NEW ALBULATUNNEL II

Albulatunnel
Line Chur – St. Moritz, Switzerland

Albula, Tunnel construction project

The Albula Tunnel is a single-track narrow gauge railway tunnel of the Rhaetian Railway on the railway-line from Chur to St. Moritz, which undercrosses the Albula Pass (2'312m)

Scope

- After the tunnel inspection in the year 2006 the refurbishment of several areas of the existing tunnel (5’865m) and safety improvement were decided
- The final decision was to build a new tunnel parallel to the existing one
- After refurbishment of the old tunnel it will be used as an emergency escape tunnel
- Both tunnels will be connected by cross-passages approx. every 450m
- The new tunnel will have a single- shell shotcrete lining, with double-shell lining near portal areas
- Length of new tunnel will be 5’855m

Challenges

- Difficult geological conditions and water inflow at portal areas. Greywacke formation of 100m thickness with “swimming mountain”
- Mountainous climatic conditions at 1‘800m a.sl., cramped conditions at installation areas, complex logistic conditions
- Conservation of environment and heritage, ensuring max. work safety at the same time

Amberg Services

- Overall project management
- Progress, cost and quality control

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- View from the tunnel to Preda

- Old tunnel, after passing soft ground area

- Old tunnel, deteriorated sections and brick lining

AMBERG FACTS

Contracted value JV
- Total CHF 6.5 Mio.

Contracted value Amberg
- Total CHF 6 Mio.

Project Phases & Duration
- Planning phase Nov. 2010
- Construction phase since 2014
- Project completion 2020 / 2022

Project Details
Construction of the new tunnel
- Narrow gauge single track tunnel
- Cross-section 40m^2
- Double shell lining in portal area and in wet areas
- Single shell lining for the remaining tunnel
- Fixed carriageway and power rail catenary

Refurbishment of the old tunnel
- Refurbishment of the old tunnel in accordance to new safety requirements
- Securing of the tunnel using shotcrete, mortar and anchoring for the desired new safety functionality

Cross-sections, niches and safety measures
- Cross passages at 435 – 456m intervals between new tunnel and old tunnel (safety tunnel)
- Technical infrastructure in separate rooms within the cross passages
- Ventilation of safety tunnel with overpressure

CLIENT FACTS

Overall costs
- Total: 359 Mio. CHF

Overview Project
The Albula Tunnel is a single-track narrow-gauge railway tunnel running between Chur and St. Moritz / Tirano (I).

During an inspection in 2006, severe damages were discovered in several areas of the existing tunnel, with the urgency of a refurbishment in up-coming years. Additionally, the tunnel was not meeting the modern requirements for either the clearance envelope (load gauge) nor for safety.

For these reasons, a new single-track tunnel will be built parallel to the existing one. The old tunnel will be used as safety tunnel.

Geology
- Soft ground and brittle rock (0.3km)
- Allgäuer schist (1.1km)
- Rauwacke dolomite section (100m)
- Albula Granite (4.4km)

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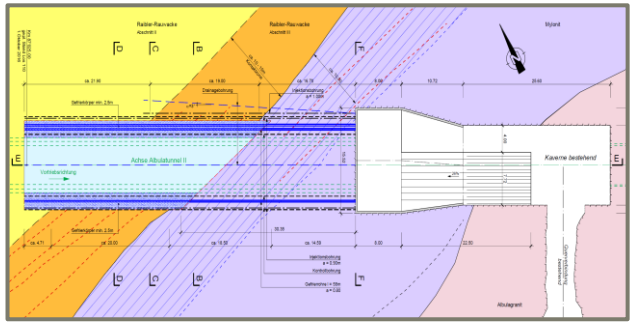
CHALLENGES

Handpiece; floating mountains

Greywacke zone as construction challenge

- Approximately 100 m thick Greywacke formation at Tm 1’150
- Section I and Section II including fractures zones and poor rock quality, additionally heavy water ingress
- Section III with Greywacke and „swimming mountain“, 110 years before multiple collapses of the tunnel in this section. Approximately 1 year construction time for the Greywacke formation was needed

ENGINEERING APPROACH



Situation at the freezing test cavern

Determination of construction method with fall back solutions

- Development of concept for the construction of the sealing body
- Development of auxiliary construction measures
- Assessment of measures with respect to feasibility, drainage efficiency and cost
- Determination of work flow concept with fall back solutions for the sections I to III
- Establishment of an exploration cavern in context with a separate lot of the preliminary works
- Conduction of exploration boreholes
- Injection tests (laboratory)
- Freeze / thaw trials (laboratory)
- Involvement of experts

TECHNICAL SOLUTIONS

Freezing tubes at cavern at Tm 1’300

Freezing “Swimming Mountain”, Section III Rauwacke Formation

- Development of heading concept for sections I and II using injections
- Working out of the freezing project for section III
- Conduction of freezing works at section III independent of construction lot by a specialized company
- Excavation starting from cavern and installation of sealing as well as inner lining as counter advance to avoid any time dependence with the heading in the main tunnel.

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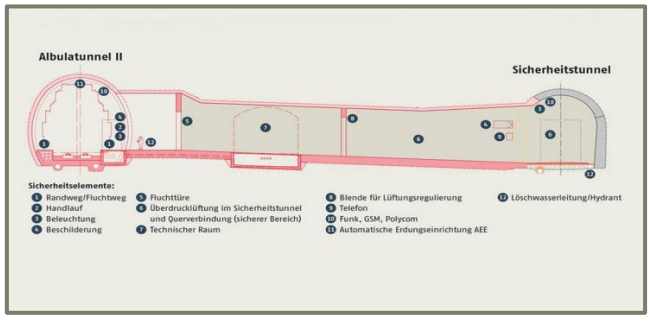
CHALLENGES

Damaged vaulted area of old tunnels

New tunnel instead of refurbishment

- Existing tunnel shows damages, which needed to be refurbished in up-coming years
- Clearance gauges were extremely narrow and did in most cases not provide the necessary space for reinforcements
- The safety did not meet the current requirements
- The existing tunnel is part of the UNESCO world heritage of the Albula and Bernina railway line
- Variant study refurbishment vs new tunnel building
- Consensus with federal authorities for the solution to build a new tunnel on the basis of a detailed variant comparison

ENGINEERING APPROACH



Safety concept using cross-passages & old tunnel

Tunnel System for Maximum Security

- The solution with the new tunnel allows the re-use of the existing railway tunnel as safety tunnel in respect of the passenger self-rescuing
- The new tunnel can be connected to the safety tunnel by cross-passages
- Escape routes lead directly to the cross-passages and into the safety tunnel, which can be over pressured by the ventilation in case of emergency
- The new tunnel shows a very high level of security, which complies fully with the nowadays safety requirements
- Determination of the intervals between the escape exits by means of a quantitative risk analysis including an escape situation simulation
- Investigation of a ventilation concept (including ventilation measurements in the existing old Albula tunnel) leaded to the result, that a separate ventilation in the new tunnel was not necessary

TECHNICAL SOLUTIONS

Escape door (sliding door) to the secure area

Save Escape Route from the New Tunnel

- Escape route is equipped with a fire safe sliding door
- Behind the sliding door air over pressure is prevailing, this avoids any ingress of fumes
- Technical rooms are located in the area of the cross-passages, which also contain the technical infrastructure as well as the safety equipment
- At the portal areas are installed locks with additional integrated ventilators for the negative pressure ventilation (suction)
- The safety tunnel provides the clearance for the access of the rescue teams, especially fire fighters, but also for operation and maintenance
- The safety tunnel contains a continuous extinguishing water pipe with taps at the cross-passages
- The escape route is signalized and secured by an illuminated handrail, illuminated escape exits and illumination in the safety tunnel itself.

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CHALLENGES

- Site installation Preda

- Drill-and-blast advance Preda

- Production and loading of the railway ballast

ENGINEERING APPROACH

- Landfill Las Piazzettas

- Exploration cavern

- Merge between the old and the new tunnel

TECHNICAL SOLUTIONS

- Drill-and-blast advance Spinas

- Drive backwards Rauwacke from the cavern

- Albula, UNESCO world heritage

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