Rapid Construction Technology for Large Cross-section Extremely Gassy Tunnel

China Railway Tunnel Group Co., Ltd.

China
1. General presentation

Entry category: Technical Project Innovation of the Year;
Entry title: Rapid Construction Technology for Large Cross-section Extremely Gassy Tunnel;
Country: China.

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Rapid Construction Technology for Large Cross-section Extremely Gassy Tunnel.
2. Project short description

Scope and Type of works: Tianping Tunnel is a passenger-freight mixed railway tunnel.

Diameter or Dimension: 150.37m²
Duration: 4 years
Date of completion of tunnelling civil works: February 2017
Overall cost: €162,000,000
Tunnel civil works cost: €148,500,000
Length of Drive and/or Excavated volume: single-tube double-track tunnel, 13.98km in total length
Tianping Tunnel is defined as Class I single-tube double-track tunnel, with a design speed of 200km/h, main tunnel length of 13.98km. It passes through Longtan Formation coal measure strata comprising 22 coal beds, 3 of them having a big impact on the tunnel. It is rare to see a coal mine with a gas pressure of 2MPa. But the gas pressure in this tunnel is 3.58~3.67MPa. This tunnel is determined as Class I high-risk tunnel and the most critical control works for the entire line.
3. All other stakeholders
Client’s name: Chongqing-Guiyang Railway Co., Ltd.

Designer: China Railway Tunnel Survey and Design Institute Co., Ltd.  
(Has been reorganized to China Railway Liuyuan Group Co., Ltd.)

Contractors: China Railway Tunnel Group Co., Ltd. (CRTG)

Engineer: Henan Great Wall Railway Engineering Construction Consulting Co., Ltd.
4. Entry description, with indication of how ITA criteria are addressed

(1) Regional gas outburst control for two tunnels at the same time

Treat the main tunnel and parallel heading as a whole region. Eliminate outburst risk by using bed-crossing grid to extract gas from coal beds in the extremely hazardous area of 154,640m³ (64.1m length, 71.8m width, 33.6m height; coal reserves: 74,024t). This reduces the difficulty of construction organization while guaranteeing safety and extraction effect, taking 6 months less than the traditional method of extracting gas from the two tunnels separately.
4. Entry description, with indication of how ITA criteria are addressed

(1) Regional gas outburst control for two tunnels at the same time
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(1) Regional gas outburst control for two tunnels at the same time
(2) Wireless gas monitoring transmission system

The traditional wired transmission system is easy to be damaged and result in system failure, providing interrupted gas monitoring data on working face. To address these issues, a wireless gas monitoring system was developed specifically for tunneling to provide continuous, reliable and accurate gas monitoring data, reducing time lag to nearly zero.
（2）Wireless gas monitoring transmission system  
- An integrated system of People location monitoring was used in this Project, we can monitor the manpower’s location in real time, specially when gas level is alerted on system.
(3) Energy efficient ventilation technology combining gallery segregation and forced ventilation

Ventilation distance is shortened considerably by providing a partition wall between gas zone and non-gas zone, sending fresh air via exit zone, fan and pipe to working faces and discharging dirty air through the transverse gallery. In addition an automatic energy-saving ventilation control system is developed for air-gas interconnection, cutting energy consumption for gas tunnel ventilation by 18.5%.
（3）Energy efficient ventilation technology combining gallery segregation and forced ventilation

- Another important purpose of this special ventilation system is for environmental protection, TianPing Tunnel Project located at YaoLong Mountain which is a beauty spot in China.
(4) Trackless transport technology for extremely gassy tunnel

The spatial and temporal movement patterns of gas poured out from excavation face under three conditions were investigated, providing basis for application of explosion-proof refitted equipment to tunneling in extremely gassy ground conditions. The introduction of supporting technology for explosion-proof trackless transport equipment created a new model of trackless transport for gassy tunneling, improving the efficiency of material transport.
(4) Trackless transport technology for extremely gassy tunnel

- We revised the trackless equipment together with equipment suppliers to achieve explosion-proof.
(4) Trackless transport technology for extremely gassy tunnel

- We revise the trackless equipment together with equipment suppliers to achieve explosion-proof.
(5) Progressive coal uncovering technology for large cross-section extremely gassy tunneling

On the basis of geotechnical forecast, parallel heading (by two-bench method) and main tunnel (by three-bench method) were excavated according to the location of coal bed occurrence and make adjustments to bench dimensions and construction sequence. Thus coal was excavated and discharged safely during construction of the large cross-section tunnel.
(6) Safety Shelter
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(6) Safety Training and PPE

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(7) Environmental Protection

- Silt Trap and water recycling system
(7) Environmental Protection

- Final Landscape
5. Elaboration on relevance of works, Relevance of the project and on the tunnelling solution.

As the critical section of the entire railway, Tianping Tunnel was successfully completed. It is of great significance to drive economic growth along the line and the whole southwestern region and leading people in old revolutionary base areas along the line out of poverty and toward prosperity at a faster pace.
Successful completion of the long extremely gassy tunnel is a development and refinement of extremely gassy tunnel construction technology.

The successful completion of Tianping Tunnel offered useful experience and inspiration to future similar projects.

These have offered case studies and solid basis for modification and improvement to the previous standard for design and construction of extremely gassy tunnel.
7. Additional supporting materials to be appended

Tianping Tunnel Profile Design Drawing

The tunnel passes through upper Permian Longyan Formation (P21) clay rock, sandstone, silicious rock and limestone, intercalated with 3-25 coal beds and several siderite beds. Each F12 is present. This fault zone contains broken rock masses like crushed breccia. Gas outburst, combustion or explosion is possible during construction.
Patent for invention:

Title of invention: A method of wireless gas monitoring between tunnel working face and monitoring substation

Patent number: ZL201410503361.8

Date of application for patent: September 28, 2014

Patentee: China Railway Tunnel Group Co., Ltd.; CRTG Institute of Science and Technology Co., Ltd.

Date of authorization proclamation: January 20, 2016
China Railway Tunnel Group Co., Ltd.

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Expert comments:

The committee concluded that this technology reaches international advanced level, especially the world-leading uninterrupted extraction of gas from parallel holes. This innovative technology is expected to bring significant contributions to the field of tunnel construction technology.
Completion Acceptance Report for Chongqing-Guiyang Railway Upgradation Project

**Name of works:** Tianping Tunnel

**Construction**
- **Location:** DK132+307.126 (K145+541.017)
- **Start Date:** 2013 年 4 月 5 日
- **Completion Date:** 2017 年 2 月 28 日
- **Owner:** Chongqing-Guiyang Railway Co., Ltd.

**Acceptance Conclusion:**
Acceptance conclusion: Accepted; construction quality meets design specification and applicable acceptance standards.

**Client's name:** Chongqing-Guiyang Railway Co., Ltd.

**Construction Teams:**
- **Owner:** Chongqing-Guiyang Railway Co., Ltd.
- **Design:** Chongqing-Guiyang Railway Co., Ltd.
- **Construction:** China Railway Tunnel Group Co., Ltd.
- **Monitoring:** Chongqing-Guiyang Railway Co., Ltd.
- **Design:** China Railway Tunnel Group Co., Ltd.

**Technical Project Innovation of the Year 2019**

Miami, USA 18th November 2019

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Rapid Construction Technology for Large Cross-section Extremely Gassy Tunnel
Second Prize for Technological Advancement from Chongqing 2016: extremely gassy tunnel construction technology
First Prize for Technological Innovation in Road Engineering 2017: key construction technology for large cross-section extremely gassy tunnel

Miami, USA 18th November 2019
Certificate

Scientific and Technological Innovation Achievements of Highway Engineering

In order to commend the significant contributions made in the scientific and technological innovation of highway engineering, we hereby issue the certificate of highway engineering scientific and technological innovation achievement as encouragement.

First class prize

Name of Award-winning Achievements: Key Construction Technology for Large Cross-section Extremely Gassy Tunnel

Award-winning company: China Railway Tunnel Group Co., Ltd.

China Highway Construction Association

China Railway Tunnel Group Co., Ltd.

Second Prize for Technological Innovation from China Association of Construction Enterprise Management 2016: Research and Application of New Construction Technology for Extremely Gassy Railway Tunnel

Miami, USA 18th November 2019
Third Prize for Technological Advancement from Chongqing 2013: Research on Joint Ventilation of Segregated Gallery and Air Duct for Super Long Tunnel

China Railway Tunnel Group Co., Ltd.
Rapid Construction Technology for Large Cross-section Extremely Gassy Tunnel
Third Prize of Science and Technology from China Railway Society 2014: research on joint ventilation of segregated gallery and air duct for super long tunnel.

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Rapid Construction Technology for Large Cross-section Extremely Gassy Tunnel.
Henan provincial-level construction method 2015: pre-extraction of coal bed gas for gas tunnel using bed-crossing grid (EJGF114-2015)
Henan provincial-level construction method 2014: joint ventilation by segregated gallery and air duct for long tunnel (EJGF15-2014)
Chongqing municipal-level construction method 2017: joint ventilation by segregated gallery and air duct for long tunnel (YJ [2017] No. 502)
Guangdong provincial-level construction method 2018: joint ventilation by segregated gallery and air duct for long tunnel (GDGF362-2018)
Thank You