

Ing. Doru Zdrengea

ISPCF - Institute for Studying & Projecting for Railways, Blvd. Dinicu Golescu 38, A Gate,
Bucharest, tel.: + 40 213 160 190

REHABILITATION OF POARTA TUNNEL

CHAPTER 1 SUMMARY

Poarta tunnel is situated on railway track Bucharest – Jimbolia between km 436+168 – 437+036, and was built in years 1967-1970 in track version and parallel with the old tunnel, due the action of electrification of the main railway track Bucharest – Craiova – Timisoara. The execution method for this tunnel was the classic Austrian method. The cross section which was choose it is for single track (one track), which can be applied also for electric dimensions, in a ovoid shape, composed from two reinforced concrete layers, closed at the base by a reinforced concrete block turn vault. Between these two reinforced concrete coats it was previewed a intermediary waterproofing done from aluminum folly by 0.5 mm thickness, between 2 layers of bitumen membranes and 4 layers of rubber bitumen.

The portals are composed by simple concrete with false bandeau of masonry with assize and concrete slabs.

During the exploitation time of the tunnel, at intraback were showed up big water infiltrations which produced big degradations of the vault and walls, and in the months with low temperature it's creating ice icicle which affected the electric contact line and the access dimensions.

From the geotechnical study results that the zone which is crossed by tunnel it is a hill zone, composed from sedimentary of marne-clay, with intercalations of deposits by porous-permeable materials, composed from gravels.

During the wet periods, inside the gravels it's accumulates big quantities of water, which for the reason of big filtering coefficient of the gravels, migrates easily in the neighbor areas, so also toward the coat of tunnel.

The gravel deposits and sands met during the geological studies are filled with clay, and sometimes it seams to be clean, having instead a medium compression. In the geological drillings were found out water in two sandy complex. The underground water is situated in superior sandy complex and gravels above of marnes horizontal.

Because of the big thickness of clay layer (approximately 15.00 m), the waters from this complex don't communicate with the water under this. Water don't circulate free in layer, but appears under a form of bags.

From the analyze of the cotes where water shows up, can be seen that toward the central part of the tunnel it's creating a balance, the waters being guide to the heads of this. At the contact with the sediments of marnes-clay where are situated the aquifer gravels, the water from rains and snow it's mineralizing, so in the end the underground water which results has a modified chemical structure and affects the integrity of the tunnel coat.

Respect of the geological profile described above, results that the tunnel was executed in the following zones:

- Km 436+168 - 436+250 și 436+925 - 437+036 zones in the sandy layer with intercalations of gravels and clay;
- Km 436+250 -436+325 și 436+850 – 436+925 zones with marnes layers, with intercalations of grey sand very tiff (cram);
- Km 436+325 – 436+850 a zone with sand complex with intercalations of tiff gravels, with small quantities of water. At the execution of the tunnel were met some difficulties caused by the soil nature, which in water presence it was bubbled and it was damaged, resulting local collapses and resulting also the compression of the head gallery with 2.00 – 2.50 m on some areas.

The waters from infiltrations, which penetrate at the intraback of the tunnel, are not part of joints of straight walls – vault or part of joints between the rings, resulting the fact that is no any concordance between the joints of external coat and from inside coat.

Inside the tunnel the main reviled damages were:

- infiltrations under the shape of drops, leakages, wet zones, ice icicle and ice blocks or effects of these under the shape of deposits (efflorescence) and concretions;
- damages of the coat tunnel under shape of ex-folly or voids, corrosions, porosities or segregations.

Infiltrations and effects of these were reviled in the following zones:

- Drops on vault, on small areas;
- Droppings and leakages on the straight legs;
- Wet zones on vault and on the straight legs;
- Ice icicle and ice stones on the straight legs;

- Deposits of salts (efflorescence) were reviled in general around the wet zones and rarely independent;
- Concretions;

Degradations of the inside coat:

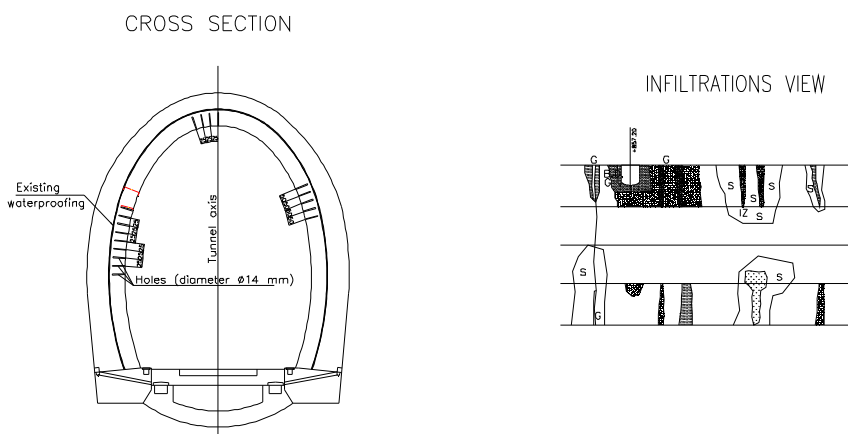
- voids in coat;
- damage concrete;
- Crack at km 436+882 right.

CHAPTER 2. PROJECTED WORKS AND THEIR EXECUTION

According with the technical expertise done by Mr. prof. dr. eng. Teodor IFTIMIE, the ISPCF (The Institute for Studies and Design in Railways Bucharest) started to prepare the design of rehabilitation of the tunnel. The projected works were the following:

- The consolidation trough internal injections in the mass of inside coat of the zones with fissures and cracks with polyurethane resins with high mechanical resistance;
- Sealing of the inside coat by injections with 2C polyurethanes resins;
- The consolidations of zones with damaged concrete;
- Intraback drainage;

According with damages relived and of infiltrations, the works for sealing were executed by S.C. Tuncle S.A. – Brasov, with injections of 2C polyurethanes resins with high mechanical resistance, according with the following technology:



- were delimited the exact surfaces which have to be treated;

- The wet surfaces on which were executed the injection works were cleaned, washed with water and flushing with pressured-air;
- were executed the drilling holes for injection, on 30 cm deep, and the distance between the axes of 25 cm;
- were montage the injection tubes, and the injection devices (packers) were installed and fixed in such way to can not be take out from the hole because of the pressure from injection;
- The injection on one packer was done till the moment when injected material get out from the neighbor holes which were not been injected, or till the pressure of injection rise to manometer over the pressure set to the injection pump (pressure which is established in site by the executor and designer);
- The pressure was followed on the manometers, installed on the injection gun and also to the injection pump. In this way the differences appeared between the pressure from packers and the one from pump, indicates a changing of the consistence of the injected material;



The reparation of the fissures and cracks was executed like following:

- Were done the injection holes with an inclination respect of the fissure surface which crossing inside the coat, under an angle of 45°.
- It was closed the fissures on the surface with gel-paste;
- It was injected resin inside the fissures;

The injections works were executed with specialized and qualified staff, from a rail platform, due the track closing or between the traffic windows of 6 hours/day and shift, with the turn off under the tension of the electric contact line.

The consolidations of the damaged concrete zones were executed following the technological process:

- Was hammered the concrete on a deep of 4-6 cm until the rods from the inside net were released from the reinforcement of the coat;
- Was cleaned, washed and painted with cement milk (suspension).
- Was concreted the zone.

The works of drainage at intraback were executed in this way:

- were executed diggings in tale-swallow shape;
- were executed drillings at the end of diggings at +4.30 m from Superior Level of Cross Beam, by 30 cm deep for collecting of the water from extraback;
- were installed the semi tubes from PVC – GD – Ø63 x 4,7 mm;
- were covered the semi tubes with a geotextile layer;
- Were concreted the zones with concrete C 12/15.

CHAPTER 3. CONCLUSIONS

The rehabilitation works of the tunnel were finished in the autumn of year 2008.

Respect of the classic waterproofing works from extraback with membranes and access trough head gallery and climbers, works of waterproofing by injections has the following advantages and disadvantages.

Advantages:

- alert execution, superior respect of the classics technologies (1m/day in windows traffic or 3 m/day due of total closing of traffic). Result: shorter terms of execution;
- reduced manpower;
- reduced job-site organization;
- much more cheaper even in case of continuously sealing;
- easy post-intervention;

Disadvantage:

- Disturbing of the traffic.

The usage of the polyurethane resins for sealing and consolidation of the underground constructions in Romania leads to revile of some problems with which were confronted the designers and executors:

- The necessity of regulations (norms, guides) or of a practice code for usage and put in work of those resins;
- The necessity of preparation of a design specialists and of a specialized technical staff (including execution teams) at the entrepreneurs implicates in these kind of works, due the realization of training course;
- Realization of a tests and research works who contribute to the improvement of these technology and to increasing of the beneficiary trust.