Using Microcomputer Technology to Realize the Exploration of Electromechanical Equipment Automation of Extra-long Tunnel in Plateau Area

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Abstract. Tunnel engineering construction in high altitude and cold region is greatly affected by the environment, the construction difficulty is high, and the resource allocation is also different from ordinary mountains. In this paper, the mechanical and electrical equipment automation technology of extra-long tunnel in plateau region is explored for the reference of readers.

Keywords: Microcomputer Technology, Long Tunnel, Automation of Mechanical, Economic Conditions

1. Introduction
With the rapid development of highway in China, the construction of mountain tunnel is accelerating, and engineering technology will play a more important role. Based on the analysis of the construction personnel and the configuration of mechanical and electrical equipment, this paper explores the automation technology of mechanical and electrical equipment for the extra-long tunnel in the plateau area.

2. Project overview
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The lithophany Tunnel site belongs to the cold region with an altitude of 3,200 ~ 4,041m, and the entrance of the tunnel is 3,200m above sea level [1-3]. The strike of the ridge intersects with the direction of the tunnel almost directly, and the slope at the entrance is relatively steep, with a slope of 45~50°. The right line of The Tunnel is 5565m long, and there are no inclined shafts or shafts in the whole tunnel. It adopts the tunneling method at both ends, which is very rare in China. Our department is responsible for the construction of the entrance section of the right line [4-6]. The starting and ending pile number is YK17+182-YK19+850, with a length of 2668m. The single tunnel has a width limit of 10.25m, a net height of 7.2m and a building limit height of 5.0m. The designed driving speed is 60km/h.
2.2. Meteorology and hydrology
With an average altitude of about 3,400m, the mountain is characterized by high radiation intensity, low temperature, abundant precipitation and mostly snow. The average annual temperature in the middle and high mountainous area above 3,100m above sea level is less than 0.7 °C, the coldest average monthly temperature is -16.0--16.7 °C, the highest extreme temperature is 28.7 °C, the lowest extreme temperature is -37 °C, the maximum permafrost depth is 111-130cm, the maximum wind speed is 20m/s, the maximum snow thickness is 23mm, and the initial and final snowfall lasts for 7 months from October to May. The pressure at the Site of the Tunnel was 660h Pa with altitude hypoxia and mild altitude sickness.

3. Analysis of the influence of altitude hypoxia on personnel and machinery

3.1. Comparison of oxygen content
According to the theoretical calculation, the oxygen content in the atmosphere accounts for 20.95% of the total atmospheric composition, and the proportion of oxygen varies little with altitude. However, due to the change of atmospheric pressure, the plateau pressure is low, so the air is thin, leading to the decrease of oxygen content. By collecting the data of air pressure measurement in different areas, the oxygen content comparison table is calculated. With an average altitude of 3,400m, The mountain is located in an oxygen-deficient area. Severe hypoxia can occur on cloudy days under the condition of rain and snow, especially in winter when the green vegetation disappears, and when snow falls, severe hypoxia causes breathing difficulties (see Table 1).

| Altitude/M  | Air pressure /Pa | Oxygen content compared | Remarks                        |
|------------|------------------|-------------------------|--------------------------------|
| 0 ~ 100    | 1010             | 100%                    | Lianyungang, Jiangsu, China    |
| 1370       | 850 ~ 860        | 84.2%                   | Datong, Shanxi, no hypoxia     |
| 2400       | 760 ~ 770        | 75.2%                   | Mild hypoxia around Xining     |
| 3200       | 660 ~ 670        | 65.3%                   | Anoxic Ridge mountain tunnel   |
| 4000       | 570 ~ 580        | 56.4%                   | the top of the ridge           |

3.2. Influence of altitude hypoxia on personnel
The plateau has a special natural environment, characterized by low pressure, low oxygen, dry and cold climate, high wind speed, and significantly increased solar radiation and ultraviolet radiation. People aged between 18 and 40 are the most adaptable to the plateau environment and the most tolerant to the low-pressure, hypoxia and alpine environment of the plateau. However, people aged between 25 and 32 have the strongest anti-hypoxia ability and are in the best state at this age. The effect of plateau environment on physical labor: the labor capacity is reduced by a level compared with the plain area. The hygienic limit of plateau labor capacity: the continuous working time of 3000–4000m should be less than 6h, the continuous working time of above 4000m should be less than 4h, the labor cycle of above 4000m should not exceed 6 months, the working period of above 4000m should not exceed one year, and the workers should rest at low altitude for 2~3 months.

3.3. Effects of altitude hypoxia on machinery
With the increase of altitude, atmospheric pressure decreases, air density decreases, and oxygen content in the air decreases accordingly, which has a very prominent influence on construction machinery powered by internal combustion engine. For naturally aspirated internal combustion engine, due to the reduction of excess air coefficient, the deterioration of combustion, the corresponding decrease of power and torque, the increase of exhaust temperature, specific fuel consumption and smoke degree, the decrease of mechanical operation efficiency and the high fuel
consumption. According to the research data of Xining Plateau Construction Machinery Research Institute (hereinafter referred to as Xiao Institute), the power of the non-supercharged diesel engine decreases by about 24%~42% and fuel consumption increases by 18%~27% at altitude of 3000m. The power of supercharged diesel engines decreases by about 3%~24% and fuel consumption increases by 3%~18%, among which the power of supercharged and medium-cooled diesel engines decreases by about 3%~12% and fuel consumption increases by 3%~15%. The decline of diesel engine power in plateau construction will cause the sharp decline of construction machinery and equipment performance, or even cannot be used. The ZL40 loader can only work barely at the site with an altitude of 2800m, but when working at the site with an altitude of 3000m, the lifting capacity of the bucket decreases by half and the operating efficiency is greatly reduced, so it cannot be used normally. The 6135-64K W diesel generator set used by a pipeline regiment stationed in Glomus area is in short supply due to "altitude sickness". The D80-12 bulldozers, which are equipped by the 103-armed forces of the Armed Police force, are satisfactory in low-altitude Xinjiang, but struggle to operate empty vehicles when they are used to build roads in Tangela Mountain. Therefore, the impact of plateau environment on the dynamic performance of internal combustion engine is very serious.

3.4. Brief introduction of project construction organization

Laisha tunnel geological structure is mainly composed of a series of fold and fault, the mountain formation time is shorter, complex geological strata, and poor stability, according to the characteristics and the new and the construction principle, V reserved by ring core of surrounding soil excavation construction, III, IV class surrounding rock, to adopt positive steps excavation construction method, by using the theory of smooth blasting plan formulation.

After comparing the advantages and disadvantages of trackless slag discharge and trackless slag discharge, the trackless slag discharge is selected. According to the characteristics of more trackless slag discharge machinery and poor air in the tunnel, the ventilation in the tunnel is strengthened to ensure the normal construction of the tunnel (see Figure 2).

![Figure 1. Comparison of rail and trackless transport.](image-url)
4. Configuration of construction personnel and mechanical and electrical equipment for high altitude and cold extra-long tunnel

4.1. The number of personnel increased due to the lack of oxygen at the plateau

In order to ensure the normal progress of the project and the reasonable working time of each cycle, tunnel personnel should be increased appropriately compared with those in plain tunnels. Tunnel construction team, with 96 people in attendance, was responsible for tunnel construction. Due to the cold and long winter time on the plateau, coupled with the lack of oxygen and altitude sickness, especially the poor construction environment in the long tunnel, the altitude sickness was further aggravated. The construction of tunnel on the plateau was faced with problems such as high wages, high mobility, and difficulty in recruiting workers.

Based on the actual situation, the project has improved the living environment, enhanced ventilation, and improved the working environment in the cave, and set up emergency rescue measures such as oxygen cylinders and oxygen bags in the cave and the palm surface. Besides, it has also raised workers' wages, given extra rewards for completing construction tasks and other measures to retain construction workers as far as possible. As the backbone of the construction, technical workers with little altitude sickness will be retained with a large sum of money, and a small number of local workers from Qinghai will be provided as a supplement to ensure the smooth progress of the construction.

4.2. The mechanical power decreases and the quantity increases

Tunnel machinery supporting should be scientific and reasonable, the first consideration of technical conditions and economic conditions, under the premise of meeting the technical conditions, the focus of consideration of economic conditions. Construction machinery should be compatible with the construction environment and construction method, and should not be blindly invested to avoid waste. The project has a deep understanding of the harsh plateau environment, low air pressure and low oxygen content. New equipment is adopted for construction machinery, and many mechanical equipment with pressurized engines are selected to reduce the impact of the plateau region on machinery, while increasing the machinery reserve to prevent shutdown due to mechanical failure and other reasons.

Second lining construction the hole set two concrete mixer mixing, feeding ZL50C loader, 8 m³ concrete transportation vehicles to deliver concrete hole type HBT60C towed concrete pump casting two lining concrete, the second line car adopts hydraulic integral steel lining shutter, a total of three configuration, 9 m and 12 m segment lining shutter is hole 1, widened section (from the driveway) 6 m pallet 1, each car is equipped with other homemade multi-function platform 1, cooperate with geotextile waterproof board hang set.

4.3. Comparison and improvement of the number of plateau tunnel machinery

Considering the impact on the construction machinery, the construction machinery adopts new equipment, and many mechanical equipment with turbocharged engines are selected to reduce the impact on the machinery in the plateau area, while increasing the machinery reserve, to prevent the shutdown due to mechanical faults and other reasons. In addition to the conventional construction methods, to improve the shotcrete construction link, the reference design sprayed concrete mixing station hopper feeder, and add a ZL28 loader, five loading, saving the original 2 shotcrete machine need 8 people, now only need 3 people, and greatly reduce Labor intensity, reduce plateau, the difficulty of employment. High pressure air is very important in tunnel construction. Two air compressors can meet the requirements of drilling and blasting, bolt drilling and shotcrete construction during tunnel construction. At 1800 places inside the tunnel, due to increased losses, four air compressors outside the tunnel can't meet the requirements of construction inside the tunnel.

5. Conclusion

To sum up, as the excavation gets deeper and deeper, the construction is more and more difficult, and
the construction progress is very limited. Through careful analysis, according to the construction tasks, the project gradually increases the construction personnel, mechanical and electrical equipment configuration, accelerates the construction progress, and achieves good results.

References
[1] Liang Bin. Freeze thaw mechanical characteristics and construction control technology of frozen soil at portal of super long tunnel in plateau area [J]. 2020,41 (06): 58-64 + 7.
[2] Wu Jie. Mechanized supporting technology for main operation line of super long single track railway tunnel in Alpine Region [a]. 2016:7.
[3] Wu Jie. Comprehensive information [J]. Western transportation technology, 2016 (07): 7-8.
[4] Li Yong. Mechanical and electrical equipment selection and configuration of plateau super long tunnel [J]. Construction machinery, 2014 (09): 42-45 + 4.
[5] Liu Fu. Discussion on ventilation technology for construction of extra long highway tunnel in plateau high altitude area [J]. Southwest highway, 2014 (02): 31-33 + 52.
[6] Zhang Lizhong, Zhang Jianying, an ting. Construction personnel and mechanical and electrical equipment configuration of extra long tunnel in high altitude and cold [J]. Construction technology, 2012, 9 (S2) : 86-89.