The Current Actuality and Developing Trend of Chinese Urban Underground Space Utility

Shu Yu¹,², Wang Xuan¹, Peng Fangle¹, He Lei¹

¹Tongji University Underground Space Research Center, Shanghai, China
²Tongji United Co. Academy of Underground Space Planning and Design, Shanghai, China

ABSTRACT

When in the 21th century, the tactic transfer, “Creating the source conservation and environment friendly society”, happens in Chinese big cities. Whereas the urban underground space resource development and utilities guarantee the reality of the tactic target. The author analyses the Chinese urban development trend and discusses the development orientation and strategic aims on the basis of investigating and summarizing the experiences and lessons on the underground space resource development and utilities in big cities home and overseas. Also it is the first time to bring forward the Chinese general administrant system, mechanism and legal system.

1. UNDERGROUND SPACE UTILIZATION - CREATING THE CONSERVATION AND HARMONY SOCIETY

1.1 The basic character of the conservation and harmony society

There are four points:
1. Source conservation: Including the ground, water, energy sources and material.
2. Speediness and promptness: That is the demand of the urban life.
3. Protecting environment: That protecting environment and continuable development, is always the aim to persist in our cities construction.
4. Safety and easiness: The essence of the conservation and harmony society is human. So it is prime for human to establish safe and easy environment.

1.2 The forming character of underground space

Underground space is encircled by the rock, soil, air, and water. It can be classified two basic types:
1. Spontaneous: It is formed by the nature power. For example, underground cavity, underground river, and so on.
2. Manmade: It is formed by man. For example, tunnel, subway, basement, and so on.

1.3. The properties of the underground space environment

Underground space has different environment properties from that of the environment above ground. The differences mainly in such aspects as below:
1. Seal and isolation
Surrounded by the rock and soil mass, the underground environment is naturally sealed space that is isolated from the interference of the above ground, so that it can create tranquil working and study atmosphere. To some special scientific experiences and mechanism refining and processing plants
which have strict environmental demand, it is always a good choice to make the deep underground space as worksites.
2. Constant temperature and moisture
Underground space has constant temperature and moisture because of the ground thermal field. Such character makes it appropriate for the preserve of special materials and reduce the cost of environment control. On the other hand, the heat stored within the stratum can be extracted or displaced by particular technology for ground heating supply.
3. Stability and resistance
With rock mass media and stratigraphic coaction, underground space forms strong shock resistance which gives it irreplaceable advantages in earthquake resistance as well as in revival of the city lifeline system after catastrophes.
4. Concealment and shield
As a natural concealment and interference-barrier, underground space also possess great advantages in city disaster prevention and civil defense projects.

1.4. The value orientation of city underground space

1. Underground-ward trend of the city function
As the development of the underground resources, the downward trend of some urban functional facilities is speeding up. For example, urban facilities, means of transportation, disaster prevention work establishment, commercial facilities, culture, physical, medical treatment and scientific research establishment, accommodation unit, wrought establishment, storage establishment, manufacturing facilities.
2. The space prolongation of the city land resources
Underground space exploration and usage is an effective way to materialize effective and intensive and maximum exploitation of the urban land resource. It mainly in three aspects bellow:
   (1) Space recourses incrementation
   (2) Space function multiplicity
   (3) Space exploitation compounding

1.5. Urban underground space and harmonious society

Land is the most valuable resource in constructing economy type tune society and harmonious society. Only by using underground space effectively and comprehensively can we realize the maximum exploitation of city land resources. Many successful experiences from home and abroad have proved that urban underground space exploitation can make contribution to some aspects as bellow:
   (1) soil space resources utilization broadening
   (2) soil energy resources utilization broadening
   (3) soil environment resources utilization broadening
   (4) soil material resources utilization broadening

2. THE INTERNATIONAL TREND OF URBAN UNDERGROUND SPACE UTILIZATION

2.1 Europe

The experiences of the London: Railway
In 1845, the first railway was built in London ,Britain. Form that time, it is a way to solve the traffic problems by building up railway in big cities and huge cities. Right now, there are railways, which have been run, in 44 countries and regions, 99 cities, almost 5900km. Still, there are so many railways been planned, designed, and constructed.

The experiences of the Paris: recycling the abandoned pockets and the three-dimensional city
The early urban underground space development came form recycling the abandoned pockets in Pairs.
It was set sewer, common conduct, aerial defense and disaster defense establishment. In the Pairs Expo, it is successful to setup the Chinese shop and Indian shop in the abandoned cavities in 1980, which received a huge stir.

In the inner city of Pairs, Les Halles, a three-dimensional reconstruction happened. It changed a trade center into a multi-functional public campaign plaza. In fact, it safeguarded the traditional architectures, and formed a pedestrian plaza. At the same time, there are traffic, business, entertainment, physical training under the plaza, coming into a huge underground syntheses.

Another famous case in Pairs is La Defence in the new town. Under ground of La Defence, there are colossal underground roads systems. The traffic arrived at or passed through was accomplished in the underground space. Above the ground, it is just like a garden full of greenbelts and plaza. It is convenient to walk.

2.2 North American

The experiences of the Boston: Underground roads
Boston's middle thoroughfare experienced the underground course from elevated road to underground road. This project was defined as the public work which are maxima construction capacity, the longest construction period and the most funds plunged into and it also demonstrated the underground trend of urban highway and overhead road.

The experiences of Canada: Montréal, an underground city
Because of Montréal’s frigid climate in Canada, it's not so convenient for the inhabitants to go out. In 1972 when the World Expo was successfully held in Montréal, it developed large-scale underground syntheses. Nowadays Montréal have already built up the longest underground walk systems in the world.

2.3 Asia

The experiences of Tokyo in Japan: Common canal
Common pipe, also is known as composite pipe gallery or common canal at the soonest form Paris in France. Later through the development for few decades, it reaches the mature stage in Japan. The length of Tokyo ' common canal ranks head in various big cities all over the world and it has formed a full range of full-scale law, code, provision and measure from above to below and from bottom to top on many aspects such as programming, design, construction, management, operation and so on.

The experiences of Korea: Get history scene breathe
In the 1970s, in order to solve the latitudinal direction transportation problems in main district of the old urban area, Korea Seoul government filled the latitudinal direction watercourse named Qingxi river and converted it into a stilt city express artery by covering plates over the river. Form 2003 to 2005, mayor Mingbo Li did his utmost to restore Qingxi watercourse in order to supply a hydrophilic environment possessing recreation and leisure condition for citizens.

The experiences of the Hong Kong: Comprehensive development along the orbit transportation line
Hang Kong Metro Corporation is one of the few corporations who gain profit instead of relying on government finance subsidy in the world. From the very beginning of metro's programming and construction, Hong Kong government gave metro right-of-way and around land in a certain range all together to metro development company for construction. Also with the metro built up, around land property valued up. They use income of housing to equal the deficit of metro construction and transport operation and to accomplish surplus.

3. THE UTILIZATION SITUATION OF CHINESE CITIES' UNDERGROUND SPACE

Present status and achievement
(1) In China the development of current city's underground space stemed from urban disaster prevention projects and as far as the end of the 20th century disaster prevention work projects still are
the main bodies of the development and utilization of underground space.
(2) The development of disaster prevention technical has accumulated experience, technology and talent for the comprehensive development of urban underground space.
(3) Until the 21 century the development and utilization of urban underground space have phased out a new epoch of metro construction.
(4) The construction of urban transport tunnel and underground car parking achieved great success.
(5) The programming and establishment work of urban underground space procure new headway.
(6) The policy and code of urban underground space are being made up and sounded.

Representative cases
Zhongguan village in Peking, Qianjiang river new town in hangzhou, the composite rebuild of Luo lake in Shenzhen, metro, underground syntheses, composite pipe canal, civil defense and tunnel over river in shanghai and the planning of urban underground space in Peking and shanghai.

Existing problems
(1) The lag of programming
(2) The singleness of facilities' function, the lack of connection, intercommunication and system conformity and the wide gap between our country and abroad in composite benefits.
(3) The construction of managerial system, mechanism and legal system is also out of date.
(4) There is a wide gap between China and overseas in the developmental level of construction mechanics, science and technology.

4. THE POTENTIAL OF URBAN UNDERGROUND SPACE IN CHINA

(1) Idea
Borrowing ideas from abroad countries' successful experience and domestic successful practices, I think the exploitation and utilization of our country's urban underground space should follow such guiding ideology: science and technology leading the way, the precedence of programming, transportation, the synchronisation of disaster prevention, giving prominence to the key points, development in moderation, structural optimization, system conformity, people oriented, innovation for changes, resource economization, environment protection ecology harmonious, co-development.

(2) Guidelines
Our country's development guideline of resource exploitation and utilization of urban underground space is: erecting soundly triune security, resource and environment as development guideline, developing and utilizing underground space resource and superior environmental condition provided by it reasonably, in moderation and orderly, struggling to decrease the negative impact, exerting aggressive and virtual contribution for the development object of our country's urban modernization construction.

(3) Precedence developmental underground installation.
1. The underground of transportation facilities.
2. The large-scale underground syntheses.
3. The facilities for Civil defense and composite disaster prevention.
4. The underground and intensives of municipal pipeline.
5. The underground of basic facilities.
6. The underground of storage facilities.
7. The intensives and compound of both science and technology and talent.
8. System, mechanism and policy, code

(4) The optimized developmental science and technology region
1. The theory, methods and technique standard for the planning and design of urban underground space.
2. The localization of large and deep underground space facilities, new construction technique and serial mechanical equipment.
3. The localization of the vehicle and equipment drawing for transport operation of orbit communicants.
4. The development study of the theory, technique, standard and correlation facility for the building comfort and safety underground space environment.
5. The research and development of ecology and energy conservator new material, new technology and new facilities which are suitable for the development and utilized of underground space.
6. The new technique for the development and utilization of underground space and urban environment protection and calamity prevention and cure.
7. The digitalization, informatization and adaptive technology of underground space resources.
8. The emergency countermeasure and measure research of the out bursting accident in urban underground space.
9. The economy of integration research of the development and utilization of urban underground space.
10. The insurance mechanisms and risk investigation of the development and utilization of urban underground space.