Brenner Autobahn Rehabilitation - Case Study

Context

Renolith, also known as NanoTerraSoil (NTS[1]), is an additive for cementitious stabilisation. Renolith enhances the application process and improves pavement performance. This document provides a case study of Renolith usage in the Brenner Autobahn rehabilitation project.

Brenner Autobahn

The Brenner Autobahn is a major European truck route that connects Innsbruck in Austria to Verona in northern Italy. Carrying more than ten million cars and two million heavy goods vehicles (HGVs) per year, it is one of Austria's busiest highways. It is also one of Europe's main north - south transit routes across the Alps. Due to its location at high altitude, it is subjected to below-freezing temperatures several months of the year.

Project Need

The Brenner motorway surface between the 1st and 6th km suffered shoulder longitudinal cracking and formidable asphalt shrinkage and fatigue [1]. Reconstruction of the south bound and north bound roads was required. Fast completion of the project was critical to enable the motorway to be reopened to traffic as soon as possible.

Road Trial

A trial road was built in the Emilia-Romagna region of Italy to evaluate the performance of NTS/Renolith compared to conventional road construction methods.

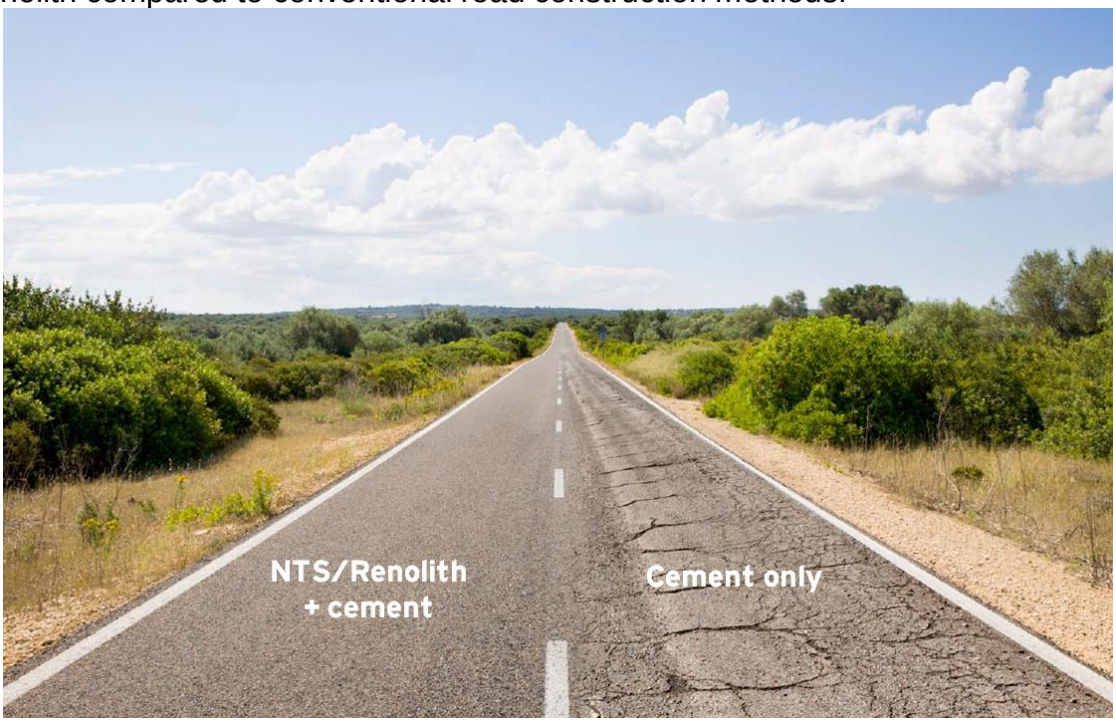

Figure 1 – Emilia-Romagna Trial Road Stabilization

[1] NanoTerraSoil (NTS) and Renolith are the same chemical product. The NTS brand is no longer supported. Renolith 2.0 is a double concentrate of Renolith.

The trial assessed the impact of the Renolith additive compared to cement-only stabilisation. Per Figure 1, significant shrinkage cracking developed in the cement-only stablised base layer, which propagated through the wearing course. The Renolith treated side performed well.

Design & Construction

The failed roadway (base) of the Brenner motorway (1st to 6th km section) was made from inert material, course aggregate and no cement stabilization. The area is subject to enormous fluctuations in temperature and powerful lateral water afflux at certain times of the year.

The subject section of motorway was reconstructed over a 4 week period in April/March 2006. The existing bitumen courses were removed. The existing base layer was strengthened via in-situ stabilisation with a mix of coarse gravel, 25 kg cement and 2 litres of Renolith per m², to a depth of 30cm. A new asphalt wearing surface was applied.

During reconstruction ambient temperature fluctuated between plus 2°C and minus 12°C. This intermixture proved to be advantageous as follows:

- the hardening process was accelerated; trafficable after 12h and able to lay asphalt after 24h.
- improved deformation modulus
- Field of application improved because use in low temperature was possible (to minus 8°C). [1]

Figure 2 – Cold recycling of base course

Tests

To allow the pavement to be reopened to traffic quickly, a critical technical parameter was to achieve a minimum of modulus elasticity of 80 N/mm² within 60 hours after construction. 150mm sample cylinders of varying heights were tested for mechanical performance after 24 and 48 hours. Mean results were:

- Compressive strength: 2.2 MPa
- Modulus of deformation: 84.4 MPa
- Indirect tensile strength: 0.3 MPa

SEM images of half-cylinder core samples are at Annex A.

Benefits

The key benefits of constructing the base layer using Renolith & cement compared to the conventional[2] construction method were realised as follows:

- **Materials cost.** Materials cost approximately 50% lower.
- **Time & labour.** More than 3 times faster to construct.
- **Logistics & environment.** 12,000 m^3 gravel not required, saving 800 truck journeys.
- **Strength & stiffness.** Very high bearing capacity (Ev2 range: 1000 – 2000 MPa).
- **Durability.** Greater frost resistance. Considerably more durable.

Performance

As of 2022, roughly 30 million trucks and 150 million cars later, the pavement remains in service. No problems have been reported. No repairs have been necessary.

Media Reports

See Annex B.

Bibliography

[1] K. Bergmeister, “Innovative Application of emulsion (nanoterra®soil) for compression / hardening load bearing layer of Autobahn,” University of Natural Resources and Applied Life Sciences, Vienna, 2007.

[2] K. Jopp, “Invented asphalt with less risk of potholes,” Welt, Berlin, 2010.

[3] D. Steinbach, “Munich lawyer sells anti-pothole additive,” Bild Newspaper, Berlin, 2010.

[4] “"Creeping Asphalt" - the new remedy against potholes,” Bild Newspaper, Berlin, 2011.

[2] Hydraulically bound gravel base course and frost protection layer

Annex A – 20,000x magnification of half-cylinder cores

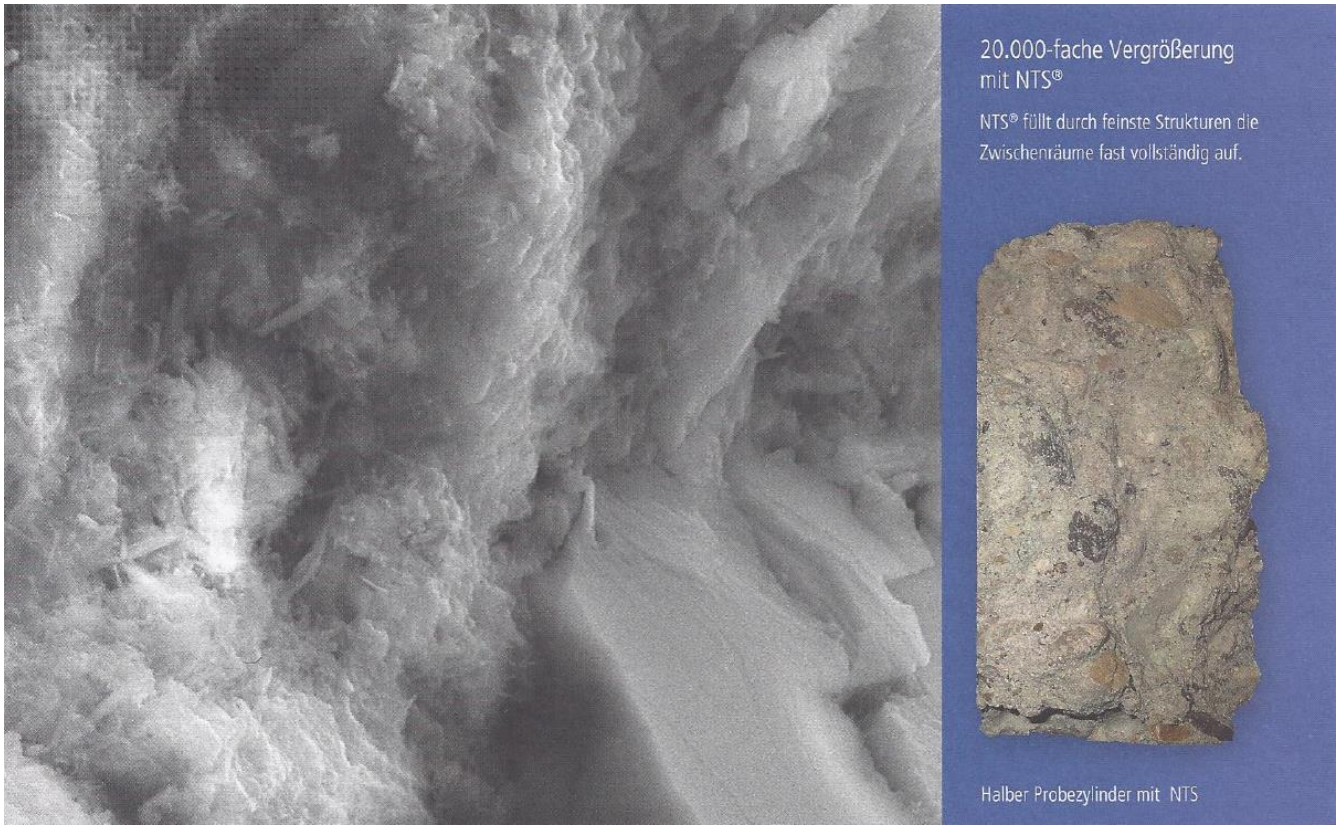

Figure 3 - With NTS - NTS fills the gaps almost completely with the finest structures

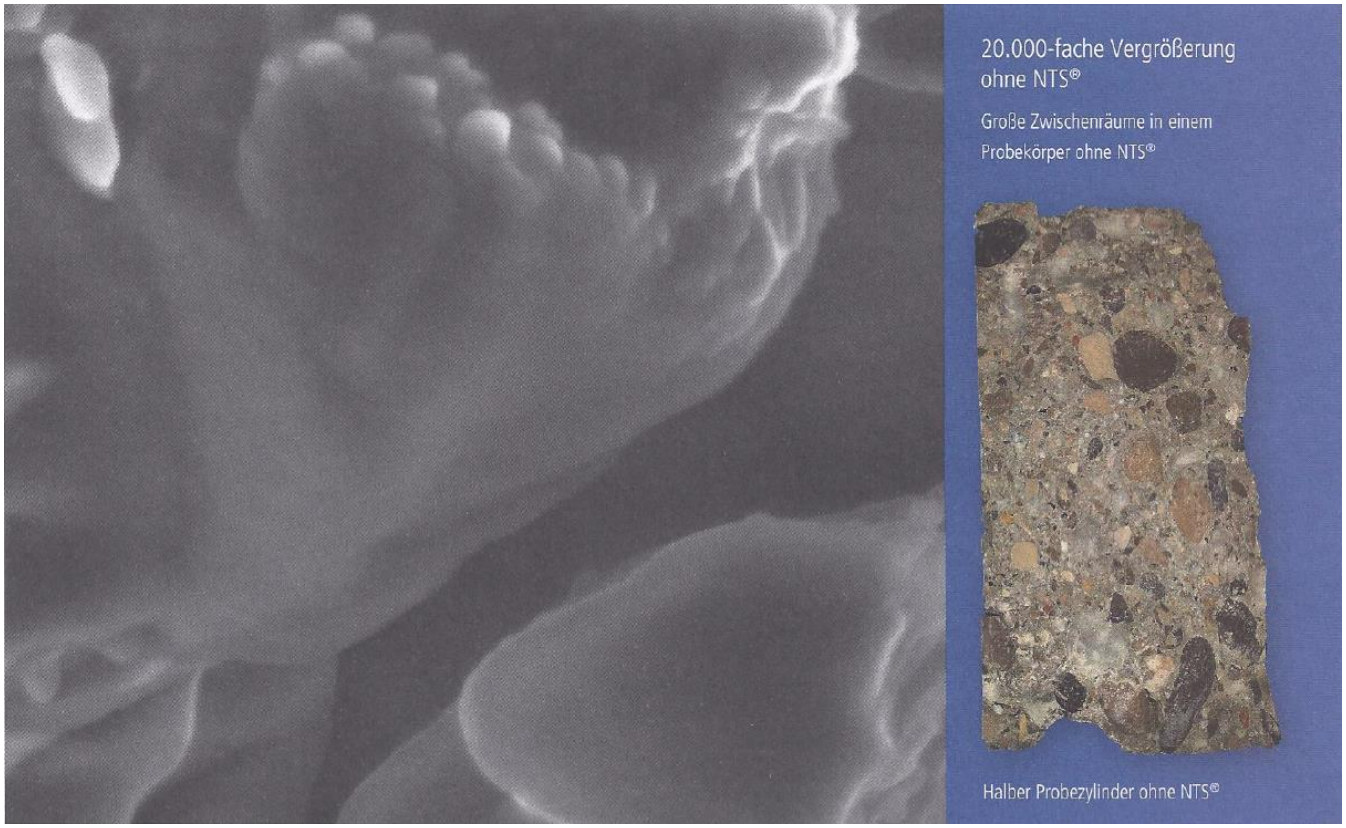

Figure 4 - Without NTS - Coarse spaces (Weaker bonds, porous)

Annex B – Media Reports

Roads: Invented [Polymer Additive] with Less Risk of Potholes [2]

The winter can still be seen on the streets. The ADAC calculates that the potholes in the asphalt will cost three billion euros. For Paolo Duiella, President of the Brenner Motorway, this is a waste of money: "There is a process that we tested with great success on the Brenner Motorway in 2006 and that uses the nanotechnology of a German company."

At that time, eight kilometers of the important north-south connection were renovated in a hurry. Under the most difficult weather conditions, asphalt was laid on the Brenner Pass, which NanoSky AG from Munich has been offering worldwide since this year. The company, founded at the end of 2009, has specialized in research, development and nanotechnological processes, particularly in the areas of construction, corrosion, and fire protection. The patented product NanoTerraSoil (NTS) is installed in particular on roads and paths…

The operators of the Brenner Autobahn give the innovative process excellent testimonials: "NTS has many advantages - high processing flexibility, great strength and long service life, limited penetration depth of water and great resistance to frost," Duiella lists the properties of the additive that in small amounts - only about one percent by weight - is added. Although the installation on the Brenner had to be carried out at low temperatures of down to minus twelve degrees Celsius and up to 7,000 heavy trucks thunder over the route every day, the fresh highway surface has remained intact to this day…

"Both the construction times and the costs are reduced by up to 30 percent," says Duiella. The asphalt dries quickly: the lanes can be driven on again after just two to four days.

Munich Lawyer Sells Anti-Pothole [Additive] [3]

The company has developed the building material NanoTerraSoil for roads, which is built into the base layer and prevents water penetration. The result: the asphalt holds up better because the base layer does not break or tear open in the worst frost or extreme heat.

The solution to all pothole problems. Another advantage is that the existing soil does not have to be removed and disposed of as was previously the case. " The construction costs are reduced by 30 percent" says Dr. Scheele.

The new technology has already been used in several countries. This also applies to nine kilometers of the Brenner autobahn. The operator is delighted. "We have tested it with great success," says Paolo Duiella. "Not only the costs, but also the construction times are falling rapidly." And the new road can be used again after just two to four days.

Scheele is proud that NanoterraSoil has also received approval in Russia. "Due to the extreme conditions, this is the road builders' Champions League."

"Creeping Asphalt" - The New Remedy Against Potholes [4]

Does it mean the end of the potholes? The new [polymer additive] "NTS" should last longer and be cheaper than before. What good is the alleged miracle cure?

According to the ADAC, removing all the potholes will cost eleven billion euros. However, often not the best, but the cheapest repair is used. Consequence: The roads open up again. The

Munich company Nanosky [distributes] a [polymer additive] called Nanoterra-Soil (NTS), which is said to work wonders. The mixture contains a latex-based binder. It therefore creeps into the smallest pores in the supporting road substructure. Water inclusions, which burst open the asphalt during frost, are avoided in this way. Nanoparticles make the agent bomb-proof when curing.

The proof is still pending. ADAC spokeswoman Wiebke Thormann: "If a conventional substructure usually lasts twelve to 15 years, this modified building material has to pass 20 years of practical tests. But the oldest example on the Brenner is just five years ago." Munich's [polymer additive] was paved over eight kilometers of the Brenner autobahn in 2006. No damage has been registered since then.