backup

rowa TUNNELLING LOGISTICS

Niagara Tunnel Facility Project
Ontario, Canada
Back-up installation for a Robbins Gripper TBM

Editorial

Dear reader's

In this issue we present the Niagara Tunnel Facility project in Ontario, Canada.
The world's largest open tunnel-boring machine with a diameter of 14,4 metres presents considerable challenges for the back-up train. More than 1'500 tonnes per hour of hard rock have to be transported away from the front face of the tunnel. The stratified rock parallel to the tunnel is capable of swelling and therefore requires that rock protection work be carried out. The tunnel height, which corresponds to that of a five-storey building, calls for intelligent back-up systems and optimised logistics. We have accepted the challenge presented by this unique environment. Accompany us as we explain how we did this.

Your Rowa team

Construction of the building site

Project

The Sir Adam Beck hydroelectric power plant, which was built in 1958 and is the largest of its kind in Ontario, is currently being enlarged.
The contract covers the construction of a 10,4 km tunnel under the city of Niagara Falls in order to supply more water to the existing power plant and to reduce the erosion of the Niagara Falls (0,6 m/year).
Included in the design/building contract are inlet and outlet structures, as well as secondary work. From 2009 the power plant will increase its energy production by 1'600 gigawatt hours to 13'400.
The volume of rock excavated from this enormous tunnel (approx. 1,6 million cubic metres of hard rock) is roughly equal to the volume of rock contained in the pyramid of Cheops. This rock will have to be broken down, transported and deposited within three years under conditions of swelling, stratified strongly aquiferous rock.

The customer's opinion

Ph. D. Ernst Gschnitzer, Strabag AG, Project Manager – Niagara Tunnel

The Niagara Tunnel Facility Project, because of its scale, the variable geological conditions and also the restrictive system of bonuses and penalties, presents major challenges for everybody involved. Thanks to intensive cooperation and joint project development that began as early as the tender phase, it was possible to create a modern and highly mechanised logistics system, which, despite initial difficulties, achieved an advance of over 18 metres per day once we had passed the 500-metre mark.

Know-how, innovation and closeness to the customer are the key to the optimum solution.

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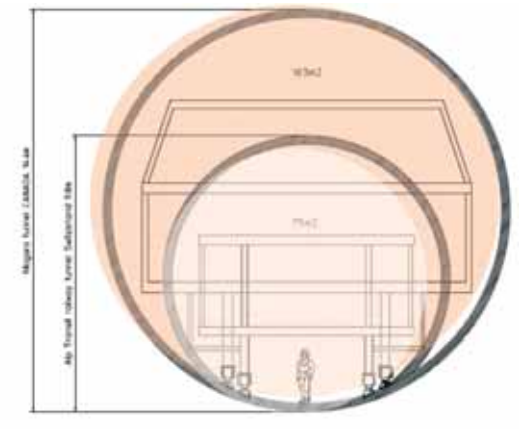
Niagara Falls



Comparison 10 m (AlpTransit, Switzerland) to 14.4 m (Niagara Falls, Canada)

Overall view of back-up system

Project-Daten

Country	Canada
Execution	2006–2009
Owner	Ontario Power Generation
Client	Strabag AG, Austria
Tunnel length	10'421 m
Excavation diameter	14,4 m
Inclination	-7,82/+0,1/+7,25%
Curve radius	> 1000 m
Typ of heading	Gripper-TBM
Supply	by truck
Removal	conveyer belt

Rowa's order

On 16 September 2005, Strabag AG of Austria, the principle contractor responsible for this enlargement project, contracted Rowa Tunnelling Logistics AG to develop, produce and deliver the back-up system for what is presently the world's largest Gripper TBM with a drilling diameter of 14,4 metres.
One special feature of this job is the varying gradients. Initially the TBM bores into the subsoil at a descending gradient of 7,8%, then continues almost horizontally for approximately 7,4 km, surfacing again at an ascending gradient of 7,3%. This calls for numerous special design features. In particular, all machines have to be specially adapted for descending and ascending advance. Additionally, both ramps in the back-up system are subject to enormous forces, which must be absorbed. This task was made all the more demanding by the enormous boring diameter.

Technical demands

– Sophisticated logistics for supply and removal
– High daily advance
– Coping with the large boring diameter of 14,4 metres
– Tunnel line direction determination, ascending and descending gradients
– Rock protection directly to the rear of the boring head with secure and mechanised work platforms
– Adaptability to varying geological conditions
– Safety and health protection for workers

Technical Data

Length of the back-up installation	105 m
Weight	approx. 900 t
Installed power	approx. 1400 kW
Length of rock bolt	6 m
Shotcrete range	360°
max. power per day at 20 h	40 m

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Stepper

Stationary work platform L1

Shotcrete robot L1 immediately behind flight conveyer

Overhead travelling crane

The Concept

High-performance back-up system

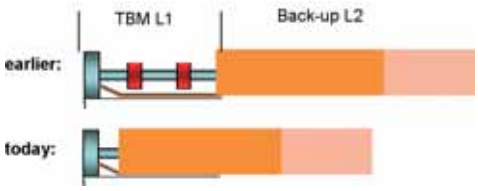
The back-up system (total length 105 m) is constructed on four tiers and consists of four back-up train components.

The first muck-car (NL1) is installed with a stepper because it is located immediately behind the boring head and as yet no suitable line is in place there for this procedure. Two rock-bolting devices are fitted on the consolidation car (NL1). These can bore and displace rock bolts to a length of 6 m. The car is also equipped with two longitudinally moveable shotcrete robots with a spraying range of 360°, and an 8-metre longitudinal track.

The other wagons are pulled on crawler tracks. In addition to this is the infrastructure for operation of the advance system, dedusting and ventilation systems, shotcrete installation, cooling and waste water systems, as well as the installation site for the tunnel conveyor extension. The excavation material is removed using a hauling lift from the machine belt via the back-up train belt and the tunnel belt straight to the disposal site.

Particularities

The TBM and back-up train function as a single unit. The back-up structure begins within the L1 sector directly behind the boring head. From the beginning the TBM and back-up train were developed simultaneously and their functions coordinated.



Special devices on the TBM

A new development is the use of a shotcrete robot in the TBM sector directly behind the flight conveyer. The shotcrete robot ensures rock protection in horizontal stratified rock and has a spraying range of 200°.

The new work platforms ensure safe and comfortable working conditions when displacing the rock bolts, meshes and ring beams and while conducting other work. New side platforms have been installed on the adjustable work platforms in order to increase the working and storage space.

Two floor cleaning devices have been set up at the rear of the TBM to remove accumulated material in the TBM sector (floor).

Overhead travelling crane

A two-track overhead travelling crane is suspended from the roof of the tunnel. This crane works in conjunction with the back-up train and ensures direct supply from the transport vehicle past the TBM to the installation site behind the boring head. An integrated swivelling telescopic arm is installed in the overhead travelling crane, to supply any point, from the roof heads to the floor. This type of high decreed mechanisation delivery, produce a remarkable increase in efficiency.

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Mobile work platform L2

Shotcrete robot L2

Mobile and stationary work platforms in the L2 section

Necessitated by the large boring diameter, the new work platforms ensure safe and comfortable working conditions when displacing the rock bolts, meshes and ring beams and while conducting other work.

Shotcrete robot L2

To improve the ratio of advance time to spraying time, and to ensure that the rate of advance is not restricted by the large amounts of shotcrete required, two independently functioning, longitudinally mobile shotcrete robots are used.

Experiences

We are able to state with satisfaction that, together with our partners, we chose the right plan for the back-up train. Even after 500 metres of excavation it is possible to achieve considerable daily performance rates, without being restricted by the back-up train.
The task of constructing a back-up train that works both for down-grading and up-grading advances placed great demands on our technical team. Furthermore, the sheer size of the boring diameter left no room for bottlenecks in the logistics chain. Every detail of the logistics system had to be thoroughly thought through.

Rear of back-up train

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