Case Study

Elasticity for the Slab Track in the Gotthard Base Tunnel, (CH)

- The project of the century: With 57 kilometres the world's longest railway tunnel
- Highest requirements: Outstanding material properties over the entire service life
- Optimised solution, comprehensive project support and just-in-time logistics

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Elastic Sylodyn® Insertion Pads for Sleeper Boots in the World's longest Railway Tunnel

Description of the project

Prestigious project with highest requirements in terms of railway technology

At 57 kilometres in length, the Gotthard Base Tunnel is currently the longest railway tunnel in the world. It links the Swiss communities of Erstfeld and Bodio. The tunnel forms part of the New Railway Link through the Alps (NRLA), which is at present the largest construction project in Switzerland. With the construction of this "project of the century", north/south railway transit traffic will be further improved, meaning that transit traffic can be moved off the roads and onto the railways. Moreover, travel time for public transport services will be significantly reduced – in conjunction with the Ceneri Base Tunnel which is currently being constructed – (the travel time from Zurich to Milan will be cut by one hour), thereby considerably increasing the attractiveness of railway travel compared with taking the car or plane. In future, passenger and freight trains will pass through the tunnel at speeds of up to 250 km/h.

Slab track with LVT system

Lines feeding into the tunnel with ballast superstructure

The Gotthard Base Tunnel will be opened in 2016 and is a model project that exceeds all previous dimensions in terms of tunnel length, engineering and logistics.

There were multiple reasons to choose a slab track for the superstructure in the Gotthard Base Tunnel: in terms of high availability (due to low maintenance outlay), resilience and longer service life, the slab track comes out significantly ahead of the conventional ballast superstructure. What is more, with a slab track the tunnel cross section can be smaller – meaning a considerable decrease in construction costs, as this form of superstructure requires a lower construction height compared to a ballast superstructure. Of course, great importance is also placed on the topic of safety. For this reason, the decision has been made to have two separate tunnels (evacuation concept), permitting access for emergency vehicles if necessary.

In order to ensure that superstructure components can be used for a long time respectively to avoid excessive stress, a slab track must be fitted with elastic components – this compensates the lack of ballast elasticity.

For this prestigious project, the requirements in terms of railway technology were already very high: particular environmental conditions are found in the tunnel, such as ambient temperatures of up to 40°C and humidity as high as 70%. Moreover, strong pressure and suction forces are at work due to the high speed of the trains. Similarly, the extremely frequent use of the track, with up to 250 trains per day, also puts the line under above-average stress.

Pre-assembly

The solution with Getzner

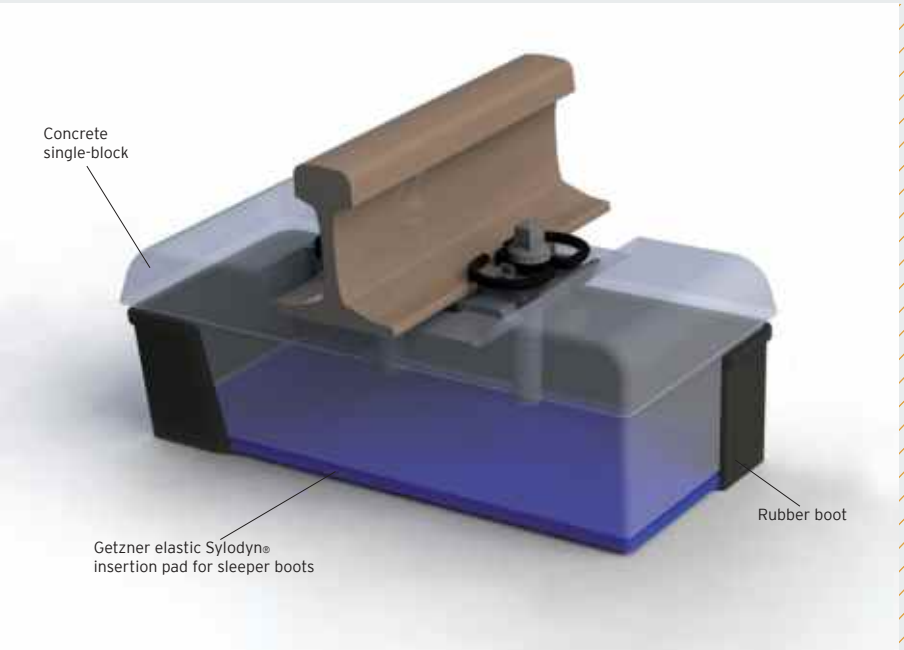
Elastic insertion pads for sleeper boots and under sleeper pads

All the materials in the Gotthard Base Tunnel and on the lines leading to the tunnel portals must provide outstanding performance over their entire service life. For these special requirements, Sonneville's LVT (Low Vibration Track) system was selected – one of the world's first slab track systems. In the case of the LVT system, the track is designed with single-block sleepers in rubber boots, with elastic Sylodyn® insertion pads from Getzner. The unreinforced track is laid directly on the inverted arch. The advantages of this special type of superstructure are that the individual components can be replaced (no rigid connection between the track panel and the slab), the high level of track accuracy, long service life and reliability, as well as the low maintenance costs.

In addition, all the slab track turnouts (manufactured by voestapine-Weichensysteme GmbH) in the tunnel have been supported elastically with Sylodyn® material. Numerous turnouts and individual track sections with ballast superstructure on the main lines feeding into the tunnel have also been fitted with Getzner under sleeper pads.

Materials for the most stringent requirements

The award of this contract to Getzner is primarily due to the excellent material properties, but also to the company's



LVT system

Aligned track

Measurement

technical knowledge and expertise and the LVT projects that have been demonstrably successful: this system has already proved its worth multiple times and is in successful use on five continents, with more than 1,000 kilometres of track in total.

Even in the early stages, within the framework of project planning, the materials were required to withstand tests with high permanent load and also artificial ageing tests. "Our products in slab track systems have now been proving their worth for over 25 years – this is not only confirmed by the test results, but also by multiple well-known references and measurements on actual tracks", explains Helmut Bertsch, Project Manager at Getzner Werkstoffe. Getzner calculated the optimum choice of materials and the extent of rail deflection of the turnouts using its own "finite element calculation".

Sylodyn®, the material used, is a closed cellular elastomer that only has very low dynamic stiffening, even in the high frequency range. Getzner materials have now been successfully used in railway superstructures for more than 40 years – as shown by numerous long-term references.

Slab track turnout

Increase of track stability and service life

It is important that all components fulfil the most stringent requirements, particularly in case of the high-speed turnouts in the tunnel: Various types of highly-elastic Sylodyn® inserts ensure even deflection as the train passes over, along the entire length of the turnout and in the transition area between the straight line and the turnout.

"High-speed turnouts were developed especially for this project, based on the latest technology. The high requirements placed on the materials and in terms of execution represent a major challenge for all manufacturers. Getzner Werkstoffe convinced us with their high-quality materials and excellent international references", explains Erich Wipfler, Director of Engineering at voestalpine-Weichensysteme GmbH.

A conventional ballast superstructure with padded monoblock sleepers and bearers has been installed on the lines feeding in to the tunnel portals. The Getzner under sleeper pads are used to protect the ballast and extend the tamping intervals required, as well as the service life of the superstructure. The special elastoplastic material properties of the under sleeper pads result in the ballast embedding into the padding, thereby increasing the contact surface and reducing the stress on the ballast. This property has a proven positive effect on track stability and the service life of the superstructure. Moreover, the dynamic deflection properties of the turnouts when a train traverses them have been optimised with the aid of in-house "finite element calculations".

High supply availability and optimum quality

Even if we consider only the particular requirements in terms of quality and logistics, the Gotthard Base Tunnel is an extraordinary project: "Getzner had to ensure high supply availability for the whole duration of the project, and guarantee a consistent extremely high level of quality – for the entire period of use", explains Anabel Hengelmann, the Chief Executive Officer of Sonneville AG. Getzner not only provides clients with individual support, but also offers attractive, professional project support – from material selection and detailed installation plans to tailor made just-in-time deliveries. This project was no different in this respect, being supported by highly-qualified Getzner employees from the areas of systems development, product management, application technology, quality assurance and production.

Key data for the Gotthard Base Tunnel

Client:	ARGE Transtec Gotthard
Operator:	Schweizerische Bundesbahnen (SBB) [Swiss Federal Railways]
Builder:	AlpTransit Gotthard AG
Track engineering:	AFTTG
Elastic components:	Getzner Werkstoffe GmbH, Bürs
Slab track system:	Low Vibration Track (LVT) from Sonneville AG, Vigier-Rail
Planned opening:	2016
Construction time for railway engineering:	2009 – 2016
Length:	114 km – 2 tunnels measuring 57 km each
Getzner products:	Elastic Sylodyn® insertion pads for sleeper boots, pads for sleepers and bearers for slab track and ballast superstructure, under ballast mats
Products installed Tunnel:	Elastic Sylodyn® insertion pads for sleeper boots: – 390,000 pcs. for the LVT standard system – 4,000 pcs. for the LVT high attenuation system – for 10 slab track turnouts manufactured by voestalpine-Weichensysteme GmbH
Products installed Feeder track:	Under sleeper pads for: – 33 pcs. ballast superstructure turnouts – 30,000 pcs. B91 sleepers More than 5,000 m² of under ballast mats
Project support:	Model and forecast calculations using finite element calculation, installation plans, quality assurance

Turnout tunnel portal

Photo credits: AlpTransit Gotthard AG, Getzner Werkstoffe

Facts and figures at a glance

Getzner Werkstoffe GmbH

Foundation:	1969 (as a subsidiary of Getzner, Mutter & Cie)
Chief Executive Officer:	Ing. Jürgen Rainalter
Employees:	340
2015 turnover:	EUR 77.9 million
Business areas:	Railway, construction, industry
Headquarter:	Bürs (AT)
Locations:	Berlin (DE), Munich (DE), Stuttgart (DE), Lyon (FR), Amman (JO), Tokyo (JP), Pune (IN), Beijing (CN), Kunshan (CN), Charlotte (US)
Ratio of exports:	85 %

LVT references (extract)

- Lötschberg Tunnel (CH)
- Weinberg Tunnel (CH)
- East London Line (GB)
- City Tunnel Malmö (SE)
- La Sagrera (ES)
- Marmaray Tunnel (TR)
- Moscow Metro (RU)
- Gautrain Johannesburg – Pretoria (ZA)
- SAS Second Avenue Subway (US)
- Nangang Extension (TW)