection within the transition zone reduces the impact loading of the wheel/rail system and superstructure, significantly extending the service life of the transition zones and thus the availability of the line as a whole.

Benefits for customers

- Optimised graduation of large variations in stiffness and deflection differences
- More even load distribution
- Reduced ballast loading
- Less hollow areas
- Reduced impact loads as the train passes over
- Less settlement
- Less wear of superstructure components
- Increased safety and ride comfort
- Less maintenance work
- Increased availability
- Longer service life

3 | Optimal Solution thanks to a Combination of Elastic Components

Interplay of different elements

Project-specific challenges require specific solutions. Thus: The ideal solution often consists of a combination of different Sylomer® and Sylodyn® components.



Rail pads

Elastic rail pads are placed directly under the rail base. They have a defined stiffness and increase the elasticity of the superstructure. The improved load distribution protects the superstructure and offers greater ride comfort. The increased elasticity has a positive effect on the wear of superstructure components.

Rail pads are a simple way of achieving a targeted graduation of deflection differences without having to carry out any work on the system underneath the sleeper. However, due to the maximum permissible rail deflection within the fastening system, the compensation options are limited. Getzner offers a full range of rail pads for every required stiffness. The rail pads made from Sylodyn® HS in particular impress with their very long service life in numerous application areas.



Baseplate pads

Modern railway lines are increasingly built as slab track systems. Highly elastic Getzner baseplate pads, which are installed underneath the baseplate, provide the elasticity for such systems.

Elastic baseplate pads preserve the load-distributing function of the rails and reduce vibrations caused by wheel and track irregularities. Deflection differences are minimised by the targeted adjustment of the pad stiffness – for example, across the transition from slab track to ballasted track. Compared with rail pads, baseplate pads provide the option to add more elasticity inside the rail seat.

Find out more about Getzner rail pads and baseplate pads at: www.getzner.com/downloads/brochures



Rail pads



Baseplate pads



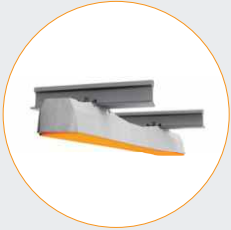
Under sleeper pads



Under ballast mats



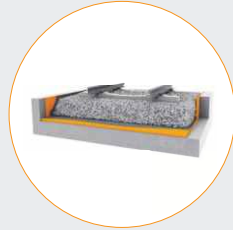
Mass-spring systems



Under sleeper pads

Under sleeper pads provide vibration isolation and ballast protection. They increase the size of the contact area and have a load-distributing effect that reduces the stress between ballast and sleeper and consequently minimises settlement. Furthermore, hollow areas under the sleepers can be avoided by fixing the top ballast layer.

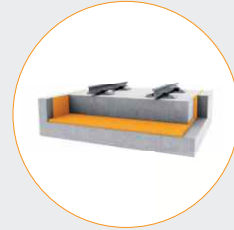
These properties and the functionality mean that under sleeper pads increase the service life of the track and ballast. Under sleeper pads, which are available in different stiffnesses, permit the targeted graduation of large variations in stiffness and also reduce settlement in transition zones.



Under ballast mats

Under ballast mats are used to achieve a high degree of track elasticity. In addition, they also exhibit extremely high dynamic effectiveness. Due to their ballast-protecting effect in the track, the installation of under ballast mats is the ideal solution in areas with very high subsoil stiffness, for example on bridges or in tunnels.


The respective elastic requirements in the transition zones can be accurately matched when selecting the appropriate mat type. Getzner under ballast mats are easy to work with, can be installed quickly and can be driven over by heavy construction equipment.



Mass-spring systems

Mass-spring systems from Getzner provide particularly effective protection against vibrations and noise for people living next to railway lines. Getzner offers three types of bearings for such systems: point, linear and full-surface support. Which of these types to use depends on economic as well as technical requirements.

The wide range of materials with varying degrees of stiffness and the ability to adapt to the geometry permit a very exact and detailed graduation of the stiffness of the superstructure system. Mass-spring systems can therefore be used to implement very defined transitions.

 **Find out more about Getzner under sleeper pads, under ballast mats and mass-spring systems at: www.getzner.com/downloads/brochures**

4 | Every Transition Zone is different, so are our Solutions

Customised design

The optimal stiffness distribution in transition zones is achieved by taking into consideration the prevailing framework conditions and specific material properties. Getzner therefore tailors its solutions to each and every transition zone.

In order to achieve its goal of obtaining an even graduation of the rail deflection across changing superstructure constructions, Getzner provides components that are tailored to the respective underlying conditions. The calculation, which takes account of the elastic properties of the elemen-

ts being used along with the optimal combination of individual bearings in the transition zone, is realised by means of simulations based on the Finite Element Method (FEM).

Realistic FEM model

Based on the drawings of the superstructure constructions provided by the customer, the FEM model permits a project-specific and realistic calculation of the transition zone. The transition zone is simulated in the FEM model by utilising the constructional design of the superstructure (guardrails, transi-

tion slab) and the relevant parameters, such as subsoil stiffness.

Once the FEM model has been prepared and divided into the individual sectors for the respective superstructure construction, the simulation program is used to determine the vertical deflections. The rail seat forces, rail foot tensions and stress between ballast and sleeper can also be calculated. The bending line of the whole track panel for each load collective can be presented and analysed.

Transition from ballasted track to slab track





Transition from open track into a tunnel

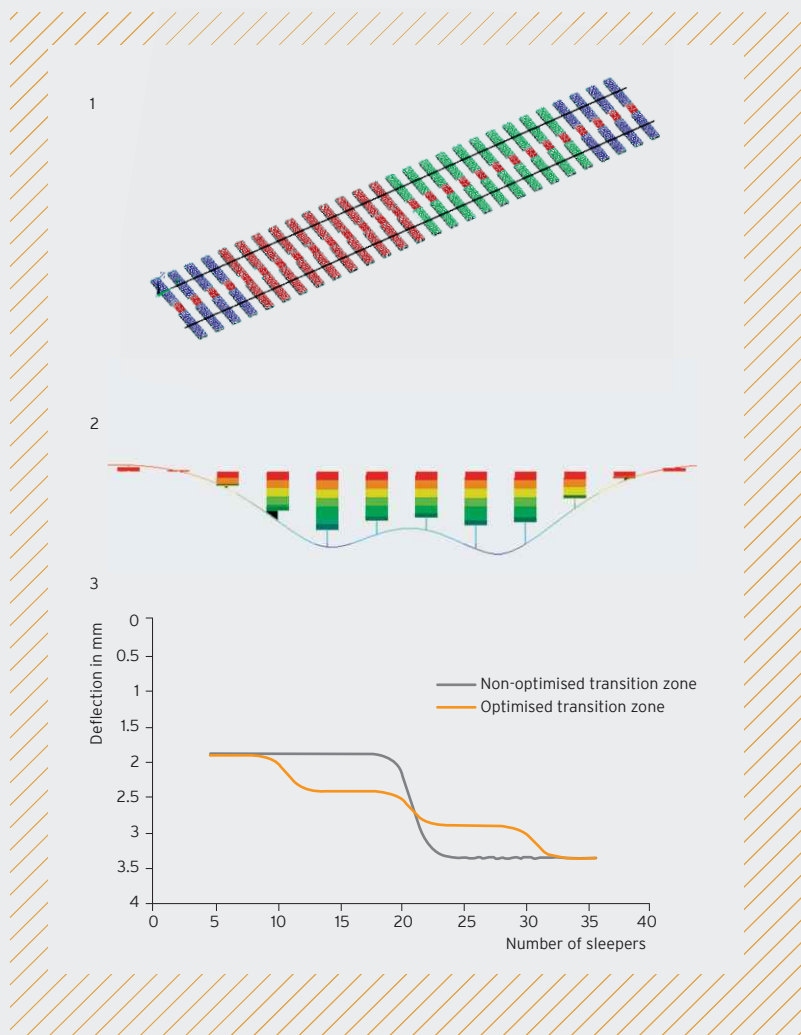
Individual calculations

Perfect solutions based on accurate data

Based on the substantiated calculations of the FEM model, Getzner looks at the particular demands of a transition zone and offers solutions involving a combination of various elastic components.

Getzner has used the empirical values from numerous projects to further enhance and validate the simulation program.

Calculations based on the Finite Element Method (FEM)



Benefits for customers

- Consideration of bedding of different superstructure forms
- Simulation of train traffic
- Minimisation of deflection differences
- Combination of various elastic components
- Consideration of a number of structural factors influencing the superstructure construction
- Adaptation of the solution whilst taking account of the logistical conditions on site

1 FEM model subdivided into sectors
 2 Calculated static deflection of the rail
 3 Optimised transition zone

5 | References

Tried-and-tested solutions used around the world

Getzner solutions have stood the test of time all over the world, as evidenced in the success of the Swiss Federal Railways network (SBB).

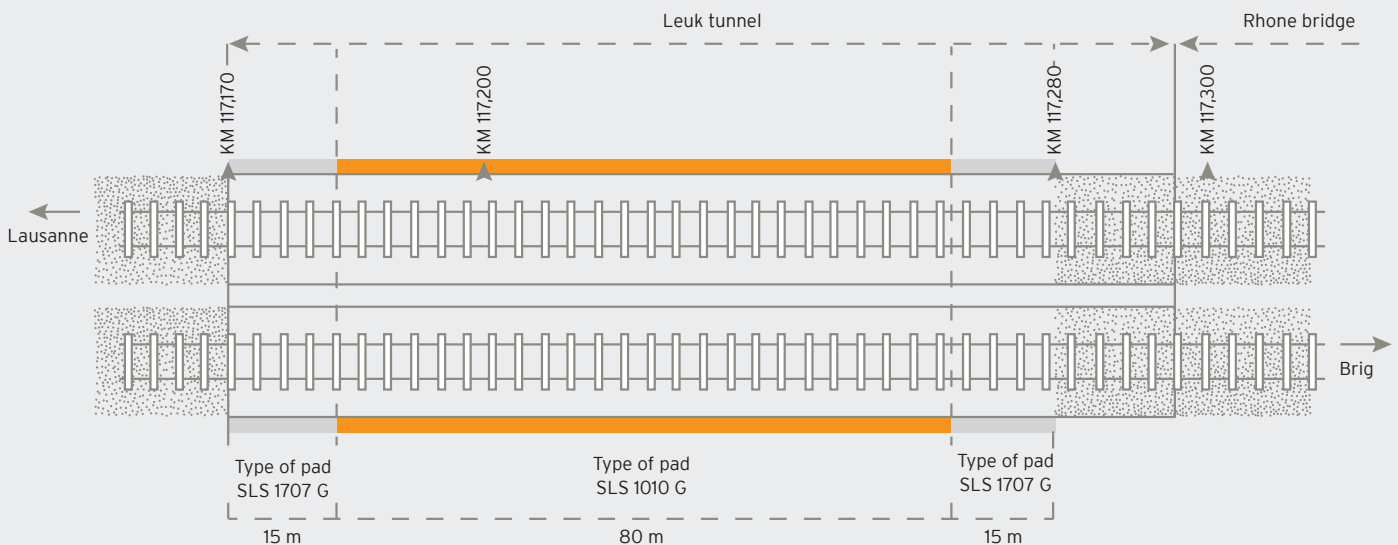
Project SBB-Leuk, Switzerland

In Leuk, a new tunnel was opened along the Lausanne-Brig line. Trains travel at speed of up to 160 km/h. To protect the buildings above the tunnel portal, the SBB and Getzner have retroactively fitted the concrete sleepers with under sleeper pads.

Two types of under sleeper pads were installed along a section of the line. Sleepers over a stretch of 80 m were fitted with SLS 1010 G from Getzner. In order to compensate for the anticipated difference in deflection caused by this relatively soft under sleeper pad, which has a static bedding modulus of 0.10 N/mm³, a transition zone was provided at both ends. The stiffer SLS 1707 G under sleeper pads were used

in these transition zones. The deflection differences in the transition zone between the open track and tunnel were able to be smoothly evened out by using the two different types of under sleeper pads. As the measurements of the rail deflection made by the SBB track geometry car illustrate, this objective was successfully achieved.

Lausanne-Brig track section



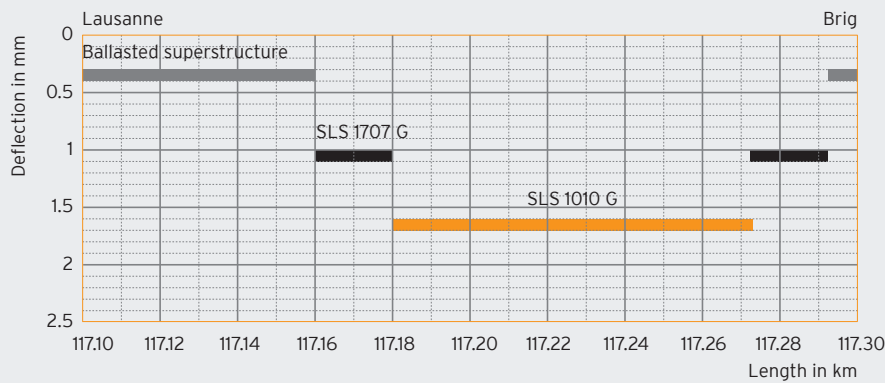


Installation of under ballast mats on a bridge in the USA

**Effective-
ness
confirmed**

Transition zone references (extract)			
CUSTOMER/PROJECT	COUNTRY	APPLICATION AREA	GETZNER SOLUTION
TTCI/ Pueblo Heavy Haul Loop	USA	Heavy haul	Under ballast mats
Union Pacific/ Nebraska Oskosh	USA	Heavy haul	Under sleeper pads
Ferrocarriles Suburbanos/ Puente	Mexico	Urban transport	Under sleeper pads + rail pads
Canadian National/ Toronto Oakville Bridge	Canada	Heavy haul	Under ballast mats
Cadiz/ Tramo 2	Spain	Urban transport	Mass-spring systems
ÖBB/ Lainz tunnel	Austria	Standard-gauge railway	Mass-spring systems + under ballast mats
Rhaetian Railway/ Samedan	Switzerland	Standard-gauge railway	Mass-spring systems + under ballast mats
SBB/ Leuk	Switzerland	Standard-gauge railway	Under sleeper pads

Vertical deflection Lausanne-Brig



Fact box

- Ballasted superstructure / open track, rail deflection approx. 0.4 mm
- Transition zone, rail deflection approx. 1.0 mm
- Under sleeper pads, type SLS 1707 G (Cstat = 0.17 N/mm³)
- Ballasted superstructure / tunnel, rail deflection approx. 1.7 mm
- Under sleeper pads, type SLS 1010 G (Cstat = 0.10 N/mm³)

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