Universe Scientific Publishing

ORIGINAL ARTICLE

Development and Prospect of Chinese Tunnel and Underground Engineering

Xin Cai*

Ningbo University of Technology, Ningbo 315000, Zhejiang, China. E-mail: 1099132131@qq.com

Abstract: In recent years, with the rapid development of China's economy and the continuous expansion of the scale of urban construction, the urban population has grown rapidly, and the phenomenon of urban traffic congestion has become increasingly serious. The construction of urban rail transit is an important measure to alleviate urban traffic congestion. Highway tunnels and subways have the advantages of improving routes and shortening travel time in transportation and ultimately improving operational efficiency. Therefore, in recent years, China has increasingly invested in tunnels. Underground engineering has become an important symbol of a country's overall national strength, urban economic strength, people's living standards and modernization.

Keywords: Underground Engineering; Open Cut Construction Method; Cover Excavation Construction Method; Shallow Buried Excavation Method

1. Current status of highway tunnels and underground projects in China

In the 21st century, as China accelerates the process of urbanization, the development and utilization of underground space becomes increasingly important. The construction of tunnels and underground projects is both an opportunity and a challenge. Since 2018, China's National Development and Reform Commission has opened the door for the approval of the urban rail transit project. In particular, at the end of 2018, in just two months, a total of 10 rail transit construction projects were approved, with an investment of 1,088.942 billion yuan. Up to now, China's rail transit construction plans in 43 cities have been approved by the state, with a total mileage of 8,600 kilometers. According to the provisions of Article 19.1.22 of "Metro Code Design" (GB50157-2003): "between two single-line interval tunnels, when the continuous length of the tunnel is greater than 600m, a communication channel shall be set up". Therefore, the number of communication channels to be built is extremely large.

2. Commonly used construction methods in China

2.1 Open cut construction method

Open cut construction method refers to the operation on the ground surface, digging the earth and stone from the ground to the bottom. When it reaches a certain design elevation, the base will be constructed in succession. When the main structure of the tunnel is completed, the ground backfill foundation pit will be restored. This method is the most basic construction method for underground engineering. Its safety and convenience in construction have advantages that other construction methods do not have. However, this method is only suitable for uninhabited people,

doi: 10.18686/utc.v5i1.77

inconvenient transportation and relatively few buried pipelines. Local application, because of the restrictions on the construction environment and the noise and vibration caused by the construction, has a great impact on the surrounding environment. Open-cut is the most widely used method to construct subway stations, and can be divided into single-layer open-cut station, one-layer open-cut station, double-layer open-cut station, and three-layer open-cut station based on different buried depths.

2.2 Cover excavation construction method

The cover excavation construction method is to dig down from the ground to a certain depth, then close the top, and the rest of the lower part of the project will be constructed under the closed roof. It is mainly suitable for areas with loose geological conditions and tunnels above groundwater level. This method is a commonly used construction technology including: cover and excavation along the way, cover and excavation reverse operation, cover and excavation semi-reverse operation, compared with open excavation method. On the one hand, it has little impact on the construction of other projects. Underground pipelines can use cover. The board is used as protection, thereby reducing the workload of pipeline relocation and correspondingly reducing the investment of the construction unit. Even if the pipeline and structural location conflict and the pipeline needs to be relocated, the relocation can be carried out simultaneously with the construction of the project. The cost is low, and the required time is shortened, and the impact of the pipeline demolition on the project construction is minimized. On the other hand, the cover excavation method is less affected by other factors. The cover excavation method is conducive to the comprehensive construction of the underground structure of urban municipal engineering that can not be implemented by side construction or complex pipelines without affecting normal traffic conditions and maintaining traffic flow. In addition, the cover excavation method is used in underground construction, and the noise vibration is small, which effectively reduces the noise pollution during the construction process. It is more flexible, which can not only ensure the construction period, but also ensure smooth traffic, which is extremely important for the construction of subway stations in the city.

2.3 Shallow buried excavation method

Shallow buried excavation method refers to a method of underground excavation construction of various types of underground caves near the ground surface. Shallow buried mining method is a new method developed in recent years. According to the basic principles of New Austrian law, shallow buried mining method is based on "pipe ahead, strict grouting, short footage, strong support, early closure, diligence" "Measurement" is the main point of construction control. The underground caverns constructed by shallow burying and underground excavation have shallow burial depth (minimum cover span ratio can reach 0.2), poor stratum lithology (usually Quaternary weak stratum), presence of groundwater (need to lower groundwater level), and complicated surrounding environment (adjacent Existing buildings, structures) and other characteristics. The core of the method is to use the surrounding rock support tunnel to form the supporting ring of the surrounding rock itself, and use a variety of auxiliary construction methods to implement advanced support, so as to mobilize the self-supporting capacity of part of the surrounding rock to ensure that the construction process and completion. After operation, the amount of subsidence in the ground and in the ground is less than the limits specified by adjacent building structures and pipelines. Due to the characteristics of low cost, less demolition, flexibility, no need for too much special equipment, and no interference with ground traffic and surrounding environment, the shallow buried excavation method is widely used in similar stratums and various underground projects across the country. However, there are problems such as inconvenient mechanized operations, high labor intensity, poor working conditions, and high risks. This method has been widely used in urban underground engineering.

2.4 Shield construction method

The shield construction method is a fully mechanized construction method in the construction of the dark excavation method. It is to advance the shield machinery in the ground, and support the surrounding rock through the shield shell and the segment to prevent the collapse into the tunnel. At the same time, a cutting device is used to

excavate the soil in front of the excavation surface, and it is transported out of the hole through the excavation machinery, jacked up at the rear by jacking, and prefabricated concrete segments are assembled to form a mechanized construction method of the tunnel structure. At present, the shield method construction has been widely used because it has: (1) excavation and lining operations under the cover of the shield, with sufficient construction safety; (2) underground construction does not affect ground traffic, and construction under the river is not affects the navigation of the river; (3) construction operations are not affected by climatic conditions; () the resulting vibration, noise and other environmental hazards are less harmful; (5) the impact on ground buildings and underground pipelines is less obvious advantages.

2.5 Pipe jacking construction method

Pipe jacking construction method is an underground pipeline construction method developed after shield construction. With the help of the jacking force generated by jacking equipment in the working well, the friction between the pipe and the surrounding soil is overcome, and the pipe is jacked up according to the designed slope go into the soil and transport the earth away. After one pipe section has been jacked into the soil layer, the next pipe section will continue to jack in. The principle is to push the tool pipe or the boring machine from the working pit through the soil layer to the receiving well by using the thrust of the main top oil cylinder, the pipeline and the relay room. The pipeline is buried between the two shafts immediately after the tool pipe or the boring machine. The main problem of pipe jacking technology in China is that the mechanical equipment technology is relatively backward, the regional differences are obvious, the level is uneven, the lack of standardization, and the shortage of talents are yet to be further publicized. China mainly relies on imports for pipe jacking machinery and equipment. Although there are also domestic production enterprises, the technology is still lagging behind the international advanced level. The type of roadheader is not enough to meet the needs of the project. There is no rock disk for China above medium strength rock formation. The machine is not suitable for the range of soil quality, and the durability, mechanization and automation are not enough.

3. Outlook

Academician Mengshu Wang pointed out that the 21st century is a century of great development of tunnels and underground spaces. With the continuous advancement of technical level and the need for operational development, the tunnel will inevitably become longer and wider, making the construction more difficult. Moreover, the various problems faced are becoming more and more complicated. China is a big country in the construction of tunnels and underground projects, but it is not a theoretical power. Many modern design theories are still based on the situation in the West. The design models and methods still have many shortcomings. There is still a big gap.

References

1. He D. China's road development (in Chinese). China Highway 1999; 99(7): 19.
2. Wu F. Talking about shallow buried and undercutting construction of metro station (in Chinese). Science & Technology Information 2009; (21): 80. doi: 10.3969/j.issn.1672-3791.2009.21.073.
3. Zhang G. Development and prospect of subway construction technology (in Chinese). Scientific and Technological Information 2007. doi: 10.3969/j.issn.1673-1328.2009.16.222.
4. Jiang S. Application and prospective review on reserved construction method for urban underground space development. Building Construction 2004; 26(4): 280-283.
5. Wang Y. Application of cover and excavation method in China's subway engineering (in Chinese). China Civil Engineering Journal 1996; 29(1): 3-14.
6. Xu Z, Zhao X. Reverse design and construction (in Chinese). Beijing: China Machine Press; 2002.
7. Wang M. General discussion on shallow buried and underground excavation technology of underground engineering (in Chinese). Hefei: Anhui Education Press; 2004.
8. Bai L. Construction technology of shallowly buried and undercut underpass in soft ground under railway station (in Chinese). Railway Engineering 2008; (9): 54-56.

9. Yang S. Technical measures for shallow buried and subsurface excavation of mud texture (in Chinese). Journal of Railway Engineering Society 2003; (2): 64-67+78.