Research on the Construction of New Transportation Infrastructure in Beijing

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Abstract. This paper analyzes the development of new transportation infrastructure in Beijing by taking the utility tunnel as an example. The utility tunnel is a modern and intensive urban infrastructure that is constructed by integrating various engineering pipelines, such as electricity, communications, gas, heating, water supply, and drainage in the underground tunnel space of cities. The construction of the underground pipe gallery is conducive to ensuring the comprehensive utilization of the underground space of cities, which can meet the needs of continuous growth of roads and paths, and facilitate intensive management. This article focuses on the development of the construction of the utility tunnel in Beijing. Based on analyzing the development bottlenecks of the underground utility tunnel in Beijing, implementing scientific planning, realizing intelligent management of the utility tunnel and establishing the paid use system are put forward in order to provide solutions for promoting the development of the utility tunnel in Beijing and solving urban transportation problems, and to promote high-quality development of transportation in Beijing.

1. Introduction

The utility tunnel, as a type of new transportation infrastructure, is of great significance to promote high-quality development of transportation. The utility tunnel is a public tunnel, which is built underground in cities to accommodate two or more types of urban engineering pipelines[1]. The utility tunnel, as a quasi-public municipal infrastructure, produces positive externalities such as avoiding repeated excavation of urban roads due to maintaining pipelines, making use of urban underground space resources effectively and intensively, prolonging the service life of municipal pipelines, and ensuring the safety of important lifelines in cities like water, electricity, gas, and communications[2]. Therefore, the implementation of the utility tunnel is beneficial to the comprehensive utilization of the urban underground space, and to improving the fine management level of cities.

With the rapid development of Beijing, there is increasingly demands for upgrading and maintaining the underground pipelines, placing urban roads and underground pipeline network space under the serious pressure. The construction of the utility tunnel has become an inevitable choice in commercial districts, transportation facilities, conservation districts of historic sites, and other areas integrating crowd, business, entertainment, and catering, because the construction of direct buried pipelines would occupy shallow underground space and affect the use value of the land. Thus, Beijing Urban Master Plan (2016-2035) was issued[3], to establish development goals of the utility tunnel, achieve economies of scale of the utility tunnel, and to cultivate the related industries of the underground utility tunnel. Table 1 shows the utility tunnel projects constructed in Beijing from 2019 to 2020[4].
Table 1. Beijing key construction projects of the utility tunnel from 2019 to 2020.

| Project                                                                 | Site                                                                 |
|------------------------------------------------------------------------|----------------------------------------------------------------------|
| The utility tunnel project at Dali Road, Linkong Economic Zone         | Daxing District-Daguang Expressway to Jingtai Expressway              |
| The first-stage construction of the underground utility tunnel project at Daxing International Airport Expressway in Beijing | Daxing District-South 5th Ring Road to New Airport                   |
| The underground utility tunnel project at east extension of Rail Transit Line 7 | Tongzhou District-Wansheng South Street 1st Road Intersection to Tuqiao Middle Road |
| The utility tunnel at Yongyin South Road                                | Shijingshan District-Jinding North Road to West 5th Ring Road        |
| The underground utility tunnel project at Tongzhou Cultural Tourism Zone | Tongzhou District-Cultural Tourism District                         |
| The utility tunnel project at Old Line of Qingli Road, Linkong Economic Zone | Daxing District-Changbei Connecting Line to Dali Road               |
| The utility tunnel project of supporting facilities at Winter Olympic Games of Yanqing division | Yanqing District-Zhangshanying Town                                  |
| The utility tunnel at Huairou Science City                               | Huairou District-Science City starting area                        |

2. The bottlenecks of the utility tunnel development in Beijing

2.1. Deficient in the master planning for underground space
The construction of the utility tunnel is likely to conflict with the existing urban planning of Beijing, and there is little reversibility in the construction of the utility tunnel. Therefore, it is of great importance to coordinate the urban planning and the master planning for the underground space and to determine the priority of the layout of the utility tunnel in order to avoid waste of pipelines.

In addition, there are no clear definitions about the issues, like the ownership of underground space and cost sharing. The unified management department is required for various types of underground pipelines. The main pipeline construction departments have been acting as management department, to lead the route selection, engineering construction and the time sequence for construction. Cross-use of the construction site and matching the construction period difficulty might happen when the utility tunnel implemented with the urban rail transit at the same time, due to the different construction management subjects and construction units. As a consequence, it would be hard to coordinate the overall construction of the utility tunnel from the macro perspective.

2.2. Lack of a unified standard system for the utility tunnel engineering
The national construction specifications of the utility tunnel include various policy documents, such as Technical Standards for Engineering of Monitoring and Alarm System of the Urban Utility Tunnel, Technical Specifications for the Urban Utility Tunnel Engineering, Guidelines for Engineering Planning of the Urban Underground Utility Tunnel, National Design System of Building Standard for the Urban Utility Tunnel, and Technical Guidelines for the Construction and Planning of the Urban Underground Utility Tunnel.

The engineering standard system of the utility tunnel in Beijing is mainly composed of Design Specification of Urban Utility Tunnels, Operation and Maintenance Specification of Urban Utility
Tunnels, Construction and Quality Acceptance Specification of Urban Utility Tunnels, Project Management Specification of Urban Utility Tunnels, Construction Specifications of Installation Engineering of Monitoring and Alarm Equipment of Urban Utility Tunnels. Engineering Design Specification of Urban Utility Tunnel in Beijing has been implemented.

The engineering standard system of the utility tunnel in Beijing is established relatively late. Integrated piping and various types of inlet and outlet piping have formed their own design specifications. However, the operation of the pipelines in the utility tunnel is different from the situation as they are laid separately. So, the design standards of the pipelines are required to match the technical standards of the utility tunnel.

In addition, the construction costs of the utility tunnel include not only the construction, management and maintenance costs, but also the costs affecting the normal traffic order and road pavement of cities at the stage of construction [5]. Therefore, it is crucial to solve the technical problems in the standardization of auxiliary facilities, the standardization of waterproof and anti-seismic design, the connection of internal and external pipelines, and the installation and maintenance of pipelines.

2.3. Incomplete investment and financing mechanism

The funding policy of the utility tunnel is still in the stage of “one utility tunnel-one policy”, lacking the stable special funding source. The pricing mechanism and related supporting policies have not been formulated, which would be detrimental to the long-term sustainable development of the utility tunnel. The construction of the utility tunnel of Beijing is mainly invested by the local government from road construction funds, but the annual management costs place a heavy burden on the receiving unit. Part of the construction costs and daily management costs should be borne by the units of pipelines, but it is limited by various competent departments of pipelines[6]. Therefore, the existing investment and financing mechanism of the utility tunnel is manifested by the great financial pressure of government, inefficient operational management, and all or major risks undertaken by the government.

3. Suggestions for promoting the development of the utility tunnel in Beijing

3.1. Implement scientific planning

On the one hand, the concept of smart city is supposed to be integrated into the medium and long-term planning of the utility tunnel to meet the need for infrastructure with the rapid development of urbanization, to scientifically guide the planning, design, operation and maintenance management of the underground utility tunnels, and to turn infrastructure into a lifeline of Beijing. On the other hand, the urban comprehensive carrying capacity and urban construction quality will be improved through scientific planning of the utility tunnel, which is beneficial to promoting the transformation and upgrading of traditional construction industry in Beijing, and to forming the intensive and efficient urban development model.

3.2. Realize intelligent management of the utility tunnel

The basic research of the utility tunnel should be strengthened, especially the application of firefighting systems, Internet of Things and 5G technologies in the construction of the utility tunnel, to form the key technologies of the utility tunnel with intellectual property rights. The construction of intelligent management systems of the underground utility tunnel should be promoted, building the visual operation and maintenance management platform with BIM technology, in order to provide solutions for the decision-making, monitoring and early warning mechanism during the operation and maintenance phase[7], to realize the integration with the basic information system of underground pipelines and the digital city management system, and to continuously improve the visualization and intelligent monitoring management level of the utility tunnel.
3.3. Establish the paid use system

The investment and financing channels need to be expanded. TOT, BOT models can be used to form an investment and financing mechanism that is led by the government integrating funds and social capital. The costs of the utility tunnel are composed of construction costs and operation and maintenance costs, and the latter are a continuous investment. In terms of the principle of being responsible for maintenance of pipelines as long as they are used, reasonable charging mechanism is supposed to be established to charge the users of pipelines, which can provide the fund sources for the repair and replacement of equipment in the utility tunnel, reduce government pressure, and avoid the chaos of operation of the utility tunnel.

4. Conclusion

Based on the importance of the utility tunnel for the urban development of Beijing, this article analyzes the development of new transportation infrastructure in Beijing by taking the utility tunnel as the research object and focuses on the bottlenecks of the utility tunnel development in Beijing, which are deficient in the master planning for underground space, lack of a unified standard system for the utility tunnel engineering and incomplete investment and financing mechanism. Policy recommendations are provided for solving the issues in the overall planning, technical specifications and investment and financing mechanisms of the utility tunnel, which aim to promote the high-quality development of transportation in Beijing, and to offer a sample for the construction of the national utility tunnels.

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