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Research on the pattern of urban underground space development and utilization in medium cities

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Abstract. The development and utilization of urban underground space has become an effective means to solve the urban land tension. In China, with the rapid development of a large number of medium-sized cities, most of which urban population has exceeded one million, urban land increasingly tense. The development and utilization of urban underground space is an inevitable trend in the future. This paper starts from the present situation of the secondary city development and utilization of underground space, the general characteristics of urban development are summarized, and the type of underground space development and utilization are analyzed, and puts forward the key points in the development and utilization of underground space.

1. Introduction

According to the national standard of China in 2014, the medium-sized city is a city with non-agricultural population between 500 thousand and 1 million. The medium-sized city in this paper mainly refers to the prefecture level cities. Which accounted for a large number of Chinese cities, and great achievements have been made in the construction of city, outstanding performance in the high-rise, construction of Urban Elevated Road, and so on. However, the utilization of underground space is limited to the small area, and occupies a small proportion in the overall urban planning; development type is relatively less, too. As an important part of urban construction, urban underground space planning should be combined with the overall urban planning. Based on the achievements of urban two-dimensional planning, the detailed planning content of long-term control in underground space is gradually increased. Based on the overall plan of the "Trinity" of the city, the steps and types of development of underground space in the city are clarified. This ensures the organic nature, continuity and integrity of overall urban planning.

At present, in medium-sized city, the main manifestation of the development and utilization of underground space is in city underground pipeline facilities, civil engineering, underground commercial, underground parking and river tunnel etc. Among them, the city underground pipeline construction history over a long period of time, is the basic guarantee for the normal operation of the city for city information, drainage and mitigation, energy transportation and waste dumping and other functions; the constructing speed is accelerating; underground commercial space based on business and logistics space on the ground and set in dot, which has not yet formed a large area situation of exploitation and utilization; most of the underground parking set with the new residential areas and the central business district, a decentralized layout.

2. The development characteristics on the ground in medium-sized cities



The development and utilization of urban underground space is the continuation of the construction of the ground. It relies on the development of urban ground constructing, which has the following characteristics.

2.1 Residential building intensive

Residential buildings are the most numerous types of urban buildings. With the increase of urban population, the density of urban buildings is increasing. For example, the population in Linyi City of Shandong Province in 2016 has been over 2 millions, in order to meet the basic needs of urban residents living, whether it is the old city or the new city, there are large tracts of intensive residential buildings. And many of the new urban high-rise residential buildings, residential buildings in the old city is also in the reconstruction with multi-storey building to high-level. Urban residential density continues to increase, residential land is tenser and tenser.

2.2 Commercial and service industry cover an area of a large proportion

The rapid development of medium-sized cities is based on the accurate positioning of their economic development, and most of them depend on the commercial and financial sectors. Apart from the traditional large area of the old city retail commercial land, the new urban also has large commercial buildings and neighborhoods. In addition, for some geographical features of the city, the proportion of its service industry is also larger.

2.3 Crowded traffic and Lack of urban public green

With the rapid economic development of medium-sized city, on the one hand, urban population density increases, the larger transportation is demanded; on the other hand, with the rising of people's living standard and consumption ideas, household car growth is accelerating, citizens total travel demand continues to increase. So as to gradually form the phenomenon of traffic congestion, urban congestion is serious especially in rush hour. Of course, there are some other reasons intensifying the situation of traffic congestion, such as that public transportation is not developed enough, shortage of motor vehicle parking garages, not adapt between urban planning and road traffic development, the traffic safety consciousness to legal system of traffic participants, and so on.

The public green area of the city can be divided into concentrated green and scattered green. Large area of concentrated green in the city performances as the green with the natural rivers, all kinds of lakes, city parks, city hills and the large residential areas, and so on. The scattered green of the urban mainly includes the green between the city roads, with the large of residential areas and other urban buildings. Overall, in the context of rapid economic development and rapid population growth in urban areas, the urban land is constantly tense, and the urban green area is insufficient.

3. Study on the constructing form of the underground space

According to the present situation and the demand of the construction of the underground space in the medium city, this paper analyzes the construction form of the underground space to provide the reference for the development and utilization of the underground space in the future.

3.1 Dot shape

At present, most of the underground space has been building with the dot form in the middle city, which is the basic form with the city underground space development and utilization of the early, but also the basic elements of underground space. Dot underground space form is particularly suitable for the underground commercial, leisure and entertainment function spaces, and which can be layout with the ground positions of the commercial, Recreation & Entertainment and traffic. Although the dot underground space is an important part of the spatial structure of the city and plays an important role in the city's living, but it's too independent in the comprehensive utilization of the underground space, and can not be effectively integrated and utilized with each other.

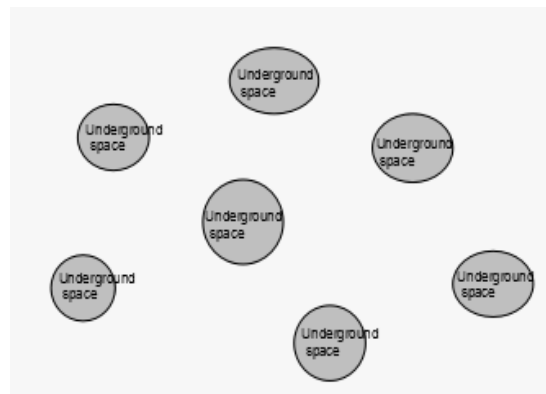


Figure 1 Dot shape

3.2 Central radiation shape

The central radiation shape in the development of the underground space mainly refers to a large urban underground space as the core, which form an radiation shape with connecting other underground space in the cities. That is a form of local space in integrating or developing on the basis of the dot shape of the underground space. It is also a common form in the early development and utilization of urban underground space. The central radiation shape of the underground space is based on the development of the large center underground space in the city, which can effectively promote the development and utilization of the underground space around. And, the local underground space of the city forms a relatively complete system.

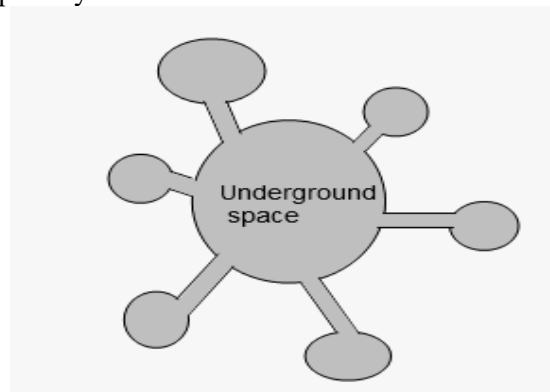


Figure 2 Central radiation shape

3.3 Band radial shape (Ridge shape)

The band radial shape of the city underground space is also known as linear radiation or ridge shape. That bases on the certain size of underground space with a linear shape as the axis, efficiently developing the underground space on the both sides of the axis. And than, all the development spaces of the underground connect to each other and form a system. Linear underground space can be underground Commercial Street or the parking lane in the underground parking system. The underground space of the both sides of the axis can be the basement or garage on both sides. This shape can also solve the integration and utilization of the local underground space and improve the utilization efficiency of the local underground space.

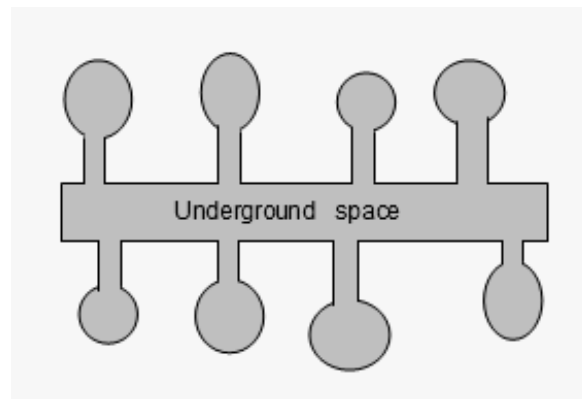


Figure 3 Band radial shape (Ridge shape)

3.4 Network shape

The network shape of urban underground space includes local network and overall urban network. The former is based on a few large scale underground spaces, which are connected to each other and formed a network. The underground space which can be connected with each other can be comprehensively utilized, which mainly solves the problem of the shortage of land in the central areas of the city for the over exploitation. The latter is based on the design of overall urban underground space, the urban underground traffic as the skeleton to communicate the entire underground space with various forms, which forms the overall underground space network system. Generally take the subway as the skeleton, take the site as the node, and organic combination according to various underground space function, the region and the construction sequence and so on. The overall urban network of the underground space is a sign of closing to maturity in the development of urban underground space. The establishment of urban underground space network can greatly enhance the vitality of the city's development on "three in one". This is also improve the efficiency of urban land and been the medium and long term goal of the development and utilization of underground space in medium cities.

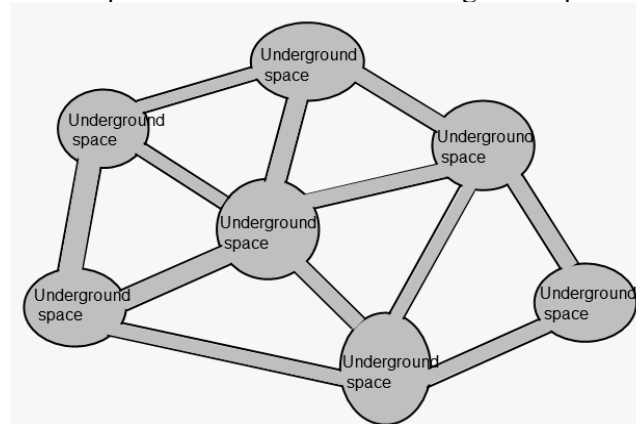


Figure 4 House Network shape

3.5 Three dimensional shape

The three-dimensional urban underground space construction is the integration of the ground and underground city space, forming a complete urban spatial system. So as to give full play to the functions of the ground and underground space, "spaces" to do their best to improve the urban environment. This is the ultimate version of the construction of underground space in each city, but also the general direction of the development and utilization of underground space in medium-sized cities.

4. Main points in constructing of underground space in medium cities

4.1 Strengthen the management of underground space

The ownership of underground space in urban areas is clearly defined to prevent the chaotic development of underground space in the early stages of development and utilization. The aim is to scientifically manage the underground space construction of the city from the perspective of development. As most of the medium-sized city more than one million populations, it is important to make the management principles and rules from the macro to the micro in the development of city underground space, according to the city's characteristics. That is good to eliminate all kinds of possible problems and escort for the use of city underground space efficiently and safely.

4.2 Rational planning and long-term development

Preparing the overall planning or conceptual planning of underground space, putting forward the guiding ideology of underground space development, key areas and development scale, layout, function, timing requirements, etc.. Combined with the transformation of the old city and the construction of the new city, it's important to draw up the controlled detailed plan of underground space constructing, clear the function, strength, size, layout and development strategy and investment model of the urban underground space. At the same time, the concept of green, ecological, low-carbon technology development and utilization should be introduced actively and ensure the maximum rationality and the long-term development of the urban underground space.

5. Conclusion

Underground space is a closed space which is formed naturally or artificially in the soil layer or stratum below the surface. Also, the urban underground space refers to the developed and utilized space under the ground of urban area. Which solves the difficult problems in the process of urbanization, but in the development and construction of urban underground space, it is necessary to consider as many possible adverse problems. Because of the use of urban underground space to bring opportunities and benefits to urban development, but also faced with all kinds of hidden dangers and challenges. For a large number of medium-sized cities that have not yet developed the underground space on a large scale, the sustainable planning of underground space in a timely and effective way can play a positive role in the development of urban underground space.

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