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Utilization of underground space in Japan ☆

Takayuki Kishii *

Nihon University, College of Science and Technology, Department of Civil Engineering, Japan

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ABSTRACT

This paper discusses the utilization of underground space in Japan. Firstly the classification of underground space is indicated and then the utilization of underground space under private lands and public lands is explained separately. Finally the characteristics of Japanese underground shopping malls and the future use of underground space is analyzed. Many people must contribute diverse ideas including measures for planning and using the space under public areas and private properties in an integrated manner, streamlining the relationships between occupying properties and systems for rationally managing above-ground and underground spaces.

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1. Community aspects of underground space

In May 2012, Tokyo Skytree, which has a height of 634 m (certified as the world's highest tower by Guinness World Records in November 17, 2011), opened. While the Skytree is drawing attention with its height above the ground, it is equipped with various facilities underground including heating equipment and water retention facilities for disaster management and their depth is said to be roughly 35 m (equivalent to 10 stories).

As such, the Skytree is an integrated structure that extends a total of 670 m from the base of its underground levels. This form of construction of facilities is possible because, based on Japanese law, land ownership is considered to extend above and under the ground. Regarding height above ground, however, the range of use of space as a building may be limited by the Civil Aeronautics Act and the City Planning Act.

In contrast to the situation aboveground, for the underground, no regulations on the depth of buildings and structures existed for a long time until the Act on Special Measures concerning Public Use of Deep Underground (hereinafter “Deep Underground Act”) came into being in 2000. This Act is adapted to the three metropolitan regions of Tokyo, Osaka, Nagoya and it defines the “deeper underground of either (1) the depth at which basements are generally not constructed (40 m or more underground) or (2) the depth at which building foundations are generally not built

(10 m or more underground from the so-called bearing stratum surface)” as “deep underground,” which has led to permission for public use of this deep underground space without purchase of the surface lot in line with the “Basic Policies on the Use of the Deep Underground” prescribed by the government.

That is, the concept is that the conventional private land ownership does not extend to public use of the deep underground and the Act has greatly changed the perspective of underground utilization (Kishii, 2011b, 2012).

As a result, community aspects of underground space have now come to depend on the ownership of land above the ground and the depth, which can be conceptually classified as shown in Fig. 1.

This article mainly presents the state of utilization of the shallow underground.

2. Utilization of shallow underground space under private land

Concerning “shallow underground space” at a shallow depth under “private land” owned by an individual or corporation, the landowner is free to use his or her own land within the scope of laws and ordinances and such space is often used as the basement floors of a building or for housing related facilities (such as substation facilities, machinery and equipment relating to supply and disposal services, distribution facilities and car/bicycle parking lot). In particular, in city centers with high land prices, areas of land available are limited, which is one reason why basement floors are often built under buildings.

For basement floors of these buildings, conventions relating to their construction have been put in place based on the Building Standards Act, Fire Service Act, etc.

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* Address: 5-15-1, Snimomeguro, Meguro-ku, Tokyo, Japan

E-mail address: kishii@civil.cst.nihon-u.ac.jp

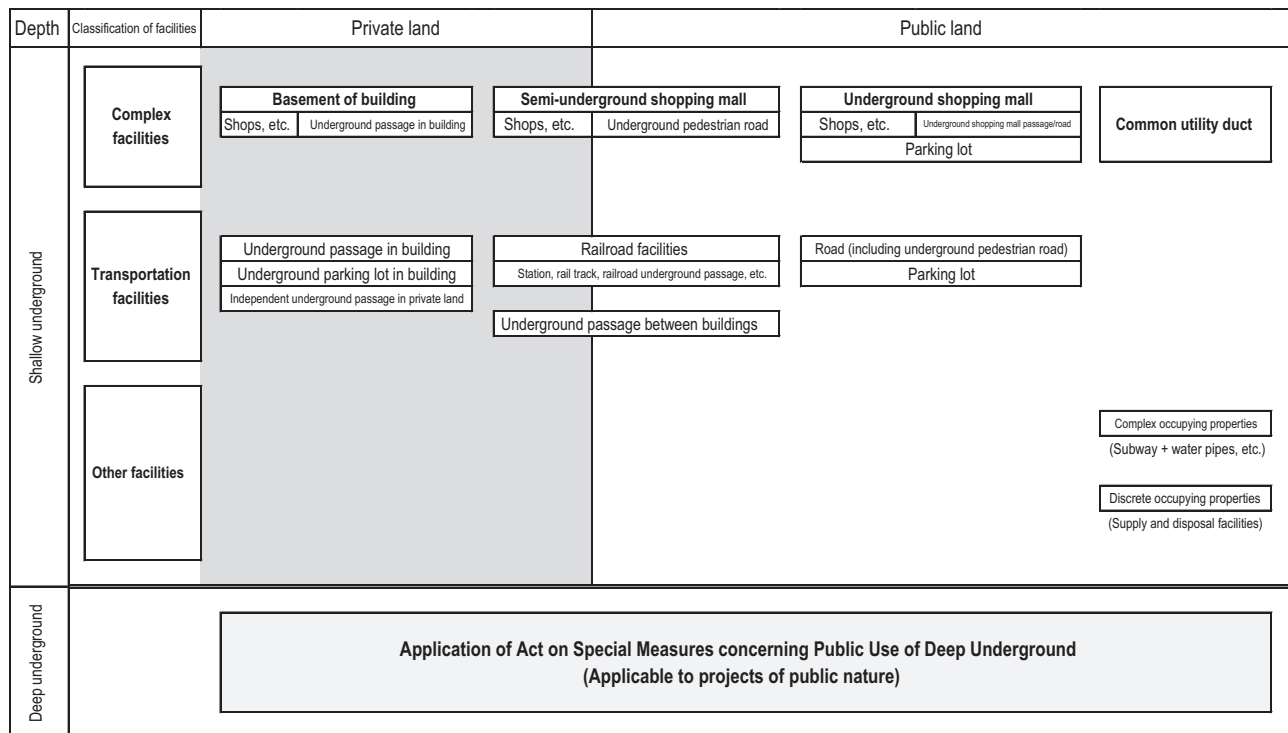


Fig. 1. Classification by community aspects and usage of underground space.

It is widely known that, in Japan in the Edo period (1603–1868), many *anagura* (cellars) were built underground for protecting valuable assets from fires.

Underground space is advantageous in terms of seismic resistance, thermal insulation and constant humidity and allows easy control of various elements of the indoor environment. Accordingly, there is a recent example of an entire plant for manufacturing precision machines buried underground (Yamazaki Mazak Optonics Minokamo Factory, <https://english.mazak.jp/our-factory/optonics/>).

In fact, however, underground utilization of private land like this in practice has been limited to a certain depth.

Data studied for establishing the Deep Underground Act shows that, in Tokyo, more than 99.9% of the existing buildings have their basement within a the equivalent of four stories. This reality of the status of underground utilization has led to the concept of “deep underground” described earlier.

3. Utilization of underground space under public lands

In present-day cities, there are lands under the management of the government including public land other than private land, roads, parks, rivers and station squares, or so-called public spaces. Above all, roads are the biggest unbroken public spaces and often account for 15–25% of the district in terms of area. With such land, it may be more reasonable to build public facilities themselves as an underground structure depending on the topographical conditions of the area surrounding the facilities. However, generally costs are higher than construction on the land surface and, in reality, use of the underground is seldom chosen unless there is a factor such as environmental issues affecting the surrounding area. Still, underground space is used when vertical use is unavoidable due to congestion, use of the land surface for other purposes is desired or the environment on the land surface should be preserved (Nishi et al., 2000; Takasaki et al., 2000; Nakada et al., 1996; Endo, 1993; Kashima et al., 1993; Igarashi and Okumura, 1993; Matsusita et al., 1993).

One example is the Shinjuku Line (Yamate Tunnel) of the Central Circular Route of the Shuto Expressway (<http://www.shuto-ko.jp/ss/tokyo-smooth/shinagawa/en/>) that opened in 2010, which was built as a huge tunnel structure that extends approximately 11 km under the Yamate Road. In addition, river water retention and discharge facilities are also built under the road. For example, large underground river facilities, retention facilities and discharge channels (Fig. 2) are buried under Tokyo's Loop Road 7 and National Route 16. Recently, there has been an increase in station square mechanical bicycle parking lots (Fig. 3) that utilize underground space.

Use for other than the relevant public facilities falls under the concept of “occupancy” of public space and the administrators of the respective facilities permit such use within a scope that does not hamper the original functions. Specifically, typical examples are subway lines and ducts of various supply and disposal facilities buried in space under roads. The total length of such ducts is said to be approximately 1.6 million km (40 times around the earth)



Fig. 2. Metropolitan area outer underground discharge channel. (<http://www.ktr.mlit.go.jp/edogawa/gaikaku/english/index.html>).

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