Development Mode and Strategy of High-density City Underground Space

Dongming He

Hubei Institute of Fine Arts, Wuhan Hubei, 430205, China

Keywords: High-density; city, Underground space, Development model, Strategy.

Abstract. The large-scale development of urban underground space is the inevitable trend of high-density city economic development height. With increasing height and density of buildings, urban ground space is very crowded, such as, traffic congestion, lack of greening, serious environment pollution and lack of humanized living space. Therefore, in order to address this tension state of ground, we must strive to develop underground space, and form a three-dimensional and highly-efficient urban space system.

Introduction

The underground city is the issue complex related to independence and relation. In the development process, active studies are required to be made by various experts, such as, city planning designers, project implementers, developers and builders and the like. In order to construct a reasonable underground space design concept, we need to achieve comprehensive urban planning of buildings and residence, and to promote the integration of technology, environment, society, economy and other factors as a whole.

High-density City Underground Space Development Mode

"Annular connection" mode

Liquidity of building space provides valuable comments and suggestions for the construction of underground space, also optimizes the construction of building group, and promotes urban three-dimensional development. Modern building is a kind of liquid form of ideas, mainly influenced by social ideas and personal thoughts. The "annular connection" mode of underground space is typical case of openness, mainly taking underground corridors as communication links of the entire space, and then using various systems for connection, but the center portion becomes a core element of underground space. In the "annular connection" mode, the connected space is distributed independently, and it is not only the function core of the underground space, but also the hub of various transportations, and under normal circumstances, mainly used in the central part of the city. For example, Zhongguancun and World Trade Center in Beijing, use annular public space to link building group and buildings, resulting in better integrity, and relatively closed people flow orientation. The respective units of the mode are connected annularly or semi-annularly under the ground, able to form the basic framework of the entire underground space. Annular underground space design is primarily a structure in which a plurality of units with different guiding functions complement each other[1]. "Annular connection" mode has relatively small range, but strong development forms, in particular, relatively dense metro network, and relatively small underground tunnels can achieve greater connection.

"Ridge axis driving" mode

"Ridge axis driving" mode is a conventional form of urban space to achieve three dimensions, and also one sequencing way of space development on the ground. Underground space often develops by the structure of commercial street or rail hubs. This mode is flexible, with a certain role in the development of high-density city, not only suitable for cities at all levels, and also for cities with large or small population. Underground space development axis has a certain centrifugal effect. If a city

achieves axis rolling development in the underground space development process, it can achieve higher overall efficiency. Underground space axis and above-ground space axis coincide with each other, able to achieve higher overall efficiency, and promote the pace of urban development. The change of the mode is mainly manifested in two aspects, one of witch is the ridge axis, mainly referring to the backbone of underground public pedestrian street, composed of one or a plurality of space axes, and the other of which is the flat form by which that both sides of the ridge axis drive the development, the city's major building group, formed by commercial open form. “Ridge axis driving” underground space development mode has its own features. First, it connects the various buildings and subway stations through underground public space, reducing passing through adjacent ground. Second, the underground street mainly is the public passage, supplemented by the commerce. Although it is municipal road construction, the actual construction costs are relatively high, and there is a small flow of personnel, but the form is open throughout the day, able to ease ground traffic, and achieve the freedom of connection in a clear

“Dendritic growth” mode

“Dendritic growth” development mode of underground space between buildings has characteristics of independence and inward development, as the primary communication means of underground space, able to promote the sustainable development of underground space. This form continuously extends in underground space, enhances connectivity, and takes the whole network of underground space as the goal, able to grow continuously between buildings and neighborhoods. For example, local underground space is based on track to achieve the network connection. For example, the metro in Suzhou area is established on the basis of this planning form, according to the city”s air defense facilities, take the construction of the metro as a major opportunity for development and realize an underground complex around the metro, so as to form “dendritic growth” underground space system.

Significant Value of Underground Space Planning and Design

Adapting to space concentration demand

First, it `is able to quickly adapt to the demand of cities on underground space. The acceleration of urbanization process in China, not only greatly improves our living environment, but also rapidly changes urban space forms. Therefore, in order to make urban underground space adapt to the reasonable merger of urban space, use urban space resources, develop transportation routes basic service facilities, and provide the basis for the development of rational space development phase. Therefore, in the underground space planning process, adopt compact space form, to improve transportation efficiency and service level of the city. Second, change two-dimensional space planning forms into multidimensional forms, in order to achieve integration and innovation of space. Underground space planning can promote networking and systematic change, able to take advantage of planning of the underground transportation system and rail transport organizations to achieve three-dimensional and integrated architectural space. It also can guide scientific development means of urban underground space in during the update process of the city, because three-dimensional development forms of the old city consume large amount of funds and wide area for the implementation, so that three-dimensional development in the central region can push update and transformation of the entire region at the level of point line and surface.

Adapt to system regularization demand

First, it can promote systematicness and collaboration of above-ground and underground space. Urban space systems are mainly based on above-ground space, but the realization of underground space should need systematic creation. Because the underground space has complexity and relevance, in which, the actual conditions for the development, and related functions and the development sequences are greatly correlated, and physical properties of underground rock and soil layers present development complexity. Second, the underground space transforms isolated development into regulated and efficient development, because the urban three-dimension development includes

upward or downward development. And downward development has relatively high degree of complexity[2]. And it is also based on the gradual development and planning, able to form the network system of space.

High-density City Underground Space Development Hierarchy and Method

Underground space hierarchy design and planning

Underground space hierarchy planning is relatively similar to urban planning, divided into general level and detailed planning level. The general level of urban underground space planning should analyze above-ground space development, and develop appropriate planning objectives according to different projects and different economic conditions, then make the entire project form a construction network. The general planning method including determining functions of space, predicting the size of the underground space, and determining the layout of underground space and the like. In general, the development of underground space focuses on the start phase of urban new area development, to achieve unified planning of above-ground and underground space. And, also according to the actual conditions of the construction of underground transport, build some underground passages and underground parking lots, thereby changing traffic conditions throughout the city. During development, analyze the comprehensiveness of underground facilities, to achieve the larger interests with minimal land development as far as possible. For the detailed planning of underground space, based on the individual special projects of general planning, in varying degrees, analyze control indicators and planning and management requirements of underground space, so as to promote coordination of above-ground and underground space. For example, for the underground space content, capacity, and layout, it needs to determine the construction program to promote contacts between various procedures, but also make a strong preparation conditions for the planning and implementation of the next stage.

Underground space general planning technology and methods

First, prepare corresponding content for the general planning of underground space. According to the relevant conditions of urban underground space development and utilization in China, it is necessary to not only develop integrated development conditions able to adapt to economic and technical level, but also analyze some prevention measures for disasters and communications, to promote the rational planning of the entire city. In the preparation process, we must first determine the underground space development strategy, analyze underground space resource quantity, quality and value and so on, then to determine the development needs of urban underground space, and guide the development and utilization of underground space in general.

Second, underground space general layout technology and methods[3]. First, it should define development and utilization patterns of urban underground space, especially in important areas and public centers of the city, take rail network as a basis for planning and development of urban underground space, to forming a point-line-face network space system. Moreover, determine the main distribution of underground space functions, mainly divided into single function, mixed functions and integrated functions. Finally, determine the development depth of urban underground space, because the complex underground space uses rock and soil and groundwater as the medium, the underground development depth is influenced by engineering geology and hydrological conditions. With the economic development of the city, land value, engineering technology and other aspects have a closer relationship with the development depth of urban underground space.

Third, planning of the underground space subitem systems, mainly including planing of the underground transportation, underground municipal administration, underground public works and underground facilities. During the period, underground transportation should plan rail transit, underground parking facility, underground pedestrian system and underground vehicles roads, and underground overpass system. Underground municipal facilities mainly focus on the layout and design of power supply, water supply and other facilities. For underground public service facilities, such as, the layout of the business district, cultural entertainment and sports facilities must comply

with the general requirements of commercial network. For air defense projects, position according to the spatial layout and population distribution of the city and divide into various types of air defense projects to be achieved.

Underground space detailed planning technology and methods

First, the of control content underground space detailed planning mainly includes the nature of the land, the intensity of the development and the overall layout of the building, etc.[4]. It needs to control and plan not only the building density and height, but also some public facilities and municipal facilities, etc. Underground space control and planning does not require greening, population, building color and height and other factors to follow certain control requirements, but makes quantitative and qualitative analysis on space, and can guide and control according to the relevant layout of the above-ground buildings.

Second, underground space detailed planning index system. Because land prices are relatively high in high-density urban areas, and there is a strong function complexity, therefore, the establishment of the system can conduct effective controlled. First, control on land use in the underground space. During the period, control, crowds, traffic and other factors in the development of underground space, and especially underground space development capacity, strength and depth, size and other requirements must be in accordance with the relevant national standard specifications。

Third, the underground space building design requirements, mainly including design requirements on space between underground buildings, pineline spacing, and the old and new underground buildings. According to relevant national standards, put forward substantive requirements on the use function and connection of underground space.

Fourth, guidance design of underground space. During the underground space design, indicators are mainly used to guide, to a certain extent, which can reduce people's psychological pressure[5]. Therefore, in order to design safe and convenient underground space, we must use public space and parking space planning indicators for guidance.

Underground Integrated design method

First, the design concept. In the design, the city will study an extensive range of objects. It needs to design the form of buildings, urban public spaces and road transport facilities, but also achieve the design form of functional complexity and three-dimensional development. Moreover, it is necessary to promote the integration of underground and above-ground space, to improve the efficiency of land use and the expansion space of the city, and also optimize the traffic organization,and promote sustainable urban development.

Second, the design method. First, achieve diversified architectural space organization, according to the specific needs of people on the space, achieve integrated design and promote mutual binding mutual penetration between organizations. Moreover, three-dimensional organization of public transport can promote orderly urban space, contribute to the efficient operation of transportation, but also optimize the ecological environment of the city. For example, to design the underground environment meeting people's needs, mainly use light and landscape to improve the underground design space.

Third, integration of underground and above-ground space. Realize the integration of underground public space and above-ground greening, such as, Beijing CBD expansion area. Realize the integration of underground public space and above-ground roads, such as, commercial streets in various cities, improving the urban traffic environment, and also enhancing the city's business climate.

Conclusions

The three-dimensional space in high-density urban environment and sustainable development are the inevitable choice for realization of large-scale cities in China, but also the practical needs of urban development. In the new era of social development, in order to create compact and environmentally friendly cities, we need to not only follow the people-oriented concept, achieve diversification of

space, but also according to the actual needs of China's economic development, efficiently combine horizontal and vertical urban space, for the development of three-dimensional space of the city.

References

[1] Wan Hanbin. Urban Underground Space Development Strategies of High-density Areas, Tianjin University, 2013.

[2] Lu Ying. Geotechnical Engineering Problems of Urban Underground Space Development in High-density Areas, *Urban Roads and Bridges & Flood Control*, 2013 (9): 181-184.

[3] Zhao Shan. Comprehensive Development and Utilization of Tall Buildings Underground Space in City Center, Taiyuan University of Technology, 2011.

[4] Wang Qiao. Pre-disaster Planning of City Central Area in High-density Environment, Tianjin University, 2013.

[5] Wang Qi. Urban Square Disaster Prevention Function and Integrated Development Model of Underground Space, *Research on Theory of Urban Construction*, 2014 (10).