



Vienna, 10th of March, 2007

Innovative Application of emulsion (nanoterra@soil) for compression / hardening load bearing layer of Autobahn

1. General remarks

Reconstruction measure had to be taken on the south bound as well as on the north bound track between km 1 and km 6 within the scope of clearing up the Brennerautobahn. In doing so the roadway was reinforced by use of cement and a polymer – emulsion named nanoterra@soil. This action was necessitated due to o heavy truck, - high wheel loads-, and traffic causing shoulder longitudinal cracking and formidable asphalt shrinkage and fatigue. Starting in the middle of March 2006 this task was accomplished by halfway through April of same year. While working on the respective tracks, the heavy traffic (4.000 trucks and 20.000 other vehicles per day) was diverted to the opposite track thus finishing the job in the shortest time possible.

Quality conformance test were laboratory confirmed concomitantly by certified NIEVELT – Laboratory Ltd (I-37138 Verona Via Gramsci 12), having engineer (university grad.) REMOTI in charge. Respective test – report was compiled by 13th Dec. 2006 and delivered to undersignee Feb. 2007.

In order to keep construction – site advancing steadily plate load test were to be prearranged as to specify minimum parameters for deformation by (traffic) pressure. These parameters were to be accomplished at the latest after within 60 hours after construction.

- Minimum of modulus elasticity : 80 N/mm²

To keep construction – site progressing still further for then construction vehicles were to navigate on this site much sooner, it was essential to achieve designated hardening of load layer as early as possible. Also to be considered were ambient air temperature up to minus 12°C on site. Following technical measures taken are being described. Prior it should be recorded that basically cements are binding very slowly at minus 2°C and

below. This setting of cement was to be facilitated plus being potentiated within a range of low temperature by blending in said polymer – emulsion.

2. Technical provisions

Thirty five years ago the Brennerautobahn was constructed. South of the Brenner the road way consists of inerte material and crude granulations not being consolidated by cements. Additionally this area is located in a umbrageous region plagued by very low temperatures and edgeways constant trickles towards the highway – soil; at ca. 1.300 m above sea – level it faces atmospherical temperatures between minus 30°C and plus 35°C plus permanent and partly heavy intrusion of surface water in spring time due to the routing by way on the left mountain side. Therefore it was required the road way to be frost – resistant and tolerate permanently heavy wheel – loads up to 160 kN (16 ton per axis). As reconstruction - material the outworn stock of highway were to be used. A “weight in motion” measuring – system mapped the heavy wheel – loads.

- **2 Liter Polymeremulsion „nanoterra@soil“**

The bitumen base layer was removed in course of reconstruction to be followed up by the actual concrete construction- procedure. Based on prior examination for reconstructed load layer depth of 30 cm

- 25 kg cement per square meter and
- 2 litres of polymer – emulsion “nanoterra@soil”

were blended in by continuous fraise. To the primordial scarified material was blended in by granulation (Graining 8 to 30mm). Outworn stock was not replaced although calcareous and claygerous granulites as well as mica slate were discovered. In extracts the results of said laboratory, NIEVELT, are presented. They indicate relatively high results of plate- load –tests although when conducted very low temperature dominated. Here are some of them:

- **elasticity modulus:**

km	Time [h]	Temperature[°C]	Modulus of Elasticity [N/mm ²]
2,14	24	+2	150
4,27	48	-8	81
5,41	48	-2	136
5,41	24	-2	81
Mittelwert	24	Von 2 bis -2	84,4

Indirect elasticity

On average test of indirect elasticity exhibited 0,3 N/nm² per sample compression-cylinder diametering 153 mm and height of 53 till 138 mm.

Pressure strength under compression

Pressure strength was determined by using said cylinders diametering 150 mm and height of 100 – 169 mm. On average 2, 2 N/mm² was indicated fluctuating between 1,6 and 2,6 N/mm².

3. Summary Assessment

In course and time of reconstruction ambient temperature fluctuated between plus 2°C and minus 12°C. Per m² of scarified roadway was blended in with 25 kg and ca. 2 liters of „nanoterra@soil“

This intermixture proved to be advantageous as follows:

- the hardening process was accelerated, after 24h already trafficable
- improved deformation modulus
- Field of application improved because of use in low temperature was possible; up to minus 8°C still allowed to get in reasonable results in short terms.

In physical terms the improvement was caused by adding the polymer emulsion „nanoterra@soil“ thus accelerating the process of setting of the cement. An earlier and accelerated Hydration of cement – paste took place obviously, although only normal cement (CEM 32,5) was used. In this setting process thermal is caused so the process of Hydration can take place even when outer lower temperatures are dominating. The more rapid Hydration takes place the more thermal output exceeds per time unit. This process could be improved even more when using fast-hardening cement (e.g.: CEM 52,5).

Altogether improved adhesive strength of cement – paste with granulation was observed plus an improved elasticity, wherefore a prime frost resistant can be obtained.

It is to be recorded no damage of reconstructed road way was diagnosed after a year of heavy traffic by up to 7.000 trucks (high wheel loads) per day. Hence I come to the conclusion the by stabilising of cement by 25 kg/m² and adding ca. 2 l/m² the load capacity of road way was improved significantly plus an easy application respectively reconstruction even in the range of rather low outer temperature was to be accomplished.

Univ. Prof. Dipl.-Ing. Dr. Dr. Konrad Bergmeister