Project

The Limberg II project is presently the biggest hydro power construction site in Europe. The aim is to connect the two existing reservoirs by means of a pressure pipeline into a pumping storage station.

The capacity of the existing PPS Kaprun upper stage amounts to 240 MW. The PPS Limberg II which is currently under construction will expand capacity to 480 MW, thereby enabling a combined capacity of 720 MW in the upper stage alone, after start-up.

Within the 5.4 km long propulsion waterway is the approximately 4 km long headrace gallery with a 7m diameter; a mechanically-driven TBM and an existing Rowa back-up, starting at the upper reservoir level, advance this gallery. From the cavern level, a 45° inclined shaft with 5.80m diameter and a length of 770m provides access to the pressurized tunnel, where one of Rowa’s back-ups as well as the novel anti slip back system were employed.

The Customer’s Opinion

Ing. Rupert Rohmoser, G. Hinteregger & Söhne GmbH

Safety must be secured at all times during heading operation in a pressurized tunnel under such extreme conditions. With the development and supply of an anti slip back and a back-up system, Rowa has fulfilled the very high requirements with innovative solutions on time. With this project, safety considerations, reliability and total commitment during the entire project phase were of utmost importance. Rowa has proven to be a competent partner with these abilities.
Rowa's order

On August 23, 2006, Rowa has received the order from the consortium PPS Limberg II (G. Hinteregger & Söhne Baugesellschaft m.b.H AG, Salzburg, Porr Tunnelbau GmbH, Wien, Östu-Stettin Hoch- und Tiefbau GmbH in Leoben, Swietelsky Bau Tunnelbau GmbH in Innsbruck) to produce, supply and install the anti slip back system, the back-up system, the material transloading crane in the back-up area and the development of the heading installation by means of a funicular. These installations are state-of-the-art constructions.

Specific features

Special influencing factors:
- Ascending gradient 45 degrees
- A mechanical heading with a boring diameter of 5.8 m is, the largest ever achieved with a single cut.
- The heading installation will be extremely heavy, due to the TBM used (Jarva machine) and back-up system required totalling 560 tons.

The back-up must meet the special preconditions of EN815 which decisively influences planning and design:
- Factors dictated by norm EN815 for inclined shafts must be taken into account when planning and designing.
- The entire back-up must be constructed such that, in case of malfunctioning of a support or a connecting butt strap, a second and independent construction is able to take over the loads.

In order to reach and supply the back-up during heading operation, a material- and passenger train in form of a funicular must be planned and installed.

Safety

The anti slip-back system is designed in a way that its nitrogen filled pressure cylinder will brace, independent of external energy sources such as hydraulic pump or electricity supply. The pressure cylinders always brace, except during change over.

The anti slip-back system wedges itself tightly through its mechanical lever system, as soon as the holding friction on the tunnel walls is achieved. Therefore, the pressure cylinders merely have an initial function.

During the design phase, examination of plans, of constructions, of production and assembly is crucial and always must take place on various non interdependent stages, and wherever possible, by independent authorities (i.e. testing statics).

With a risk analysis, measures and strategies for normal as well as malfunction cases are developed.

With such a systematic procedure, installations in inclined shafts are becoming safe!
Concept

Back-up Installation
The back-up installation is assembled as follows:
– Suspension to main bearing housing via double traction rod
– Anti slide back system with trailing cylinder
– Sledge 1 with control cabin and hydraulic aggregates rigidly connected to anti slip back system
– Infrastructure sledges 1 to 6
– Track installation point with funicular station

Trailing
The back-up is attached at the casing of the main bearing and, therefore, is located at the boring head. A double traction rod is connected flexibly with the TBM head with a 200 mm bolt.

Norm EN815 always demands two independent systems which must be able to hold the entire weight in case of necessity. For this reason, two additional 150 mm bolts are mounted for security in case of malfunction of the main bolt.

Along the left and right of the TBM, the two traction rods are directed towards the anti slip-back system and connected with it through two trailing cylinders.
Anti Slip-Back System

Because of the extreme weight of the heading installation and the rising gradient of 100%, the anti slip-back system must exert 800 tons through each of its pressure jaws into the tunnel wall to guarantee safe holding friction. A special pressure cylinder ensures that the pressed plates build up holding friction on the tunnel wall.

The main force transferred onto the tunnel wall occurs through the mechanical expansion lever system.

Trailing Cylinder

The anti slip back system is connected to the TBM through the trailing system via two trailing cylinders (piston diameter 360 mm). After each boring stroke (1.5m), the back-up installation drags the anti slip back system together with these cylinders.

During boring, the anti slip back system is anchored and stabilizes the back-up installation.

Conclusion

The need for ever bigger boring diameters in combination with high rising gradients poses great challenges to anti slip-back systems.

- The weight of the heading installations to be secured proportionately to the boring diameter.
- Therefore, enormous contact pressures of the anti slip-back system pressure plates are needed. The combination of lifting movement and pressing force of the pressure cylinders with the necessary nitrogen volume for bracing are conflicting parameters to be optimized.

Mechanical implementation of a technically functioning and economically feasible combination is a great challenge.

An anti slip-back system with the relevant heading installations is an engineering specialty which, besides a systematic approach, also requires distinct overview of safety engineering.