

# Proof of performance from the laboratory

for the ballast bonding resin GREBOPOX® system.

## Reliability in the long term, for the toughest requirements in rail transport

The ballast bonding system of the GREBOPOX® ballast bonding resin, developed by Gremmler Bauchemie GmbH has been continuously developed by Terra System GmbH in a "practical process", and now represents a sophisticated stabilization process that has proven itself in many years of practice. Corresponding test reports document the advantages of this technology.

### Here are a few examples:

- The lateral displacement resistance is increased 8-10 times compared to a normal ballasted track.
- The long-term durability is proven by the simulation of 125 million tons of load; the bonded areas were completely undamaged. This simulation corresponds to approximately 7-years of operating load on an averagely busy track.
- We now have various reference projects where the track position has remained unchanged for more than 10 years due to the ballast bonded with our GREBOPOX® (e.g. high-speed routes Göttingen and Frankfurt/Main, Halle and Bitterfeld, Kassel-Fulda, Erfurt-Nuremberg). Various transition bonding, where transitions from solid road to ballasted track were bonded with GREBOPOX® by Terra System GmbH, are still intact to this day.
- Efficient protection against flying ballast was successfully proven in 2015 on the DB AG Erfurt-Ilmenau route, in 2016 on the Milan-Turin RFI route, and, most recently in 2020, on the Turkish Railway TCDD (Türkiye Cumhuriyeti Devlet Demiryolları) route.
- The testing office for the construction of land transport routes at the Technical University of Munich analyzed the resilience of the bonded ballast under authentic practical conditions. The bonding withstood the toughest demands, e.g. displacement tests with a 90 kN hydraulic press. After completion of the tests, only minimal settlement was found. The elastic deflection (Swing width between upper and lower load) was approx. 0.1 mm, which corresponds to the elasticity values of a track after approx. 1-1.5 years of operation.
- Since 2019, our GREBOPOX® ballast bonding resin has met the building material class DIN EN 13501: A2fl-s1 in conjunction with natural stone and may be used in tunnels in accordance with the EBA tunnel guidelines.



# Special machine technology

for the processing and application of GREBOPOX® ballast bonding resin.

## Tempered bonding on site

The 2-component hot casting machine is a self-contained system that mixes the epoxy resin and the hardener (amine) homogeneously into the end material via a mixing unit. Within the system, resin and hardener can be heated to a constant, uniform temperature, which on the one hand ensures a continuous, homogeneous mixing process and on the other hand triggers the reaction process of the bonding

resin. The gravel is bonded using mobile 2-component mixing units (so-called hot casting machines), a special development from Gremmler Bauchemie GmbH and Terra System GmbH. Due to the flexible application options, coupled with high work performance, this [technological] machine enables a particularly efficient work process.



terrasystem®  
a strong partnership

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## The use of BALLAST BONDING in track construction

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# Ballast stabilization in track construction

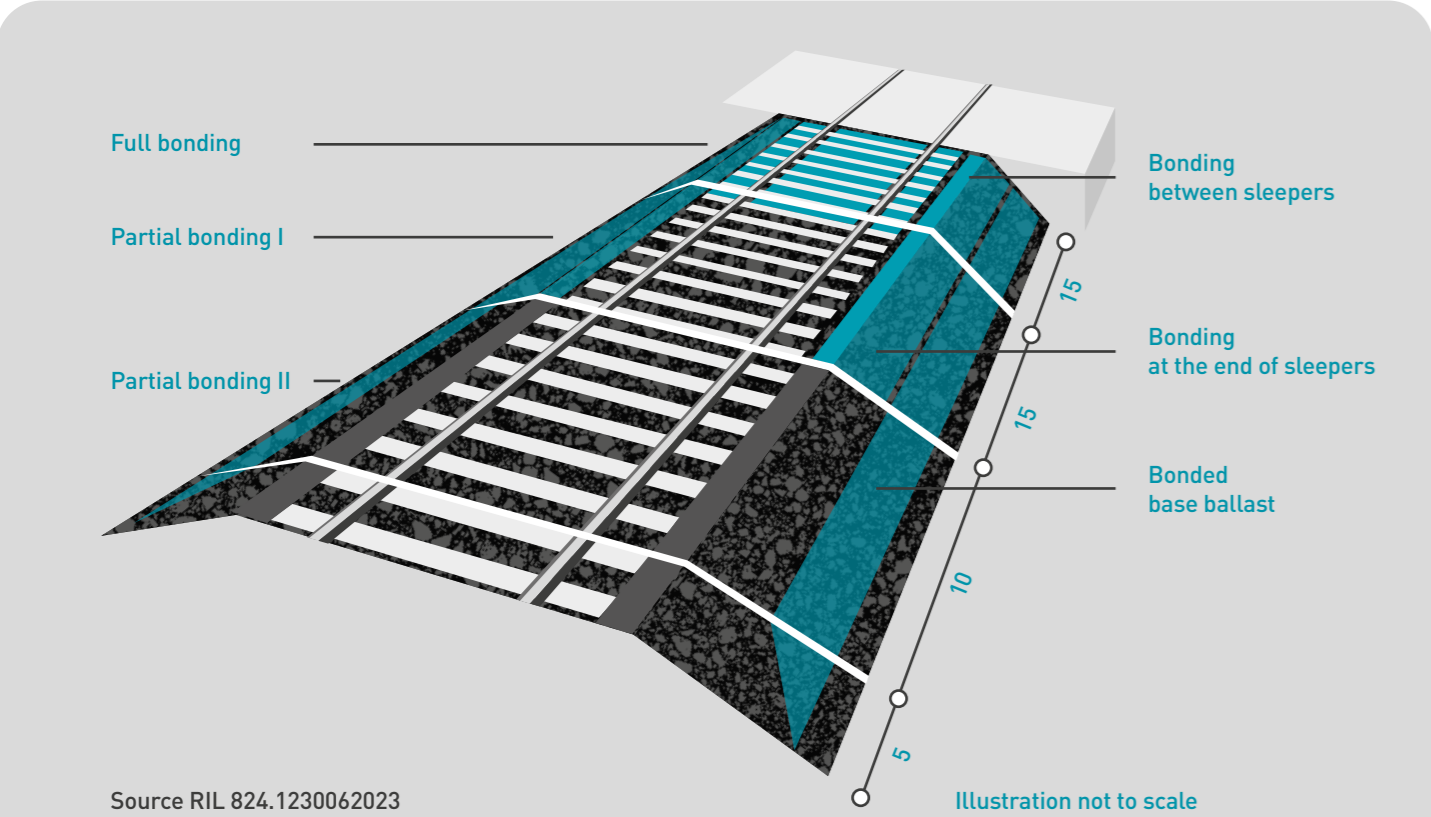
Solvent-free, efficient, and environmentally friendly, the Ballast Bonding resin **GREBOPOX®**

**Gremmler Bauchemie GmbH**, based in Hünxe, has been a reliable manufacturer of **GREBOPOX®** ballast bonding resin, approved by the Federal Railway Authority, for the temporary and technical bonding of track ballast, and gravel, in railroad and road construction for more than 25 years. Since 2019, our **GREBOPOX®** ballast bonding resin has met the building material class DIN EN 13501: A2fl-s1 in conjunction with natural stone and can be used in tunnels on the tracks of the Deutsche Bahn in accordance with the EBA

## Its very good processing properties

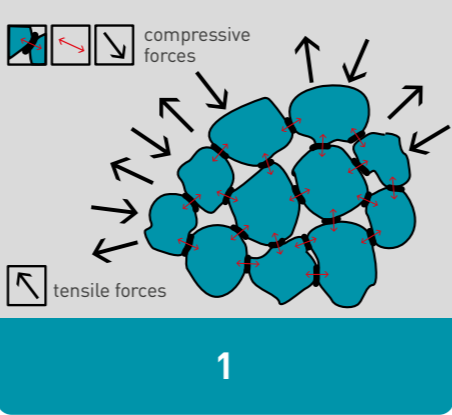
In contrast to the 2-component polyurethane resin-based and 2-component silicate resin-based bulkhead bonding resins that are also available on the market; our **GREBOPOX®** gravel bonding resin is particularly suitable for outdoor use. This means that the **GREBOPOX®** ballast bonding resin is characterized by its good moisture stability even when bonding matt, damp stones, and can be processed when warmed up from a temperature of 2°C. Due to the

## Stabilization of transition areas between ballasted track and slab track (see No. 3)



tunnel guidelines. **Terra System GmbH** – which has been the exclusive cooperation partner of **Gremmler Bauchemie GmbH** for over 15 years – supports the responsible use and professional installation of our **GREBOPOX®** ballast bonding resin system. The high functionality, coupled with its exceptional environmental compatibility, has been confirmed by several recognized institutions in a series of extensive tests.

efficient hot casting process, our ballast bonding resin shows very good flow behaviour, which means that even bonding – depending on the size of the stone – can be guaranteed, even at depths of up to 30 cm. The processing time of around 30 minutes, with a curing time of between 6-10 hours at a substrate temperature of 10°C-20°C makes the system very user-friendly.



## Ballast bonding for high stability and low maintenance costs

Higher travel speeds and axle loads increase the demands on track systems. The consolidation of the ballast with our special, environmentally friendly EP resin **GREBOPOX®**, sustainably extends the stability of the track, and thus travel comfort. Nowadays, this bonding technique is indispensable for bonding ballast at switches, insulating joints and transition sites.

### Durable and economical

Long-term tests by the Central Office of the German Federal Railways, and the Technical University of Munich, confirm the extreme resilience of the tracks stabilized by bonding. Gravel flow that loosens the gravel under the sleepers, or exposes it in front of the head is eliminated. In addition, the high long-term stability significantly extends the tamping intervals. For these reasons, bonding makes a significant contribution to reducing maintenance costs.

### Completely drainable

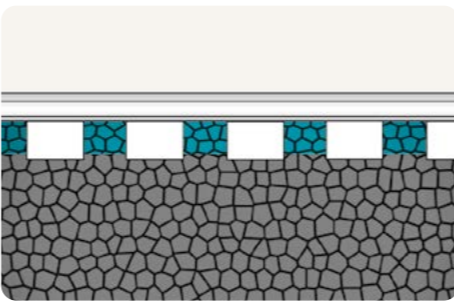
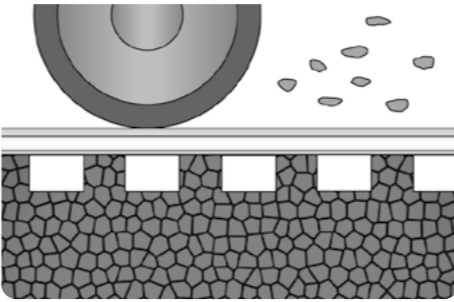
Due to our point bonding technology with **GREBOPOX®**, the water permeability (drainability) of the ballast track is fully retained. Even with strong downpours, during rainfall, the drainage of the track ballast is not reduced.

## Protection against ballast flying

The vortex created by high-speed trains, and the icefall that occurs on all rail vehicles when entering the tunnel are the main causes of flying ballast. This can damage the rails, the trains themselves, and facilities in the adjacent track area. Bonding with **GREBOPOX®** secures the gravel against any turbulence. Additionally, bonding the ballast with **GREBOPOX®** prevents individual stones from being picked up and used as projectiles, (vandalism).

### Long-lasting surface bonding

Thanks to the extremely durable bonding materials with **GREBOPOX®**, flying gravel is eliminated over the long term. The economical application process, and the long-term, stable hardening, pay for themselves in a very short time.



## Stabilization of transition areas between ballasted track and slab track

Transitions between ballasted railroad and slab track create different characteristics. Compositions, and compactions of the superstructure and substructure as well as settlements. In order to maintain safety and driving comfort, a high level of maintenance is usually required, which is significantly reduced by bonding.

### Prevents the movement of the ballast stones

By bonding with **GREBOPOX®** ballast adhesive resin, the gravel is held in its previously packed position, which prevents the stone from being rearranged. The abrasion of the stone as a result of dynamic stress is significantly reduced, and, in some cases, completely avoided for a longer period of time.

### Bonding in full, and partial bonding according to RIL 824. 1230 06 2023

In the last 5 years, various construction projects with transitional bonding, have significantly improved reduced maintenance intervals, due to the long-term stable track position, thereby saving maintenance costs.



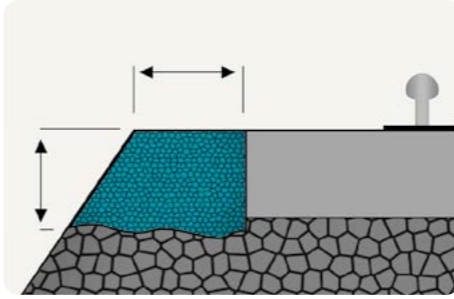
## Increasing the transverse displacement resistance

Insufficient ballast in front of the sleeper head can occur, especially on narrow curves, as well as leading to track distortions in front of signals, switches and platforms. Bonding the ballast with **GREBOPOX®** prevents it from moving.

### Permanently securing the ballast in front of the sleeper head with GREBOPOX®

The risk of the track being exposed in front of the head is eliminated thanks to permanent bonding with **GREBOPOX®**. The deep hardening increases the transverse displacement resistance at the same time.

The safety factor of the track increases. In cases where a 0.4-0.5 m ballast shoulder in front of the head is not possible for structural reasons, the same transverse displacement resistance can still be achieved by gluing with **GREBOPOX®**.

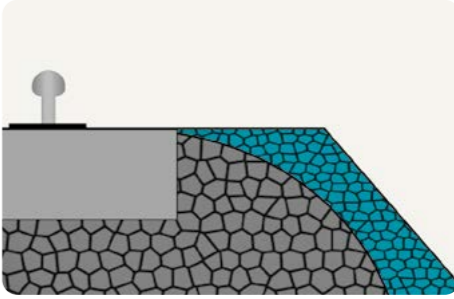


## Stabilization of the ballast shoulder when removing soil on the neighbouring track

When dismantling the neighbouring track of a two- or multi-track line, the earth level is approx. 1-1.5 m below the top edge of the rail. Passing trains and construction machinery can cause ballast to roll, particularly in front of the sleeper head, and impair the transverse stability of the operating track, which is avoided by bonding with **GREBOPOX®**.

### GREBOPOX® Ballast Bonding resin, an extremely cost-effective alternative

A highly stable bond is achieved by applying **GREBOPOX®**. This process prevents the movement of the stone, in many cases replacing conventional shoring and is an extremely cost-effective alternative. In addition, the bonded stone can be re-stuffed or reused for other purposes or bonded again if necessary.



## Excellent cleaning ability of the gravel surface

The gravel is often very dirty, especially in train/tram stop areas. Cleaning it is made more difficult by the fact that gravel stones are picked up during vacuuming which often damage the sieves and filters of the suction machine. The use of high-Pressure washers in turn will also cause the stone to shift. Only surface bonding with **GREBOPOX®** ballast bonding resin enables optimal handling.

### Unrestricted drainage despite being bonded

Bonded gravel surfaces can be cleaned particularly effectively and economically using the methods mentioned above. Due to the point bonding, the drainage capability of the ballasted track is fully retained, which means that the risk of the ballast being displaced or washed out is eliminated, even during heavy rain or cleaning work using high-pressure cleaners.

### A decorative variant is chip bonding

Stops where the cavities in the track ballast on the surface are filled with chippings (e.g. grain size 8-12 mm) and bonded are particularly attractive. Depending on the color of the natural chippings, or colored quartz, we would recommend using a UV-resistant binder to ensure long-term colour stability!

### Additional security benefits

An advantageous side effect is that bonded gravel surfaces are easy to walk on. Emergency routes are often made with **GREBOPOX®** created with bonded chippings.