



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.



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

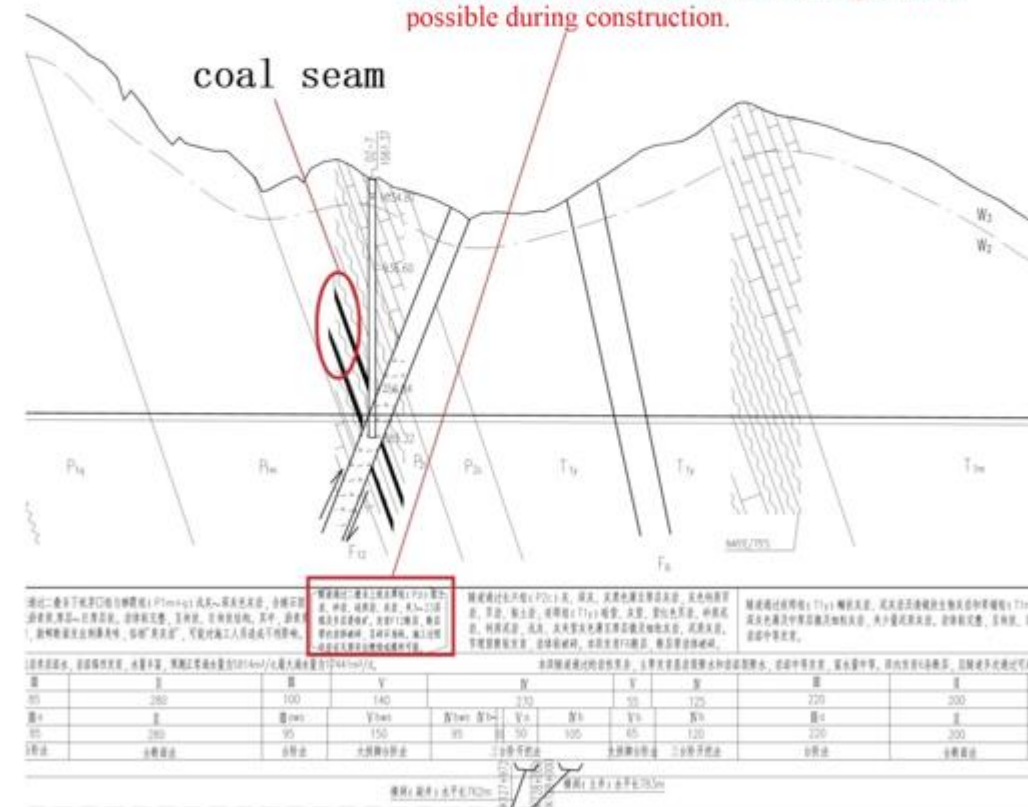
Tunnel civil works cost: €148,500,000

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.

The tunnel passes through upper Permian Longtan Formation (P21) clay rock, sandstone, siliceous rock and limestone, intercalated with 3~23 coal beds and several siderite beds. Fault F12 is present. This fault zone contains broken rock masses like crushed breccia. Gas outburst, combustion or explosion is possible during construction.



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.



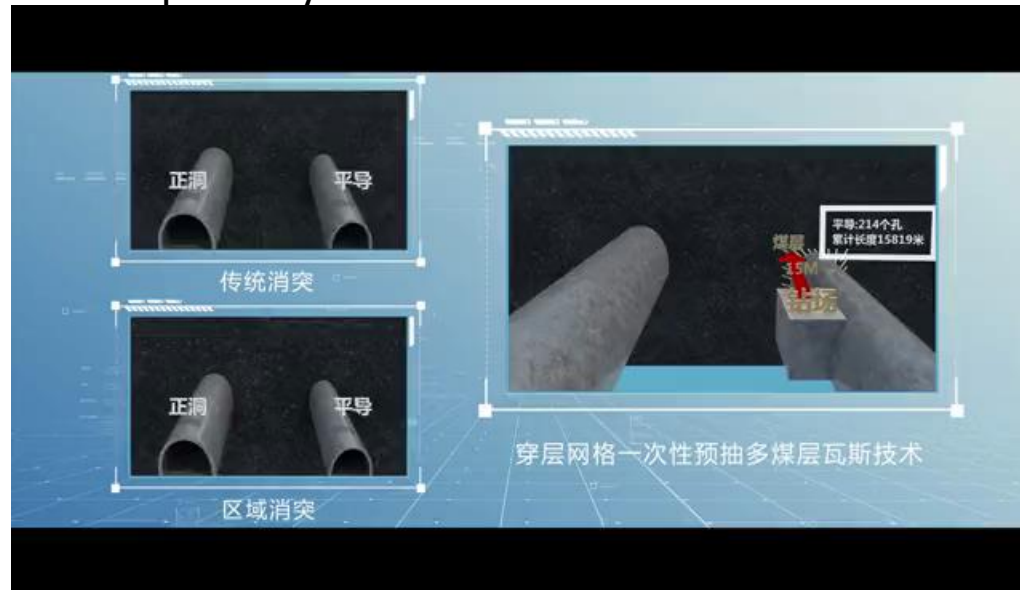
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4. Entry description, with indication of how ITA criteria are addressed

(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.



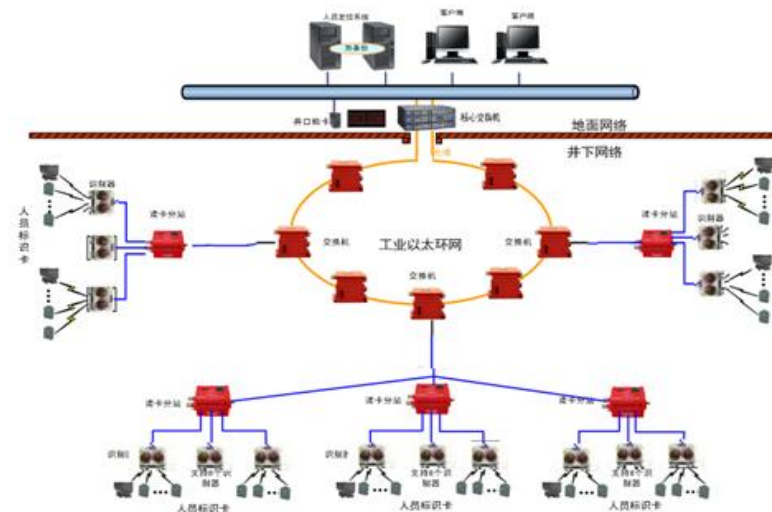
4. Entry description, with indication of how ITA criteria are addressed

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



(2) Wireless gas monitoring transmission system

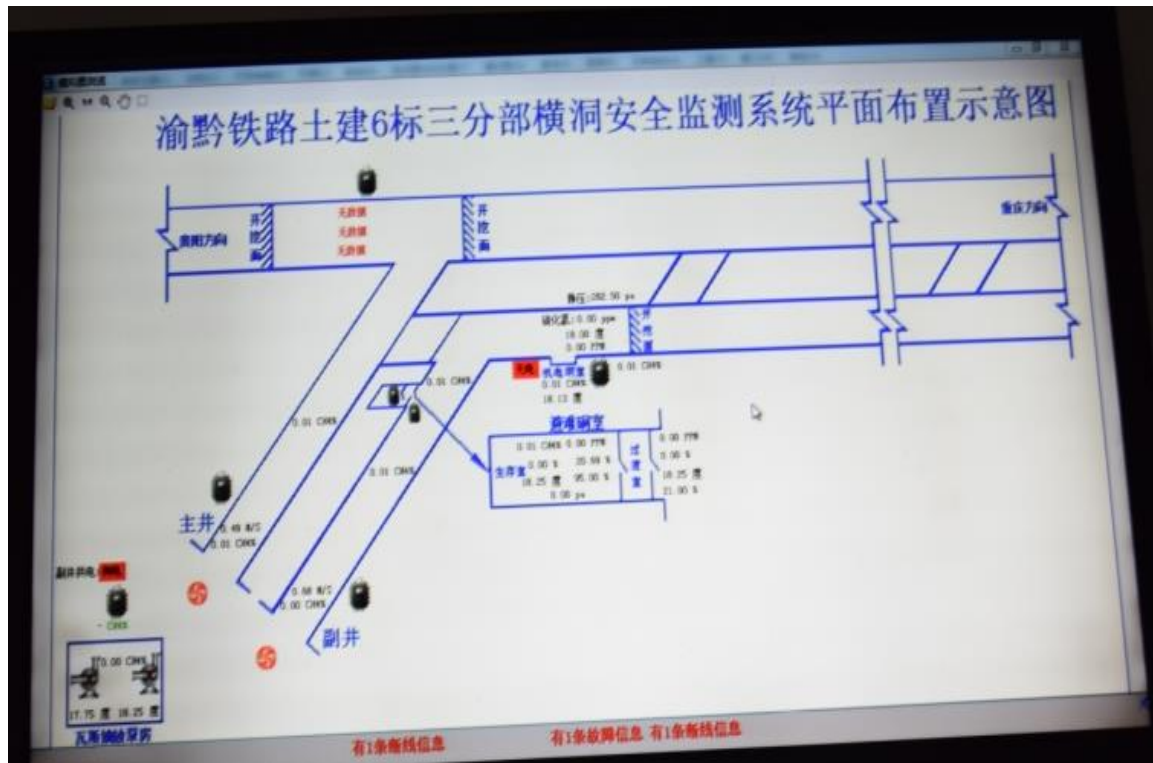
The traditional wired transmission system is easy to be damaged and result in system failure, providing interrupted gas monitoring data on working face. To address these issues, a wireless gas monitoring system was developed specifically for tunneling to provide continuous, reliable and accurate gas monitoring data, reducing time lag to nearly zero.





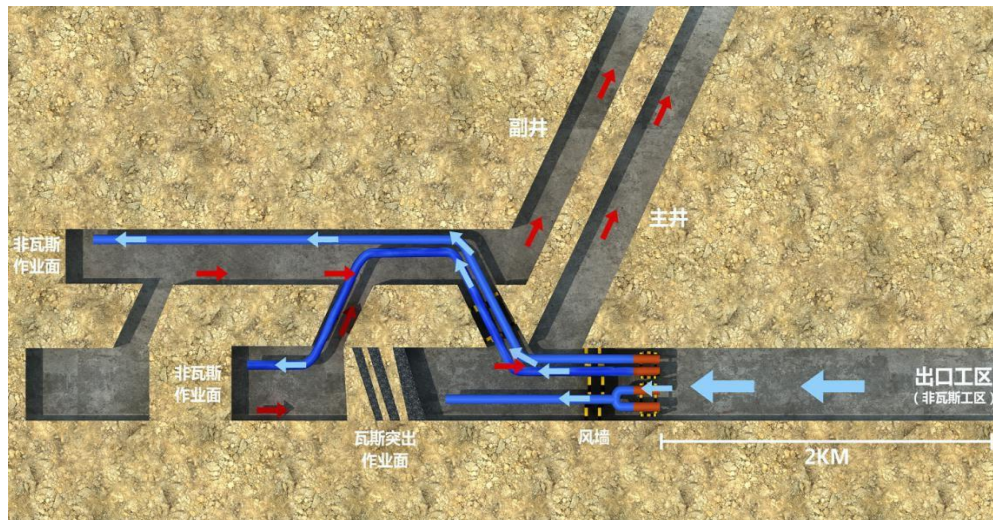
(2) Wireless gas monitoring transmission system

- 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%.



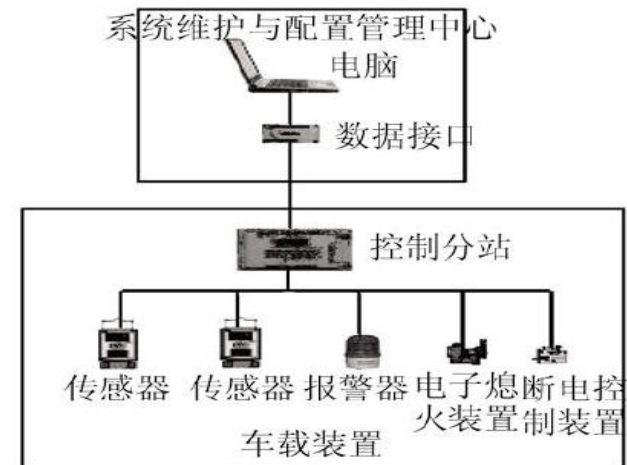
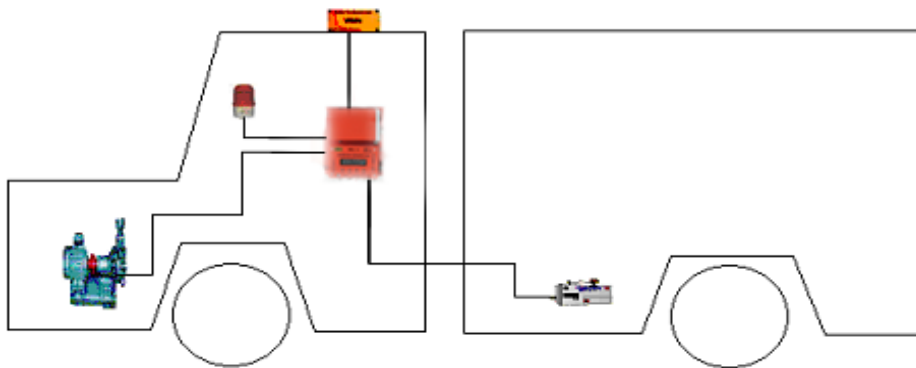
(3) Energy efficient ventilation technology combining gallery segregation and forced ventilation

- 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.



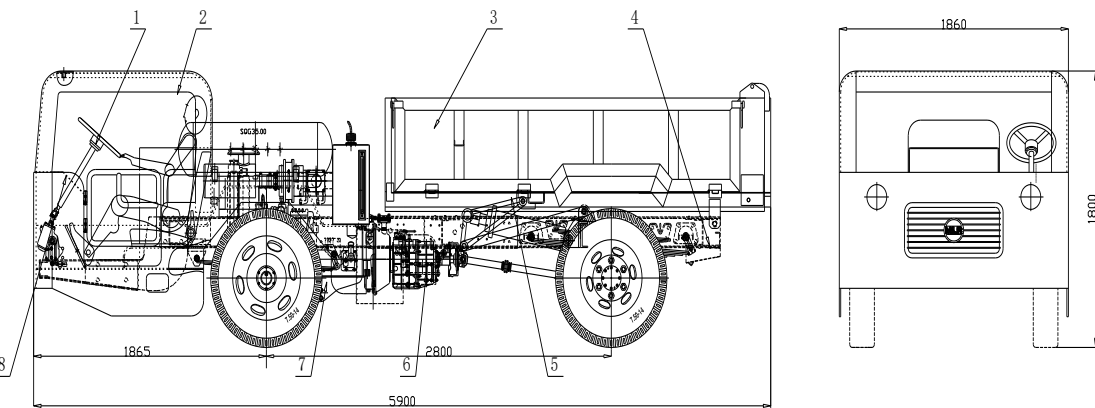
(4) Trackless transport technology for extremely gassy tunnel

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.

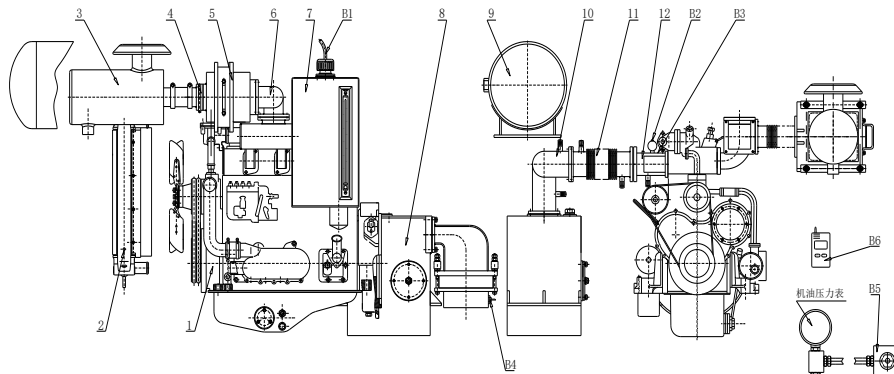


1、转向系统 2、驾驶室 3、车箱 4、车架 5、制动、举升及液压系统 6、传动系统 7、动力系统 8、监控系统与电气



(4) Trackless transport technology for extremely gassy tunnel

- We revise the trackless equipment together with equipment suppliers to achieve explosion-proof.



1、NC柴油机 2、散热器 3、滤清器 4、进气风门 5、进气箱 6、进气波纹管 7、补水箱
8、废气处理箱 9、储气管 10、排气管 11、排气波纹管 12、排气管
B1、水位传感器 B2、冷却水温传感器 B3、表面温度传感器 B4、排气温度传感器 B5、机油压力传感器 B6、瓦斯报警仪



(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.

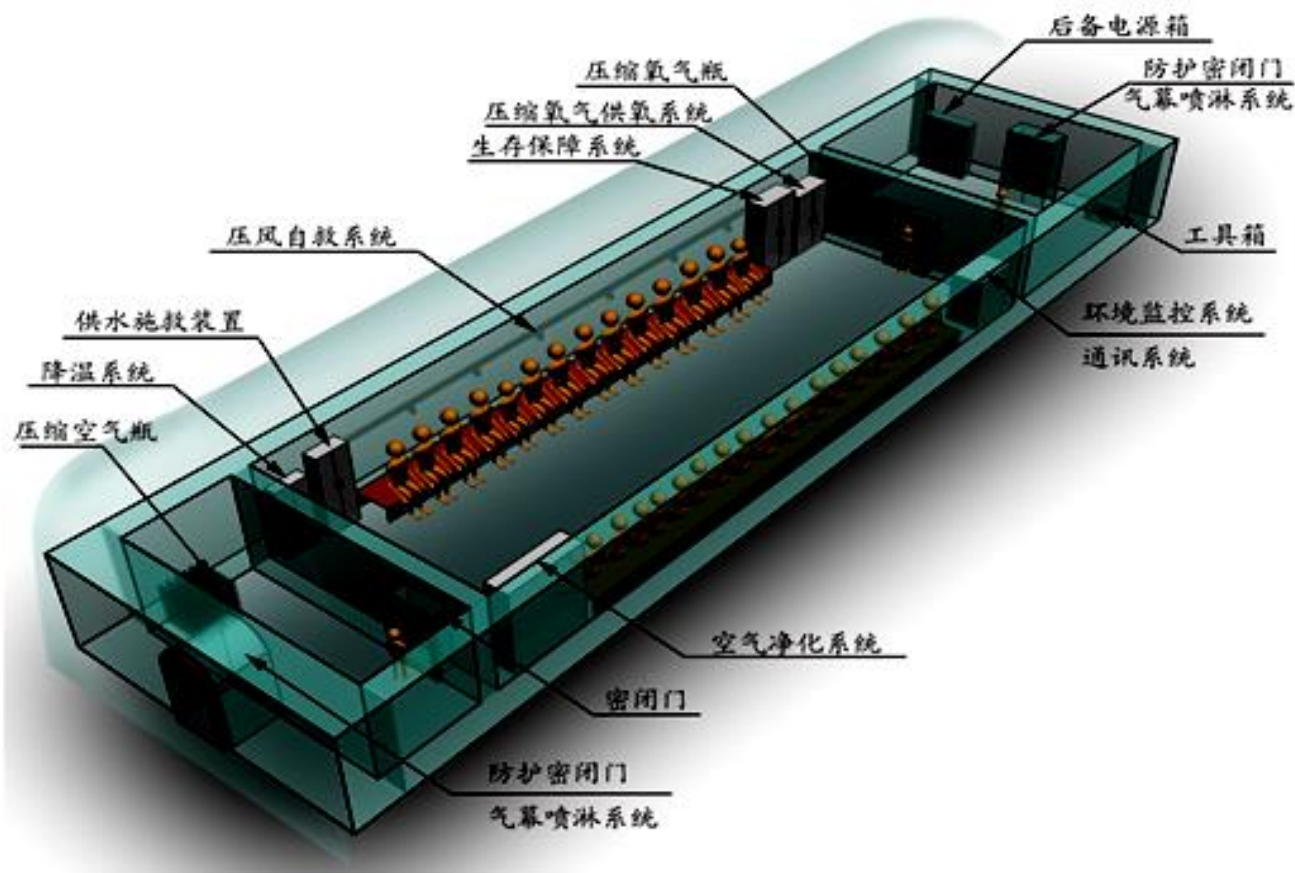




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(6) Safety Shelter



(6) Safety Shelter



(6) Safety Training and PPE



(7) Environmental Protection

- Silt Trap and water recycling system



(7) Environmental Protection

- Final Landscape

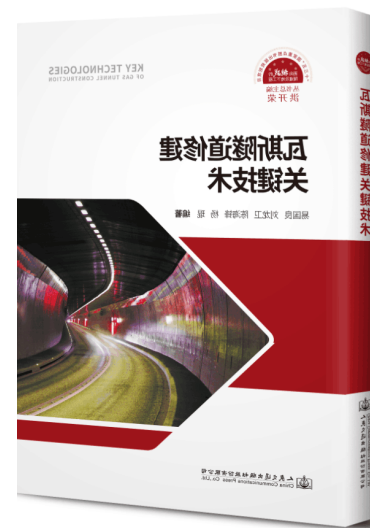


5. Elaboration on relevance of works, Relevance of the project and on the tunnelling solution.

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.

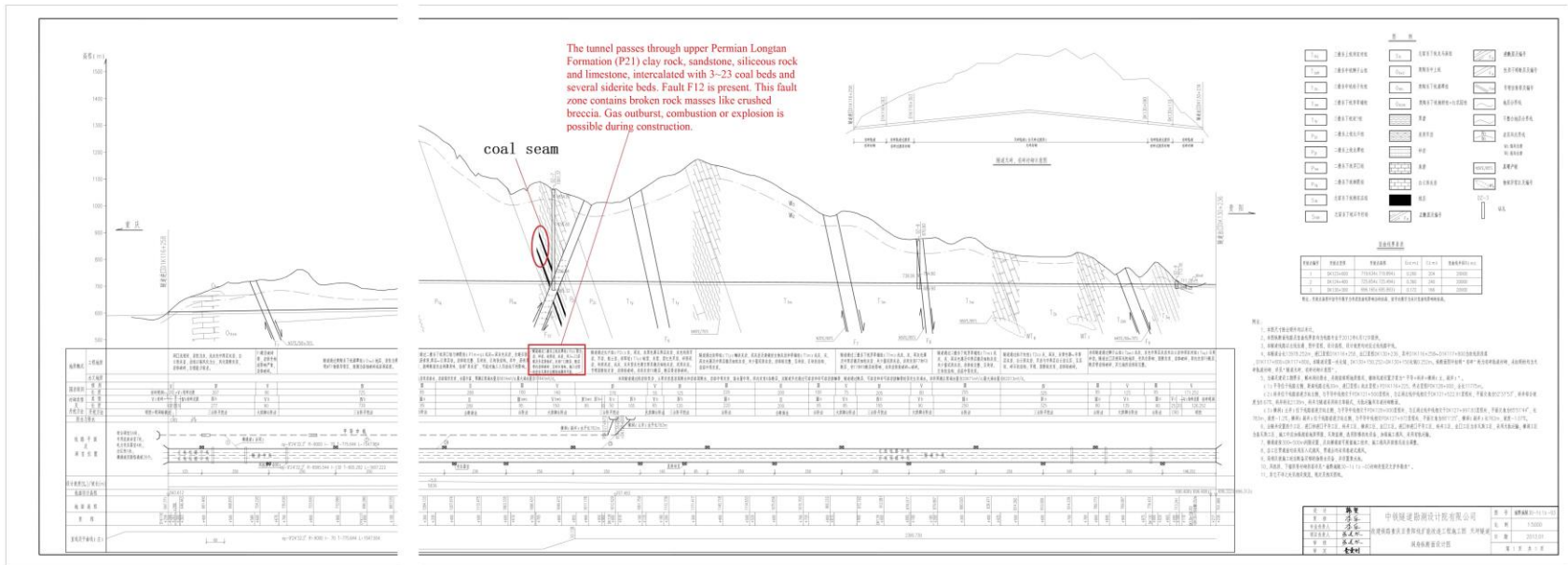




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7. Additional supporting materials to be appended



Tianping Tunnel Profile Design Drawing



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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



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成果	登记号	
登记	批准日期	

Certificate of Accreditation of Scientific and Technological Achievements

科学技术成果鉴定证书

鉴字[2016]第 20 号

Name of Achievement

成果名称: 瓦斯突出隧道修建关键技术

Key Technologies of
Extremely Gassy Tunnel
Construction

Complete Company

完成单位: 中铁隧道集团有限公司

China Railway
Tunnel Group Co., Ltd.

中铁隧道集团有限公司
中铁隧道集团科学技术研究院有限公司

Tissue
Identification
Unit

鉴定形式: 会议鉴定

组织鉴定单位: 重庆市科学技术委员会 (盖章)

鉴定日期: 2016年5月13日

鉴定批准日期: 2016年5月23日

Chongqing Science and
Technology Commission

国家科学技术委员会
一九九四年制

On May 13, 2016 Chongqing Science and Technology Commission organized an evaluation committee led by Zhou Fengjun, an academician of the Chinese Academy of Engineering, to assess the "Extremely Gassy Tunnel Construction Technology".

鉴	定	意
<p>2016年5月13日, 重庆市科学技术委员会组织专家对中铁隧道集团一处有限公司等单位共同完成的“瓦斯突出隧道修建关键技术”项目进行科技成果鉴定。鉴定委员会听取了项目组汇报, 审阅了相关资料, 经质询与讨论, 形成如下鉴定意见:</p> <p>一、提供的技术资料齐全, 符合鉴定要求。</p> <p>二、针对瓦斯突出极高风险隧道修建关键问题, 本项目对隧道瓦斯分布规律、隧道瓦斯抽放消突技术、瓦斯隧道节能通风技术、大断面隧道揭煤施工技术、隧道无线瓦斯监测技术、瓦斯隧道无轨运输技术和瓦斯隧道安全施工组织管理等进行了系统深入的研究, 获得了如下创新性成果:</p> <p>(1) 开发了瓦斯隧道穿层网格节点预抽煤层瓦斯技术及施工工法, 实现了平导和正洞两条隧道煤层瓦斯的一次性抽排, 规避了瓦斯突出风险。</p> <p>(2) 开发了隧道瓦斯无线传感监测系统, 保证了隧道瓦斯监测数据的连续性和及时性。</p> <p>(3) 基于风机变频及瓦斯自动监测技术, 建立了瓦斯隧道分隔巷道与风管联合通风系统, 实现了瓦斯隧道通风系统的节能。</p> <p>(4) 基于煤层暴露面积和瓦斯突出危险度的关系, 合理分配了各台阶开挖揭煤面积, 提出了有效的安全揭煤施工方法。</p> <p>(5) 系统研究了防爆设备改装技术、瓦库闭锁技术和高瓦斯隧道无轨运输设备配套技术, 为高瓦斯隧道施工无轨运输设备改造标准的编制提供了技术支撑。</p> <p>该项目获得5项发明专利、2项省级工法, 在渝黔铁路天坪隧道等工程的应用中, 取得了显著的经济、社会和环境效益。</p> <p>综上所述, 鉴定委员会一致认为, 研究成果总体达到了国际先进水平, 其中平导和正洞一次性同时抽排技术达到国际领先水平。同意通过科技成果鉴定。</p> <p>建议加强研究成果的推广应用。</p>		
<p>The committee concluded that this technology reaches international advanced level, especially the world-leading uninterrupted extraction of gas from parallel heading and main tunnel.</p>		
<p>鉴定委员会主任: 周凤俊 副主任: 汪明俊 等</p> <p>2016年5月13日</p>		
<p>Director of the Accreditation Committee</p>		

Zhou Fengjun (an academician of the Chinese Academy of Engineering)

Expert comments



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Completion Acceptance Report for Chongqing-Guiyang Railway Upgradation Project 2

重庆至贵阳铁路扩能改造工程 竣工验收报告

Name of works	Tianping Tunnel
工程名称:	天坪隧道工程
开工日期:	2013 年 4 月 6 日
工程地点:	DK123+247.126(K145+341.017)
竣工日期:	2017 年 2 月 28 日
预算号:	
交接日期:	2017 年 8 月 8 日
工程造价:	
<p>(验收人报告: 工程范围及意见, 工程之优缺点)</p> <p>渝黔铁路天坪隧道长度 13978.252m, 平导长度 11775m, 新增斜井长度 295m, 斜井长度 2138m, 横洞主井长度 1050m, 横洞副井长度 1061m, 隧道进、出口均采用单压耳墙式明洞门。验收情况如下:</p> <ol style="list-style-type: none"> 1、洞口工程、明洞工程检测质量符合设计和验收要求。 2、洞身开挖、支护检测质量符合设计和验收要求。 3、衬砌(模板、钢筋、混凝土)检测质量符合设计和验收要求。 4、防水和排水检测质量符合设计和验收要求。 5、辅助坑道及附属洞室检测质量符合设计和验收要求。 6、附属设施检测质量符合设计和验收要求。 <p>工程质量符合设计、规范及相应验收标准要求, 经验收优良。</p> <p>保养注意事项: 按照隧道设备维修规范, 正常保养和维护。</p>	
Client's name	Chongqing-Guiyang Railway Co., Ltd.
建设单位:	渝黔铁路有限责任公司
代表:	[Signature]
接管单位:	中国铁路成都局集团有限公司重庆工务段
代表:	[Signature]
施工单位:	中铁隧道局集团有限公司 渝黔铁路土建5标项目经理部
代表:	[Signature]
监理单位:	河南长城铁路工程建设咨询有限公司 渝黔铁路5标监理项目部
代表:	[Signature]
设计单位:	中铁隧道院勘测设计院有限公司 重庆至贵阳铁路天坪隧道配合施工组
代表:	[Signature]
附件:	

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

Completion Acceptance Report for Chongqing-Guiyang Railway Upgradation Project



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Second Prize for Technological
Advancement from Chongqing 2016:
extremely gassy tunnel
construction technology



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First Prize for Technological Innovation in Road
Engineering 2017: key construction technology
for large cross-section extremely gassy tunnel

China Railway Tunnel Group Co., Ltd.



Miami, USA 18th November 2019

Rapid Construction Technology for Large Cross-section Extremely Gassy Tunnel



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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

China Railway Tunnel Group Co., Ltd.

Rapid Construction Technology for Large Cross-section Extremely Gassy Tunnel



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Third Prize for Technological
Advancement from Chongqing
2013: Research on Joint
Ventilation of Segregated Gallery
and Air Duct for Super Long
Tunnel



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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



Henan provincial-level construction method 2015: pre-extraction of coal bed gas for gas tunnel using bed-crossing grid (EJGF114-2015)



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省级工法证书

工法名称：长大隧道分隔巷道与风管联合通风施工工法

批准文号：豫建协[2015]21号

工法编号：EJGF15—2014

完成单位：中铁隧道集团有限公司

河南省建筑业协会

二〇一五年二月

Henan provincial-level construction method 2014: joint ventilation by segregated gallery and air duct for long tunnel (EJGF15-2014)



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重庆市城乡建设委员会

渝建〔2017〕502号

重庆市城乡建设委员会 关于公布 2017 年第一批重庆市市级工法的通知

各区县（自治县）城乡建委，两江新区、经开区、高新区、万盛经开区、双桥经开区建设局，有关单位：

按照《重庆市工程建设工法管理办法》（渝建发〔2006〕176号）、《重庆市城乡建设委员会关于进一步加强重庆市市级工法申报管理工作的通知》（渝建发〔2013〕10号）的规定，经企业自愿申报、专家评审推荐和公示程序，决定批准《混凝土结构钢筋锚固及焊接箍筋施工工法》等 71 项工法为 2017 年第一批重庆市市级工法，现予公布。

附件：2017 年第一批重庆市市级工法名单



28	长大斜井竖向坡度急剧变化段 TBM 控制施工工法	中铁十一局集团第五工程有限公司	同意该工法为重庆市市级工法	张开顺、邱承有、王元清、刘明辉、汤启栋
29	长距离大坡度斜井壁后填充施工工法	中铁十一局集团第五工程有限公司	同意该工法为重庆市市级工法	张开顺、刘明辉、唐天东、王元清、郝金柱
30	长大隧道分隔巷道与风管联合通风施工工法	中铁隧道集团一处有限公司	同意该工法为重庆市市级工法	陈海峰、周水强、陈建国、罗先刚
31	预应力混凝土空心薄壁桁式结构桥梁爆破拆除施工工法	重庆城建控股（集团）有限责任公司	同意该工法为重庆市市级工法	汪龙、孟祥林、陈代耘、田均、陈磊
32	连续箱梁桥整体顶推复位施工工法	重庆城建控股（集团）有限责任公司	同意该工法为重庆市市级工法	杨寿忠、朱光华、孙波勇、贺恩明、夏家富
33	城市地下空间开挖准静态微震爆破施工工法	重庆城建控股（集团）有限责任公司	同意该工法为重庆市市级工法	汪龙、孟祥林、陈代耘、田均、唐先泽

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Chongqing municipal-level construction method 2017: joint ventilation by segregated gallery and air duct for long tunnel (YJ [2017] No. 502)



ITA TUNNELLING
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省级工法证书

工法名称：长大隧道分隔巷道与风管联合通风施工工法

批准文号：粤建市函〔2018〕2933号

工法编号：GDGF361-2018

完成单位：中铁隧道局集团有限公司

主要完成人：辛国平、陈海锋、刘龙卫、周水强、陈建国、
张文明、罗先刚、张志和



二〇一八年十二月二十日

Guangdong provincial-level construction method 2018: joint ventilation by segregated gallery and air duct for long tunnel (GDGF362-2018)



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Thank You