

# The Queershan Tunnel on National Road 317

The People's Republic of China

Presented by : Xianming Shi



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## 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



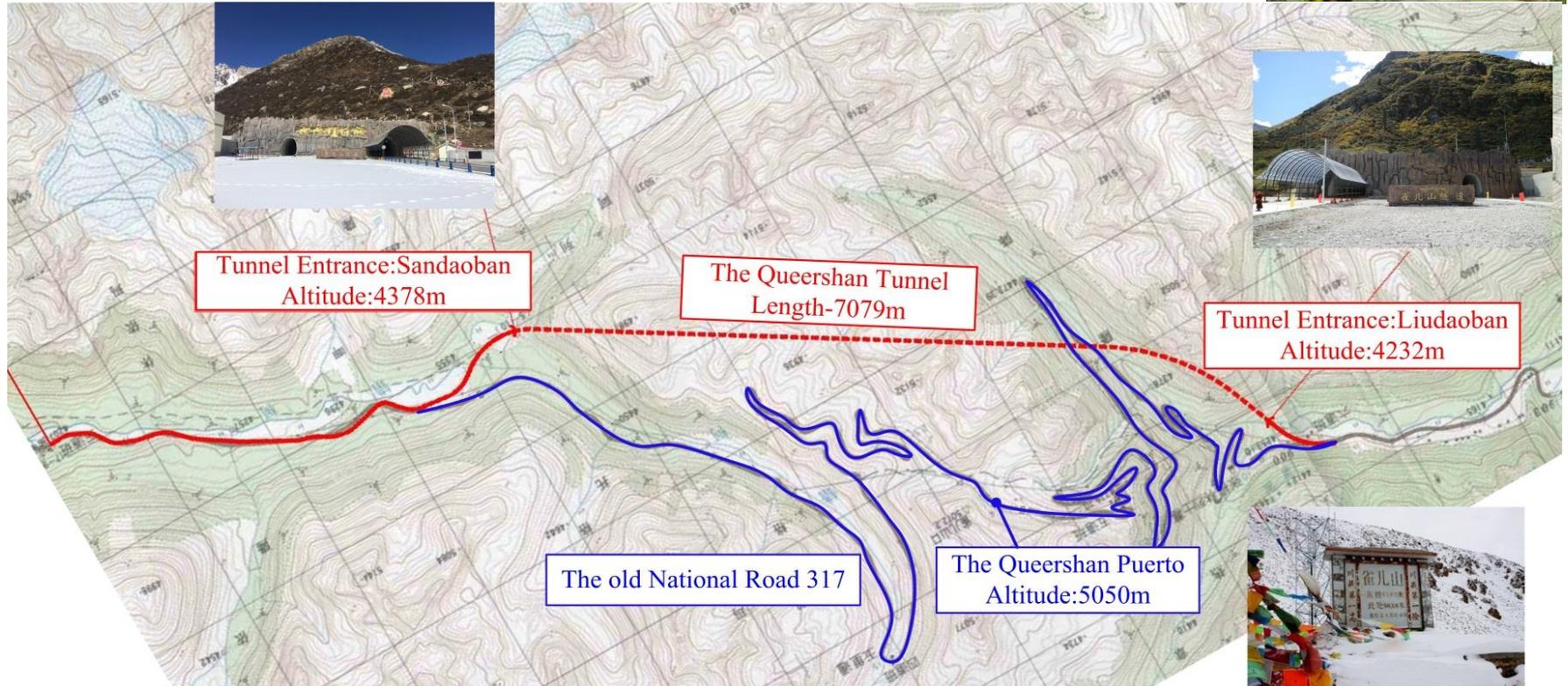
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- G317 of China is an important channel connecting Sichuan Province with Tibet Autonomous Region. The section of Queershan has been the bottleneck of G317.
- The length of the original road is about 30km, and the elevation of the Puerto is 5050m. There 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.



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- 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**

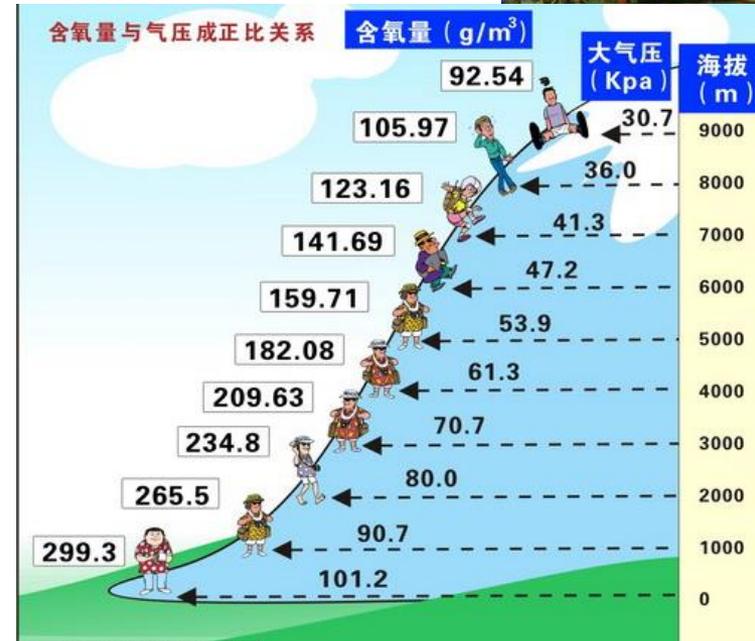
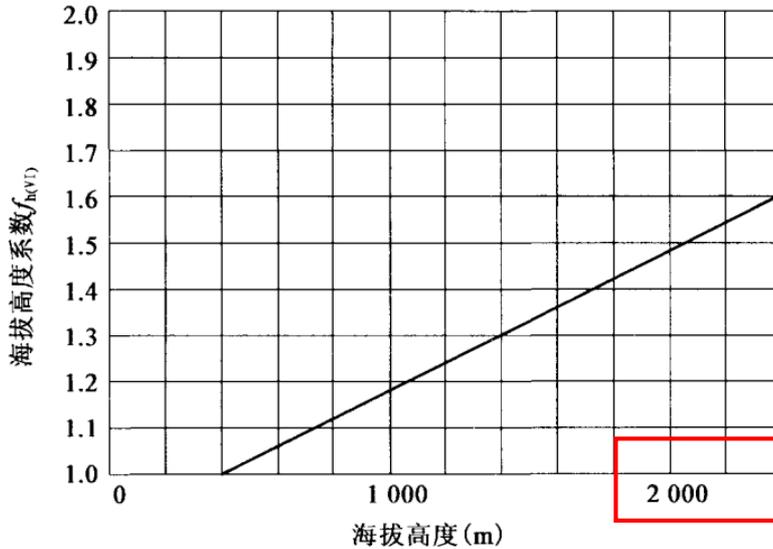
-40 °C

The characteristics of the tunnel are low oxygen content, low air temperature and long tunnel.





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- 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

ming Shi— The Queershan Tunnel on National Road 317



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- 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.

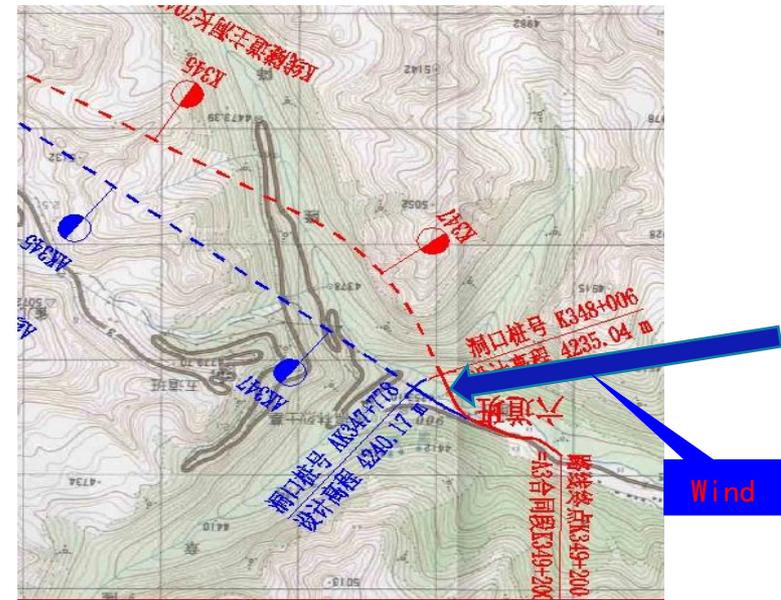


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## (1) The design concept of “weather routing” for high-altitude tunnel was first established

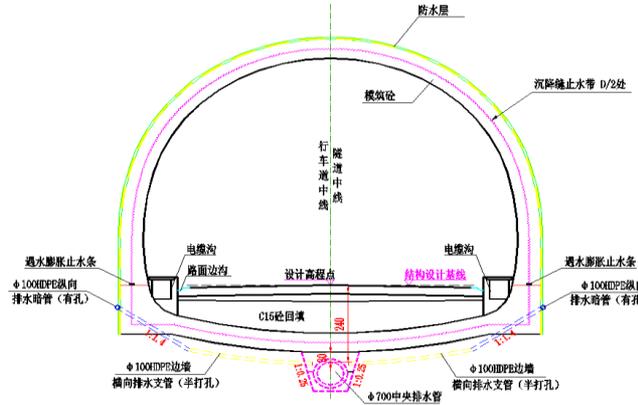


- On the basis of conventional geological survey, two observation stations and seven observation points were established, and two-year meteorological monitoring was carried out.
- The “weather routing” method was first established to determine the optimal route of the tunnel, which not only avoided the 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.



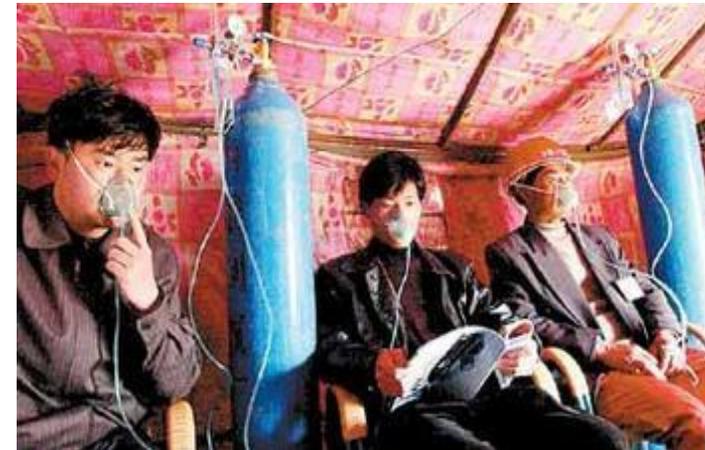
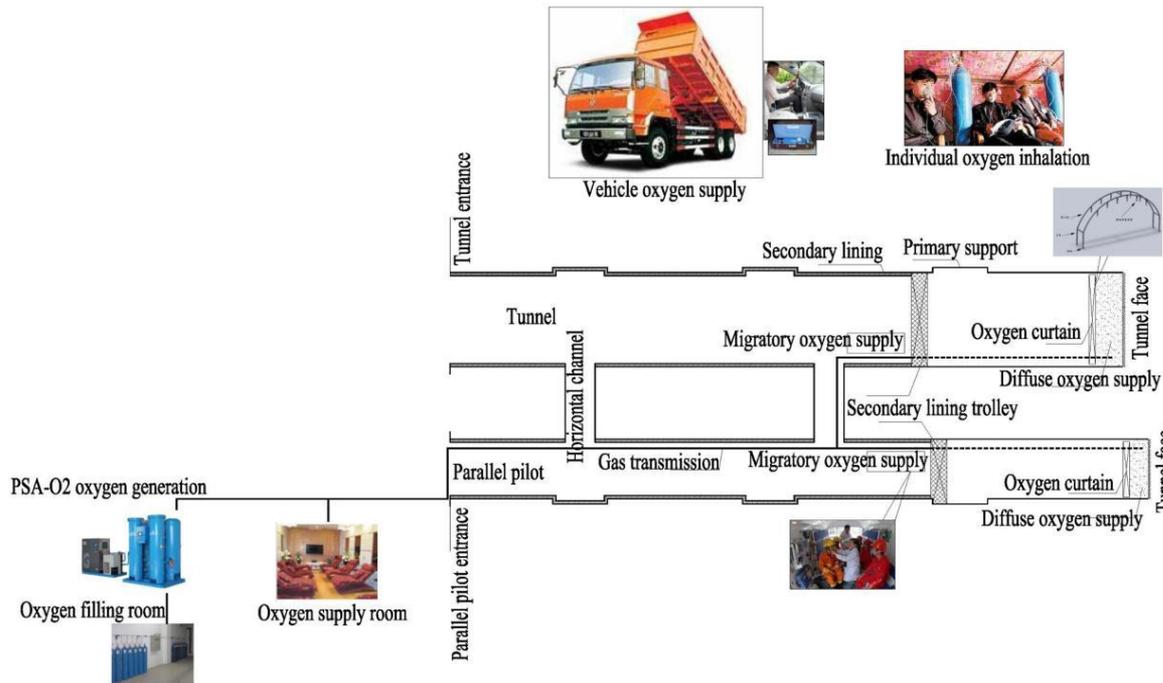
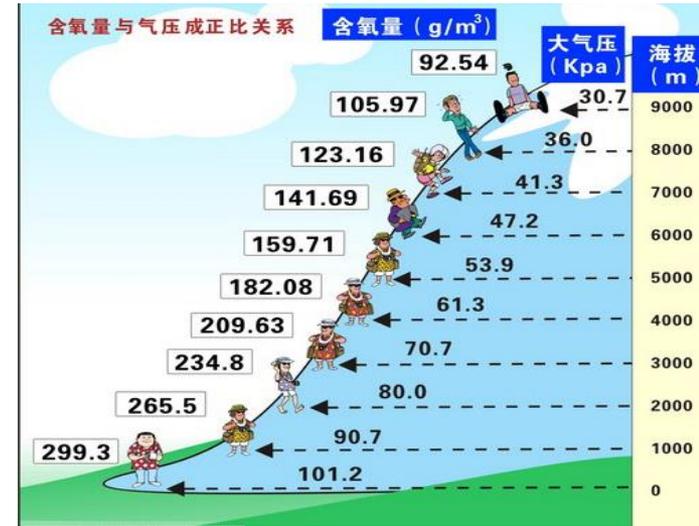


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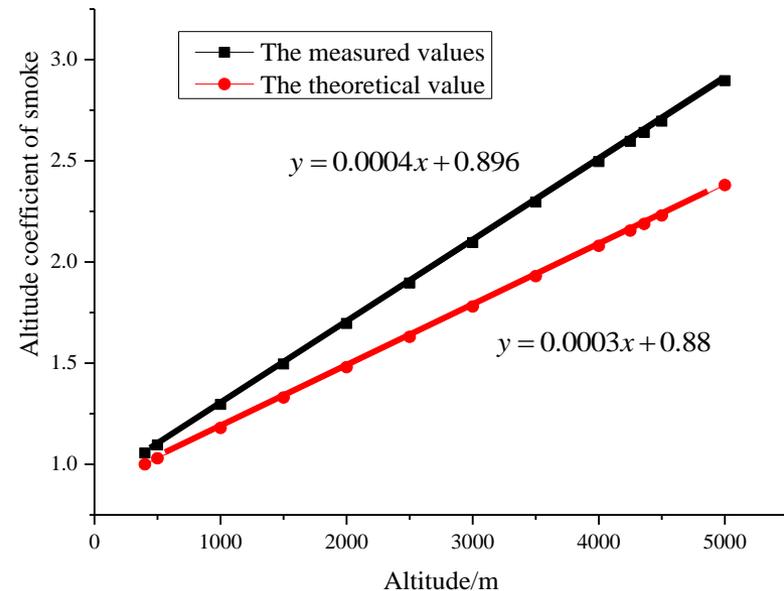
## (3) Oxygen supply and oxygen control standard for high-altitude tunnel

- 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

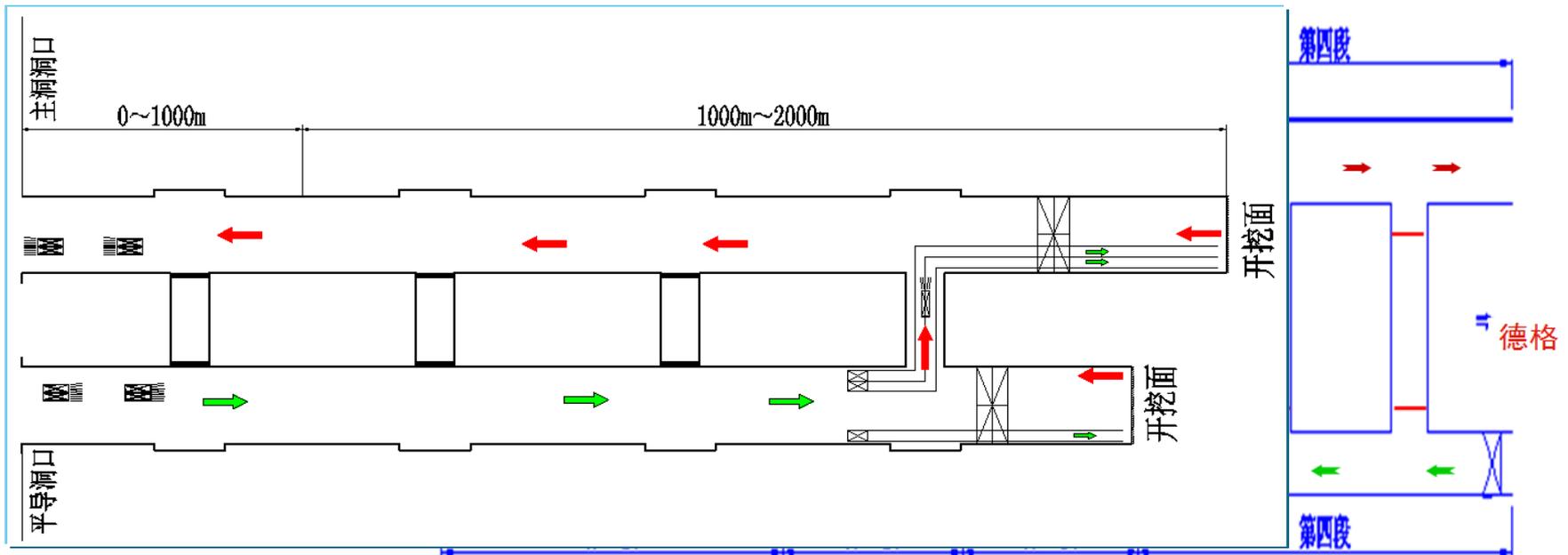
Altitude coefficient tests from 400m to 5000m were carried out, and the actual measured data was 3800 sets. The existing tunnel ventilation calculation standard increased from less than 2400 meters to 5000 meters, which filled the relevant technical gap for ventilation and oxygen supply of high-altitude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





## (5) Efficient application of parallel pilot

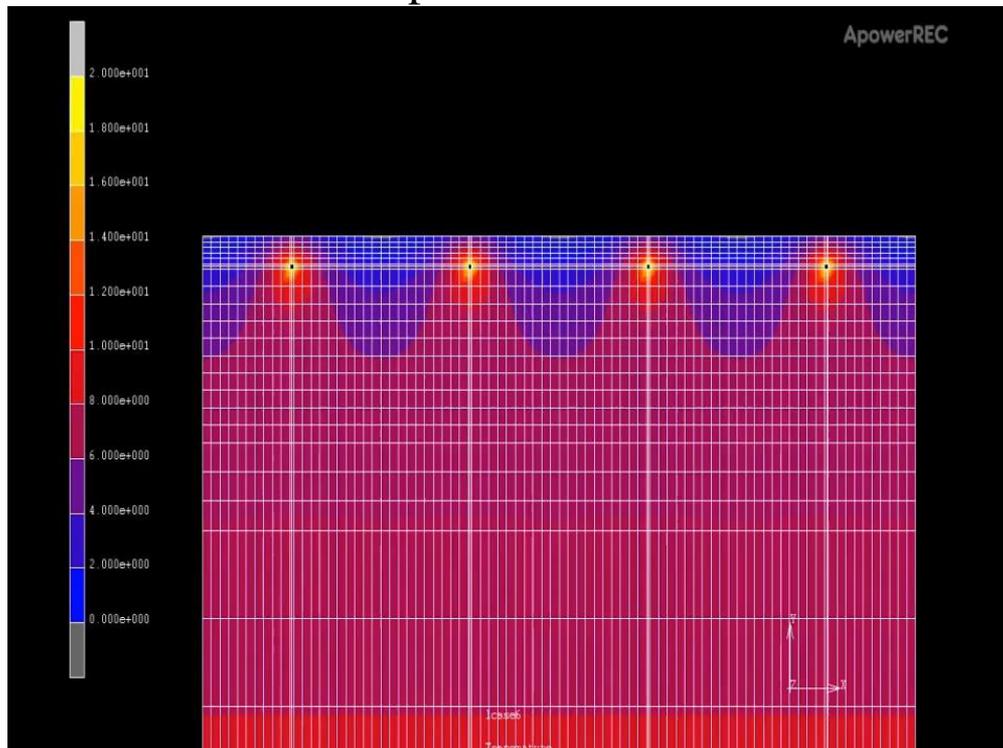
- parallel pilot ensures ventilation requirements for high-altitude and long-distance tunnel construction.
- It will be used for segmented air supply and ventilation during operation , and the ventilation energy saving will be more than 20%.
- Provide emergency rescue channels in the event of a tunnel 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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工程名称	国道 317 线雀儿山隧道工程
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201  
建成通  
年来川  
加快发  
195  
顽强的  
在4年多  
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半，而

项目穿越甘孜-玉树地震断裂带，海拔高、地应力高、地震烈度高，所在区域地形、地质条件差、自然环境和气候条件恶劣，有效施工期短，建设管理难度极大；项目建设区域滑坡、泥石流、崩塌、季节性冻土、路基冻融与翻浆、雪阻（飞吹雪）、涎流冰（暗冰）等不利条件众多，成因复杂，工程治理难度极大；项目沿线生态环境极为脆弱，自然环境恶劣，环境保护和植被恢复、绿化难度极大；项目沿线建筑材料缺乏，材料运距远，道路运输条件较差，成本控制难度极大。

雀儿山隧道洞口海拔4370米，隧道长7079米，目前为世界上海拔最高超特长公路隧道，经过十多年的不断科技攻关，克服了高寒高海拔超特长隧道的诸多技术难点，形成了高海拔隧道勘察设计与施工的成套技术。3000多名参建人员克服高原、高寒、缺氧、工效低，山高、路远、料少、运输难，隧道长、通风难、地质情况复杂、围岩级别变化快等诸多难题，创造了在海拔4300米以上恶劣条件下的施工奇迹。建设团队首创“气象选线”的设计理念，提出高海拔隧道综合抗防冻技术，将现有隧道通风计算标准仅满足2000米以下提高到5000米，形成了高原隧道施工制氧供氧技术，构建了人员、机械和医疗管理方法，有效指导了雀儿山隧道的施工建设，取得了高海拔超特长隧道施工零伤亡事故的成绩，保障了隧道按期完成，节约了工程造价，质量优良率达100%。工程建设得到了公众的高度评价，在“超级工程”、“还看今朝”等央视和地方媒体集中报告，其成功经验对国内外同类隧道建设提供重要参考与借鉴。

雀儿山隧道建成后将彻底改变雀儿山段的路况，道路冬季因冰雪灾害断道成为历史，保障了国道317线全线全年安全畅通。隧道实施后可降低原公路海拔高度800米，较原路节约里程近20公里，通行时间由2小时缩短为10分钟，绕避了原公路3处共长达4.7公里的雪崩易发危险路段，6处共2220米泥石流路段，以及大量的冻土、滑坡，雪害、冰害等安全隐患严重路段，长久以来的交通瓶颈将彻底消除。



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.



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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...



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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....



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## 专访雀儿山隧道设计代表：首创多项隧道技术 破解世界级难题

2017-09-26 21:26:36 来源：四川网络广播电视台 分享到：





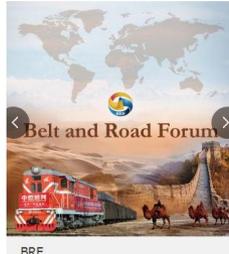
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### Tibet less remote as world's highest road tunnel opens

Nov. 11, 2016 15:53:00



### 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.

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

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### Welthöchster Autobahntunnel wird in Südwestchina eröffnet

Tweet 28.09.2017

Quelle: german.china.org.cn



Welthöchster Autobahntunnel wird in Südwestchina eröffnet

Der 13 Kilometer lange Queershan Tunnel der nationalen Autobahn 317 in Ganzi in der Provinz Sichuan wurde am 26. September dem Verkehr übergeben. Mit seinem Scheitelpunkt auf 4378 Metern über Meer ist er der höchstgelegene Autobahntunnel der Welt. Für seine Fertigstellung wurden 15 Jahre benötigt.





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.

Altitude(m)		<2500	2500~3000	3000~3500	>3500
Name		Jingkoushan	Ergali	Xueshanliang	Balangshan
Length(m)		2281	1095	7966	7940
Altitude(m)		1719	2574	3450	3850
Road		G353	G317	Chuanhuang	S303
structural measure	Reinforced concrete	⊙	√	√	√
	Thermal insulation layer	×	⊙	√	√
	Deep ditch	×	×	⊙	√
	surrounding rock grouting	×	×	×	√
Snow shelter		×	×	×	√



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# Thank you!

