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36 Concrete pavements in tunnels

Introduction

In the past, big tunnel building projects had roads with surfaces made of concrete. The reasons for using concrete surfaces were mainly the long durability of these types of roads, the low maintenance costs, good roughness and, to no small degree, the fact that such surfaces absorb less light and thus help save money on lighting while increasing driver safety. Also, ruts, which decrease driver safety, do not develop on concrete roads. In the 1980s, asphalt-concrete surfaces were used in tunnels with increasing frequency, mainly where the roads immediately connected to the tunnels had asphalt surfaces.

The use of concrete surfaces in tunnels did not return until the infamous tunnel fires. For these reasons, there was a change in the plans for the Bra-

nisko tunnel in eastern Slovakia that created the longest concrete road surface in a tunnel in the Czech and Slovak republics (the original plans called for an asphalt surface).

Highway tunnels in Slovakia

Due to the mountainous character of Slovakia (mainly in the northern part), 17 tunnels, with a total length of 38 km, need to be built on the three main Slovak highways - see picture 1 [1].

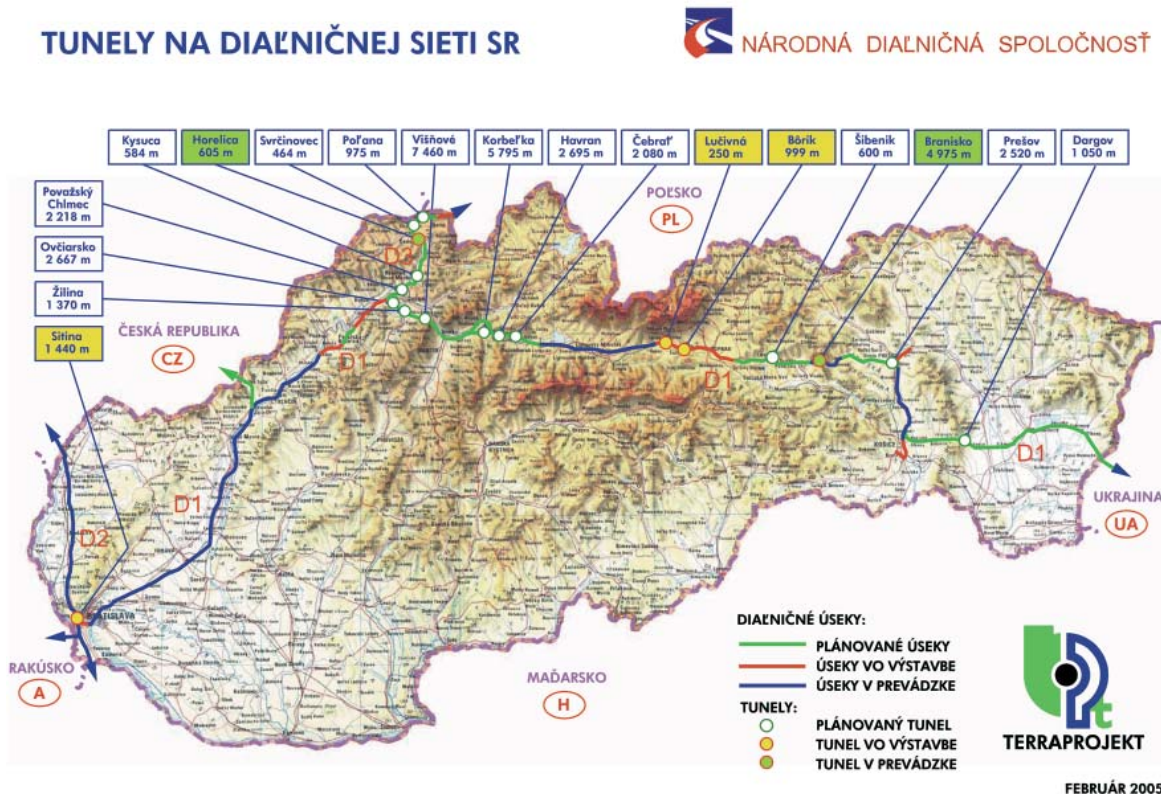
Due to the high financial demands of constructing tunnels only two tunnels, for a total length of 5570 m, have been built, and currently another tunnel, with a length of 1440 m, is under construction. The construction of another tunnel, the "Borik" tunnel, near the town of Poprad, with the length of

999 m, is scheduled to begin soon. Reconnoitering galleries have been bored for two relatively large tunnels near the town of Zilina, the Visnove tunnel of 7 460 m and the Ovciarsko tunnel of 2667 m. It is clear from this overview that 14 more tunnels, with the total length of 31 km, representing 81% of the total, need to be constructed over the next 10 years. All of these tunnels should have a concrete surface. The following can be said about the concrete roads in tunnels already completed.

The Branisko tunnel

This tunnel is located on highway D1, from Bratislava to Košice and has one tunnel tube – see picture 2-4.

The road, with a total length of 5 200 m, was built by the Uherské



Picture 1 – Highway tunnels in Slovakia



Picture 2 – Tunnel Branisko – West tunnel face



Picture 3 – Concrete road in tunnel Branisko



Picture 4 – East tunnel face of tunnel Branisko



Picture 5 – Concrete road in tunnel Horelica

Hradište branch of Skanska DS a.s. The width of the tunnel at sidewalk level is 9.5 m and the clearance height for traffic is 4.5 m. The actual width of the road is 7 m. The base layer is made of cement-bound aggregates. The original plans were adjusted in many places, on recommendation from the contractor. The original 40 mm thick asphalt middle layer was replaced by increasing the thickness of the cement-bound aggregates by 20 mm and increasing the thickness of the concrete road surface by 20 mm for a total thickness of 260 mm. A new two-layer structure of the concrete road was designed with anchor joints, anchored with dowel bars. The final road surface was adjusted by tightening the jute belt. The joints were originally meant to be cut every 15 m, but the distance was cut in half to every 7.5 m [2].

The laying of the concrete road started at the end of November 2001 and took 12 days. Many problems arose during the construction of the road, the biggest problem being limited space in the cross section of the tunnel. Finisher Wirtgen SP 1600 had to increase the width of the base to 7 m, although this almost completely extended across the profile of the tunnel. The low tunnel ceiling did not allow concrete mixtures to be dumped, even after the trucks had been adjusted. The trucks had to back up for long stretches, while there was no functioning ventilation system while the road was being built .

For the production of concrete for the road, 4000 t of special Portland road cement CPC 7.0 was produced at Holcim (Slovensko)'s cement plant in Banska Bystrice. This concrete met

all requirements for small volume changes during hardening and setting and had no problems achieving the required bending tensile strength. This finished concrete road met all requirements for driving comfort, noise and especially traffic safety.

The Cadca – Horelica tunnel

This tunnel is located in northern Slovakia on highway D3, between the town of Zilina and the Polish border and has one tunnel tube – see picture 5.

This tunnel measures only 616 m in length and the construction of the road was completed by the Uherské Hradište branch of Skanska DS a.s.. The width of the road is 8.75 m and the total width of the tunnel is 12 m. The height of the tunnel arch from the surface of the road is 7 m and the clearance height was 4.8 m. The concrete road itself had a thickness of 260 mm. Double-layer concrete was used, with the thickness of the layers measuring 190 and 70 mm. The base layer was made of void concrete with a thickness of 180 mm.

The total volume of the concrete for the road was 3500 m³ and special Portland road cement CPC 7.0, made at Holcim (Slovensko)'s cement plant in Rohožnik, was used to construct it. The concrete used to make the tunnel walls was made with cement CEM I 42,5 from the Rohožnik plant (a total of 12,000 m³ was used).

The Sitina tunnel

The Sitina tunnel (picture 6 - 8) forms an integral part of the southern by-



Picture 6 – Tunnel Sitina – Construction of south tunnel face



Picture 7 – Tunnel Sitina – shotcreting of primary lining



Picture 8 – Construction of second lining in north tunnel face

road of Bratislava. This tunnel is part of the 3,3 km long Lamačská cesta – Staré grunty section of the D2 highway which services Bratislava, the capital of the Slovak Republic, while bypassing the city center. The tunnel is under construction.

The total price of this project is more than € 95 million. The project investor is the Slovak Road Authority; the general contractor is Joint Venture: Taisei Corporation (Japonsko) – Skanska SK a.s., Bratislava. The

subcontractors are SKANSKA BS a.s. Prievidza (tunnel tube driving) and Váhostav tunely a špeciálne základanie a.s., Žilina (definitive tunnel structure). The construction of the Sitina tunnel started in September 2003 and should be finished by the end of 2005. The Sitina tunnel is a two-tube highway tunnel. The total length of the tunnel tubes after the construction is finished will be 1415 m and 1440 m. Due to the expected high variability of the mountainous terrain, both tunnel tubes had to be driven using a new bore-explosive technology according to the New Austrian Tunneling Method (NATM) – see picture 6-8 from the tunnel construction.

The width of the tunnel at the sidewalk level will be 9.5 m and the height of the traffic clearance will be 4.8 m. The actual width of the concrete road will be 7.5 m and the concrete road will continue 150 m beyond both ends of the tunnel. Even if the composition of the road has not been solved (changes to the original plans are currently being made), the concrete road will most likely be composed of two layers of concrete, with a total thickness of 250 mm and individual layer thickness of 170 mm and 80 mm. The double-layer structure of the road is likely to be anchored with joints along the length of the road which are anchored by dowel bars. The expected design will have a joint running down the length of the road, dividing it into 2 lanes of 3.75 m. This lengthwise joint will be cut every 5 or 6 m. The base layer of the road will be made of cement stabilization with a thickness of 180 mm; below this layer will be a 270 m thick layer of crushed rock with a fraction of 0-32 mm. There will be a 50 mm layer of asphalt-covered

aggregates between the cement stabilization and the concrete road. The concrete road itself will be constructed by the Uherské Hradište branch of Skanska DS a.s. in October 2005.

Holcim (Slovensko) has produced the special cement CEM I 42,5 for shotcrete, which was used for primary lining. Standard cement CEM I 42,5 R from Holcim (Slovensko)'s cement plant in Rohožnik, is also used for second lining of tunnel. Till now more than 85,000 m³ of concrete was delivered for tunnel construction.

Conclusion

Even though not many concrete roads have been built in Slovakia in the last ten years, all roads in tunnels have been built of concrete for well known reasons. We hope that drivers' and administrators' good experience with concrete roads in tunnels will convince investors to gradually begin using concrete roads to a greater extent.

Literature

- [1] „Tunely diaľničnej siete v SR“ (Tunnels of the highways network in Slovakia), published by the Slovak Road Authority, Bratislava, 2003
- [2] Ing. J. Srutka, Skanska DS a.s., Uherské Hradište, „Betonové vozovky v tuneloch“ (Concrete roads in tunnels), Proceedings from the “Special Concrete Conference”, Malenovice