The Queershan Tunnel on National Road 317

The People's Republic of China

Presented by: Xianming Shi
Stakeholders

Client: Sichuan Egang Highway Engineering Construction Co., Ltd

Designer: Sichuan Provincial Transport Department Highway Planning, Survey, Design and Research Institute

Contractors: China Railway No. 1 Group Co., Ltd;
China Construction Fifth Engineering Division Corp., Ltd

Other stakeholders: Southwest Jiaotong University;
China Railway Southwest Research Institute Co., Ltd
Outline

• 1. Overview of the Queershan Tunnel

• 2. The construction difficulties of the Queershan Tunnel

• 3. Innovation in the Queershan Tunnel

• 4. Project evaluation and description
G317 of China is an important channel connecting Sichuan Province with Tibet Autonomous Region. The section of Queershan has been the bottleneck of G317.

The length of the original road is about 30km, and the elevation of the Puerto is 5050m. There is no snowfall for only two months every year, with frequent disasters like avalanches, debris flows and snow and ice, known as “the most dangerous road in China”.

The opening of the Queershan Tunnel has become a common dream for several generations.
- The tunnel cost 1.16 billion yuan, started to survey, design and research in 2002, started construction in September 2012 and opened to traffic in September 2017. It is the world’s highest extra-long highway tunnel.

- After the Queershan Tunnel is built and open to traffic, the treacherous mountain road, which used to take more than two hours, takes only 10 minutes to pass.
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Construction of tunnels over 7km above 4300m above sea level, the construction lacks standard support and similar engineering reference.

High Altitude
4378m
Extra-long tunnel
7079m tunnel
7108m parallel pilot
Low Oxygen Content
only 58% of plain area
Low Temperature
-40 °C

The characteristics of the tunnel are low oxygen content, low air temperature and long tunnel.
Difficulties in tunnel survey and design under low temperature and oxygen deficiency conditions

Tunnel lining structure is easily damaged under low temperature frost heave

lacks standard support of ventilation and oxygen supply
The geological movements in the plateau are strong, the structure is complex, and the lithology is variable. Due to high altitude and low pressure oxygen deficiency, personnel and equipment construction is inefficient. Plateau reaction is easy to cause a safety accident, and construction is difficult. Roads are slippery under ice and snow weather, materials are difficult to transport, and traffic accidents are prone to occur.
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(1) The design concept of “weather routing” for high-altitude tunnel was first established

- On the basis of conventional geological survey, two observation stations and seven observation points were established, and two-year meteorological monitoring was carried out.

- The “weather routing” method was first established to determine the optimal route of the tunnel, which not only avoided the bad geology, but also reduced the impact of ice and snow and cold wind on the tunnel operation.
(2) Comprehensive anti-freezing technology for high altitude tunnel

- A freezing protection technology integrating anti-freezing and frost resistance is refined.
- Technical measures such as insulation layer, deep buried drainage ditch, and surrounding rock are adopted to avoid tunnel freezing damage.
- A snow-proof shed was set up at the entrance to ensure the anti-freezing and snow-proof and effectively alleviate the "black and white hole" effect of the driver and passenger.
(3) Oxygen supply and oxygen control standard for high-altitude tunnel

- Based on medical research and engineering practice, the oxygen supply standard for tunnel construction is based on 2500m altitude.
- Oxygen supply system for the construction of the Queershan tunnel was established, and there was no accident of altitude sickness.
(4) Clarified the new standard for high altitude tunnel ventilation calculation

Altitude coefficient tests from 400m to 5000m were carried out, and the actual measured data was 3800 sets. The existing tunnel ventilation calculation standard increased from less than 2400 meters to 5000 meters, which filled the relevant technical gap for ventilation and oxygen supply of high-altitude tunnel.

\[ y = 0.0004x + 0.896 \]

\[ y = 0.0003x + 0.88 \]
(5) Efficient application of parallel pilot

- parallel pilot ensures ventilation requirements for high-altitude and long-distance tunnel construction.
- It will be used for segmented air supply and ventilation during operation, and the ventilation energy saving will be more than 20%.
- Provide emergency rescue channels in the event of a tunnel accident.
(6) Energy saving and environmental protection

➢ Hot spring heat near the tunnel was innovative used. Heating during tunnel construction and operation, eliminating the snow and ice disaster in the tunnel entrance to ensure the safety of winter.

➢ All the tunnel waste slag is used for roadbed use, which realizes energy saving and environmental protection.
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Many technical difficulties faced when building the super-long tunnel in an environment of extreme coldness and high altitude have been overcome, forming a complete set of technologies on survey, design and construction of high-altitude tunnels.

The tunnel was completed on schedule, project cost was reduced and 100% rate of good quality was reached. No casualty occurred during the high-altitude extra-long tunnel construction.
China's Mega Projects of CCTV: Queershan Tunnel is a extra-long road tunnel with the highest altitude in the world at present....

Morning News of CCTV: The mountain, which even the mountain eagle could not fly across in the past, can now be crossed within just 10 minutes...
China Today” of CCTV::
The tunnel presents many challenges, such as extreme coldness and oxygen deficit, complex geological conditions and weak ecological environment....

News Simulcast of CCTV:
This tunnel has shortened the mountain road section completion time from 2h to just 10 minutes....
Chuzhou-Nanjing 7th November 2018  Xianming Shi—The Queershan Tunnel on National Road 317
CHINA FEATURES:
Tibet less remote as world's highest road tunnel opens

Tunnel builder:
The project crosses the Qola Mountains in Tibet - Qinghai Plateau, covered with snow for 8 months a year, with a peak of 6,168 meters.

CRI online:
The tunnel is 7,779 meters long and is the tallest tunnel in the world.

German.China.org.cn:
The world's tallest highway tunnel is open in southwestern China.
The successful experience of the Queershan Tunnel has been promoted and demonstrated in several high-altitude tunnels in China. The complete set of high-altitude tunnel survey design and construction technology will play an important guiding role in the construction of similar tunnels around the world.

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Thank you!