Site report

Long-distance concrete pumping in the Lainzer Tunnel in Vienna / Austria

With a pumping range from above ground of up to 1400 m produced by a BSA 2109 HE, the concrete was pumped directly into a BSA 1408 E relay pump at the arch formwork carriage.

The Lainzer Tunnel is a railway tunnel in Vienna that is 12.8 km long and, from December 2012, will connect the Westbahn (western railway) with the Südbahn (southern railway) and the Donauländebahn railway. The purpose of this plan is to increase the capacity of the east-west transit system.

The tunnel starts at the Wien-Hadersdorf station and runs below the Lainzer Tiergarten to the west of Vienna, from Speising close to the existing junction line and, at its mouth, joins the Südbahn line before Wien-Meidling station and the Donauländebahn line in Altmannsdorf. It is part of the Westbahn and the European High-Speed Line between Paris – Budapest.

The LT 31 consortium (HOCHTIEF Construction AG, Alpine Bau GmbH and Beton- und Monierbau GmbH), under the leadership of HOCHTIEF Construction AG, was commissioned by the ÖBB-Infrastruktur Bau AG to construct a main section of the Lainzer Tunnel.

To execute the inner lining in built-up areas, from October 2008, the concrete for separating the underground transport traffic from the above-ground transport traffic was pumped through a permanently installed delivery line, measuring between 300 m and 1400 m in length, from the concrete mixing plant at the construction site directly to the placement site.

The concrete mixture was designed to meet specific structural and pumping requirements and was subject to continuous monitoring from a concrete technology perspective throughout the duration of the construction project.

The interior construction of the tunnel was performed using a watertight concrete inner shell (d>=50 cm), with PP fibres added to the concrete in order to improve its resistance to fire. In addition, the inner shell was designed with an

8 cm enlarged concrete covering of the reinforcement (reinforcement proportion of the tunnel lining is approx. 85 kg/m³ of concrete).

The formwork carriages for each segment of the tunnel were 10 m in length, resulting in an installation quantity of approx. 150 m³ of concrete for the tunnel lining of each concreting section and of 90 m³ for the base.
The interior work had already commenced in parallel to the headwork, and the concrete was fed via two vertical starting shafts. It was therefore decided at an early stage to supply the concrete for the formwork carriages using a stationary concreting facility – consisting of a stationary concrete pump and a specially designed delivery line. As a result of the positive experience gained from the beginning, this form of concreting logistics was maintained even after the headwork was completed. In the construction phases S and M, one delivery line each was available for the base and the arch

The area between section M and S. In the background, you can see the formwork carriage that will connect to the existing arch of section M and continue on in the direction of S. The clear advantage of using pumps to deliver the concrete is also evident. Since no truck-mixers operate in the tunnel, the potential traffic capacity can be fully used to deliver components for the formwork carriages, reinforcing rods, foils and other items.

The separating film can be seen in front of the arch formwork carriage. It separates the inner and outer shells of the tunnel. This separating film is used to secure the steel reinforcement for the final concrete inner shell.

for the concreting logistics. As a result, up to four formwork carriages could be filled with concrete in parallel. In this way, concreting outputs of up to 500 m^3 per day with reinforcement work running in parallel could be achieved. This had the positive effect that restrictions and obstructions in the tunnel could be eliminated by simultaneous reinforcement and concrete transport. It was possible to speed up the construction sequence considerably: Six months' time saved in comparison to transport via mixers.


A hose was branched off from the delivery line and fed the BSA 1408 E at the arch formwork carriage

Concrete pumping technology

Concreting

A stationary concrete pump BSA 2109 H E (later a BSA 2107 SHP E) pumped concrete via a delivery line that was permanently installed in the tunnel from above ground to the arch and base carriages, which were a maximum of approx. 1400 m away.
At times, the base concreting ran ahead of the arch by up to 600 m. To feed the arch formwork carriage, the delivery line was branched off at an appropriate point and a delivery hose was used to guide the concrete into the stationary relay pump BSA 1408 E directly at the formwork carriage. Short distances between the crew of the formwork carriage and the pump machine operator prevented compressive stress peaks in the formwork carriage.
A P 715 fine concrete pump was available for the concreting of the cross cuts.

Cleaning

The DN 150 delivery line was cleaned by using water to force the concrete residue out in a „forwards" direction. Depending on the length of the line, this work was carried out by a BSA 2109 H D or a BSA 1409 D. „Forwards" water cleaning is usually selected for relatively long concrete delivery lines in order to prevent large quantities of concrete residue from forming. A replacement pipe is then equipped with a media separation system in order to separate the concrete from the water when the concrete residue is being forced out and, after the concreting process is complete, it is put in use directly behind the stationary pump. The replacement pipe mentioned above is usually fitted with a combination of sponge balls and wash-out pigs. Suitable media separation systems must be configured depending on the concrete delivery line installation. They are an important part of the delivery line planning to ensure the availability of the stationary concrete delivery facility.

The BSA 2109 H E (from April 2009, this is a modified BSA 2107 SHP E) pumped approx. 28 m^3 of concrete per hour over the distance mentioned above to the arch or base formwork carriage.

Concrete

A tunnel section of 20 tunnel segments, each 10 m long, was produced from self-compacting concrete (SCC). For this purpose, the Pöyry Infra GmbH (MVA

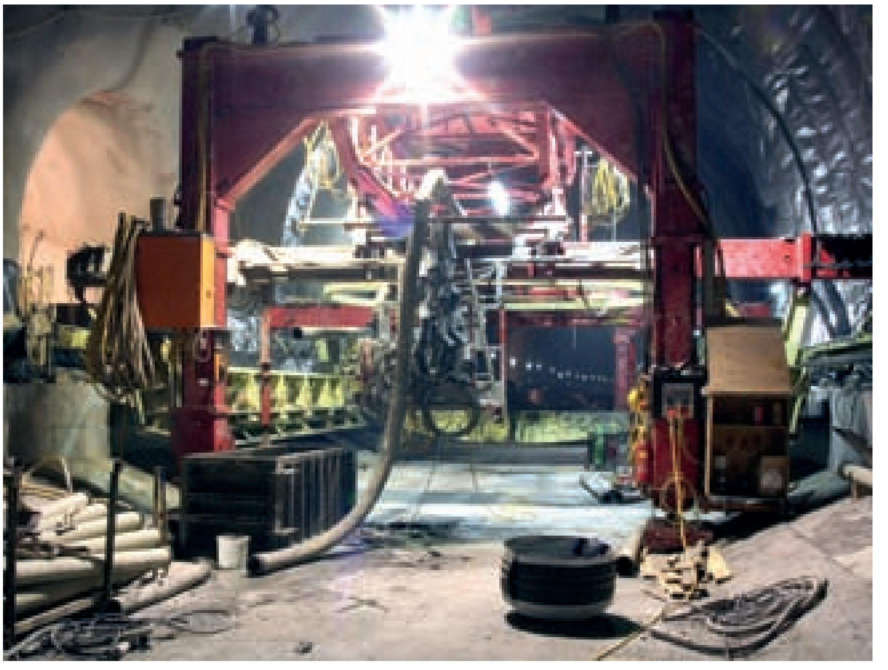
Concrete composition WDI / BBG / SCC

Base material	Quantity
Cement CEM I 42,5R HS C_3A-free	280 kg/m^3
Fluamix C	170 kg/m^3
Chargeable binder	388 kg/m^3
Water in acc. with batch report	185 kg/m^3
LZF/LZ51 1)	5.6 kg/m^3 / 1.24 % from cement amount
LP 100	0.18 kg/m^3 / 0.04 % from cement amount
Stabilisator Strong	1.6 kg/m^3 / 0.36 % from cement amount
Fibres PM 3/15 2)	1.2 kg/m^3
Stone particles (dry)	1706
0/4	70 %
4/8	10 %
8/16	20 %

1) The LZF/LZ51 was apportioned in the ratio 70:30.
2) The PM fibres 3/15 were added to the forced mixer by hand.

Strass) laboratory developed a concrete mixture that was specifically formulated for this delivery process.
The mixture breakdown of the SCC/WDI/BBG concrete (see the concrete composition table), had to meet the requirements for a construction that is dense (WDI), fire-resistant (BBG) and self-compacting (SCC), and it also had to represent an economically attractive solution for the execution. From a structural point of view, a grading curve with an increased sand content (70 %) and a reduced maximum particle size GK 16 mm round grain was selected. With a binder content of 280 kg/m³ CEM I 42,5 R (C_3A-free) and the addition of a type I additive (AHWZ - Effective Additives Prepared Hydraulically) of 170 kg/m³, a fines content of over 540 kg/m³ was prepared.
PP fibres with a short fibre length (3 mm) were added in the dosage described in the table. Consistency tests on the fresh concrete showed a diameter of concrete flow of 58 cm with very good fluidity and sufficient self-compaction.

In the next part of the construction project, Putzmeister systems engineering was also used for construction phases S and W, with a total of six stationary concrete pumps, delivery lines and functional elements. This was not just because of the design of stationary concrete pumping technology which balances economical and technical factors but also because of the outstanding local-service provided by the Austrian Putzmeister dealer, Hans Eibinger GmbH.



The formwork carriage at the front is the base formwork carriage. The prepared steel reinforcement can be seen at the end of this carriage.

The formwork elements are filled using a type of rotary distributor. The BSA 2109 H E directly supplies this with concrete.

The Putzmeister Group
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Putzmeister Concrete Pumps GmbH
Max-Eyth-Str. 10 · 72631 Aichtal/Germany
P.O.Box 21 52 · 72629 Aichtal/Germany
Tel. +49 (71 27) 599-0 · Fax +49 (71 27) 599-520
E-mail: pmw@pmw.de · www.putzmeister.com

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