# Comparative study of domestic and international mandatory policies on three-dimensional greening - Shenzhen as an example

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**Abstract.** With the accelerated urbanization in China, the phenomenon of insufficient green space in urban built-up areas is becoming increasingly prominent, and the construction of rooftop gardens to increase the green coverage of cities and improve the urban ecological environment has become an important element of urban construction. Taking Shenzhen as an example, this paper studies the current three-dimensional greening policies and regulations of the Shenzhen government, the three-dimensional greening policies and regulations of advanced foreign cities and analyses the problems that exist at the level of urban green space planning and policies and regulations in Shenzhen. In the course of the study, it is found that there are three problems in its, Shenzhen's three-dimensional greening policy planning: small scope of application, lack of planning elements, and low degree of compulsion, By combining the governance experiences of other cities, this paper will propose corresponding improvement solutions and optimization suggestions to address the shortcomings of urban three-dimensional greening policies from the policy level and offer suggestions for the cause of three-dimensional greening in Shenzhen.

**Keywords:** Three-Dimensional Greening; Mandatory Policy; Policy Comparative Analysis.

## 1. Introduction

With the development of urbanization, various environmental problems have become increasingly prominent, and the contradiction between man and nature is becoming increasingly acute. The rising heat island index and the rising global temperature all affect the future of human beings. Three-dimensional greening can improve the greening area and improve the urban environment without occupying more land resources, which has almost become a necessary topic in urban planning, and various policy discussions around three-dimensional greening are also ongoing.

According to the data released by the National Bureau of Statistics, by 2020, China's green space coverage rate in built-up areas has reached 42.1%, an increase of 1.4% from the previous year, indicating that China has been effective in urban greening policies and implementation. Among them, Shenzhen, as a first-tier city, ranked first in the "2018 China City Construction Comprehensive Level Assessment", and its outstanding urban green space coverage rate also reached 45.08%, ranking first. According to statistics, the roof area of Shenzhen is about 210.54 million square meters, with only 19% of green overpasses and 110; 403 pedestrian bridges and 280. It can be seen that Shenzhen three-dimensional greening space and potential are great, but due to the difficulty of property ownership, safety and other factors, the greening improvement work needs to be gradually promoted gradually.

At present, the Chinses research on three-dimensional greening started late, and there is a certain gap with foreign countries. Chinese three-dimensional afforestation is slightly different from other countries in concept where three-dimensional afforestation is divided into vertical greening and roof greening. In addition to the above two kinds, overhead layer, bridge body, window balcony has been summarized into the three-dimensional afforestation in China. On the whole, domestic three-dimensional greening can be interpreted as all forms of greening except plane greening.

There are few studies in China that take a mandatory three-dimensional greening policy as a perspective, and there are large gaps. The attitude of the Research center of the Ministry of Forestry towards the sustainable forestry is: the national decision-making control and administrative intervention [1]. Shenzhen is currently in the forefront of the national three-dimensional greening, as a socialist pilot demonstration area, has a strong role of "experimental field". Therefore, this paper takes Shenzhen city as an example, compares the mandatory policies of foreign three-dimensional greening, to provide practical support for promoting Shenzhen three-dimensional greening, and makes suggestions.

## 2. Literature review

As far as three-dimensional greening is concerned, the policy guidance is very critical, and it is very necessary to discuss the policy. In the study of policy tools, the three-dimensional greening policy is mainly divided into incentive and mandatory, but the two are essentially divided by the degree of coercion, so there is a strong causal relationship in the final policy.

Incentive policy is a policy carried out in the form of financial subsidies and green space area conversion in the three-dimensional greening policy. The research of scholars and experts from all over the world in the three-dimensional greening policy mainly focuses on the incentive policy. In their research on foreign three-dimensional greening policies, Jiarui Li and Li, Yan Sun and Ying Zhang suggested that the Chinese government strengthen the publicity of roof greening and pay attention to the role of NGOs [2]. In 2017, the first organization engaged in the three-dimensional greening industry in China, Shenzhen three-dimensional greening Industry Association was established. A study by the School of Architecture and Urban Planning of Shenzhen University detailed the contents and characteristics of foreign incentive policies, and pointed out the problems of single incentive policy form and weak policy pertinence in China [3]. In 2019, the government issued the Implementation Measures of Three-dimensional Greening of Shenzhen City, which for the first time promulgated three-dimensional greening as a separate policy and regulation, and proposed two incentive methods: greening conversion and funding reward [4]. These achievements and experiences have promoted the development of the three-dimensional greening industry in Shenzhen, draw on the suggestions of previous studies, and enrich the three-dimensional greening policy in Shenzhen. But there is still a big gap compared with foreign policies.

Mandatory policy is a tool to guide or control the action of the target groups with the ruling authority [5]. Yibo Xu and Stanfano Boerry fully demonstrated the green values represented by the non-anthropocentric ethics. Under this value, the implementation of greening can sacrifice the living space of human beings to achieve the due degree of greening, which is a representative concept of foreign mandatory policy [6]. In the German city of Stuttgart, the US city of Pol Pot and the Singapore metropolitan area, the government has a tough ecological compensation policy and accompanying penalties. According to horsepower and Zhibo Li, China's three-dimensional greening can be summarized as not mandatory and powerful [7]. In addition to Shuliang Lin put forward innovation suggestions in greening technology in his research, Shuliang Lin also believed that the Shenzhen municipal government can take hard measures to coordinate the three-dimensional greening and plan the three-dimensional greening area [8].

In terms of these two types of policies, although incentive policies are the best item in the theories related to public policy, China is currently in the primary development stage of three-dimensional greening. If there are no relevant compulsory measures to guarantee them, it takes a long time of public participation and concept publicity to achieve the ideal effect. Especially in the current shortage of land resources in Shenzhen environment, the implementation of three-dimensional greening is urgent. With the severe global environmental problems, China, as a responsible and responsible major country, needs to actively explore three-dimensional greening policies and continue to provide experience for the United Nations Conference on Sustainable Development.

# 3. Compulsory policies for three-dimensional greening at home and abroad

## 3.1 Compulsory policies and characteristics of foreign three-dimensional greening

Some foreign countries such as Germany, Japan, Singapore have been well implemented three-dimensional greening, and the implementation time is relatively early. In the practice of European and American countries, we can see: first, people's concept of environmental protection is generally improved; second, with a strong legal system and public policy; third, there is a perfect three-dimensional decoration technology system [9].

Relevant research results at home and abroad show that all the policies with good implementation results will greatly promote the rational development of cities, and in turn, they will have the opposite effect [10]. Therefore, in order to realize the comprehensive and rapid development of three-dimensional greening, the key is to rely on the relevant laws and regulations and mandatory policies to regulate and guide.

The foreign three-dimensional greening system is dominated by the city, and each city has formulated its own laws, but its commonness can be summarized as: the integrity and compulsion of laws and regulations.

In Europe, Germany was the first to develop three-dimensional greening. In Berlin, Germany, for the development of the city, the corresponding regulations on three-dimensional greening, and the local environmental protection law has also become a strong support of this regulation. According to the German draft Building Plan and the Environmental Impact Report, owners of new homes return the occupied land [11]. When applying for a construction project, you should build the roof for greening, otherwise the application will not be accepted. From 1991 to 1997, in order to ensure the correct implementation of three-dimensional afforestation, relevant laws and regulations were issued from the whole country to various regions. In The city of Stuttgart, Germany, all roofs with 8-12 degrees of slope in industrial plants require large-scale green renovation [9]. In the Federal Construction Act of 1998, it was clearly stipulated that the use of three-dimensional greening for ecological restoration, and in the urban development plan, three-dimensional greening must be taken as the primary condition for land use. Today, Germany achieves nearly 80 percent of the national roof greening rate. Driven by the government, the German roof greening market is growing up [12].

Compared with Germany, although the three-dimensional greening construction in Japan started relatively late, it is due to the limited land resources and the relatively high level of attention to it, and has been among the international advanced level. Since the 1970s, Japan has introduced various laws and regulations to ensure the implementation of three-dimensional greening. The Tokyo Metropolitan Nature Conservation Regulations are based on floor area and land area, and the new construction and renovation projects must be green on one-fifth of the floor area, or they will be fined [13]. In 1991, the Japanese government passed the Urban Green Act, which required proper green planning for the roof of the building before construction, or the project would be rejected. In December 2004, Japan adopted a complete set of policies and regulations and greening rate calculation methods, which continued to emphasize the importance of three-dimensional greening, and regulated it through strict penalties and financial subsidies [14]. Due to the strict reward and punishment system, the three-dimensional greening in the major Japanese cities is developing rapidly.

Singapore also has limited land resources, so it attaches great importance to three-dimensional greening. Its first environmental development plan, introduced in 1992, was designed to help build development models for environmental protection. The 2009 Blueprint for Sustainable Development 2009 proposes a sustainable development strategy focusing on stereoscopic greening, and aims to reach 50 hectares by 2030.In the Singapore Blueprint for Sustainable Development 2015, its target was increased to 200 hectares. In 2018, Singapore's stereoscopic greening area has reached 100 hectares [15].

The most important policy of Singapore's stereoscopic greening is the landscape replacement area strategy proposed in the Urban Space and High-rise Building Landscape Plan in 2009.In addition to the mandatory indicators, developers must conduct green space replacement to make up for the loss

of green space caused by development. The minimum greening standard is set according to the different development intensity, and the construction requirements and the proportion upper limit of the three-dimensional greening included in the overall landscape replacement greening area are clarified [16, 17]. The goal is to introduce more green space for the city through private and public development projects. In 2009, the Urban Space and High-rise Building Garden Planning (LUSH 1.0) was launched, and the subsequent updated LUSH 2.0 and LUSH 3.0 were further required and optimized for the renovation target, greening type, rigid requirements and reward standards, respectively [18].

The legislation and management system of three-dimensional greening in foreign cities have two characteristics:

A sound legal guarantee system. Their variety include both strict building, environmental laws and federal building regulations and less stringent codes and guidelines.

In the three-dimensional greening policy can be enforced from top to bottom, always throughout the whole process of the project. This allows policies to be well implemented to deliver the desired results.

On the whole, foreign three-dimensional greening policies have a long history of development, a wide coverage, clear goals, and a large overall strength.

### 3.2 Three-dimensional greening policy of Shenzhen city

With land resources becoming increasingly scarce in Shenzhen, three-dimensional greening is an important way to broaden the city's green space. After years of research and accumulation, Shenzhen has seen a number of three-dimensional greening projects, such as the tallest green wall in China and the most beautiful three-dimensional greening landscape slope, including the greening of the roof of the Shenzhen Stock Exchange and the greening of the upper cover of the Xinghe Dandi Tunnel. The municipal government of Shenzhen attaches great importance to greening, and is committed to achieving the first-class greening in Shenzhen in China, as well as reaching certain international standards.

**Table 1.** Summary of three-dimensional greening policies and regulations of Shenzhen City

| Policies and regulations | Release time | Significance |
|---|---|---|
| Implementation Measures of Shenzhen Roofing Greening | In 1999, | The City's roof greening guiding documents |
| "Ten Measures for Shenzhen City to Implement a New Round of Greening Guangdong Great Action | In 2013, | It is made clear that the stage needs to achieve the greening index |
| Greening Regulations of Shenzhen Special Economic Zone | In 2016, | Made clear the explanation of three-dimensional greening, and introduced the corresponding incentive policies |
| Shenzhen Municipal Implementation Rules for the Green Design Code of Civil Buildings | In 2017, | The specific requirements of the three-dimensional greening index are put forward |
| The Implementation Measures of Shenzhen Municipality for Three-dimensional Greening | In 2019, | The city's first independent three-dimensional greening regulations |

In 2016, Shenzhen city implemented the Greening Regulations of Shenzhen Special Economic Zone, which was the first time that the Shenzhen government had established a policy on implementing three-dimensional greening. Shenzhen plans to exceed the 460,000 square meters of three-dimensional greening. The solid greening scope, from the initial overpass solid greening, has increasingly entered the public institutions to enforce the solid greening of various new public buildings, requiring monetary subsidies and the responsibilities of solid greening, such as the special

solid greening plan, and the urban people's government. It will be constructed, supervised and protected in accordance with the law to guarantee the sustainable development of three-dimensional greening. In 2017, Shenzhen Implementation Rules proposed three-dimensional greening indexes, site planning and outdoor environment selection, and the three-dimensional greening is mainly based on planning suggestions. In 2021, Shenzhen Municipal Government further revised Shenzhen Three-dimensional Greening Implementation Measures: the indexes of new public buildings for roof greening or overhead greening should not be less than 60% of the roof or overhead greening area. For new public buildings and municipal facilities to implement wall greening, bridge greening, scaffolding greening, window and balcony greening, hard slope greening indicators, the actual greening area should not be less than 20% of the greening area of the carrier facade. Table 1 provides a summary of Shenzhen's three-dimensional greening regulations.

## 4. Differences and problem analysis of three-dimensional greening policies between Shenzhen and foreign countries

### 4.1 The small scope of application

Table 2 compares the mandatory policies of Shenzhen, Stuttgart and Tokyo.

**Table 2.** Comparison of the mandatory policies of three-dimensional greening in Shenzhen and foreign cities [4,19,20]

| City | Shenzhen | City of Stuttgart | Tokyo |
|---|---|---|---|
| Relevant policy | New public buildings, new viaducts, pedestrian overpasses and large municipal public sanitation facilities shall be subject to three-dimensional greening in accordance with relevant standards and technical specifications. | The application for the design of new built or rebuilt projects must be submitted to the roof greening design at the same time, otherwise it will not be accepted. The industrial area has all flat roofs and a slope of at 8°-12°. The slope roof must be a large area of green, the substrate depth shall not be less than 12cm. | The floor area is more than 1,000 m2Civil facilities and 250m of2The above public buildings must be greening when built, rebuilt and expanded, and the greening area shall not be less than 20%. |
| Scope of application | New public buildings | New (reform) construction, industrial zone | New (expanded) construction |
| Restrictive condition | indeterminacy | not have | area |
| Mandatory degree | weak | stubborn | stubborn |

Compared with foreign three-dimensional greening policies, the current mandatory policies in Shenzhen are too narrow in the nature of buildings, which will lead to too low public participation. There are only one provisions in the Implementation Measures of Three-dimensional Greening in Shenzhen City, and they only aim at public facilities. For other non-public buildings (structures), they are promoted in an encouraging and voluntary way.

The greening work of public buildings will be easier than other buildings, because of their clear property rights, wider users, and clear responsibilities of all the parties concerned, but this does not mean that other buildings only need to implement the greening work by encouraging and advocating ways. The application scope of foreign three-dimensional greening policy is very wide, and civil buildings and industrial buildings are included in the scope of implementation, so the implementation effect of its three-dimensional greening is also better.

### 4.2 Lack of planning elements

Planning and control are not only the development blueprint of three-dimensional greening, but also an important means to ensure the enforcement of the greening work, and there is a certain gap in the three-dimensional greening planning and control at home and abroad.

Although Singapore's territory is small, but the urban green coverage rate is more than 70 percent [21]. Its greening achievements are largely due to the planning guidance issued by the Singapore Urban Reconstruction Authority: LUSH. LUSH has very clear provision design and requirements in spatial development timing, hierarchical planning and control, and development objectives and indicators, and the indicators also have special statistical methods and calculation methods as shown in Table 3.

**Table 3.** LUSH Developments [22, 23]

| Plan version | LUSH 2.0 | LUSH 3.0 |
|---|---|---|
| Promulgated time | In 2014, | In 2017, |
| Partial content | 1. The landscape replacement area*Expand to other areas;<br>2. Divide the intensity according to the total floor area ratio, and make the stepped greening area requirements of the building. | 1. Include the vertical greening and green roof in the landscape replacement area;<br>2. Support green roof agriculture through landscape replacement areas, and clarify the proportion of replacement area;<br>3. Formulate greening proportion standards for private development projects to ensure greening density. |
| Joint entry into force | | |

Note: *Landscape Replacement Area: an area where developers must replace green space to compensate for the loss of green space due to development based on the intensity of the development, which is ground and building high rise.

Table 4 shows the landscape replacement and green plot ratio in Singapore.

**Table 4.** Index provisions of landscape replacement (soft landscape) and green plot ratio in Singapore [23]

| Development situation | Minimum soft landscape requirements (Percentage of the base area) | Minimum G n PR under LUSH 3.0**ask |
|---|---|---|
| Development in the strategic field | 40% | 4.0 |
| Defined developments outside of the strategic field (GPR*≧2.8） | 40% | 4.0 |
| Development identified outside of strategic areas (1.4 <GPR <2.8) | 35% | 3.5 |
| Development identified beyond the strategic area (GPR 1.4) | 30% | 3.0 |

Note: *GPR (total plot ratio) = total floor area/total site area; **GnPR (green plot ratio) = total green leaf area in soft landscape replacement area/total area of development area total leaf area = leaf area index (LAI) (corresponding to specific plant species) x canopy cover (trees/palms) x planting volume (number/area), type to which specific plant species belong and leaf area index (LAI) [24]

In the "Shenzhen Green Space System Planning (2014-2030)", the three-dimensional greening is shown as the greening guidance of other Spaces, and there is no relevant design for the specific effect of the implementation and the greening indicators. For example, in the planning of the overpass greening, only "strengthen the overpass greening, make full use of the overpass and the surrounding space for three-dimensional greening" two [25]. In addition, there are no other supplementary provisions, which will blur the policy basis for the specific evaluation and implementation of the

three-dimensional greening work. The evaluation party and the construction party can each have their own explanations, which is prone to low efficiency of the greening work and poor implementation effect.

### 4.3 Low degree of coercion, do not have the penetration

The distinctive characteristic of foreign three-dimensional greening policy is the high degree of mandatory, and the mandatory measures can run through the whole project process, which can run through from the application and approval stage to the implementation management stage and even the daily maintenance stage, and with strict punishment measures. In the current three-dimensional greening policy in Shenzhen, except for the provisions listed in Table 3, all the other provisions are expressed by the words "advocacy" and "encouragement" for the implementation of three-dimensional greening. At the same time, there is no penetration and punishment measures, which may not be able to ensure the start and continuous promotion of the greening work.

## 5. Optimization direction of Shenzhen three-dimensional greening policy

### 5.1 Comprehensive consideration of the nature of the building, the implementation of hierarchical classification of management

In view of the problem that the scope of policy application is too narrow, we can study the nature of other buildings to be specifically classified, so as to expand the scope of application of the three-dimensional greening policy. From Table 2, we can find that foreign three-dimensional greening is widely applicable in different building properties. These policies cover a wide range of areas and are highly mandatory. Therefore, Shenzhen can appropriately expand the scope of application of buildings, and it can also learn from the differentiated requirements of Stuttgart city for different properties of buildings in the implementation of greening.

Table 5 is a classification management table designed according to the nature of buildings. This table can continue to be refined and increase the classification dimension along with the continuous increase of the included elements of the classification management, and can also be flexibly adjusted according to the actual situation.

After the implementation of hierarchical classification management, the corresponding three-dimensional greening implementation standards should be issued according to different building types.

**Table 5.** Management table for implementing three-dimensional greening according to the building nature classification

| Architectural nature | Architectural classification | The implementation of grading |
|---|---|---|
| Industrial architecture | Chemical plant | (1) |
| | Pharmaceutical plant | (1) |
| | gas station | (3) |
| Civil architecture | Cultural and sports center | (2) |
| | house | (1) |

Note: (1) means that three-dimensional greening should be implemented, (2) means that whether three-dimensional greening can be judged according to the specific situation, and (3) means that three-dimensional greening cannot be implemented.

### 5.2 Scientific evaluation and clear indicators

Scientific and sustainable planning and design is the basis of achieving the three-dimensional greening goal, and also the blueprint of guiding the direction. The spatial timing and specific implementation indicators shown in Tables 3 and Table 4 reflect the importance that the planning

attaches to three-dimensional greening. In terms of the system, its content is complete and well-organized. There is specific regulation in both macro and micro aspects; including both coercion and guidance. Operation system, multi-department cooperation, management is orderly. Multiple departments and enterprises to participate in the division of responsibilities, clear construction management procedures, supervision is extensive and effective. Therefore, Shenzhen in the green space planning or environmental planning, should improve the attention of three-dimensional greening in the planning, rather than simply included in other project provisions.

Clear the corresponding indicators of the planning target, such as the implementation of three-dimensional greening of the overpass, can introduce specific area provisions, as well as the implementation of the guardrail, column and other specific parts of the requirements. We can also learn from foreign advanced index calculation methods and introduce them into China. In the overall planning, the corresponding investigation should be carried out to establish a three-dimensional greening database, so as to better evaluate the implementation status of three-dimensional greening and plan the future spatial layout.

### 5.3 Improve the degree of coercion and pay attention to process control

At present, the three-dimensional greening needs more strong measures to ensure, increase the mandatory degree of the three-dimensional greening policy, and introduce more mandatory policies. Can take area, building height, building nature as restrictive conditions, when meet certain standards, must implement three-dimensional greening. This mode of operation is simple to implement, easy to conduct classification and management, and there are relevant implementation standards. The ecological compensation mechanism of Germany and Singapore is undoubtedly the best choice of mandatory means, which is not only the implementation of the sustainable development strategy of "prefer clear waters and green mountains rather than gold and silver mountains", but also ensures the necessary economic development.

Process control requires that a regular inspection and supervision mechanism should be established for specific projects to ensure strict supervision and approval in the whole process of the project, which can not only lay a foundation for the subsequent establishment of the comprehensive quality management of three-dimensional greening, but also ensure the efficiency of the implementation of three-dimensional greening at the present stage.

## 6. Conclusions

At present, China's three-dimensional garden is in a period of rapid development, the main factor that restricts its development is policy. The overall degree of development of three-dimensional green space in China is relatively backward compared to the developed countries in the world, and the unbalanced regional development makes it difficult to guarantee the long-term effect of the policy. The research aim of this paper is drawing on the existing mandatory system of urban three-dimensional greening in other countries, based on their own development, to develop a three-dimensional greening policy to suit the actual situation in China. The problems in Shenzhen are small scope of application, missing planning elements and low degree of compulsion and non-penetration. The direction of optimization of Shenzhen's three-dimensional greening policies includes comprehensive consideration of building nature and implementation of graded and classified management, scientific assessment and clear indicators, and increase of the degree of compulsion and focusing on process control. From the development history of three-dimensional greening in relatively successful other cities, the implementation of three-dimensional green space requires a systematic policy and means.

## References

[1] Guan Jingfen. Research on the Sustainable Development of Urban Forestry in China [J]. Forestry economy, 1995 (02): 26-33.

[2] Li Jiarui, Sun Yan, Zhang Ying. Implications of Foreign roof greening Policy on the Green Development of Chinese Cities [J]. Environmental Protection and Circular Economy, 2016,36 (06): 61-66.

[3] Yun Li, Yali Hu, Jinghua Zhong. Analysis on the Incentive Policy of Vertical Greening in China: a Case Study of Shenzhen City[J]. IOP Conference Series: Earth and Environmental Science,2019,283(1).

[4] Notice of Shenzhen Municipal Administration Bureau on Printing and Issuing the Implementation Measures of Shenzhen Municipal Three-dimensional Greening [J]. Shenzhen Municipal People's Government Bulletin, 2019 (04): 40-44.

[5] Li Lingling on policy tools and public administration [J]. Theoretical discussion, 2008 (01): 133-137.

[6] Xu Yibo, Stanfano Boerry from "vertical forest" to "City of forest" a nonanthropocentric urban phenomenon [J]. Times Architecture, 2016 (06): 66-71.

[7] Ma Li, Li Zhibo,a comparative study of the public policies of three-dimensional greening at home and abroad [J]. Land and Natural Resources Research, 2018 (02): 65-67.

[8] Lin Shuliang. Status quo and existing problems of three-dimensional greening in Shenzhen area [J]. Chinese Horticultural Digest, 2017,33 (12): 74-77.

[9] Tan Yifan. Public Policy at home and abroad [J]. Chinese Garden, 2015 (11).

[10] Gao Minghong,Public Policy Research [D]. Xi'an Jiaotong University, 2009 (12): 46-47.

[11] Feng Yan. Research on legal issues related to roof greening in China [D]. Southwest University of Political Science and Law, 2012:11-12.

[12] Xiao Han,Mode of urban space and future development [D]. Beijing Forestry University, 2012.

[13] Xu Lu, Chen Zongmei Japan encourages roof greening related policy [J]. Residential Industries, 2005 (10).

[14] Sun Jian, Li Yaqi, Hu Chun, etc. Enlightenment of Japanese roof greening construction to China [J]. Guangdong Agricultural Science.2012(11) .

[15] Gardens in The Sky [EB/OL]. (2018-08-13) [2022-08-01]. https://www.nparks.gov.sg/ skyrise greenery.

[16] Development Control Parameters for Residential Development [EB/OL]. (2018-03) [2022-08-01]. https://www.ura.gov.sg/Corporate/Guidelines/ Development-Control/Residential.

[17] Development Control Parameters for Non-Residential Development [EB/OL]. (2018-02) [2022-08-01]. https://www.ura.gov.sg/Corporate/ Guidelines/Development-Control/Non -Residential.

[18] Xiao Lei, and Ji Tong."Singapore three-dimensional greening control mode and inspiration. "Chinese Garden 36.05 (2020): 110-115. doi: 10.19775/j.cla.2020.05.0110.

[19] Lawlor G, Currie B A, Doshi H, et al. Green roofs: a resource manual for municipal policy makers[J].2006.

[20] Kenichiro Fujisaki, Shiro Ogimizu, and Mengran Gan. Green roofs in Japan[J]. China Building Waterproofing,2010(23):52-53.

[21] Feng Xiliang. Case analysis of stereoscopic greening in Guangzhou, Hong Kong and Singapore [J]. Guangdong Garden, 2015,37 (05): 41-45.

[22] Urban Redevelopment Authority. Circular Package: Landscaping for Urban Spaces and High Rises (LUSH) 2.0 Programme [EB/OL]. (2014-01-12) [2022-08-01]. https://www.ura.gov.sg/Corporate/Guidelines/Circulars/dc14-lush20.

[23] Urban Redevelopment Authority. Updates to The Landscaping for Urban Spaces and High-Rises (LUSH) Programme: LUSH 3.0[EB/OL]. (2017-11-09) [2022-08-01]. https://www.ura.gov.sg/Corporate/Guidelines/Circulars/dc17-06.

[24] Xiao Lei, Ji Tong. Singapore three-dimensional greening control mode and enlightenment [J]. Chinese Garden, 2020,36 (05): 110-115.

[25] Shenzhen City Planning and Land Development Research Center. Shenzhen Green Space System Planning (2014-2030) [EB / OL]. (2020-10-26) [2022-08-01]. http://www.upssz.net.cn/newsinfo_803_4619.html.