



华南理工大学
South China University of Technology

专业学位硕士学位论文

公共空间视角下的城市高架桥下空间更新
设计研究——以广州环城高速沥滘段为例

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论文提交日期 2025年10月

**Research on the Design of Space Renewal under the Urban
Viaduct from the Perspective of Public Space
----Taking the Lijiao Section of Guangzhou Ring
Expressway as an Example**

A Dissertation Submitted for the Degree of Master

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分类号：TU98

学校代号：10561

学 号：202221006351

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申请学位级别：建筑学硕士

学科专业名称：建筑学

研究方向：城市设计

论文提交日期：2025年10月17日 论文答辩日期：2025年11月26日

学位授予单位：华南理工大学 学位授予日期： 年 月 日

答辩委员会成员：

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摘要

在增量规划时代，随着城市规模的不断扩张，城市道路和轨道交通线路里程也在急速增长。其中各类快速交通设施的建设往往采用高架形式。其建立初衷是解决城市交通拥堵问题，其带来通行便利的同时也带来诸多方面的问题，如改变城市原有风貌、形成城市消极灰空间，割裂城市空间与文脉、滋生新的社会问题等。合理、高效地利用城市高架桥下空间一定程度上能够有效满足市民对于公共空间日益增长的需求，挖掘城市空间潜力。目前，北京、广州、重庆，上海，深圳等城市不但出台了一系列政策，也有了很多桥下改造利用的成功案例，但国内对于桥下改造利用的理论研究尚处于探索与完善阶段。

本文首先确定了城市高架桥下空间为研究对象。并对相关概念以及国内外关于高架桥下的相关理论研究进行梳理，然后通过对我国城市高架桥及桥下空间特征等的基础研究、对广州城市高架桥下空间更新现状进行系统调研以及对各地特别是广州和北京关于桥下改造利用相关政策及设计导则包括《北京市桥下空间利用设计导则》的解读，并总结现存问题，吸取相关经验；以国内外桥下项目实践为研究案例，提出了具有普适性的城市高架桥下空间的设计策略，包括六大方面：空间的功能重组与复合利用策略，空间重塑与序列体验策略，交通缝合与流线组织策略，空间叙事构建与文化植入策略，生态技术与可持续策略，共享共建与有序管理策略。

最后进行应用实践。本研究选取广州市环城高速沥滘段桥下空间为设计实践对象，在本场地所在的海珠创新湾(沥滘片区)上位规划背景下，通过对桥下及周边区域现状及人群的调研分析及问题的总结，将研究部分提出的设计策略进行运用。结合广州政策上关于环城高速下建设“环城公园”的倡导、考虑周边人群需求及周边环境，以提升桥下品质和功能、缝合城市、保留原场地桥下市场记忆、有机延续沥滘地方文脉，为人民群众打造有实效的高品质公共空间为目标，提出“一轴六区”的设计方案：以环城高速高架桥为轴线，打造桥下线性序列空间并串联沿线城市区域，形成儿童娱乐、市民休闲、商业市集、文化展示、体育运动、生态自然等六大区域，促进高架南北两侧区域之间的社会交往，缝合周边城市功能与空间结构，在共建共享的基础上将桥下空间打造为功能复合多样、空间形态多样、可达性良好、融合生态理念和在地文脉的高品质公共空间。

本文旨在为我国城市高架桥下空间，乃至城市空间优化提供有益的理论和实践参考。

关键词：城市高架桥，桥下空间，高品质公共空间，沥滘

Abstract

In the era of incremental planning, with the continuous expansion of urban scale, the mileage of urban roads and rail transit lines is also increasing rapidly. The construction of all kinds of rapid transit facilities often adopts the elevated form. The original purpose of their establishment is to solve the problem of urban traffic congestion, but they bring convenience and at the same time bring a lot of problems, such as changing the original appearance of the city, forming a negative gray space in the city, splitting the urban space and cultural lineage, and breeding new social problems. Reasonable and efficient utilization of space under urban viaducts can, to a certain extent, effectively satisfy the growing demand of citizens for public space and explore the potential of urban space. At present, Beijing, Guangzhou, Chongqing, Shanghai, Shenzhen and other cities have not only introduced a series of policies, but also have many successful cases of under-bridge renovation and utilization, but the theoretical research on under-bridge renovation and utilization is still in the stage of exploration and improvement in China.

This paper firstly identifies the space under the urban viaduct as the research object. Then, through the basic research on the characteristics of China's urban viaducts and under-bridge space, the systematic research on the status quo of Guangzhou's urban under-bridge space renewal, and the interpretation of the relevant policies and design guidelines on the utilization of under-bridge renovation in various places, especially in Guangzhou and Beijing, including the "Beijing Municipal Under-bridge Space Utilization Design Guidelines", the existing problems and relevant experiences are summarized, and the practice of under-bridge projects at home and abroad are taken as the research cases, so as to put forward the universal application of under-bridge space. It also summarizes the existing problems and learns relevant experiences; takes the practice of under-bridge projects at home and abroad as research cases, and puts forward universal design strategies for urban under-bridge spaces, including six aspects: functional reorganization and reuse strategies, spatial remodeling and sequential experience strategies, traffic sewing and flow organization strategies, spatial narrative construction and cultural implantation strategies, ecological technology and sustainable strategies, and sharing and building and orderly management strategies. management strategies, ecological technology and sustainability strategies, sharing and co-construction and orderly management strategies.

Finally, the application practice is carried out. This study selects the space under the bridge of Lijiao section of Guangzhou Ring Road as the object of design practice, and applies the design strategies proposed in the research part through the research

and analysis of the current situation of the bridge and the surrounding area and the summary of the problems in the context of the upward planning of the Haizhu Innovation Bay (Lijiao Area), where this site is located. Combined with Guangzhou's policy of building a "ring park" under the ring highway, considering the needs of the surrounding people and the surrounding environment, and with the goal of improving the quality and function of the bridge, sewing up the city, preserving the memory of the original market under the bridge, and organically continuing the local cultural lineage of Lijiao, and creating an effective high-quality public space for the people, we propose a "one axis and six zones". The design scheme of "one axis and six districts": taking the Ring Road Viaduct as the axis, creating a linear sequence of space under the bridge and linking up the urban areas along the route, forming six areas for children's recreation, citizens' recreation, commercial bazaar, cultural exhibition, sports, ecological nature, etc., to promote social communication between the north and south sides of the viaduct and sewing up the surrounding urban functions and spatial structure, in order to promote social communication between the north and south sides of the viaduct and sewing up the surrounding urban areas. Functional and spatial structure of the neighboring cities, on the basis of common construction and sharing, the space under the bridge will be built into a high-quality public space with diversified functions, spatial forms, good accessibility, and integration of ecological concepts and local culture and veins.

This paper aims to provide valuable theoretical and practical references for optimizing the space beneath elevated highways in Chinese cities, and even for urban space optimization as a whole.

Keywords: urban viaducts; under-bridge space; high quality public space; Lijiao

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Chapter 1 Introduction

1.1 Research Background, Purpose and Significance

1.1.1 Research Background

(1) Single Function of Urban Transportation Infrastructure Restricts Sustainable Development

In the context of rapid urbanization in my country, the land area of all transportation facilities usually accounts for more than 10%. The shortage of construction land and the surge in the number of motor vehicles have also made viaducts and other transportation facilities an important means of alleviating traffic pressure. However, current construction focuses on improving transportation capacity and lacks comprehensive consideration of ecological, aesthetic and public activity needs ^[1], resulting in damage to the continuity of urban space, decline in vitality, and the formation of a large number of underutilized negative spaces. The resulting decline in environmental quality, fragmentation of urban fabric, waste of resources and safety hazards have become urgent problems to be solved in urban governance. As cities enter the "stock renewal" stage, the function of transportation infrastructure has transcended the single transportation attribute ^[55], and its functional limitations are becoming a key factor restricting the sustainable development of cities. The space under viaducts, as a typical "oddball space," is gradually being recognized as an urban resource with development potential.

(2) The space under viaducts, as an urban public asset, has a sufficiently large usable scale.

Since Guangzhou built the first urban viaduct in mainland China in 1987, a large number of similar bridges have been built across the country. According to data from the National Bureau of Statistics in July 2022, the total number of highway bridges in China is nearly 800,000, and the total mileage of viaducts is about 400,000 kilometers, ranking among the top in the world. Moreover, according to publicly available data, Guangzhou ^[56] has the largest area of space under bridges among my country's first-tier cities. Guangzhou has over 10 million square meters of under-bridge space, with approximately 1.46 million square meters usable. Shenzhen has 3,488 bridges

and culverts of various types (including pedestrian overpasses and passageways), including 576 urban interchanges and 216 viaducts, covering an area of 4.19 million square meters. Beijing has over 1,000 under-bridge spaces, with approximately 750,000 square meters within the Fifth Ring Road (including the Fifth Ring Road), and 361 under-bridge spaces on urban roads and 96 under-bridge spaces on highways within the Third and Fourth Ring Roads^[2].

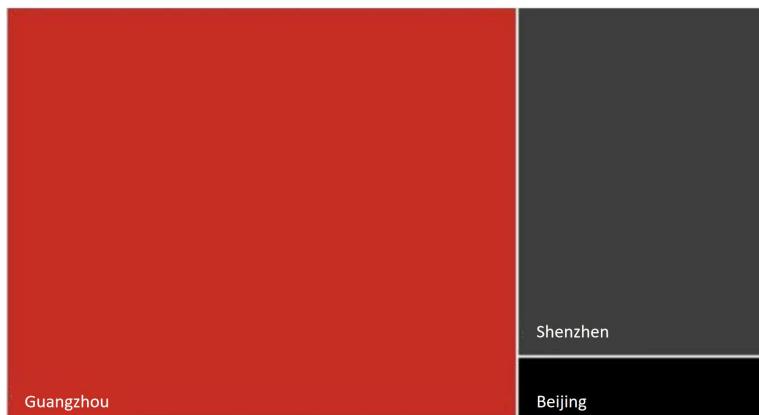


Figure 1-1 Guangzhou has the largest under-bridge space among first-tier cities

(Image source: Urban Design Alliance)

(3) The current inefficient use of space under viaducts

Jane Jacobs pointed out in "The Death and Life of Great American Cities" that the boundaries between single-function zones in cities are easily reduced to neglected gray areas, i.e., negative spaces^[3]. As a byproduct of urban expansion, the space under viaducts, though vast in area, suffers from unclear functions, fragmented structures, and insufficient maintenance due to a lack of planning and management. This results in negative characteristics such as idleness, neglect, and low-quality landscapes. These spaces are ecologically sensitive, highly enclosed, and lack vitality, remaining in a passive and negative state for a long time.

(4) Public Expectations for High-Quality Urban Public Spaces

As urban development shifts towards "stock renewal," the past extensive expansion model has been abandoned, and refined governance has become the dominant approach. The public has higher demands for the quality and function of public spaces. However, a large number of negative spaces in cities still exist with poor accessibility, lack of facilities, and unattractive functions and landscapes, failing to realize their due social and cultural value^[4].

With the established stage of urbanization and the scale of the built environment in my country, the focus of urban development has shifted from outward expansion to

the stock renewal stage of internal improvement. Against this backdrop, the core task at present is to effectively activate idle, abandoned, or negatively impactful micro-spaces, and to reconstruct the value of existing spaces. This not only responds to the public's demand for high-quality urban spaces but also provides new opportunities for improving urban governance and functionality.

(5) Multi-party Collaboration Mechanism

The creation of public spaces is not only a problem for cities and buildings, but also a daily life issue of common concern to the whole society. With the efforts of professionals, and as related discussions and practices increasingly enter the public eye, a multi-party collaboration mechanism involving architects, planners, government, and citizens is becoming increasingly mature. Top-down professional decision-making and bottom-up public participation are working together, and a powerful social force is forming^[59].

For the renewal of spaces under viaducts, it is necessary to establish a regular collaborative platform coordinated by government departments, professionally guided by planners and architects, and actively participated in by residents of surrounding communities and the public. Through joint discussions, design workshops, and other means, the needs and responsibilities of all parties should be clarified, and efforts should be made to transform negative spaces into vibrant public spaces.

1.1.2 Research Significance

This study is of great significance for promoting the transformation and development of under-bridge spaces from environmental, social, and practical perspectives.

From an environmental perspective, the transformation of under-bridge spaces helps optimize urban functional layout, improve the quality of the living environment, and enhance urban vitality. Currently, under-bridge spaces in major Chinese cities generally suffer from problems such as being closed off, dark, and fragmenting the urban fabric. Through landscape renewal, the urban environment can be effectively beautified, neighborhood relationships can be repaired, and the damage caused by viaducts to the urban spatial structure can be compensated for; at the same time, the efficiency of space utilization can be improved, forming new landmarks that showcase the city's governance level and regional characteristics.

From a social perspective, the renewal of under-bridge spaces can significantly

improve space utilization efficiency and the quality of life for residents. Under the background of existing planning, transforming the negative spaces under viaducts into multi-functional public open spaces can not only stimulate regional vitality and improve urban service functions, but also create high-quality activity venues for citizens. From an economic perspective, by introducing commercial service functions, new consumption scenarios can be cultivated, enhancing economic benefits.

From a practical perspective, this study provides theoretical and practical references for the transformation of under-bridge spaces. By systematically analyzing existing problems and best practices, this study proposes universal renewal strategies. Using the Lijiao section of the Guangzhou Ring Expressway as an example, it presents specific design ideas and solutions, providing a reference for the renovation of under-bridge spaces in similar areas, particularly Guangzhou, Guangdong. This project responds to Guangzhou's "Ring Park" construction initiative and is adjacent to the Lijiao Village, currently undergoing renovation—a crucial component of the "Haizhu Innovation Bay" development, located in a densely populated area, thus possessing significant practical value and demonstrative significance.

1.1.3 Research Purpose

While the construction of viaducts fulfills its transportation function, it also profoundly impacts the surrounding spaces. As an important component of urban space, the rational utilization of under-bridge spaces is increasingly valued. Scientifically and effectively revitalizing under-bridge spaces can bring multifaceted positive benefits to urban development and residents' lives.

This study aims to systematically classify and analyze relevant literature and cases on viaducts and their under-bridge spaces both domestically and internationally, combining relevant theories to summarize their typical characteristics and existing problems, and then propose universally applicable strategies for the reuse of under-bridge spaces. The research results can provide a certain reference for future research on under-bridge spaces and even urban space optimization. It also helps to promote the revitalization of existing urban spaces, enhance urban vitality, and build a good living environment.

This project finally focuses on the empirical design of the space under the bridge of the Lijiao section of the Guangzhou Ring Expressway. The specific solution formed not only serves the actual construction of the project, but also provides

reusable experience and strategies for cities with similar regional backgrounds such as Guangdong to carry out similar space renewal.

1.2 Current Status of Domestic and Foreign Research

1.2.1 Overview of Domestic and International Theoretical Research

(1) Overview of Domestic Theoretical Research

For a long time, the domestic academic community has mainly focused on traditional transportation spaces. The theoretical exploration and practical research on the utilization of space under urban viaducts are still in the stage of continuous deepening. With the public's increasing requirements for the quality of urban public spaces, and the increasing prominence of problems in visual experience, safety performance, and coordination with the surrounding environment of space under bridges, various urban contradictions caused by this have made space under viaducts a hot topic of social concern. From the perspective of policy guidance, governments at all levels are also trying to activate space under bridges through diversified means in order to make full use of this type of negative urban space and revitalize public space [57].

In recent years, domestic scholars have gradually extended their research focus from the structure and shape of viaducts to the space beneath them, mainly exploring the following three directions:

1) Coordination with the urban environment

As an organic component of urban public space, the space under viaducts needs to maintain continuity and coordination with the surrounding environment. Early studies focused on the impact of the space under the bridge on the city and its current characteristics, striving to explore ways to improve and reuse it, and advocating the inclusion of traffic-related spaces into the overall urban design framework. For example, Han Dongqing et al. (1999) emphasized in "Urban-Architectural Integration Design" that the construction of viaducts should be integrated with urban space and architecture for overall planning in the early stages to achieve spatial integration and comprehensive utilization [13]; Dai Zhizhong and Zheng Shengfeng (2003) systematically reviewed various bridge spaces formed in the process of urbanization in "Urban Bridge Space", and conducted in-depth discussions on the dimensions of shape, function, spatial structure and relationship with the urban environment [14].

2) Functional Utilization of Space

In recent years, more and more scholars have paid attention to the functional utilization of spaces under bridges, exploring suitable space utilization models and design strategies in combination with the characteristics of surrounding land development and the needs of residents. Sun Zheng'an et al. (2021) defined the space under viaducts as "street remnant space" and proposed to enhance its value by injecting the spirit of place^[15]; Qin Jian (2019) drew on international experience and provided useful references for the functional development and governance of spaces under bridges in my country^[16]; Huang Zhu (2019) and Wei Zesong et al. (2018) summarized the common utilization models of spaces under bridges in China through field research and proposed a classified utilization strategy^{[17][18]}.

3) Landscape and Ecological Renewal

The structure of viaducts often leads to problems such as insufficient sunlight, poor microclimate, noise and air pollution in the space below, so landscape and ecological restoration has become another important research direction. Liu et al. (2020) proposed that optimizing the landscape of the space under bridges can help make up for the lack of public space, increase the proportion of green space, and propose systematic strategies from the aspects of spatial integration, public participation, and traffic organization^[19]; Wu Wenjie (2019) proposed optimization paths for the space under bridges from five aspects, including planning management, spatial form, and landscape ecology, based on field research on the Dongguan section of the Guangzhou-Shenzhen Expressway^[5].

(2) Overview of foreign theoretical research

Foreign research on the space under bridges has a relatively more macro perspective. Since the 1960s, this field has gradually attracted the attention of scholars. Researchers generally regard the space under bridges as a "lost space" that divides the urban environment and hinders social communication. Based on the concept of "people-oriented", they advocate that in addition to traffic function, it is also necessary to respond to the actual use needs of the city and residents for the space under bridges^{[6][7][8]}.

By the late 20th century, related research began to employ a combination of qualitative and quantitative methods, analyzing aspects such as the structural characteristics of viaducts themselves, site conditions^[9], and the preferences and needs of surrounding populations regarding the spatial environment^[10]. Research

direction also gradually shifted from the "anti-bridge" sentiment of the 1990s to the holistic planning and renewal of the space under bridges as urban public spaces and landscape infrastructure [11]. Scholars further explored the possibility of coordinated development of the space under bridges with other urban functional areas and proposed feasible pathways for its construction as ecological infrastructure to restore fragile urban habitats.

In 2013, the Design Trust for Public Space (DTSC) and the New York City Transit Commission (NYCDOT), along with several public agencies, community organizations, and designers, launched the "Under-Bridge Spaces: Reclaiming Spaces, Connecting Communities" project. This project aimed to explore how to transform negative spaces under and around bridges into positive assets with community value, and through multi-party collaboration, developed a set of policy frameworks, strategic pathways, and operational mechanisms that can be used as a reference [12].

1.2.2 Overview of Domestic and International Practical Research

(1) Current Status of Domestic Practices

Currently, urban under-bridge spaces in my country are gradually transforming from "closed management and inefficient use" to a more diversified and varied landscape. Some cities have begun to consciously use under-bridge spaces for leisure development. Pilot projects such as under-bridge parks, leisure trails, and sports venues have emerged in many cities. Typical examples include the folk park under the Renmin South Road overpass in Chengdu, the sports park under the Panhuo Elevated Road in Ningbo, and the Locke Park under the Middle Ring Road overpass in Shanghai. Chengdu's "Chenghua Fuqing Sports Space" has transformed the originally idle under-bridge area into a leisure park that includes fitness trails and landscape features; Chongqing has also built several "under-bridge gardens," which have become new places for citizens' daily activities and new urban landscapes [20].

However, the utilization level of under-bridge spaces varies significantly between regions. According to statistics, the utilization rate of under-bridge spaces in Guangzhou is about 64%, while in Zhejiang Province it is only 6.8%. Overall, even though most under-bridge spaces in China have been developed, their utilization remains relatively conservative, failing to fully consider the user experience and generally suffering from problems such as single-function design, insufficient humanistic care, and a lack of overall planning. Current practices are mostly limited

to "point-based demonstrations," serving only local communities and failing to create a systemic impact at the city level.

In recent years, some cities have begun to explore systematic pathways for the renewal of public spaces under bridges. For example, in 2018, Shanghai launched the "Activating Under-Bridge Spaces" plan to upgrade under-bridge spaces along the Suzhou Creek with potential for renovation; Shenzhen constructed the Xiwang-Qianhai Bay riverside expressway underpass slow-traffic system, connecting mountains, sea, parks, and waterways, becoming a key node in the "Mountain-Sea-City Connection" plan; and in 2020, Guangzhou proposed creating a 60-kilometer-long "Ring Park" to promote the overall transformation of underpass spaces along the Ring Expressway. Although these explorations still have room for improvement in terms of organizational mechanisms, development models, and strategy integration, their initial practices have provided important references for the systematic renewal of under-bridge spaces nationwide.



Figure 1-2 Shenzhen Qianhai Bay Elevated Road Underpass Pedestrian Public Space Project - Important Node Connecting Mountains and Sea (Image Source: Reference 44)

The space under elevated roads that has been developed and utilized is relatively conservative in various cities. A small number of spaces are utilized well and integrated with the human environment, but most of the spaces under bridges do not take into account the spatial experience of citizens under the bridges. The development forms are monotonous and lack humanistic care.



(a) Xiamen BRT Elevated Bicycle Lane Alignment Design (b) Shanghai Low-Line Park



(c) Shenzhen Xiwang-Qianhai Bay Pedestrian Public Space (d) Green Corridor Under Bridge in Taichung, Taiwan

Figure 1-3 Examples of Domestic Under-Bridge Space Renovation Cases (Image Source: Youfang, Reference 44)

(2) Current Status of International Practice Research

Developed countries started systematic research and renewal practices on urban elevated road spaces earlier and formed different development paths according to their respective urban backgrounds.

1) Japan - Commercial Transformation Path

Japan's development of elevated road spaces has undergone an evolution from spontaneous utilization to systematic operation. From the post-war period to the early 21st century, the areas under elevated highways were mostly gathering places for vendors and informal markets. Although some lines had scattered shops, the overall utilization was inefficient and lacked coordination. As urban land resources became increasingly scarce, these long-neglected spaces gradually attracted the attention of developers.

The opportunity for systematic transformation stemmed from railway infrastructure upgrades from 2008 to the early 2010s, such as the seismic

reinforcement project of the elevated highways near Nakameguro Station, and the through operation of the Tokyu Toyoko Line and the Tokyo Metro Fukutoshin Line. With the relaxation of regulations and policies, railway companies began to promote the commercial development of the spaces under the bridges. The "Nakameguro Elevated Highway Underpass" project, which took about eight years to complete, marks the transformation of the spaces under Japanese bridges from passive idleness to high-quality commercial functions.

2) Europe and America – Overall Planning from the Perspective of Public Space and City Level

Europe and America place greater emphasis on the public nature of spaces under bridges, regarding them as an important resource for enhancing the urban environment and community connections. In terms of renovation concepts, they focus on activating spatial vitality through functional integration and landscape enhancement. Typical examples include Toronto's under-bridge sports field, Miami's "The Underline" linear park, Canada's Bentway public space, and Istanbul's Mecidiyeköy square.

In addition, European and American cities have also attempted to systematically integrate the space resources under bridges from a macro perspective. For example, Melbourne's Sky-rail project has uniformly planned the space under 17 kilometers of elevated railway bridges as a community activity venue; New York's "EL-Space" project has carried out overall functional positioning and spatial reconstruction of hundreds of kilometers of viaduct areas.



(a) Commercial space under the Nakameguro Elevated Road, Japan (b) Dandenong Railway Linear Sports Park



(c) Toronto's The Bentway public space

(d) South Korea's RoofSquare project

Figure 1-4 Examples of Overseas Under-Bridge Space Renovation

(Image source: <http://www.hhlloo.com>)

3) Summary

Japan's urban renewal strategy prioritizes central urban areas and areas with high land prices as starting points for renovation. Promoting commercial renovation in these areas not only caters to citizens' pursuit of new consumption experiences but also bridges the gaps in commercial districts caused by transportation infrastructure, effectively stimulating regional economic vitality. At the same time, facing the dual pressures of declining railway operating revenue due to a low birth rate and aging population, and a shortage of construction land, this type of development has provided railway operators with new profit channels and improved their business efficiency.

In comparison, while European and American cities may not be as high-end as central Tokyo in terms of consumption, residents have a strong demand for outdoor public spaces. Therefore, their renovation focus is on improving the quality and vitality of urban public spaces.

Different cities have different development conditions, and the selection of renovation locations and functional positioning must be combined with local realities. Whether driven by urban structural integration, improved living standards, or commercial expansion needs, responses to these practical demands have propelled elevated highways from their original singular transportation function into urban spatial carriers embodying diverse cultural significance.

1.2.3 Relevant Policies and Design Guidelines

The utilization of space under elevated highways in my country has shown initial signs of development, with policies gradually clarifying its direction. Since 2017, numerous policy documents regarding the utilization of space under elevated

highways have been issued. Many provinces and cities, including Beijing, Shanghai, Tianjin, Xi'an, Zhejiang Province, Kunshan, Guangzhou, Foshan, Dongguan, and Chongqing, have introduced management measures for the utilization of space under bridges. These measures use urban renewal and spatial governance as entry points, viewing the micro-renewal of space under bridges as an innovative way to achieve intensive land development, stimulate new vitality, and bridge traffic barriers [57].

City	Government documents	Main Content
Guangzhou	2023 <Guangzhou Municipal Bridge Underpass Space Development Plan and Technical Guidelines> 2024 <Guangzhou Bridge Underpass Space Comprehensive Utilization Demonstration Site Designation Ceremony and Bridge Underpass Space · Urban Inquiry Forum>	Guided by the principles of "functional spaces, manageable cities, and attractive landscapes," we are developing bridge-under spaces characterized by "orderly traffic, safe activities, clean environments, and shared functionality." This initiative aims to revitalize Guangzhou's urban functions and inject new vitality into the city[40]. The 2024 conference centered on the theme of "Complex Utilization of Underbridge Spaces," actively exploring initiatives to advance the planning and implementation of underbridge spaces. Adopting the approach of "one bridge, one plan; one bridge, one feature," efforts focus on safety, public welfare, functionality, and management to transform the city's original "gray spaces" into "public vitality spaces," making them an integral part of the urban public realm[63].
Beijing	2022 <Beijing Municipal Regulations on the Management of Underbridge Space Utilization> 2022<Beijing Municipal Guidelines for the Planning and Design of Underbridge Space Utilization>	The utilization of underbridge spaces should prioritize safety and accessibility while comprehensively addressing public needs through unified spatial design. This transforms the city's original "gray spaces" into "vibrant public spaces," integrating them as organic components of the urban public realm[64]. In designing the utilization of underbridge spaces, we must adhere to a people-centered approach, focus on the needs of the populace, and fulfill their aspirations for a better life. Guided by the capital's development priorities, we should continuously enhance urban governance capabilities and standards to create public spaces that satisfy the people[21].
Shanghai	2021 <Guidelines on Enhancing the Quality of Underbridge Spaces>	The Guiding Opinions propose guiding the quality enhancement of Shanghai's underbridge spaces based on the principles of "safe operation, image enhancement, environmental integration, and composite utilization." This will create opportunities for the renewal of more underbridge spaces. Through measures such as releasing space, enhancing landscapes, and introducing new business formats, replicable and scalable experiences will be formed and incorporated into the routine scope of refined management[65].

Table1-1 Domestic Policies on the Renewal and Utilization of Under-Bridge Space (Table data

source: References 21, 40, 63, 64, 65)

Domestic policies on the utilization of under-bridge space show obvious commonalities: they all emphasize public welfare attributes and safety bottom lines, requiring that utilization must guarantee public interests and not affect bridge safety. Various regions generally implement differentiated strategies of "one policy per bridge," encouraging the construction of multi-functional structures. In terms of policy systems, many regions have issued special management methods and technical guidelines, incorporating the renewal of under-bridge space into the overall urban renewal framework, aiming to activate negative spaces through refined utilization, achieving intensive use of land resources and improving urban quality.

1.3 Research Content and Methods

1.3.1 Research Content

The research content of this paper mainly includes the following components:

Part One: Theoretical Basis. The article first identifies the research object and significance, defining the research scope. Through a theoretical review of relevant concepts, domestic and international research, and theoretical foundations, including the characteristics of under-bridge space, as well as basic research on urban viaducts and under-bridge space in my country, and an interpretation of relevant policies, the existing problems of the space are summarized. This provides theoretical support for the strategic research in the following sections.

Part Two: Strategy Research. Based on theoretical research, combined with domestic and international case studies and data collection, this paper summarizes the design strategies for spaces under urban elevated highways, including five aspects: functional reorganization and composite utilization strategies, spatial reshaping and sequential experience strategies, traffic integration and flow organization strategies, spatial narrative construction and cultural implantation strategies, ecological technology and sustainability strategies, and shared construction and orderly management strategies.

Part Three: Application Practice. Taking the space under the Lijiao section of the Guangzhou Ring Expressway as the design practice object, this paper analyzes and summarizes the current situation and problems of the area under the bridge and its surroundings, and applies the design strategies proposed in the research section based on Guangzhou's policy advocating the construction of "ring parks" under the ring expressway. Combining the needs of the surrounding population and the surrounding environment, this paper proposes specific design strategies and solutions for the space under the bridge to improve its quality and function and create effective public spaces for the people.

This paper's research on under-bridge space strategies and design practice aims to provide a reference for the design and renovation of under-bridge spaces in China, especially in Guangdong and Guangzhou.

1.3.2 Research Methods

(1) Literature Review

This paper systematically reviews the relevant theories and research progress on urban viaduct spaces, summarizes domestic and international experiences in public space renewal, grasps the development dynamics and trends in this field, and draws on existing research results to lay a theoretical foundation and broaden the research perspective.

(2) Field Survey

This paper selects typical urban viaduct spaces and various types of bridge spaces that have been renovated and utilized in Guangzhou as the subjects for a large-scale field survey. It also conducts spatial status surveys and related interviews on the Tuhua and Olympic Sports Center sections of the "Ring Park" project under the Guangzhou Ring Expressway. Finally, it conducts a focused and in-depth survey of the Lijiao section of the Guangzhou Ring Expressway, observing and recording its location, bridge structure, and current functional utilization. It also conducts relevant field surveys on the surrounding environment, such as the Lijiao Ancient Village, residential areas, schools, and existing public facilities.

(3) Case Study Method

Collect domestic and international cases of bridge underpass space renovation through lectures, publications, and online platforms. Combined with problems discovered during field research, classify, compare, and systematically analyze the cases to extract design strategies and renewal mechanisms that can be learned from.

(4) Inductive Summary Method

Based on field investigations and case studies, systematically integrate and theoretically refine various information to form universally applicable design principles and strategies, providing a reference for the renewal of urban negative spaces such as underpasses.

(5) Empirical Research Method

Apply theoretical results to specific practice. Taking the underpass space of the Lijiao section of the Guangzhou Ring Expressway as an empirical object, propose an operable design scheme to achieve a complete research closed loop from theoretical construction to practical verification.

1.3.3 Research Framework

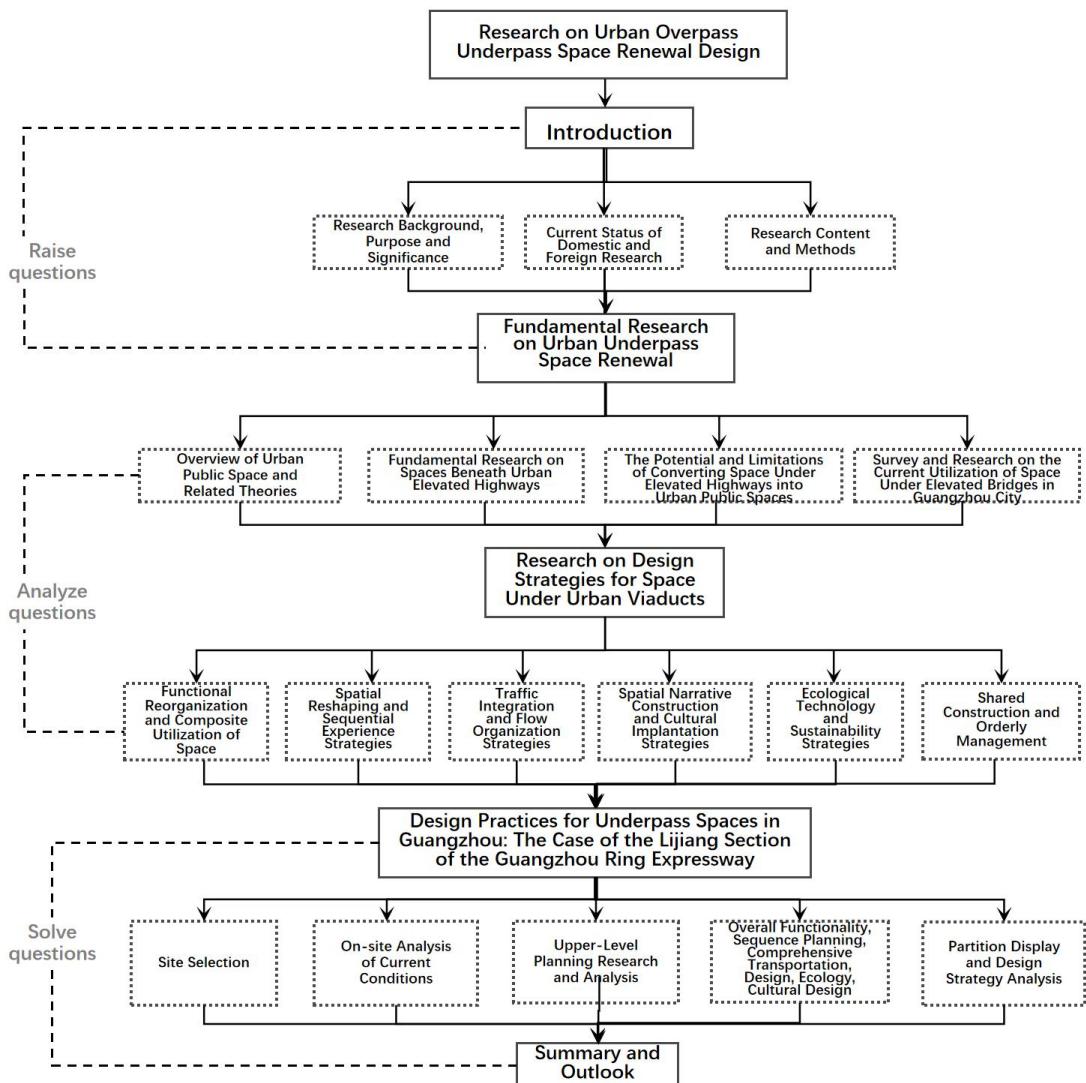


Figure 1-5 Research Framework Diagram (Image source: Author's own drawing)

Chapter 2 Overview of Urban Public Space and Related Theories

2.1 Overview of Urban Public Space

2.1.1 Concept of Urban Public Space

The narrow concept of urban public space refers to outdoor spaces that are used by urban residents for their daily and social lives. It includes streets, squares, outdoor spaces in residential areas, parks, sports venues, etc.; its broader concept can be extended to the space of public facilities, such as urban centers, commercial areas, waterfront areas, urban green spaces, etc. ^[23]. S. Zukin understands public space as a container that encompasses multiple aspects such as physical security, geographical community, social community, and cultural identity. She believes that public space is a container of urban vitality ^[24].

Chabin once said: "Open space is the most valuable undeveloped space in urban development. On the one hand, it can prepare for the future regeneration of the city, and on the other hand, it can provide outdoor recreational places for urban residents, with functions of disaster prevention and landscape." ^[25] The open and continuous spatial characteristics of the space under the overpass are similar to the urban gray space of Guangzhou's arcade, which is both ventilated and cool and sheltered from the wind and rain, providing a basis for the transformation of the space under the bridge into public space.

One of the important roles of public space is to bring about some social interaction, bringing together different groups of people to carry out spatial activities ^[26]. Their transformation and utilization all take into account the public's needs. It is not difficult to find that whether it is changing the infrastructure, such as rest facilities, pedestrian paths, ground paving and micro-topography; or the active role of the government, social organizations and the market in enhancing the "soft environment" such as cultural and artistic vitality, it is all for the purpose of improving its public utility ^[27].

2.1.2 Role and Types of Urban Public Space

Public spaces possess multiple characteristics, including openness, accessibility, mass appeal, and functionality ^[28], facilitating people's access, rest, and daily use.

They provide venues for activities and experiences, organically organize urban space and human behavior, constitute urban landscapes and maintain the ecological environment, facilitate transportation, and contribute to urban disaster prevention.

The multi-layered content carried by public spaces makes them an important carrier of the urban built environment:

① Facilities and venues for activities. Based on residents' living needs, various activities such as transportation, commercial transactions, performances, exhibitions, sports competitions, fitness, leisure, sightseeing, festival gatherings, and interpersonal interactions can be carried out in urban public spaces.

② Inheritance and development of cultural heritage. Historically, vibrant public spaces were the best carriers of urban cultural heritage and spiritual outlook. Today, the creation of public spaces also integrates more urban cultural characteristics and humanistic background, paying more attention to combining natural resources, traditional landscapes, and public art to deeply shape the urban built environment.

③ Value Creation and Enhancement. The creation of public spaces helps improve environmental quality, enhance the city's image, and strengthen urban vitality, which is also an extension and amplification of urban value. Nowadays, virtual spaces such as the Internet have emerged, where people can have multiple IDs, discuss and express their opinions online, and even influence the political life of the country. The Internet has become a new form of public space and has an impact on physical public spaces [23].

2.1.3 Development Trends of Urban Public Space

The general trend in the development of urban public spaces is functional diversification and pluralistic forms. Only by adapting to the diversity of different user needs can users be provided with multiple choices. Various public spaces carry multiple functions such as transportation, social interaction, rest, walking, viewing, fitness, entertainment, dining, exhibition, education, and festivals. The convergence of various groups of people, activities, events, and stories generates the vitality of a place, which is the charm of public spaces [60].

Currently, my country's economy is developing rapidly, and the urban landscape is changing rapidly. The urban life that people once longed for has become an increasingly unbearable pain—traffic congestion, environmental degradation, and

indifference between people. China is gradually following the old path of developed European countries, pursuing economic development at the expense of quality of life. The proposal of the people-oriented design concept has undoubtedly sounded an alarm for China's current urban planning and construction. A democratic and civilized modern city should focus on the construction of humanized and diversified public spaces. This can not only improve the living environment of residents and inherit and continue the city's cultural traditions, but also enhance the city's core competitiveness and provide a long-term driving force for the city's development.

2.2 Overview of Other Relevant Theories

2.2.1 Urban Stitching Concept

(1) Urban Stitching Concept and Elements

"Sew up" is an important basic surgical procedure, meaning to sew up a wound with special needles and thread. Extending its meaning to the level of urban design, it refers to a design method that aims to bridge the gaps between different urban spaces and create overall vitality. It involves establishing new order and connections on both sides of the fracture zone, so that the local and the whole are functionally complementary and coordinated, thereby forming a new spatial order and urban form [29].

Urban stitching goes beyond simple physical connections. In urban renewal, it is a systematic and multi-dimensional renewal method that requires the use of various strategies to achieve:

At the functional level, the "composite" stitching strategy of business activities: it is manifested in the high degree of regional function integration. Through the rational allocation and joint operation of different proportions of urban functions, the isolated state of single functions can be changed, the diverse needs of urban production and life can be met, and resources can be integrated and allocated to maximize the stimulation of regional vitality [31]. It not only promotes economic revitalization and employment growth, but also helps to form rich social interaction venues.

Traffic stitching, as the basic level, emphasizes the optimization of traffic organization and the establishment of a continuous and friendly slow-moving environment by constructing new connection methods such as pedestrian overpasses,

underground passages and ecological corridors, thereby eliminating the spatial fragmentation caused by infrastructure. For example, Shenzhen's UpperHills connects Lianhuashan Park and Bijia Mountain Park via sky bridges, forming a "five-park interconnected" slow-traffic network, increasing annual visitor traffic to over 40 million and significantly enhancing regional connectivity [30].

At the cultural level, the "continuity" stitching strategy for urban context: structurally preserving and showcasing historical cultural characteristics, and shaping the spirit of the place through functional replacement, public space integration, and cultural activity planning, formulating different strategies according to the historical characteristics of the area, so that the urban context can be continued [31]. In the Minhang Riverside project in Shanghai, the renovation and upgrading of industrial buildings and the introduction of characteristic activities such as "dye experience" tell the history of the site through landscape features, paving and other elements, achieving a stitching at the cultural level.

Ecological stitching is a guarantee of sustainability. In urban spaces, many fragmented green spaces suffer from poor management and topographical differences, resulting in a broken green space system. Therefore, we need to regulate and permeate the green space system in urban gray spaces, rationally integrate this type of space with the surrounding environment, and then conduct landscape design to connect the two sides and completely stitch up the fragmented areas [62]. It also focuses on restoring the ecological environment while connecting spaces, constructing a continuous water and land ecological corridor, and using green infrastructure such as rain gardens and permeable paving to improve the site's climate adaptability, promote biodiversity restoration, and improve the microclimate.

At the spatial level, the "connectivity" stitching strategy for the urban environment is to connect fragmented areas of the urban fabric through spatial operations, focusing on the connection and integration of spatial structure and regional environment to establish a continuous and complete urban spatial system [31].

Spaces under viaducts often disrupt the urban fabric and its spatial and functional relationships. The core objective of the urban stitching concept in the design of spaces under bridges is to focus on reconstructing the relationship between the spaces under bridges and the surrounding areas. This involves systematically repairing the fragmented urban fabric through a multi-dimensional integration of space, function, ecology, and culture. Specifically, this manifests in the following aspects:

1. Spatial and Traffic Stitching: Spaces under bridges often have "hard boundaries" formed by viaducts, railways, and other infrastructure, leading to a break in the surrounding community space. The design needs to connect the spaces under the bridges with the surrounding areas through slow-traffic systems (such as corridors and walkways).
2. Functional Stitching: The functions of spaces under bridges need to complement the needs of the surrounding areas. For example, the space under the Suzhou Creek bridge in Shanghai is divided into "animal quadrants," introducing sports facilities, viewing platforms, etc., deeply integrating with the needs of residents in Beixinjing Street.
3. Ecological Stitching: Integrating ecological concepts into the design, such as constructing rain gardens and permeable paving, connects the spaces under bridges with the surrounding ecological network.
4. Cultural Integration: By preserving industrial heritage and introducing local cultural elements, the space under the bridge becomes a cultural carrier, enhancing community identity.

(2) Case Studies and Innovative Explorations

In urban renewal practices at home and abroad, many successful cases aimed at urban integration have emerged. Shenzhen UpperHills and Shanghai Minhang Riverside Project effectively connected the fragmented areas through three-dimensional transportation and functional reorganization; Nanjing proposed a comprehensive strategy for the transformation of the abandoned section of the Ningwu Railway, including building a pedestrian-friendly street network, adding a second-floor leisure corridor, breaking down wall boundaries, using digital technology, and restoring the ecological landscape, to reshape the fragmented urban fabric caused by the railway.

At the international level, Boston's "Great Excavation" project in the United States converted elevated highways that traversed the city into underground tunnels and constructed green corridors and public space systems on the original sites, effectively mending the fragmented urban area; Seoul's Cheonggyecheon Stream project, by demolishing elevated roads and restoring the historical water system, reconnected the north and south urban areas, not only improving the ecological environment but also becoming a classic example of urban space restoration and regional re-connection.

2.2.2 Environmental Behavioral Theory

Environmental behavior theory posits that human behavior is based on responses to internal or external stimuli. Internal stimuli include human motivations and needs, while external stimuli come from the external environment [61]. Humans and the environment are not independent of each other; while humans are influenced by the external environment, they can also modify and utilize it, and the two interact. In this process, the environment carries human behavioral activities and is an inseparable part of behavioral patterns, while behavior is the main medium connecting people and the environment (Figure 2-1).

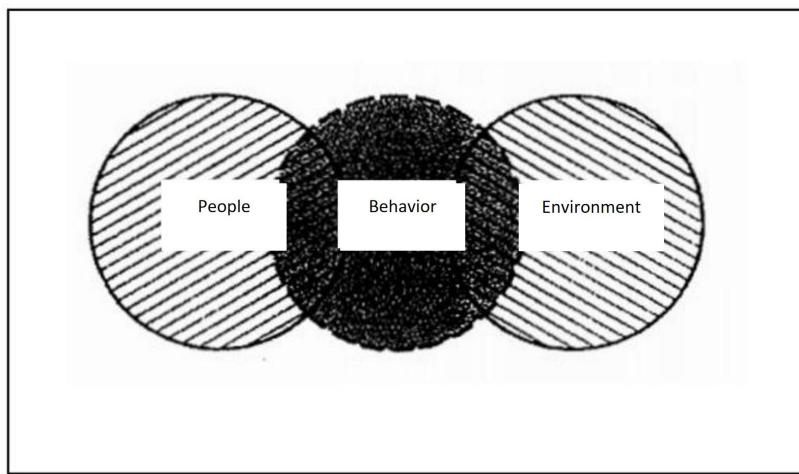


Figure 2-1 Relationship between people and the environment (Image source: *Introduction to Environmental Behavior*)

Urban public spaces contain a variety of people and groups who exhibit various behaviors and reactions to their surrounding environment. The space under urban overpasses studied in this paper, due to its unique spatial location, coexists with the city and is closely related to the lives of surrounding residents and pedestrians.

When the space under the bridge is of suitable scale, has high environmental quality, and good accessibility, it can attract people to stop and linger, thus triggering more activities. Furthermore, diverse activities can increase the perception and vitality of the space. This interactive process forms a virtuous cycle that helps the environment develop itself. Conversely, when the spatial environment is of poor quality and lacks appeal, human activity and attention will decrease, and the spatial environment quality will continuously decline, potentially leading to a vicious cycle. Properly handling the interaction among these three factors is crucial for activating the space under bridges.

2.2.3 Landscape Spatial Sequence Theory

Spatial sequence refers to the organization of space according to certain flow lines, including transitions and changes such as beginning, development, opening, and closing. In planning and design, the guiding principle is "balanced and good landscape," emphasizing the interrelationship between urban space and environment, highlighting the continuous organization and relationships of space, and stressing an organic sense of order^[32]. The organization of sequential space is based on meeting the various functions of urban space. Sequential space uses different forms to rationally organize and layout different cultural backgrounds and different sizes of pedestrian and vehicular traffic, as well as their gathering, dispersal, circulation, and direct flow, and to guide and control them in a planned manner^[58]. In terms of the needs of urban transportation, commerce, entertainment, and other functions, the rules of sequential space require a dynamic view of urban public space, leaving room for sustainable development^[32]. Gordon Cullen's "serial vision" theory emphasizes that urban space creates a sense of rhythm through the alternation of continuity and nodes^[33].

2.3 Chapter Summary

This chapter, focusing on the concept and functional characteristics of urban public space, urban stitching theory, environmental behavior theory, and landscape spatial sequence theory, elaborates on the theoretical basis for the reuse of under-bridge space from different levels, including macro, meso, and micro. As a special type of complex space, under-bridge space cannot be solved by a single approach or theory; the comprehensive application of multiple theories can effectively guide its reuse and lay the foundation for its basic design. This paper focuses on the design of the under-bridge space in the Lijiao section of the Guangzhou Ring Expressway, supplemented by the design of surrounding green spaces and transportation based on higher-level planning. Combining multiple theories maximizes the value of the transformation. Under-bridge space, with public space as its target and foothold, supplemented by stitching theory and environmental behavior theory, requires the combination of multiple theories to achieve the transformation from a "gray area" to a "vibrant node."

Chapter 3 Characteristics and Utilization Potential of Space Under Urban Viaducts

3.1 Overview of Urban Viaducts and Underpass Space

As dedicated transportation facilities in surface space, viaducts mainly serve to improve traffic connections in specific areas or enhance road capacity. Based on their different uses, bridges can be classified into various types, such as dedicated rail transit lanes, freight line passages, pedestrian overpasses, and connecting corridors between buildings. With the accelerating urbanization process, expanding population, and increasingly prominent problems such as traffic congestion, coupled with the growing constraint of land resources, the construction of viaducts has become one of the key three-dimensional solutions to alleviate the pressure on the surface road network. The implementation of such projects can not only significantly reduce road traffic density but also optimize the vehicle distribution at intersections, thereby greatly improving the comprehensive service capacity and operational efficiency of the urban road traffic system.

分类形式 Forms of classification	分类内容 Categories
桥面交通形式 Forms of transport on the flyover	①Under urban road bridge ②Under highway road bridge ③Under urban rail bridge ④Other
桥的空间形态 Spatial forms of the flyover	①Overpass ②Ramp bridge ③Cross-line bridge ④Linear bridge ⑤Other
桥下空间面积 Area of space under the flyover	①Large (>1000m ²) ②medium (500-1000m ²) ③small (200-500m ²) ④micro (<200m ²)

Figure 3-1 Three Classification Forms and Classification Content Table of Bridges (Revised by the author from Reference 21)

Based on the current status of bridge facilities and the needs of new projects, a systematic classification can be carried out from multiple aspects. According to spatial morphological characteristics, there are mainly five types: interchanges, ramp bridges, overpasses, linear bridges, and others. When selecting the Lijiao section of the Guangzhou Ring Expressway as the research sample, the focus is on linear bridges, combined with some overpasses and interchange elements for comprehensive analysis. The substructure space of an viaduct is roughly divided into four levels: large, medium, small, and micro, depending on the size of the site. The selected area falls into the large category.

The vertical space planning of urban viaducts mainly relies on some core elements. The superstructure includes the bridge deck system and main components, while the substructure includes piers, abutments, and foundations. The superstructure focuses on load transfer, while the substructure focuses more on load distribution and overall stability.

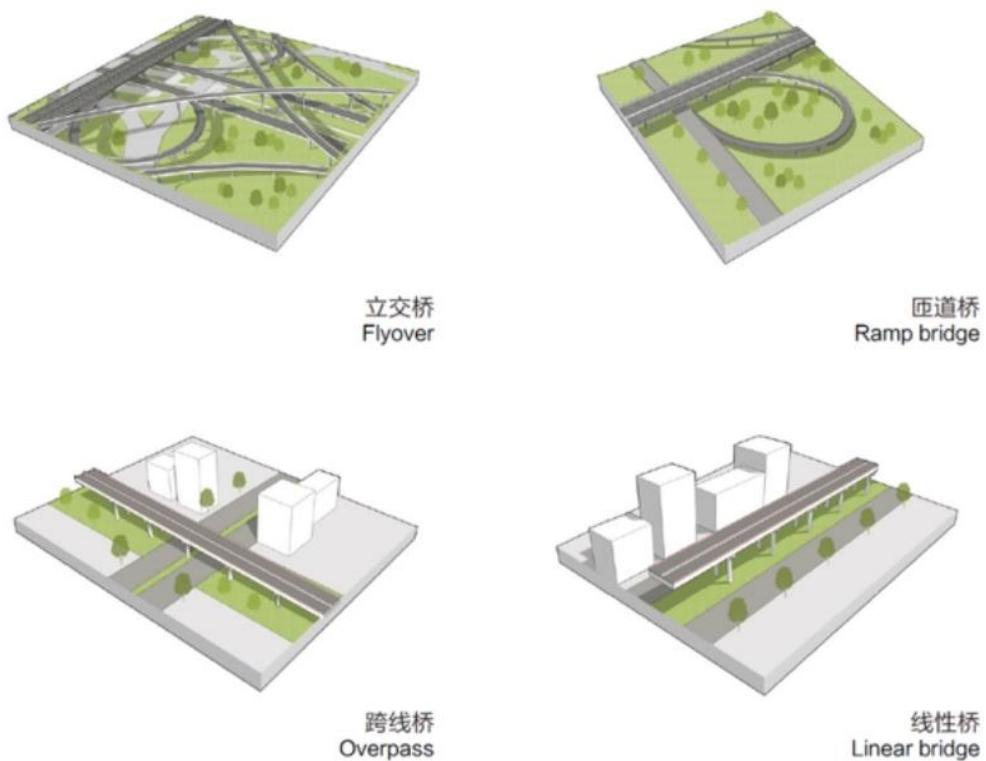


Figure 3-2 Classification by spatial morphological characteristics (Image source: Reference 21)

The space under an viaduct refers to the urban gray space within the vertical projection range below the bridge deck. The research scope includes the space under the bridge and surrounding green spaces, roads, and other urban public spaces.

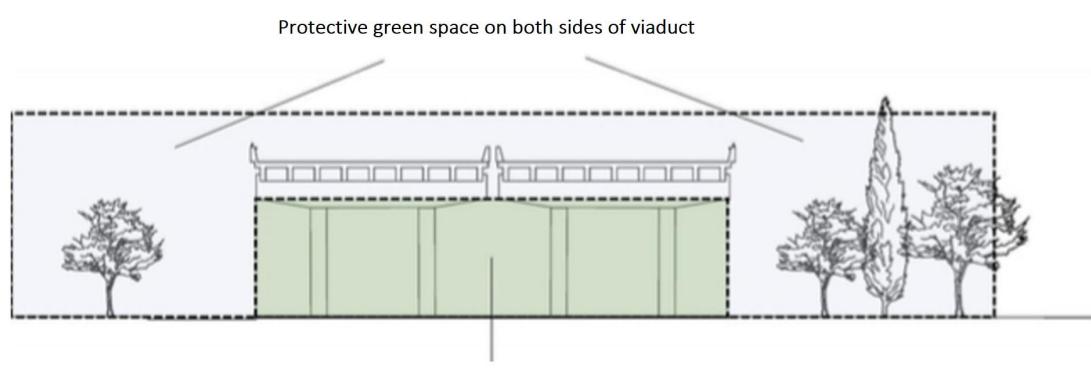


Figure 3-3 Space under an viaduct and surrounding space (drawn by the author)



Figure 3-4 Classification of clearance under a bridge
(Image source: Reference 21)

3.2 Basic Characteristics of Space Under Viaducts

1. Continuity

As a typical linear structure, urban viaducts possess a sense of extension and continuity. The space beneath them also exhibits a continuous distribution, extending through the city as the bridge extends, and interacting with various urban environments with a large contact area.

2. Urban Imagery

Viaducts are an important part of urban infrastructure. Their unique linear form and prominent visual characteristics have considerable potential to improve regional recognition. A deeper exploration of their spatial thematic attributes and the rational utilization of these characteristics can bring new ideas to the design and updating of modern urban identity systems. When creating an urban image, the five elements of "path, region, node, boundary, and signage" are interconnected, jointly contributing to the formation of the overall image. The primary function of "path perception" makes viaducts a crucial part of the "multi-faceted imagery carrier."

Due to its massive size and unique geographical attributes, this spatial layout possesses distinct multi-dimensional and dynamic characteristics, fundamentally different from traditional urban public open spaces. Within the region, it falls under the category of core landscape elements, not only serving a function of cultural dissemination but also systematically presenting local cultural connotations and deepening people's understanding of such culture, thereby forming a distinctive urban image identification system framework. Viaducts are no longer limited to their function as single-purpose facilities; they have gradually transformed into a crucial component of the region's urban brand value, becoming one of the most critical media platforms for citizens to perceive the overall urban environment. In this process, the

"imagery" quality, perceived by pedestrians through direct spatial experiences, becomes richer and more diverse. This is due not only to the sensory stimulation from external factors but also deeply rooted in the unique architectural styles, historical accumulation, and inherent cultural spirit of each region.

3. Boundary ambiguity

Architectural spaces generally have relatively clear boundary features. The top surface of the viaduct and the pier components form a certain degree of enclosure effect on the area under the bridge. However, there is a lack of actual physical separation to clarify its specific scope. In the vertical direction, this space is not completely enclosed by continuous entities. In the longitudinal direction, it shows a semi-open state. Such a design not only strengthens the traffic connectivity between the bottom of the bridge and the external environment, but also promotes the extension of the urban landscape underground and achieves the effect of functional penetration by using the blurred boundary. Thus, a composite form structure with integrity and coordination is created. The visual connection between the space under the bridge and the environment on both sides can make pedestrians aware of the landscape features on the opposite bank, and resolve the urban division caused by the viaduct by its permeability [35]. On this basis, the functional layout planning under the viaduct should take into account regional factors and make full use of the advantages of blurred boundaries, and integrate regional cultural symbols and ecological aesthetic concepts to build a multi-level spatial system architecture.

4. Convergence

Due to their advantageous location within the city, the space beneath viaducts naturally creates a significant convergence effect on traffic flow and pedestrian activity. Furthermore, viaducts, with their massive size, stand in the city and possess strong visual control and signage characteristics [36], thus the space beneath them has a strong converging effect on the sight lines of passing pedestrians.

5. Public Openness

Densely populated areas generally suffer from a lack of public activity space due to limited land resources. These areas gather large numbers of people and frequently host various social exchange activities, but existing facilities are insufficient to meet these needs. From the perspective of urban land ownership, the space beneath bridges is a public resource, and while prioritizing traffic needs, it can be equipped with other functions permitted by law and policy [37]. The space beneath bridges is typically an

open area with free access and no clear restrictions on pedestrian flow, thus becoming an open space for public activities.

3.3 Potential for Transforming Underpass Space Into Urban Public Space

3.3.1 Ownership Structure and Convenience of Renovation of Space Under Bridges

The spaces under urban overpasses, due to their enclosed, fragmented, and ambiguous ownership characteristics, are often regarded as "surplus spaces" rather than true public spaces. However, from the perspective of spatial utilization potential, these spaces generally do not involve demolition, and the property rights and maintenance units are mainly state-owned enterprises, making them potentially suitable for renovation and utilization. From the perspective of their ownership nature, these lands primarily belong to state-owned transportation or municipal units, and their public attributes are already predefined. This "state-owned" background removes the fundamental property rights obstacles brought about by privatization, providing an institutional foundation for the transition from management assets to service-oriented public resources. For instance, the space beneath the Guangzhou Ring Expressway bridge selected in the text falls under the jurisdiction of the state-owned enterprise Guangzhou Communications Investment Industrial Co., Ltd^[63]. Therefore, the transformation of underpass spaces is not a creation out of thin air, but rather an "awakening" and "returning" of their dormant public attributes. Through precise design intervention and cross-departmental collaboration, these once gray boundary areas have the potential to be reshaped into linear parks and public service facilities that connect the urban fabric and inject community vitality, thereby achieving a paradigm shift from transportation appendages to high-quality public spaces.

The space under the bridge, mainly consisting of existing built-up areas and planned construction areas, is a valuable urban renewal space resource. Effective renewal and utilization will release and activate a large amount of negative urban space, creating a demonstrative and leading effect in revitalizing existing resources. Newly built bridges, with their under-bridge space considered from the initial planning and design stages, will also become highlights of urban construction in terms of land conservation, convenience for residents, and ecology^[21].

3.3.2 Remaining Space Under Bridges Can Serve as Urban Gray Space

The remaining space under highway viaducts is bounded by three physical elements: the horizontal bridge deck at the top, the bridge pillars as vertical supports, and the ground beneath the bridge^[34]. These three interface elements naturally form the spatial form defined in architecture—gray space.

Gray space refers to a spatial form within the three-dimensional spatial category. It generally refers to the part that transitions from indoor architectural space to outdoor open space. Its top surface is covered, and there are no obvious boundaries on all sides. Semi-outdoor, semi-indoor, and semi-enclosed spaces all belong to the category of gray space. Urban gray spaces protect pedestrians and vendors from sun and rain, providing a sense of shelter and territory, and defining boundaries for activity spaces. Urban gray spaces attract and support public activities, while also possessing commercial value due to their ease of placement^[35]. The extensive, continuous roof surfaces and orderly pillars of elevated highways create a sense of enclosure, giving the space beneath the bridge a sense of place and territory. Such spaces are inherently attractive, their spatial form resembling the gray spaces formed by classical colonnades (as shown in Figure b), enhancing psychological safety and providing shade and shelter from rain for public activities.

In the humid and hot regions of South China, traditional street construction has always emphasized sun protection and wind and rain resistance, thus the arcade building, a typical gray space form, is very common. It is evident that gray spaces, capable of sheltering from wind and rain, resisting the scorching sun, and creating a cool microclimate, possess significant potential to accommodate public activities in this region. The space under viaducts also has suitable temperature and climate conditions, attracting diverse public activities and effectively fulfilling the function of urban gray space. Especially under its shading effect, compared to completely open urban spaces, most areas under the bridge feel more comfortable and pleasant, making it very suitable for construction as activity venues.

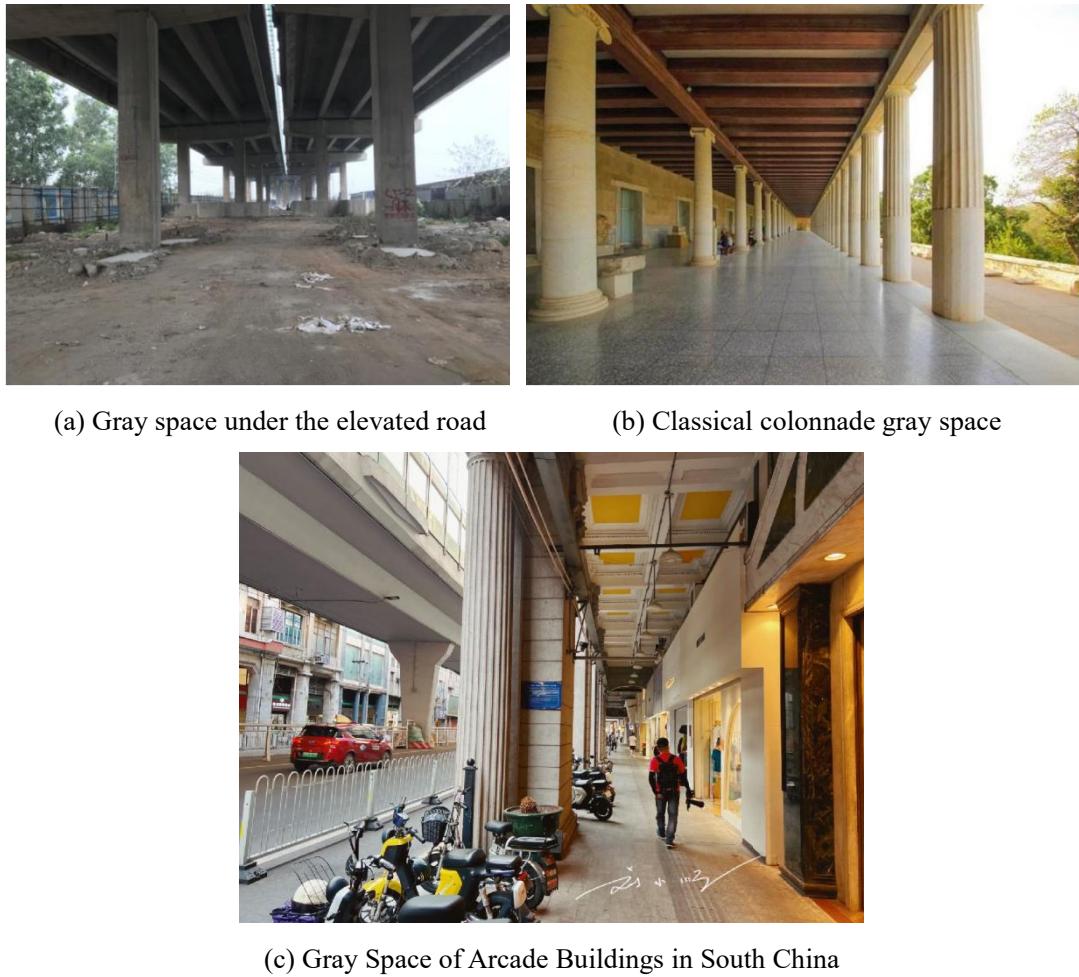


Figure 3-5 Comparison of gray space under viaducts with classical colonnade space and gray space of arcade buildings in South China (Image source: Author's own photo)

3.4 Summary of Current Problems of Space Under Viaducts

3.4.1 Planning Level

Currently, the construction of highways and viaducts rarely has systematic planning guidance. Various functional departments formulate their own implementation strategies and plans for their own battlefields, rather than working and communicating in accordance with common directions and goals. Cross-domain connections are very weak and difficult to coordinate. This decentralized management approach has resulted in a fragmented geographical distribution of transportation infrastructure. The "piecemeal" integration model makes it difficult to achieve optimal synergy through localized coordination. Simultaneously, it has negatively impacted the overall urban layout—damaging the ecological environment, leading to frequent land waste and idleness, disordered functional zoning, and an increasing proportion of ineffective use. Building clusters within unscientifically integrated functional areas,

developing independently, have gradually developed unclear boundaries or even complete discontinuity, thus reducing their inherent development potential and leaving many spatial gaps and dead zones.

3.4.2 Functional Level

Currently, the phenomenon of idle space under urban viaducts is widespread, resulting in ineffective use of land resources and a relatively singular functional type. Although under-bridge spaces have diverse development potential, most under-bridge spaces in China are still primarily used for greening and parking. While these uses alleviate the pressure of insufficient parking facilities in urban areas to some extent, the overall spatial atmosphere is monotonous, the usage is similar, and the actual utilization benefits are limited, making it difficult to fully realize the comprehensive value of limited urban space. It is worth noting that while using the space under bridges for parking can indeed alleviate the immediate problem in areas with scarce parking resources, in commercial areas and areas with frequent pedestrian activity, simply designating parking spaces is insufficient in terms of functional adaptability and restricts the possibility of multi-functional and efficient use of space.

3.4.3 Accessibility Level

According to field research on different types of spaces under viaducts, the pedestrian system under viaducts is clearly inadequate. In linear spaces under bridges, pedestrian areas are often squeezed by parking spaces and motor vehicle lanes, resulting in a lack of continuous and comfortable slow-moving environment for citizens; while at intersections, pedestrian safety is difficult to guarantee due to dense traffic flow, high vehicle speeds, and chaotic traffic flow in some areas, leading to prominent conflicts between pedestrians and vehicles. For example, at the intersection of the Ring Expressway and Lijiao Street selected in this article, the unclear separation of pedestrians and vehicles, coupled with the arbitrary occupation of space by street-facing shops, results in pedestrians and non-motorized vehicles sharing the road with motor vehicles.



Figure 3-6(left) Pedestrian and vehicle traffic mixed at road intersections under bridges

Figure 3-7(right) No pedestrian space provided on road sections next to bridges

(Image source: Author's own photo)

In addition, whether in linear sections or road intersection areas, besides poor pedestrian system organization, there is a general lack of dedicated overpass passages. The lack of safe paths forces pedestrians to either detour or risk crossing, creating a dilemma. Some spaces under bridges are even devoid of any passage facilities or spaces, leading to frequent mixed pedestrian and vehicle traffic and significant safety hazards. For example, on the Tuohua section of the ring expressway, the road parallel to the bridge section next to the sports field under the bridge lacks a pedestrian space. Overall, the weakness of the slow-traffic system severely weakens the accessibility of spaces under bridges, threatening not only pedestrian safety but also reducing the attractiveness of the area as an urban public space.

3.4.4 Cultural Level

The spatial layout planning of highway viaducts often lacks comprehensive consideration of the inheritance of local culture, causing psychological barriers among the public. As modernization progresses, traditional cultural symbols such as geographical characteristics and folk activities gradually fade from people's view, their original aesthetic features are impacted, and historical memories are difficult to preserve completely, leading to the gradual disappearance of traditional lifestyles and local customs. Take the Lijiao Archway as an example: during urban renewal in this area, the high bridges, approaching ten meters in height and with a striking visual effect, disrupted the traditional spatial layout of Lijiao Village and severely damaged its unique historical context.

The fragmentation of regional cultural context caused by the construction of viaducts has altered the functional attributes of traditional public spaces. This cultural rupture runs counter to the cultural characteristics of the surrounding environment and is detrimental to the creation and development of an overall humanistic atmosphere. In subsequent renovations, some designers attempted to compensate for potential cultural deficiencies by simply inserting cultural symbols or commercial elements, exacerbating the cultural identity dilemma caused by formalistic treatment.

3.4.5 Ecological Level

The spaces under bridges generally suffer from ecological fragility and urgently need to form a complete ecological environment support system. Current designs mostly focus on achieving functionality without considering the overall ecological protection planning concept, making it difficult to fully assess the potential impact on the surrounding natural environment. Rainwater directly discharged into the drainage pipe network under the bridge can easily cause frequent water accumulation and aggravate the risk of surface water pollution in the nearby area. The dense and continuous distribution of hardened facilities significantly changes the runoff direction, thereby further deteriorating the health level of the local ecosystem. The exhaust gas, dust, and noise pollutants generated during the construction of highways lack effective control measures, constantly damaging the spatial quality and living standards of residents in the urban-rural fringe.

3.4.6 Management and Ownership Level

Urban space has a dual nature: the characteristics of the first level of space are determined at the beginning of planning and design, while the second level gradually emerges with environmental changes and the development of social practices. The idle space under highway overpasses has been neglected from the planning stage, and the lack of public awareness of this phenomenon has kept it hidden for a long time. Due to the unclear definition of the ownership of such space rights in current laws and regulations, it is difficult to distinguish the responsible parties, which leads to a situation of mutual shirking of responsibility in maintenance and management, which has become a major problem in urban governance.

The current inefficient use of space under viaducts is not solely due to the intentional actions of planners or designers, but rather the result of the interaction of

numerous social factors. Lacking clear functional guidance, these areas have long been in a state of unclear functional boundaries, leading to persistent problems such as illegal construction and disorderly street vending. Due to the complex property rights situation and the shortcomings in the implementation of the "urban-rural integration" policy, relevant measures for "comprehensive environmental management" are difficult to fully cover the scope of application in these special areas, further marginalizing them and causing undeniable damage to their public attributes.

3.5 Limiting Factors of Space Under Viaducts

3.5.1 Spatial Scale Limitations

The scale of the space under elevated highways is primarily determined by the clearance beneath the bridge, and the actual usable height is often constrained. When the clearance is less than 6 meters, the field of vision is severely limited; the massive bridge shadow and narrow viewing angle mean that people can only see external scenery through structural gaps. The lower the clearance, the narrower the field of vision, leading to a decrease in psychological security and a feeling of oppression. This feeling is closely related to the ratio of bridge deck width (D) to clearance height (H). The larger the DH ratio, the more obvious the imbalance, the stronger the sense of spatial oppression, giving people the feeling of being on the back side of the city.

Spatial scale not only causes psychological discomfort but also affects functional design. The proximity of the bridge to people exacerbates problems of noise, exhaust fumes, and insufficient natural lighting. The existing clearance height under the bridge is usually unadjustable, further restricting the landscape and functional layout (Figure 3-8).

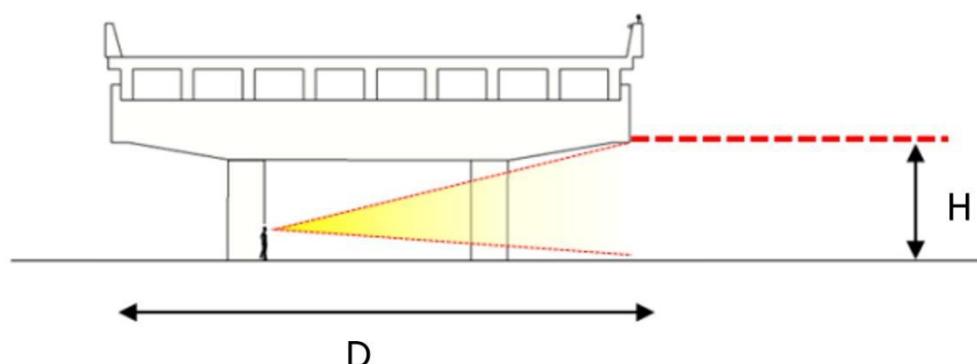


Figure 3-8 Schematic Diagram of Overpass Width (D) and Underpass Clearance (H)

(Image Source: Author's own drawing)

3.5.2 Environmental Limitations

1. Noise Interference

Viaducts have high traffic volume, resulting in a complex acoustic environment under them. Vehicle noise and vibration from bridge joints are transmitted through the structure, amplified by reflections from the ground and the bridge deck, continuously impacting the space beneath the bridge. Studies show that noise levels near elevated highways are typically 50–90 decibels, reaching up to 110 decibels when horns are blaring. Long-term exposure can damage hearing and interfere with verbal communication. The persistence and uncontrollability of the noise also exacerbate its negative psychological impact.

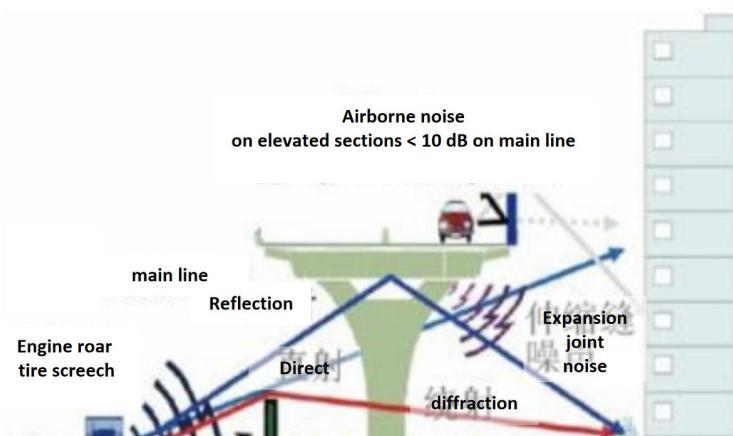


Figure 3-9 Schematic diagram of noise sources and sound propagation paths under viaducts
(Image source: Reference 38)

2. Insufficient Light

The bridge structure blocks natural light, creating large areas of shadow and reducing people's sense of security. Some elevated highways are up to 40 meters wide, and the limited clearance further exacerbates the darkness under the bridge. In densely built-up areas, side light is further blocked, and these areas often have higher public activity demands and a more urgent need for lighting. Insufficient light also inhibits plant growth and limits the possibilities for landscape design.

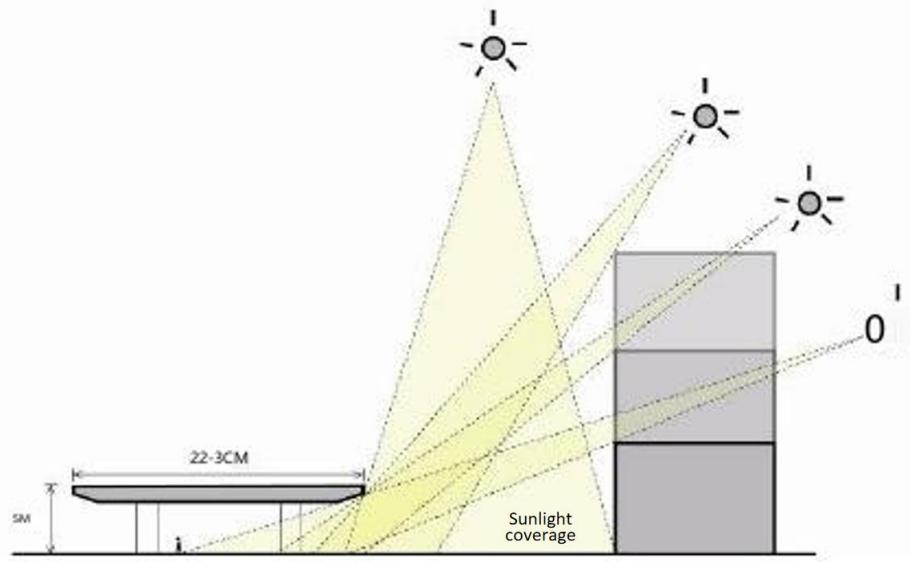


Figure 3-10 Schematic diagram of remaining lighting limitations in the space under the overpass

(Image source: Reference 39)

3. Environmental pollution

Exhaust fumes and dust from high-speed vehicles seriously affect the air quality in the bridge area. Motor vehicle exhaust has become a major source of urban air pollution, with PM2.5 and other incomplete combustion products harming human health and inhibiting plant growth. In addition, oil stains on the bridge deck are washed down by rainwater to the area below, and due to the lack of effective drainage, they form continuous pollution in the dark and hidden environment.

3.5.3 Limitations on Spatial Accessibility

The most prominent feature of high-quality public spaces is their non-mandatory nature, which gives the public the freedom of choice. Therefore, optimizing the entrances to the spaces under the bridges to facilitate convenient connection to the pedestrian system and avoid interference from vehicular traffic is crucial. In particular, the spaces under the bridges located in the middle of the road have the weakest accessibility due to being isolated by fast-moving traffic, and are very likely to become "spatial islands" that pedestrians are unwilling to enter.

Based on the reality of insufficient pedestrian accessibility, it is necessary to break away from traditional thinking and reposition the idle spaces under the bridges as areas of demand for motor vehicles and public transportation, such as setting up car catering service points, repair centers, or temporary parking facilities. Relying on

innovative design concepts to promote functional reshaping, we can transform passively into actively exploring its inherent value potential.

3.6 Policy Analysis and Case Study of Space Under Viaducts in Guangzhou

3.6.1 Relevant Policy Environment for the Utilization of Space Under Viaducts in Guangzhou

The "Guangzhou Municipal Bridge Underpass Space Construction Planning and Technical Guidelines" (hereinafter referred to as the "Plan"), proposed in February 2023, further promotes the construction and operation of public spaces under urban bridges. Following the "one bridge, one plan" work system and the "one bridge, one landscape" approach, it aims to create high-quality transportation spaces with "one bridge, one characteristic," guiding bridge underpass projects through innovative methods such as "adjustment, expansion, and renovation" ^[56]. According to the Plan, the total usable area under municipal bridges in Guangzhou is approximately 5 million square meters, comprising 629 locations, including 350 vehicular bridges and 279 pedestrian overpasses. The Plan proposes four major construction strategies: refinement, orderliness, functionality, and quality, and three major improvement categories: quality enhancement, functional utilization, and environmental cleanliness. It aims to construct bridge underpass spaces that are "easy to use, easy to manage, and aesthetically pleasing," ensuring orderly traffic, safe activities, a clean environment, and shared functions ^[40].

Huang Huiwen, a member of the Guangzhou Municipal Committee of the Chinese People's Political Consultative Conference (CPPCC) and General Manager of the Property Management Department of Guangzhou Construction Group Co., Ltd., submitted a proposal to the Guangzhou Municipal People's Congress and CPPCC sessions entitled "Awakening Guangzhou's 'Sleeping' Under-Bridge Spaces," which included a series of suggestions. These suggestions included utilizing the space under viaducts to create a window to a green and beautiful Guangzhou, constructing cultural landscapes, pocket parks, and theme parks with Lingnan characteristics and Cantonese culture, and promoting Guangzhou's horticulture as a "flower city."

3.6.2 Survey on the Practical Utilization of Space Under Viaducts in Guangzhou

1. A Survey on the Overall Practical Utilization of Spaces Under Guangzhou Viaducts

The space under Guangzhou's municipal bridges is widely distributed, mainly along the Inner Ring Road and its radial lines, the cross-river bridges on both sides of the Pearl River, the core interchange system in the city center, pedestrian overpasses, and key nodes and entrances to important urban expressways. Based on the functional nature of the bridges and the characteristics of the obstacles they cross, they can be divided into two categories: vehicular passageways and pedestrian crossings. These can be further subdivided into various specific types such as interchanges, viaducts, and river-crossing bridges.

Guangzhou has been planning and renovating the space under the bridges for many years. The aging facilities and functional degradation have been repeatedly mentioned by the public. Since 2017, the Guangzhou Municipal Housing and Urban-Rural Development Commission has included it in the scope of key projects for improving the quality of the urban environment. It has selected six typical bridges, including Guangzhou Bridge, Huangpu Interchange and Liede Bridge, as demonstration areas to carry out special treatment work. A total of about 180,000 square meters of area has been renovated.

The optimization and upgrading of the space under bridges is an important part of the construction of beautiful and livable cities and the ecological project of green and beautiful Guangdong. Its strategic significance is far-reaching. After the introduction of the "Guangzhou Municipal Bridge Under-Bridge Space Optimization and Upgrading Work Plan", all administrative districts in the city have carried out functional transformation planning for more than 60 areas under bridges and achieved the goal of district-level overall management. After systematic renovation, important nodes such as Liede Bridge, Huanan Bridge and Pazhou Bridge have promoted the transformation of sanitation facilities and private parking spaces into public service venues in the landscape belt on both sides of the Pearl River. This has formed a multi-functional composite place that combines the function of Lingnan culture display and fully integrates the needs of local historical and cultural inheritance and development, significantly improving the functional diversity and service quality of

the space under bridges.

From the perspective of governance structure, the development practice of spaces under Guangzhou's viaducts highlights the practical significance of taking pilot projects as a breakthrough and focusing on shaping a public participation mechanism. Following the goal of creating a "multi-party collaborative governance" social governance pattern, some scholars have proposed establishing a special group composed of bridge management departments, owners, street offices, community residents, planning and design institutions, and media platforms to systematically discuss functional improvement issues, improve operational procedures and the supervision system, and adopt the method of selecting typical areas to implement renovation projects first. Throughout the process, public opinions are widely solicited and feedback is provided in a timely manner, creating a positive atmosphere of co-construction and sharing, thereby effectively enhancing the actual sense of gain and happiness of social members.

2. Specific Case Studies of Spaces Under Guangzhou's Viaducts

In recent years, many spaces under cross-river bridges, pedestrian overpasses, and elevated facilities in Guangzhou, after being renovated and upgraded and integrating various functions while ensuring safety, have gradually become large open areas that can serve multiple purposes, such as art gallery exhibition areas, sports venues, garden green spaces, and popular photo spots.

(1) Integration of the experience area under the bridge with the surrounding ecological landscape belt - Nangang River Yue Dong Park, Changling Street, Huangpu District

The public space under the bridge of Beishida Erzong Road in Huangpu District has been transformed into an interesting and practical urban leisure place. The design uses a unified theme style throughout the entire process, and interactive experience areas such as children's climbing facilities, sandpit playgrounds and slides are arranged inside; the functional areas of the rest station are also planned in combination with the natural environment of the Nangang River ecological landscape belt, so that the overall layout can appear very harmonious.



Figure 3-11 (left) Nangang River Yue Dong Park and the ecological landscape corridor outside the bridge. (Right) Children's playground in the street park inside Yue Dong Park

(Image source: CNR.cn)

(Image source: Author's own photo)

(2) Combining local culture with children's activities and utilizing shipping containers—Mark Village Bridge Park in Nansha District

Dongchong Town in Nansha District has made full use of the approximately 9,000 square meters of "abandoned space" under the Xiqiao Waterway viaduct, transforming the abandoned bridge area into a "multi-functional" treasure space. A bridge park integrating fitness, leisure, and play functions has been created in accordance with local conditions. The Mark Village Bridge Park has a reasonable functional and activity/rest area, divided into a low-age exploration area, a children's experience area, an older children's activity area, a sports and fitness area, and a book reading corner. Inspired by water towns, lion dance elements, and lion dance colors, it creates an activity and rest space suitable for all ages. It has become a newly popular destination for families with young children.

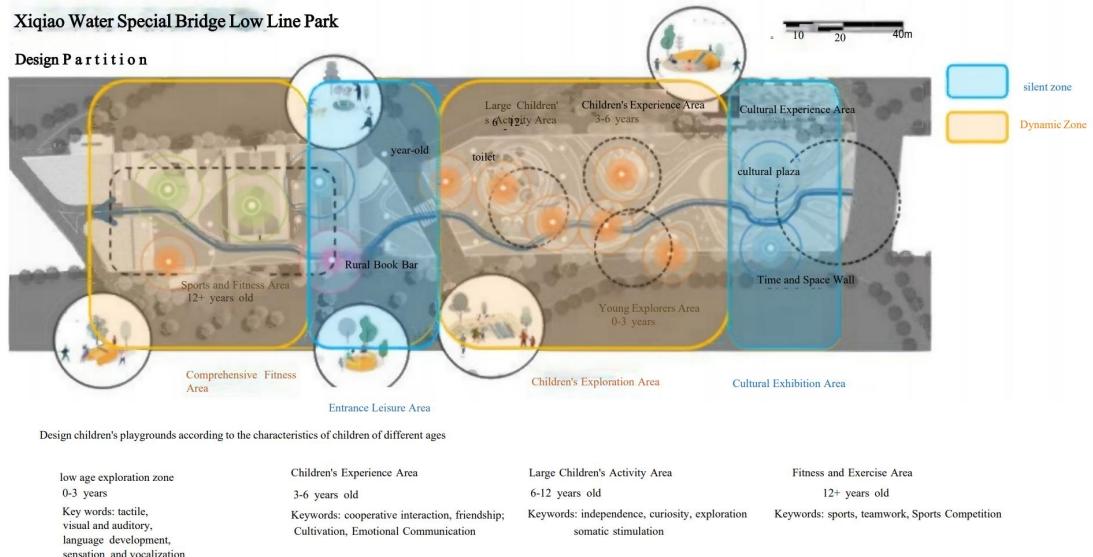


Figure 3-12 Design Zoning Map of Mark Village Bridge Park

(Image Source: Author's Redrawing)

In 1956, Mark Village established the first lion dance team in the Tung Chung area. In September 2004, Mark Primary School became the traditional lion dance culture inheritance base of Mark Village. Lion dance culture is one of Mark Village's "cultural treasures".

Mark Village Bridge Park delves into Mark Village's "lion dance culture". In the children's exploration and play area, water ripples and lion dance movement elements are integrated into the site design, and further transformed into slides and climbing nets, creating lion dance-themed amusement facilities. The cultural exhibition area features the "Mark Time" landscape wall and cultural square. The "Mark Time" landscape wall, combined with old photos, tells the story of Mark Village's origin in the Ming Dynasty, showcasing the transformation of Mark Village from a silted-up farmland in the Ming Dynasty into a cultural and tourism characteristic village in Guangdong Province that integrates modern industry, agriculture, culture and tourism.



Figure 3-13(Left) Lion Dance Cultural Theme Amusement Facilities in Mark Village

Figure 3-14(Right) "Mark Time" Landscape Wall in the Cultural Square

(Image source: Author's own photo)

The Mark Village Bridge Underground Park is also equipped with a visitor service center, public restrooms, and a large under-bridge parking lot with 600 spaces, further enhancing the experience for residents and tourists. The Mark Village Bridge Underground Park also features a "Farmhouse Bookstore" with approximately 1,500 books, covering children's picture books, literature, and science. The bookstore has a comfortable and beautiful environment, where families can enjoy reading time together.



Figure 3-15 Interior and exterior views of the container "farmhouse bookstore" in the Mark Village Bridge Park (photographed by the author)

(3) Combining the Guangfu culture with the bridge park in the urban center - Children-friendly park under the viaduct in Sanyuanli Street, Baiyun District

Children-friendly park under the viaduct in Sanyuanli Street, Baiyun District, Guangzhou City, is designed around diversified theme graffiti. It combines historical and cultural landscape walls, red landmarks and Guangfu intangible cultural heritage elements, and cleverly incorporates multi-purpose modules such as benches, trampoline facilities, leisure areas and tiered seats. In the fourth quarter of 2023, "Vibrant World" was a cultural block renovation project, creating a comprehensive sports space of about 2,500 square meters under the airport overpass. "Vibrant World" transformed the original vacant land into a functional place with both historical heritage and modern style. It can be used for the surrounding residents to exercise regularly, and can also be used for large-scale events such as youth sports competitions or folk festival celebrations.



Figure 3-16(Left) Cantonese dialect wall under the Sanyuanli overpass in Baiyun District

Figure 3-17(Right) Child-friendly park under the Sanyuanli overpass

(Image source: Author's own photo)

(4) Combining regional culture with leisure and installations under the river bridge - the riverside dragon boat culture strip park under the Liede Street Bridge in Tianhe District

The open space under the Liede Bridge and Linjiang Avenue in the Pearl River landscape belt has gradually transformed into a leisure node with Lingnan cultural characteristics after the improvement of the slow-moving system and the division of functional areas. It provides the surrounding residents with a waterfront walking route and public rest area with sports attributes. On this basis, the addition of dragon boat-themed sculptures (such as dragon head-shaped seats and oar decorative elements) further highlights the unique symbol of regional traditional culture and its historical heritage value.

The park under the Liede Bridge has been widely recognized by community residents. An elderly male interviewee said that he often rests here for a while. Some parents bring their children to carry out outdoor activities. A female interviewee said that "there are few mosquitoes here and there are safety facilities for children to play."



Figure 3-18 The bottom of the Liede Bridge has been transformed into a dragon boat culture park after micro-renovation (Image source: self-taken by the author)

(5) Improve the quality of the original landscape and create cultural facilities - the space under the Donghaochong Elevated Road in Yuexiu District

If the space under the bridge is idle or used inefficiently for a long time, it may have a negative impact on the overall image of the city and the quality of the surrounding environment, which will lead to a decline in the happiness of residents. After adopting a variety of renovation methods such as greening and beautification, public art installations and cultural theme graffiti, not only can its potential value be brought into play, but the city can also have more ecological meaning and aesthetic color.

Relying on comprehensive renovation methods such as bridge body painting repair, revetment stone improvement, and lighting facility upgrade, and with the integration of public art installations, the space under the Donghaochong Viaduct has gradually formed a unique landscape system that combines ecological aesthetics and humanistic care, and has become a representative urban landmark in the central urban area of Guangzhou.

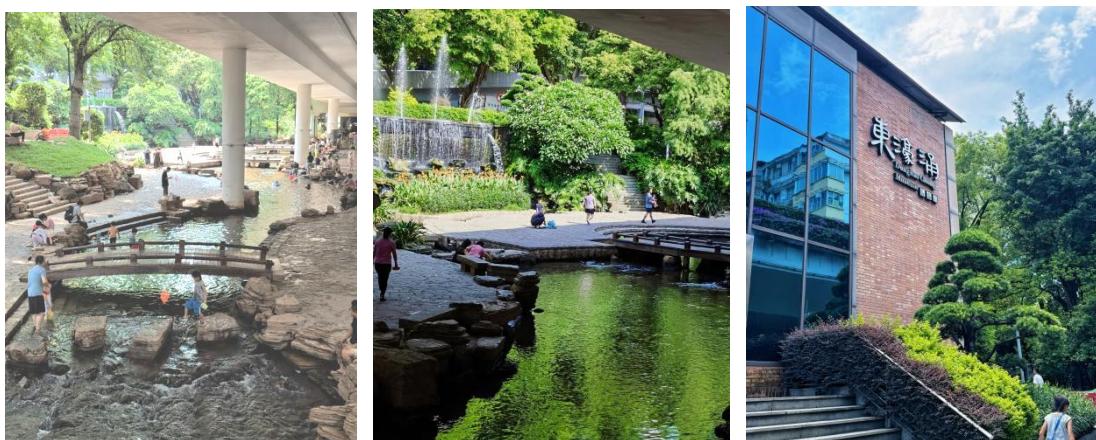


Figure 3-19 Landscape renovation and upgrading of the river under the Donghaochong Viaduct in Yuexiu District and the Donghaochong Museum

(Image source: Author's own photo)

(5) The combination of Cantonese culture with parking and service facilities to meet basic service needs and cultural heritage functions

Due to the scarcity of land resources in the central urban area of Guangzhou, sanitation facilities are scattered and functional zoning is unclear, which has a negative impact on the surrounding environment. Drawing on the successful experience of the renovation of the space under the bridge, it can be included in the scope of full life cycle management, and combined with scientific planning, the existing closed or inefficiently used space can be transformed into a multi-functional sanitation station that integrates service and leisure, thereby improving the quality of urban public space and the residents' life experience.

The space under the north side of the Liede Bridge has been planned as a sanitation service station, with rest rooms, changing areas, and shower facilities for cleaning staff. Combined with the fence design and bridge structure, and equipped with lighting to improve visibility, the municipal service station has become a comprehensive public service venue that is functional, aesthetically pleasing, and easy to manage.

The sanitation operation support parking lot located under the ramp bridge at the intersection of Dajinzhong Road and Guangyuan Road cleverly incorporates traditional elements of Lingnan architecture, such as window lattices, blue brick wall decorations, and murals. While solving the parking lot layout problem, it also transforms the idle space into a unique carrier showcasing the regional culture of the Cantonese region.

3.6.3 Research and Survey on the Ring Park Project Under the Guangzhou Ring Expressway Bridge

Guangzhou plans to optimize and upgrade the space under the bridges of its ring expressway, which has a total length of approximately 60 kilometers, to create the "Ring Park" project. This project explores a green and intensive development model through "ring traffic + urban services + public openness + garden experience," traversing the old and new urban areas of Yuexiu, Haizhu, Liwan, Baiyun, and Tianhe districts of Guangzhou. The design area under the bridges is approximately 800,000 square meters, aiming to achieve high-efficiency utilization of existing space and a high-quality improvement of the city's image based on the standards of "usefulness, aesthetics, and ease of management" [43]. The Ring Park renovation project adopts five major renovation strategies: landscape integration, lightweight architecture, urban integration, industrial revitalization, and artistic intervention. By utilizing the space under the bridges to arrange a comprehensive sports stadium, intelligent parking lot, and convenient service stations, it aims to meet the diverse needs of citizens. This project currently involves four ring road park projects located under the bridges of the ring expressway. The planning concept is based on social welfare, interconnectivity, cross-sectoral integration, diversified enhancement, and sustainable utilization. The aim is to combine the characteristics of the land parcels with various business formats, creating multiple popular photo spots and providing social welfare and convenient service facilities, ultimately serving the public [43].

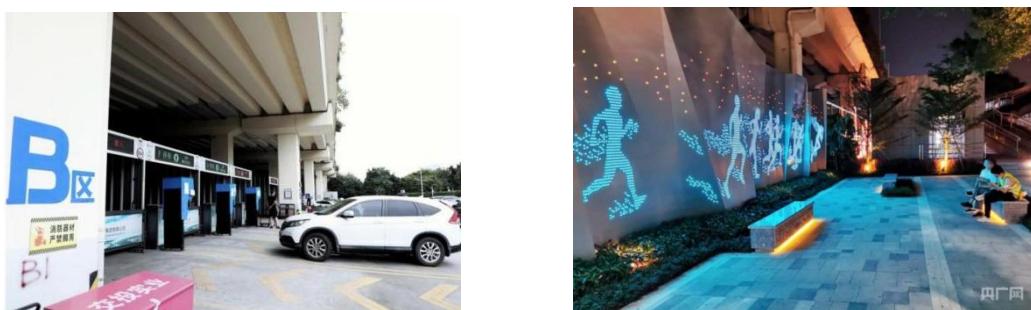
Guangzhou's central urban area faces the dual challenges of parking difficulties and a shortage of public transportation facilities. Leveraging its unique geographical advantages and convenient conditions, the spaces under the bridges can be transformed using low-cost micro-renovation methods. This can involve adding parking lots, bus hubs, and other transportation service facilities within the area, effectively improving the parking situation in the surrounding areas and optimizing

the overall quality of the public transportation environment.

In response to the lack of parking facilities in the Olympic Sports Center and surrounding areas, the Olympic Sports Center section of the Ring Expressway, leveraging its underpass space resources, took the lead in building Guangzhou's first AGV intelligent three-dimensional parking garage demonstration project. While alleviating parking conflicts in some areas and improving land use efficiency, it also provides a new approach and reference model for comprehensive urban traffic management.

The renovation project under the Huangpu Avenue overpass of the South China Expressway added bay-style bus stops, leisure seats, and small gathering plazas, providing a safe waiting environment for residents in the surrounding area while not affecting the normal traffic flow of the main road.

Guangzhou Transportation Investment Group first launched two demonstration projects in the space under the bridge of the Olympic Sports Center section of the Ring Expressway. The core theme is the "Park and Ride" interchange hub. In accordance with the planning concept of "two corridors, four zones, and four parks", the project strives to create a comprehensive space integrating intelligent services, ecological leisure, and transportation connections. The project is located near the elevated section on the west side of the Dongpu Grand Bridge. The space under the bridge is relatively spacious, and part of it has been transformed into parking facilities. The original ordinary parking lot in Zone B has been transformed into a double-layer multi-level parking garage through technological upgrades and the introduction of automated storage and retrieval devices, which greatly improves land utilization and management efficiency.



Left: Smart parking lot under the Olympic Sports Center section bridge

Right: Leisure area next to the parking lot under the Olympic Sports Center section bridge

Figure 3-20 Riverside parking lot under the Olympic Sports Center section

(Image source: Author's own photo)

Another project is the space under the bridge of the Tuhua section of the Ring

Expressway. This project is positioned with "sports + life" as its core, connecting nodes such as the waterfront plaza, sports fields, and cultural plaza through a slow-moving greenway. After the renovation, the space transcends its single function of transportation or parking, transforming into a composite living scene integrating leisure, sightseeing, and community activities. Its sports park area integrates various facilities such as a football field, basketball court, climbing wall, and roller skating rink, significantly enhancing the functional diversity and public vitality of the space under the bridge.



(a) Ice skating gateball court under the Tuhua section bridge (b) Indoor badminton stadium under the Tuhua section bridge

Figure 3-21 Sports field under the Tuhua section bridge (Image source: Author's own photo)

During the field survey, the author conducted a detailed investigation inside the badminton court in the Tuhua section. The indoor court under the bridge is quite wide, with a small portion extending beyond the width of the bridge surface, thus extending outward by about 2 meters. The roof of the extended area is made of container sheet metal. During the high temperatures of summer, participants generally reported insufficient air circulation in the indoor court, leading to stuffiness and difficulty breathing after high-intensity exercise. Communication with the venue operator revealed that although attempts had been made to improve environmental conditions by optimizing the air conditioning system layout and improving ventilation design, the added sheet metal exterior walls easily absorb heat and rise in temperature during summer, and the large building scale significantly increases energy consumption, making it difficult to achieve ideal temperature and humidity control. The survey also found that the roadway parallel to the bridge lacked a dedicated pedestrian walkway, leading to mixed pedestrian and vehicular traffic. This section of the underpass attracts a significant amount of pedestrian traffic, necessitating greater attention to accessibility and traffic safety. Based on this situation, the research sample selected

for this study should fully draw upon existing practical experience and improve the design scheme accordingly to enhance functionality and comfort.



Left image: High energy consumption in summer due to the corrugated iron exterior wall of the expanded indoor gymnasium under the Tuhua section bridge

Right image: Lack of pedestrian walkway on the roadway beside the Tuhua section bridge

Figure 3-22 Underpass and surrounding area of the Tuhua section bridge

(Image source: Author's own photo)

3.7 Chapter Summary

This chapter first provides an overall analysis of the types, characteristics, and attributes of spaces under viaducts. Then, it elaborates on the potential of transforming underpass spaces into public spaces from the perspectives of ownership structure, ease of renovation, and the characteristics of gray spaces. The following is a summary of the current problems of the space and the limiting factors for its transformation into a public space. Finally, the policy analysis and case study of the space under the viaduct in Guangzhou are presented, including the research and survey of the Ring Park project under the Guangzhou Ring Expressway, which lays the foundation for the strategy proposal and final design practice in the following text.

Chapter 4 Research on Design Strategies for Space Under Urban Viaducts

4.1 Functional Reorganization and Composite Utilization of Space

The following points interpret the functional reorganization and utilization from the three perspectives of "functional integration", "vertical layering" and "time and space sharing".

4.1.1 Functional Composite Configuration

In the transformation of spaces under viaducts, functional integration is one of the core strategies. By rationally integrating multiple uses such as leisure, sports, commerce, culture, ecology, and parking, the spatial narrative can be enriched and the vitality of the site can be enhanced. For example, the Toronto Bentway project transformed approximately 7 acres of land under the bridge into a shared space integrating an outdoor theater, ice rink, and entertainment area; the Shenzhen Xiwang-Qianhai Bay project also set up a multi-functional activity area.

Functional positioning is the basis of design and should be judged in combination with the following aspects: grasp the development direction by interpreting the overall urban plan and regional development documents; analyze the functions of the surrounding cities to identify supplementary needs; and investigate public opinion to clarify actual needs, thereby determining the space type and main functions.

At the same time, functions should be reasonably configured in combination with the spatial scale and the surrounding land use attributes to improve utilization efficiency. The specific design points are as follows:

- (1) The design scope is mainly the projection area under the bridge, integrating adjacent roads and surrounding blue and green spaces to implement overall design.
- (2) The main functions should prioritize serving the surrounding residents, creating a scene that promotes communication and activities, such as sports and fitness, children's play, leisure and rest, and supporting services, to activate the spatial atmosphere.

(3) In order to improve urban functions, strengthen regional integration, and improve utilization efficiency, different functions should be reasonably matched in the site.

Table 3 lists the compatibility matrix of the composite functions of urban bridge spaces. For example, leisure areas, sports areas, and public facilities should attract people, while social parking, bus terminals, and municipal facilities need to ensure vehicle access. The two should be set up separately to prevent interference; landscaping can be flexibly combined with other functions as a supplement or spatial separation means.

桥下空间功能复合兼容矩阵表

compatible/not compatible
 ○ 兼容 × 不兼容

	Parking	Leisure	Sports	Landscape	Municipal administration	convenience	Commerce
Parking	-	×	×	○	○	×	×
Leisure	×	-	○	○	×	○	○
Sports	×	○	-	○	×	○	-
Landscape	○	○	○	-	○	○	○
Municipal administration	○	×	×	○	-	×	×
convenience	×	○	○	○	×	-	○
Commerce	×	○	×	○	×	○	-

Figure 4-1 Table of the Functional Compatibility Matrix of Urban Under-Bridge Spaces

(Modified from literature, source: Reference 21)

Function Type	Height Requirements	Plane Requirement	Other requirement
Bus terminal	Headroom \geq 4.5 m	Continuous land area \geq 1000m ²	The dedicated turning area for the bus and trolleybus terminal under the bridge shall be located on the same side as the main traffic flow direction for passenger assembly and distribution, and its entrance and exit shall not be directly connected to the main road.
social parking	Headroom \geq 2.5 m	Priority should be given to utilizing linear spaces at the edges and corners, along the street.	Priority should be given to locating them on both sides of the straight section of the bridge area, with one side serving as the entrance and the other as the exit. Dedicated acceleration and deceleration lanes should be established to ensure safe entry and exit of vehicles.
Municipal support	Headroom \geq 3.0 m and at least 2.5 m	Under 200m ² for small point landscape greening; Linear landscape greening can be set in combination with the site	
Landscape afforestation	<2.2 m as isolated green space \geq 2.2 m binding other Function Settings	According to the requirements of various leisure facilities	It is necessary to deal with the internal streamline guidance of landscape greening, and ensure the streamline of the space under the bridge to keep overall consistency
Recreational space	Headroom \geq 2.2 m	According to the requirements of various sports venues	There should be a relatively enclosed space to ensure that there is basically no motor vehicle traffic crossing
Sport field	Badminton court \geq 9 m; Basketball, football and tennis courts \geq 7 m; Table Tennis and G	According to the area requirements of various sports venues	The outside of the site needs to reserve a certain amount of buffer zone
Convenience facilities	Public toilets \geq 2.2 m; Community service, cultural public city, etc.	Small convenience facilities are generally not suitable $<$ 200m ²	

Table 4-1 Spatial Requirements of Different Functions in Urban Under-Bridge Spaces

(Source: Reference 20)

Based on the current functions of under-bridge spaces and referring to the planning and design functions of under-bridge spaces in domestic and international cases, the spatial requirements of various functions are summarized (see the table above).

With the diversification of contemporary lifestyles, single-function public spaces are no longer able to meet the multiple needs of urban life, and public space design is increasingly trending towards functional integration.

Project name	Place	Main function types	Derived feature type
Bentway Park	Toronto, Canada	Landscape greening and recreational activities	Sports, Culture and Arts, Public Services
The Underline Park	United States, Miami	Landscape greening and recreational activities	Culture and art
Under the BQE program	New York, USA	Commercial trade	Sports
Gowanus Expressway project	New York, USA	Landscape planting	Culture and art
Folly for a Flyover Project	United Kingdom, London	Commercial trade	Culture and art
10 Kilometers Project	Bangkok, Thailand	Landscape greening and recreational activities	Sports, public services
Garden under the bridge in Mumbai	India, Mumbai	Landscape greening and recreational activities	Sports
A8ernA project	Zanzibar, Netherlands	Landscape greening, commercial trade	Public services, sports

Figure 4-2 Table of Functional Integration of Under-Bridge Spaces Abroad

(Author's own drawing)

In comparison, the degree of integrated utilization of under-bridge spaces abroad is higher.



Figure 4-3 The Bentway project in Canada (Image source: Arcdaily)

Based on the original functional characteristics of the plot selected in this paper, the following section will proceed with a case analysis and specific research on the commercial functions under bridges.

(1) Architectural Intervention as the Main Approach

Under the Gotanda Station Elevated Road on the Ikegami Line in Japan, a diverse range of shops catering to the daily lives of residents are introduced based on the concept of "urban experience." Unlike the high-end commercial formats in the Nakameguro area, such as Starbucks and international cuisine, this area focuses more on serving local residents. Starting from meeting basic living needs, it introduces fruit and vegetable shops, donut shops, bicycle shops, self-service coin-operated laundromats, and breweries, gradually stimulating the vitality of the space, attracting people, and driving regional development. In addition, the setting of bicycle lanes has also attracted cyclists, expanding the commercial activities under the bridge from small-scale operations to cross-regional commercial collaboration, achieving mutual benefit and symbiosis.



Figure 4-4 Under the Gotanda Station overpass on the Ikegami Line in Japan

Under the elevated roof of Gotanda-eki, Ikegami, Japan

(Image source:<https://matcha-jp.com/cn/5935>)

The Mikan Shimokitazawa commercial district, a mixed-use commercial facility developed by Keio Electric Railway under the elevated Shimokitazawa Station, is the birthplace of Tokyo's subculture. The area boasts a strong artistic atmosphere, with numerous small theaters, vintage clothing stores, livehouses, cafes, and other artistic spaces, attracting residents and tourists alike. The word "Unfinished" echoes the project's theme, "Welcome to this endless zone of play and work," signifying the fusion and evolution of diverse cultures here. The design firm used black metal and elevated concrete structures to create "containers," which, while seemingly rough, actually convey a sense of freedom and flexibility, perfectly reflecting the culture of Shimokitazawa and the project's core principles.



Figure 4-5 The "container" architectural style and streetscape of the "Unfinished Shimokita" commercial district in Japan (Image source: Arcdaily)

The park under the A8ernA bridge in the Netherlands fully incorporates the opinions of community residents, incorporating a supermarket, flower shop, fish shop, parking spaces, a park, and a graffiti gallery. A shooting range is cleverly located in

the ramp area. Public-private collaboration has continuously enriched the project's content; the supermarket under the bridge, combined with the bridge pillar lighting design, further enhances the commercial atmosphere.



Large-scale supermarket and commercial advertisements in the flower and bird shop under the A8ernA Bridge in the Netherlands

Figure 4-6 The A8ernA Bridge in the Netherlands (Image source: Reference 54)

(2) Night market blocks and mobile market forms

Chongqing, as the "city of bridges", has a large number of spaces under bridges due to its topography and three-dimensional transportation system. With the increasingly refined urban governance, these previously neglected "gray spaces" have been gradually activated and transformed into new urban public areas.

For example, the field karaoke venue under the Beibin Road overpass in Jiangbei District was originally a supporting land for Fisherman's Bay Wharf. Commercial development started in July 2023, attracting cultural and tourism enterprises to participate. The unique structure of the space under the bridge is quite popular among young consumers. Modern commerce is gradually moving from centralized to street-style, and the space under the bridge provides new possibilities for combination. Despite the lack of basic conditions such as water and electricity supply, with the support of the local government, enterprises and streets have worked together to explore mobile and prefabricated commercial forms and strictly protect the safety of the bridge structure.



Figure 4-7 Chongqing N37 Bridge Corner Night Light Campsite (Image source: Baidu)

Figure 4-8 Lanzhou Cross-River Bridge Gray Space Night Market Commercial Street (Image source: Author's own photo)

For example, the Higashi-Koganei shopping street and Shimokitazawa-go on the Chuo Line in Japan adopt the form of a market with movable boxes and street-side commercial installations, as shown in the figure below.



(a) Shimokitazawa Kago (b) Chuo Line Higashi Koganei Commercial Street

Figure 4-9 Using the space under the linear bridge as a commercial market

Utilization of linear under-bridge spaces with commercial image source: (a) <https://d.re-write.co.jp/works/20141031/>

(3) Providing new consumption scenarios (such as combining with cycling themes)

The space under the Gotanda Elevated Road on the Ikegami Line in Japan brings together 13 shops, forming a 230-meter-long commercial strip. Among them, the new business format "STYLE-B" with cycling lifestyle as its theme is particularly prominent. With the concept of "happier, more convenient, and more fulfilling time", the store integrates a full chain of services such as bicycle sales, repair, rental, sightseeing tours, and indoor parking with showers. Its location is based on the excellent cycling conditions of the nearby Yamate Avenue and the cluster of startups in the surrounding area. It mainly serves young commuters and cycling enthusiasts.

and has become an emerging gathering place that meets the needs of personalized community social interaction.

Other functions include ecological leisure green parks, such as the green corridor under the bridge in Taichung, Taiwan; sports and exercise functions, such as the Dandenong Railway Linear Sports Park; transportation convenience, such as the parallel design of the elevated bicycle lane of Xiamen BRT; and multi-functional public spaces, such as the Bentway public space in Toronto (see below).



Figure 4-10 The rich functional utilization of space under viaducts (Image source: Archdaily)

4.1.2 Vertical Layered Utilization

(1) Using terrain changes such as steps, stairs, and elevated platforms for vertical layering

By setting steps, platforms and elevated structures to deal with terrain height differences, the vertical layering strategy can alleviate the height restrictions of the space under the bridge, and create rich visual layers while improving the efficiency of space use.

For example, in The Bentway project in Canada, the wooden stepped platform next to the bridge pillars serves as a gathering and performance space, while the area below the platform houses community activity rooms, restrooms, and storage rooms.



Figure 4-1 The Bentway project features a stepped platform serving as an activity area, with indoor spaces below. (Image source: Gooood Design Network)

For example, the Seoul Terrace Plaza, a central space, is divided into two levels, creating a new type of public area through the rooftop. The upper level runs east-west, extending to the elevated road; the lower level integrates the surrounding blocks with the site, expanding the site boundaries. The upper level is used for cultural activities and fitness and leisure, while the lower level serves as a shaded area for residents during the day and transforms into an outdoor coffee area for nearby food stalls at night, allowing the "Terrace Plaza" to present different usage scenarios according to the daily rhythm.

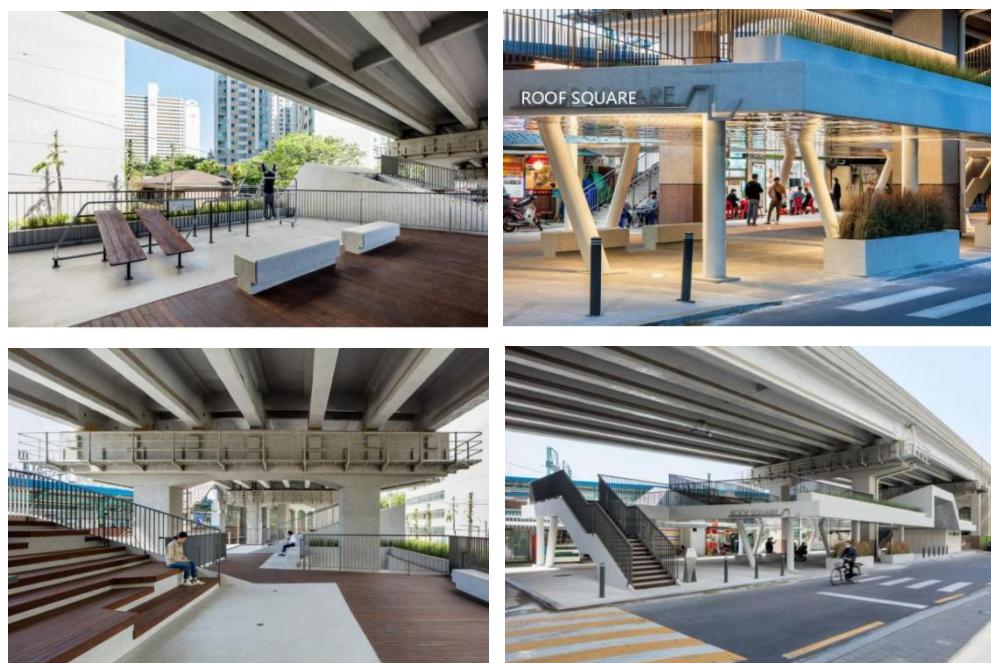


Figure 4-12 Upper and lower functional stratification in the Seoul Terrace Plaza
(Image source: Civil Engineering Online <https://bbs.co188.com/thread-10159136-1-1.html>)

(2) Ecological vertical stratification using pedestrian corridors

Taking the basic space plan under the Southeasterly Freeway in Boston, USA as an example: the bottom level serves as an ecological layer, collecting road runoff for irrigating native plants such as milkweed and yarrow, forming a rain garden and bio-depression system; the upper level is a pedestrian and activity layer, with ramps and elevated walkways, connecting to the lakeside park and providing a space for leisurely strolls.

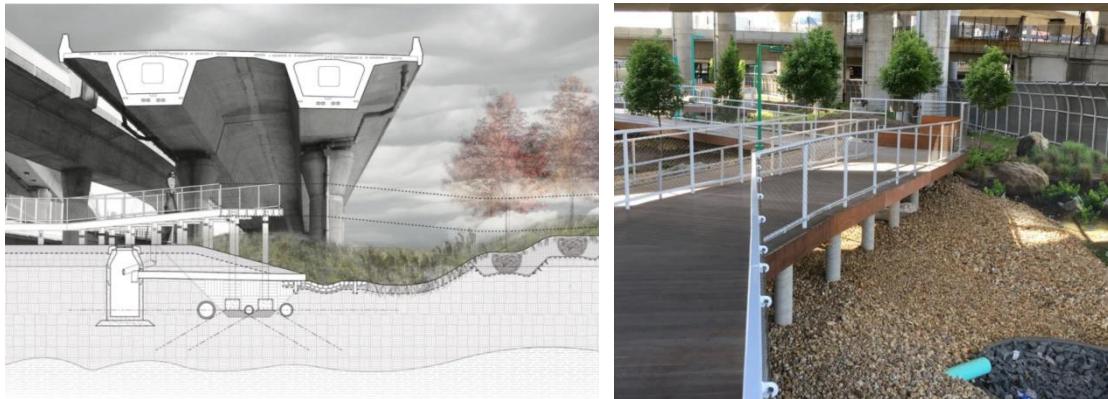


Figure 4-13 Ecological and pedestrian vertical stratification of the basic space plan under the Southeasterly Freeway in Boston (Image source: Archdaily)

(1) Vertical layering using suspended structural devices

For example, in the plaza area of The Bentway public space in Canada, art installations are suspended on the upper level, while the lower level serves as a public activity area, forming a three-dimensional layer in terms of both visual appeal and function.



Figure 4-14 Canada Bentway Public Space (Image source: Archdaily)

4.1.3 Flexible and Variable Design

Flexible and variable design can effectively cope with the dynamic changes in the space under the bridge. By introducing modular facilities and reconfigurable sites, the usage needs of different time periods and groups of people can be met, enhancing the diversity and inclusiveness of space use.

(1) Modularity and mobility

It is recommended to renovate existing buildings or add temporary public service buildings, lightweight buildings, and modular spaces to accommodate functions such as convenient services, small businesses, and community markets, providing flexible support for citizens' activities.



Temporary Public Service Facilities



Temporary structure



Portable toilet

Figure 4-15 Temporary buildings and temporary public service facilities

(Image source: Reference 21)



Figure 4-16 Mobile commercial stalls under the pedestrian bridge in Tianhe City, Shenzhen

(Image source: Author's own photo)



Figure 4-17 Modular Commercial Stalls (Image Source: OPEN Architecture)

(2) Spatial penetration and flexibility

For example, the Strachan open-air grandstand in The Bentway, Canada, is equipped with a hoisting system, allowing it to adapt to various event needs from large-scale performances to small shows, and is also used as a public viewing platform on a daily basis.

This design emphasizes the potential for continuous evolution of the site. All spaces possess flexibility and the possibility of natural development, becoming dynamic and organic entities rather than fixed structures.



The Strachan Grandstand has multiple functions, and the Bentway Plaza offers diverse activities.

Figure 4-18 Strachan Grandstand and Bentway Plaza (Image source: Arcdaily)

(3) Time Division (Day and Night, Dry Season and Rainy Season, Seasonal Transition)

1) Division by Season

The Canada Bentway public space project features a 220-meter-long winter ice track that extends along the lake shoreline, transforming into a walkway with a wading pool in the summer, giving a new seasonal experience to a neglected urban area.



Figure 4-19 Bentway, Canada: Ice track in winter, walking path in summer

(Image source: Arcdaily)

2) Division by Day and Night



Figure 4-20(left) AssBook cafeteria designed as a coffee shop and lounge area during the day

Figure 4-21(right) AssBook as an open-air cinema at night

(Image source: AssBook Design Canteen)

The "Absurd Space Under the Overpass" in Hackney Wick, London, transforms an abandoned overpass into a cinema and event space. It operates as a café during the day and transforms into an open-air cinema at night, achieving a day-night function switch.

4.2 Spatial Reshaping and Sequential Experience Strategies

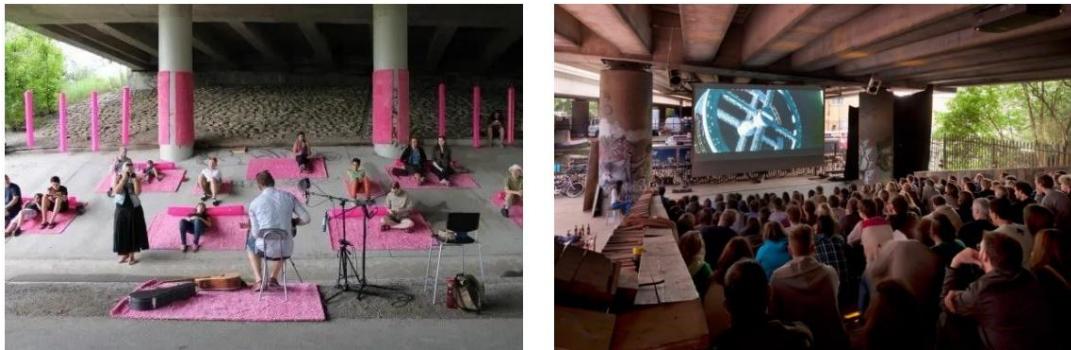
4.2.1 Spatial Form Organization and Reshaping

This article classifies spatial forms into the following types: open space (collage), elevated space, semi-enclosed space, micro-topography, infill space, suspended space, combined space, etc.

(1) Open Space

Open under-bridge spaces refer to spaces transformed into open areas. They typically involve multiple entrances and exits, and the layout of public activity

functions facing surrounding residents to guide people into use the space. Some cases also appropriately introduce temporary projects as an effective way to improve space utilization efficiency.



Pink installation concert project The Folly for a Flyover project in London, UK
Figure 4-22 Folly for a Flyover in London, UK (Image source: Archdaily)

For example, the "Pink Installation Concert" in the Queen's Drive underpass in Ottawa used carpets and inflatable devices to create a temporary performance and rest area at low cost, transforming the originally negative passageway into a bright and warm musical interaction node where pedestrians could play instruments or rest on the paved ramp. Another typical example is the "Folly for a Flyover" project in London, which transformed a space under an abandoned highway bridge in Hackneywick into an art-themed public space. The project was completed in four weeks with the help of volunteers, making extensive use of locally recycled materials, reflecting the concept of sustainability. During its nine weeks of operation, it attracted a variety of activities such as performances, seminars, catering, and film screenings, forming a multi-functional space that serves as a café and event venue during the day and an open-air cinema at night, exploring the potential value and reuse possibilities of neglected urban spaces.

Overall, open spaces are characterized by flexible circulation, diverse activity types, and abundant spatial vitality. Good visual continuity and convenient path connections further enhance the accessibility and attractiveness of the space, creating favorable conditions for users to stay and engage in activities.

(2) Elevated Space

Elevated space refers to a building structure raised above the ground using load-bearing columns under an overpass, forming a transitional area between the bridge and the ground. This design aims to inject new functions into the neighborhood

while maintaining the original pedestrian flow, and to enhance residents' willingness to stay and the vitality of the space through functional integration.

The Roof Square project in South Korea created a two-layered central space under a bridge: the lower level connects to the surrounding blocks and guides pedestrian flow, while the upper level serves as a plaza for people to stop and rest. The space functions flexibly with time, serving as a cultural activity and light exercise venue during the day, and transforming into an open-air café at night, gradually evolving into a community social center. Another typical example is the management center located under the A14 highway bridge in Nanterre, France, designed by architects Odile Decq and Benoît Cornette. The building is characterized by its striking red columns on the lower level and large glass areas on the upper level. About one-third of the building is elevated, while the rest is embedded underground, maintaining visual connectivity between the parks on both sides while naturally integrating the red arched structure into the environment under the bridge.



Figure 4-23 RoofSquare project in South Korea



Figure 4-24 A14 motorway management center

(Image source:<https://www.hhlloo.com>)

(Image source:<https://www.odiledecq.com>)



Figure 4-25 Pedestrian corridor and circular staircase under the bridge in Shanghai Low-Line Park

(Image source:<https://www.waspeak.com>)

The elevated design is characterized by minimizing the impact on the original site and possessing multiple functions. The upper level is used as a functional space

and public activity area, while the lower level is reserved for passage. This achieves the goal of providing space for people to stay without affecting passage. The table below summarizes the elevated design methods for spaces under viaducts based on the above and related cases, dividing them into platform-type elevated design, corridor-type elevated design, and architectural-type elevated design.

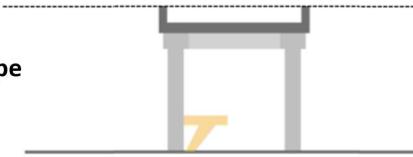
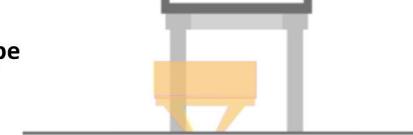
Processing techniques	Diagrams	Case studies	Characteristics
Platform-type overhead		The Bentway Bridge, Seoul Rooftop Plaza	The bridge deck is relatively wide, with features like large staircases designed to encourage community activities.
Corridor-type overhead		Shanghai Low-Line Park	The remaining bridge deck is narrow and only suitable for passage.
Building-type overhead		A14 Highway Management Center	The bridge deck is relatively wide and has architectural space requirements.

Figure 4-26 Summary of elevated design methods

(Image source: Author's self-drawn drawing based on data)

(3) Semi-enclosed

The facade treatment of semi-enclosed spaces can be divided into two methods: vertical semi-enclosed and horizontal semi-enclosed.

The Shanghai Xuhui District Smart Nursing Center uses a horizontal semi-enclosed design in its office and exhibition areas. Extended low walls enhance vertical continuity, while variations in height maintain visual openness while preserving internal privacy.



Figure 4-27 Horizontal semi-enclosed interface: Xuhui District Smart Nursing Center

(Image source: Author's redrawing)

Mumbai's "Greenland Park" employs a vertical semi-enclosed design, using dense greenery to create a transparent interface and form a rhythmic semi-enclosed space. The green barrier enriches the spatial layers, enhances biodiversity, and also helps reduce noise and regulate the microclimate (see image below).

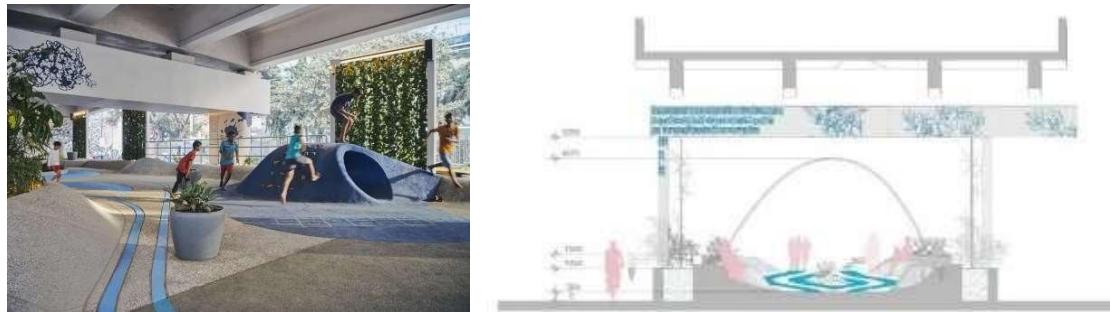


Figure 4-28 Vertical semi-enclosed interface: Greenery in Mumbai Greenland Park

(Image source: Art & Design Network)

Processing techniques	Diagrams	Case studies	Characteristics
Horizontal semi-enclosure		Xuhui District Smart Maintenance Center	Emphasizing spatial boundaries and spatial continuity
Vertical semi-enclosure		Greenland Park	Featuring spatial flexibility, it creates an interface with a sense of rhythm and variations between solid and void.

Figure 4-29 Summary of semi-enclosed space interface techniques

(Image source: Author's own drawing)

(4) Micro-topography

Micro-topography design creates uneven terrain by adjusting surface elevation differences or organizing materials to adapt to different functions and enhance the spatial experience. Its terrain design can involve large-area terrain changes or local treatments, and its elevation changes also help with functional zoning.

1) Large-area terrain changes

Taman Film Park in Bandung, Indonesia, utilizes the natural slope to create curved steps and seating, forming a tiered viewing space facing the river. Curved steps with varying inner and outer radii provide different sizes of private "spaces" for interaction. A skybridge provides shelter, allowing the site to function as an indoor

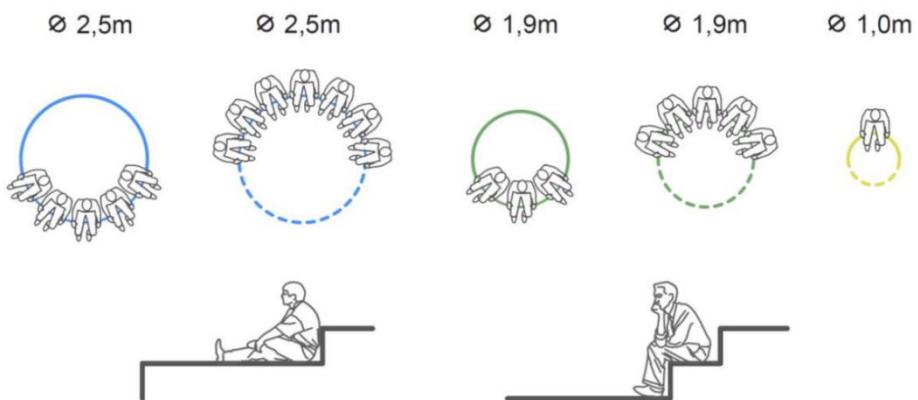
space even on rainy days, making it a vibrant gathering point for residents of the surrounding urban villages.



Figure 4-30 Grandstand section of Bandung Elevated Cinema Park, Indonesia



(a) Micro-topographical seating area simulating natural terraces



(b) Seating arrangements of different scales

Figure 4-31 Cinema Park under the Bandung Elevated Road (Image source: Landscape China)

2) Local micro-topography treatment

The Toorak Crossroads renovation project in Melbourne, Australia, transformed the gray space under the bridge into a public area of approximately 6,000 square meters, integrating a leisure area, playground, and ecological planting area. The

children's playground area uses variations in the local terrain to create a rich and interesting play space.



Figure 4-32 Micro-topographical playground in the Toorak road intersection demolition project in Melbourne (Image source: Gooood)

Similarly, Mumbai Greenland Park uses micro-topography to divide functional areas, creating undulating areas that serve as seating, children's activities, and spatial definition.



Figure 4-33 Micro-topography design of Greenland Park
(Image source: Author's redrawing; <https://mooool.com/one-green-mile-by-mvrdv.html>)

Processing techniques	Diagrams	Case studies	Characteristics
Micro-topographic variations		Greenland Park	Minor terrain modifications for functional zoning and environmental beautification purposes
		Bandung Elevated Movie Park, Kremsky Bridge Skatepark	Making micro-topographical alterations for specific athletic functions or public activities

Figure 4-34 Summary of micro-topography techniques

(Image source: Author's self-drawn illustration based on data)

(5) Infill Space

Infill space refers to the implantation of building entities under viaducts, mainly for commercial functions, but also covering residential, medical, and educational types. These projects are mostly located in residential or commercial areas. By rationally dividing space and organizing circulation, while ensuring safety and connectivity, the space under the bridge is effectively activated and responds to urban needs. This model has a relatively mature renovation process and implementation standards.

For example, the Gotanda Elevated Road project under the Ikegami Line in Japan is 230 meters long and introduces 13 shops that cater to residents' daily lives, such as fruit and vegetable shops, bicycle shops, and breweries, serving local daily needs. Similarly, the Sanagi Shinjuku project in Tokyo is located next to a shopping district and features a retractable facade, providing a multi-functional space for dining and cultural activities. Accessibility is enhanced through entrances on both sides, increasing the vitality of the area.

Similarly, under the viaduct of Mecidiyekoy Square in Istanbul, commercial buildings were set diagonally to blend into the environment under the bridge, following the direction of the pedestrian flow in the square. One is an art building that people can view from the sidewalk or enter the space to experience the exhibition; and a bookstore, which aims to revitalize and showcase the culture of the square and its surrounding area that has been forgotten for many years.



Figure 4-35(left) Project under the Gotanda Elevated Road on the Ikegami Line

Figure 4-36(right) Project in Sanagi-Shinjuku, Tokyo

(Image source:<https://yamakenlab.com/archives>)

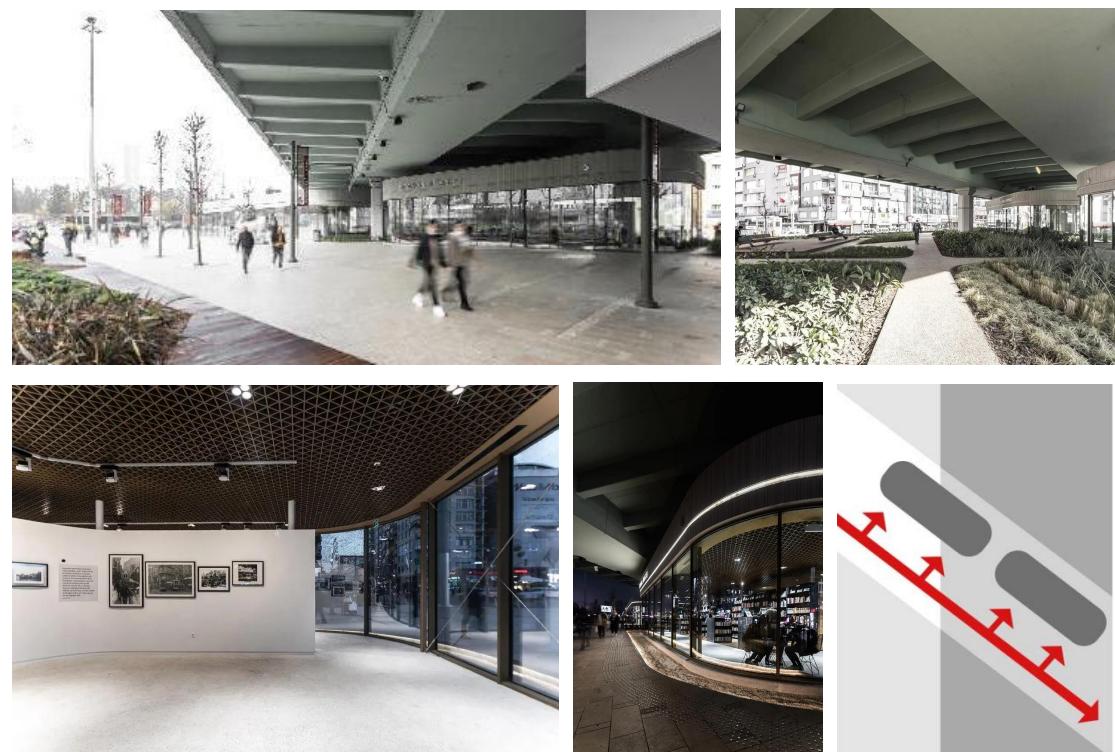


Figure 4-37 Art architecture and bookstores in Mecidiyekoy Square, Istanbul

(Image source: NetEase Landscape)

(6) Suspended Space

1) Suspended Installations

When the height and scale under the bridge are large, suspended lighting or art installations can reduce the visual height under the bridge, improve the spatial scale, and enhance the comfort of the environment under the bridge (as shown in the figure below).

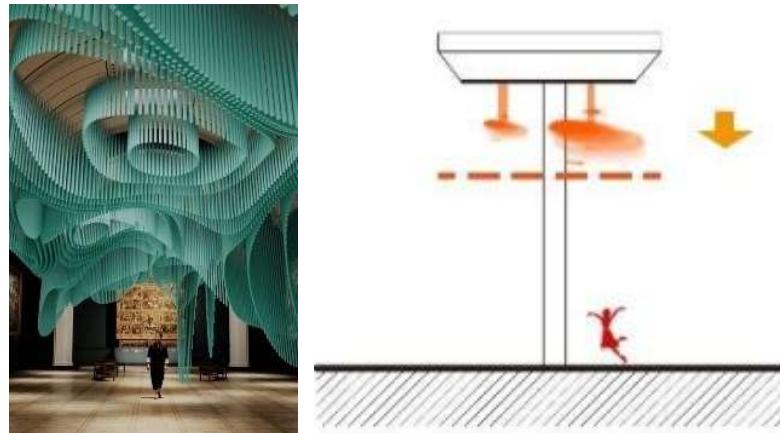


Figure 4-38 Design installation Architecture + Reality (A+R) at the London Design Festival
(Image source: Digital Arts Network)

2) Temporary Suspension of Buildings

This model suspends the building structure at the bottom of the bridge, primarily serving a small, specific group and focusing on responding to social needs. Although there are many site selection restrictions, it provides new ideas for the innovative use of the remaining space under the bridge. For example, the "Light Up Paris" project, through modular suspension units, provides temporary shelter for the homeless while transforming negative spaces into vibrant public nodes.

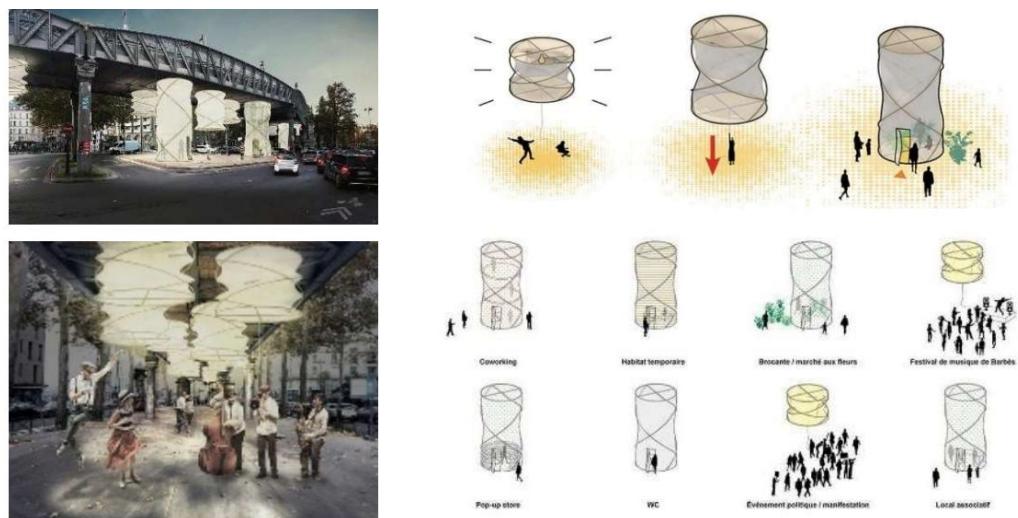


Figure 4-39 The "Light Up Paris" project in France. Figure 4-68 How to use the installation.
(Image source: NetEase)

This suspension model has the characteristics of small footprint, good accessibility, and clear service objectives, giving the space under the bridge social welfare value and representing a beneficial exploration of the refined utilization of the space under viaducts.

4.2.2 Spatial Segmentation

(1) Horizontal division

When the space under a linear bridge spans multiple city blocks, it is often naturally divided into different sections by the bridge pillars or roads. This type of division facilitates functional layout, but it also requires strengthening the connection between areas. Typical examples of this are the space under the A8ernA Bridge in the Netherlands and the Underpass Park, which use lateral roads to naturally divide the area.

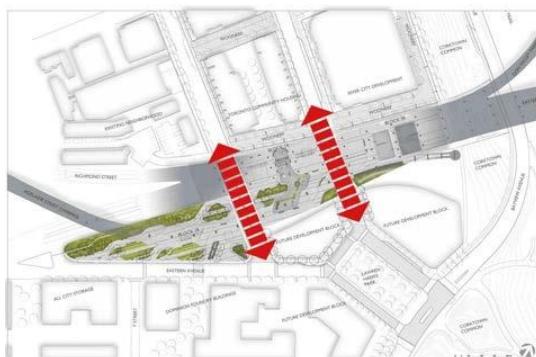


Figure 4-41(left) Underpass Park (Image source: author's redrawing)

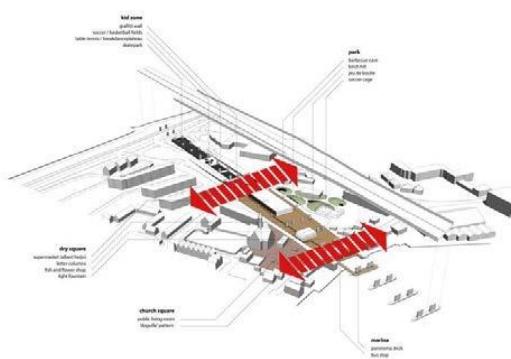


Figure 4-42(right) Underpass space in A8ernA, Netherlands (author's redrawing)

(2) Vertical division

For spaces with large depths and wide bridge decks under bridges, the cross-sectional scale and functional layout can be optimized through longitudinal division. For example, Under the K Bridge divides the space longitudinally into a green area and an activity area, forming different street-facing facades (as shown in the figure below).

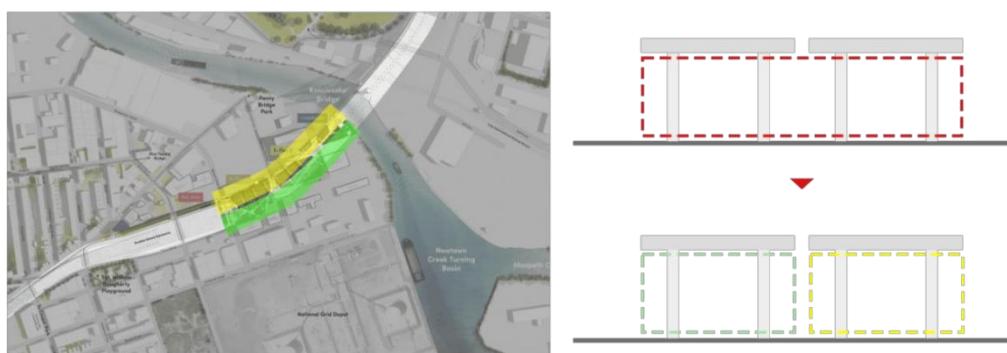




Figure 4-43 Case study of vertical spatial division: Under the K Bridge

(Image source: Author's redrawing)

The Brooklyn Broadway Hub Station uses vertical division to rationally organize multiple functional areas under a complex elevated structure with a large depth, effectively addressing the special challenges of spatial form (as shown in the figure 4-44).

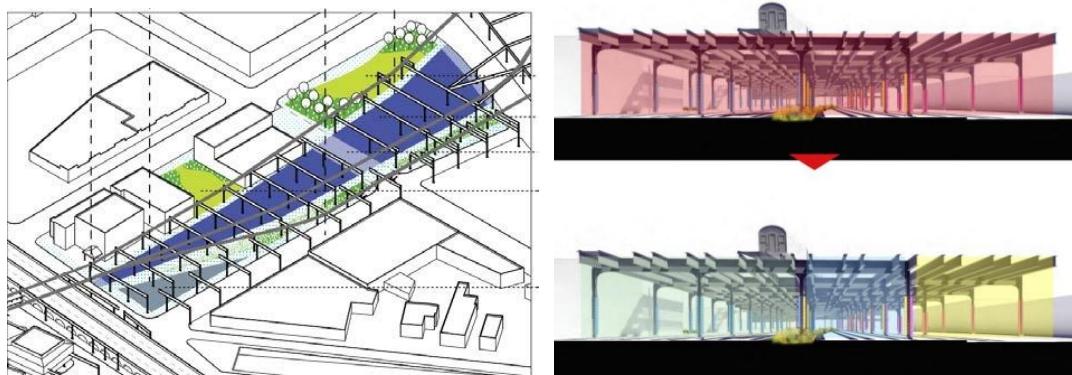


Figure 4-44 Case study of vertical spatial division: Broadway Junciton

(Image source: Author's redrawing)

Cutting techniques	Diagrams	Case studies	Characteristics	Applicable Situations
Vertical		Under the K Bridge, Broadway Transportation Hub in Brooklyn	Adjust the aspect ratio of the section to create a more comfortable and functional spatial scale.	Excessively wide spaces in the bridge deck structure
Horizontal		A8ernA, Massachusetts Foundation Space 2	Road divisions occur naturally, requiring consideration of spatial continuity.	Linear bridge-under space

Figure 4-45 Summary of spatial division methods

(Image source: Author's self-drawn drawing based on data)

4.2.3 Spatial Sequence Rhythm Design

Spatial sequence rhythm design is a core strategy based on spatial sequence theory. Cullen, G's "serial vision" theory emphasizes that urban space creates a sense of rhythm through the alternation of continuity and nodes. Similarly, linear spaces under viaducts should avoid monotony and repetition. The Shenzhen Xiwang-Qianhai Bay slow-walking public space project has formed a well-paced spatial rhythm by setting up five distinctive nodes: "Happy Market, Mufeng River Estuary, Basketball Court, Jumping Park, and Green Path". The space under bridges can create a rich spatial experience through the sequential changes of "introduction, development, transition and conclusion" (entrance guidance). The design can draw inspiration from the principles of musical composition, dividing the space under the bridge into sections such as the overture (entrance guidance area), development (main activity area), climax (core landscape area), and epilogue (transitional connection area), thus constructing a complete spatial narrative sequence.

The Shenzhen Xiwang-Qianhai Bay slow-walking public space project achieves a balanced spatial rhythm through the spatial sequence design of linear theme nodes, transforming the passive space under the viaduct into a vibrant urban public space.

(1) Linear connection and node reinforcement:

The project is 6 kilometers long and utilizes the space under the Guangzhou-Shenzhen Riverside Expressway. It forms a continuous linear space through the connection of three lines: a walking path, a running path, and a cycling path. Meanwhile, based on the colonnade-style spatial characteristics under the expressway bridge and the conditions of the surrounding resources, each section is set up with a distinctive landscape node for gatherings and activities (such as a fun market, Mufeng River estuary, basketball court, bouncy playground, and green walkway), forming a spatial rhythm of "continuous-gathering-re-continuous" to link urban life and natural ecological resources.

(2) A space experience with moderate relaxation:

“Tension” : The colonnade under the bridge creates a sense of rhythm, enhancing vertical visual guidance through colors (such as high saturation bridge column coating) and materials (recycled sleepers, gravel).

“Relaxation” : Expand the space at the node, set up art installations and rest areas,

encourage social interaction, and form a 'breathing point'.

In the slow-moving public space project of Xiwan Qianhai Bay in Shenzhen, five themed nodes (Happy Market, Mufeng River Mouth, Basketball Gathering Court, Jumping Park, Green Wilderness Road) have formed a rhythmic change with varying degrees of relaxation through different functional positioning and spatial design. This tension relaxation relationship is not only reflected in the spatial scale, but also in the comparison of activity intensity, social interaction, and environmental atmosphere.

The following is a detailed analysis of each node:

1) Happy Market ("Tension" - Gathering and Vitality)

Spatial Characteristics: Located in the Qianhai Inner Bay area, it is an open plaza formed by the widening of the space under the bridge, providing functions such as market, performance, and social interaction.

Expression of Tension and Relaxation:

"Tension": High-density crowd gathering, commercial activities (such as temporary stalls and pop-up stores) and artistic performances (such as street music and light shows) bring strong visual and auditory stimulation.

Rhythm Control: The sense of spatial enclosure is enhanced by colorful bridge pillar painting and art installations (such as suspended lights), forming a "climax".



Figure 4-46 Fun Market (Image source: <https://www.archiposition.com/items/20240729014206>)

2) Mufeng River Estuary ("Relaxation" - Relaxation and Nature)

Space features: Based on the ecological environment of the Xixiang River estuary, a viewing platform and wetland boardwalk are set up, emphasizing ecological science popularization and quiet observation.

Expression of Tension and Relaxation:

"Relaxation" : Low intensity activities (such as walking, bird watching), natural

soundscapes (water flow, mangrove wind) replacing artificial noise, linear spatial expansion, and wide field of view.

Rhythm transition: From the hustle and bustle of the joyful market to natural tranquility, utilizing native vegetation and permeable paving to soften the environment, forming a "breathing zone".



Figure 4-47 Mufeng River Estuary

(Image source: <https://www.archiposition.com/items/20240729014206>)

3) Basketball Gathering Court ("Tension" - Dynamic and Competitive)

Space features: The idle land under the bridge has been transformed into a standardized basketball court, equipped with street graffiti and night lighting.

Expression of Tension and Relaxation:

“Tension” : high-intensity exercise (competition, training), audience cheers, fast-moving visual focus (player, sphere trajectory).

Space definition: Use bridge columns to divide the site boundary, enhance the semi enclosed feeling, and form a "dynamic static" contrast with surrounding green plants.



Figure 4-48 Basketball Court

(Image source: <https://www.archiposition.com/items/20240729014206>)

4) Jumping Amusement Park ("Jump Tension Alternating" - interactive for all ages)

Space features: All age friendly amusement area, including non powered facilities

such as trampolines and slides, with some areas expanded through gaps in high-speed ramps.

Expression of Tension and Relaxation:

“Local Tension” : High frequency dynamic of children's playful screams and jumping movements.

“Overall Relaxation” : Wooden platforms and sunshades are set up in the parents' rest area to provide low-intensity care space.

Whyte, WH (1980). "The Social Life of Small Urban Spaces." Project for Public Spaces. The study on the distribution of "static" and "dynamic" activities in public spaces also confirms the zoning design of the parent rest area (Relaxation) and children's play area (Tension) in the Jumping Park.



Figure 4-49 Jumping Paradise

(Image source:<https://www.archiposition.com/items/20240729014206>)

5) Green Wilderness Road ("Relaxation" - Ecology and Slow Travel)

Space features: Connected to the West Bay Mangrove Park, with ecological observation and slow walking as the main focus, the path winds along the edge of the wetland.

Expression of Tension and Relaxation:

“Relaxation” : Minimize human intervention, preserve natural terrain, and guide attention to ecological elements such as mangroves and migratory birds.

End point soothing: As a sequence ending, weaken the node landmark and return to the "afterglow" state of linear slow-moving.



Figure 4-50 Green Path (Image source: <https://www.archiposition.com/items/20240729014206>)

Node Sequence	Happy Market	Mufeng River Mouth	Basketball Theater	Jumping Park	Green Field Park
Node Sequence	tension	relaxation	tension	tension-relaxation Alternation	relaxation
Design Techniques	Gathering Plaza	Ecological Corridor	Sports Field	Recreation Area	Natural Infiltration
Reference Image					

Figure 4-51 Analysis table of the rhythm sequence of the Shenzhen Qianhai Bay project

(Image source: drawn by the author)

This alternating rhythm not only avoids visual fatigue, but also stimulates the desire to explore through the "climax-interval-re-climax" pattern, which fits the core concept of the integration of nature and city in "mountains and seas connecting cities".

4.3 Traffic Integration and Flow Organization Strategies

4.3.1 Slow-Moving Through Traffic and Public Transportation Accessibility

Ensure the green transportation accessibility of the space under the bridge, create a break in the connection with the urban slow traffic system, and strengthen the connection with the urban public transportation system. On the other hand, it also includes the design of the traffic system under the bridge itself.

(1) Integrated with the urban slow traffic system

Integrate various functional spaces around the space under the bridge into the urban slow traffic system. Open up the slow traffic break between the space under the bridge and the urban road slow traffic system, greenway, waterfront green corridor,

etc., create a safe, continuous, comfortable and convenient slow traffic space, and ensure that the space under the bridge forms a good slow traffic interaction with the urban public space system and urban functional system [21].

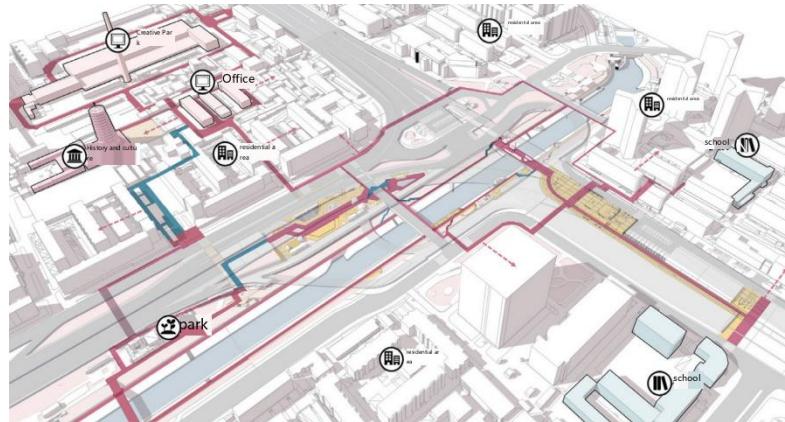


Figure 4-52 Example of slow-traffic system under and around viaduct

(Image source: Reference 21)

(2) Under-bridge traffic system - slow-traffic connection, separate lanes

In the Shenzhen Qianhai Bay project, based on different movement speeds, the colonnade space is used to connect the entire 6-kilometer-long Xiwan-Qianhai Bay line under the bridge with a parallel 3-meter-wide walking path, a 2.5-meter-wide running path, and a dedicated 4-meter-wide cycling path. All three paths are designed for barrier-free access, with a longitudinal slope of less than 5% and speed bumps to ensure traffic safety. The three paths avoid constraints such as underground gas pipelines, high-voltage cable manholes, and highway ramps, connecting disconnected points and combining with the surrounding natural endowments - rivers, bays, and mangroves to form three beautiful linear corridors [44].



Figure 53 Pedestrian, fitness and cycling paths under the Qianhai Bay Bridge in Shenzhen

(Image source: <https://www.archiposition.com/items/20240729014206>)

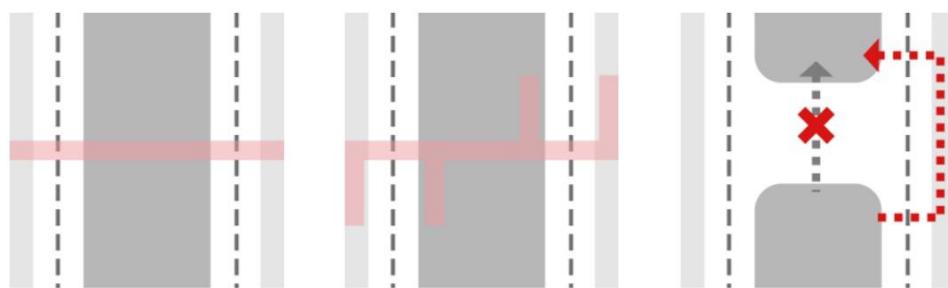
(3) Public transportation accessibility

Focus on establishing high-quality slow-traffic connections between the space under the bridge and rail stations and bus stations to support the dispersal and convenient access of people and promote the green travel mode of "public transport + slow travel".

The traffic structure under the bridge covers pedestrian, non-motorized and vehicular traffic flow. It is necessary to optimize vehicular routes and improve pedestrian accessibility through system integration. In actual use, pedestrian accessibility is the key to measuring the effectiveness of space. When the space under the bridge is filled and used for public activity space and other functions, in order to make them truly usable, it is necessary to make it safe and reasonable for people to reach the space under the bridge.

4.3.2 Optimizing Pedestrian Flow

Pedestrian flow optimization strategies are mainly divided into raised sidewalks, setting up pedestrian overpasses and adjusting pedestrian flow.



(1) Elevated pedestrian walkway (2) Setting up pedestrian overpasses and corridors (3) Adjusting pedestrian flow

Figure 4-54 Summary of pedestrian traffic optimization strategies

(Image source: Author's own drawing)

When there is a high traffic volume and fast speed section on both sides of the bridge, the existing pedestrian crossing can be used to set up an entrance to the space under the bridge; In areas without pedestrian crossings, pedestrian overpasses or underground passages are added to separate pedestrians and vehicles, connecting the three-dimensional transportation system under the bridge with the ground transportation system to ensure continuous and safe walking and improve accessibility under the bridge.



Figure 4-55 Setting up pedestrian overpass: under the viaduct of Hohhot South Second Ring Road



Figure 4-56 Connection between pedestrian overpass entrance, pedestrian walkway, and activity square under the bridge



Figure 4-57 Hohhot Second Ring Road: According to the block planning, a pedestrian overpass will be set up at a distance of about 700-900 meters to connect the green spaces and parks on both sides of the overpass, forming a trail system

Setting up pedestrian overpass: Underpass of Hohhot Second Ring Road viaduct

(Image source: self taken by the author)

Under the K Bridge Park employs raised pedestrian crossings, level with the sidewalks on both sides. This reduces vehicle speed and facilitates barrier-free access for non-motorized vehicles and wheelchairs, effectively improving pedestrian safety and continuity, while also enhancing pedestrian accessibility under the bridge. This

measure is often applicable to lower-grade roads such as secondary arterial roads in cities; for arterial roads, priority should be given to ensuring vehicle traffic efficiency.



Figure 4-58 Elevated pedestrian crossing (Image source: Baidu website, revised by the author)

In addition, pedestrian demand in expressway areas can be diverted to secondary roads. For example, Underpass Park directs crosswalk traffic to the slow lanes, enhancing accessibility under the bridge while ensuring safety.

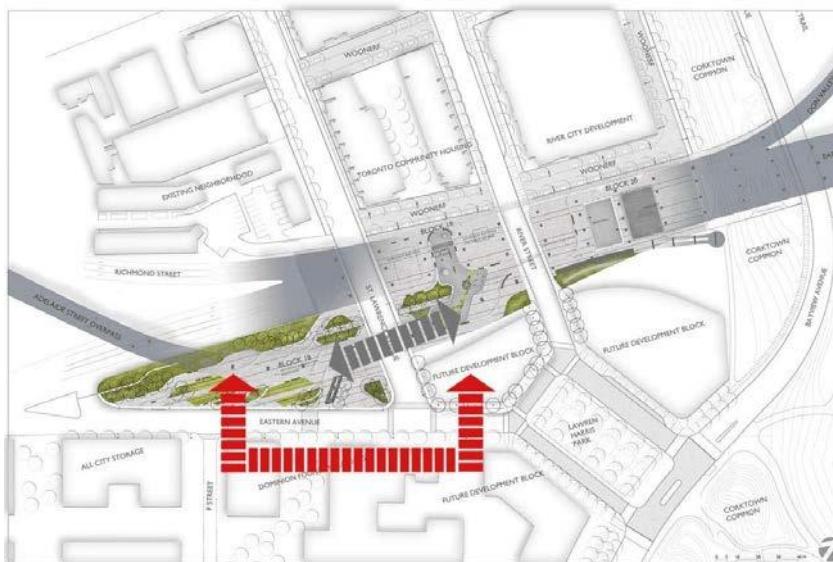


Figure 4-59 Adjusting pedestrian flow line (Image source: author's revised drawing)

4.3.3 Enhanced Guidance at Entrances and Nodes

(1) Entrance device and entrance enlargement

By installing signage devices at the entrance or expanding the entrance platform, the recognizability of pedestrian entrances can be enhanced and the phenomenon of random walking can be reduced. For example, Green Park sets up arched green structures and enlarged platform areas at the entrance to form clear spatial guidance (as shown in the figure below).



Figure 4-60 Enhanced Entrance Guidance (Image source: Baidu website, author's redrawn)

(2) Ground paving guidance

The slow-moving public space between Xiwan and Qianhai in Shenzhen is guided by patterns, colors, and text on the ground, and then enters the main activity area and traffic separation area (as shown in the figure below).



Figure 4-61 Ground paving guidance at the entrance of the Shenzhen Qianhai Bay project site
(Image source: <https://www.archiposition.com/items/20240729014206>)

4.3.4 Traffic Island and Traffic Safety Facilities

When entering or crossing the space under a bridge and crossing urban roads, it is important to focus on improving pedestrian safety. Strategies can be developed to enhance pedestrian safety by optimizing waiting times, setting up monitoring systems, and adding safety islands, or by shortening the distance of a single crossing to improve traffic safety (as shown in the figure below).



Figure 4-62 Summary of pedestrian crossing facilities (Image source: Author's own drawing)

Taking the Shenzhen Xihai Bay project as an example, operational safety was considered from the design stage. Isolation barriers were set up to prevent pedestrians from accidentally entering highway ramps, and measures such as separating pedestrians and vehicles and using speed bumps for cycling were adopted to ensure the safety of different users. Boundary isolation and lane separation designs not only meet the needs of bridge maintenance but also create an orderly environment for visitors.

4.4 Spatial Narrative Construction and Cultural Implantation Strategies

4.4.1 Continuation and Reconstruction of Regional Culture

It is the core strategy to endow the space under the bridge with unique charm, and the design should deeply explore the historical context and regional characteristics of the site, telling the "local story" through material environment design. Urban context, as a reflection of urban development and historical accumulation, is an important foundation for shaping urban characteristics. While continuing the original culture, new cultural elements should also be integrated to stimulate urban cultural vitality through the collision of old and new.

For example, the Old Chengdu Folk Park under the overpass of Renmin South Road in Chengdu reproduces the traditional street and bridge style with a group of bronze statues, murals, and miniature landscapes, becoming a cultural carrier that carries the memory of the city. While improving the visual quality of the space, it also strengthens the emotional resonance and cultural identity of the public.



Figure 4-63 Traditional Chinese Folk Customs Park (Image source: Baidu website)

Under a certain viaduct in Australia, over 3500 local ferns and other plants were planted to restore the landscape of Kuripar from the pre European period, achieving a fusion of old and new landscapes in the form of a "subtropical rainforest". While creating a peaceful environment, it also reflects the unique blend and collision of old and new.



Figure 4-64 The unique collision of old and new in the spatial landscape under the Australian viaduct (Image source: Baidu)

4.4.2 Artistic Intervention, Color Design, and Symbolic Expression

(1) Image and symbolic expression

In practical cases, Maicun Avenue in Guangzhou is one of the first batch of "Beautiful Rural Roads" in Guangzhou. The murals on the bridge pillars under the bridge showcase a livable, workable and tourist-friendly scene. The "Rainbow Highway" theme connects the mountains, rivers and villages. The murals under the bridge play an interpretive and beautifying role. The Cantonese dialect wall under the Sanyuanli Bridge is expressed in the form of symbolic text. In addition, the structure under the bridge can also be decorated with regional components. For example, in

Suzhou, traditional flower window construction and water town-themed murals can be used to strengthen cultural recognition (as shown in the figure below).



Figure 4-65(Left) Painted mural on the underside of the viaduct in Xinlong Town, Huangpu District

Figure 4-66(Right) Cantonese dialect wall under the Sanyuanli Bridge

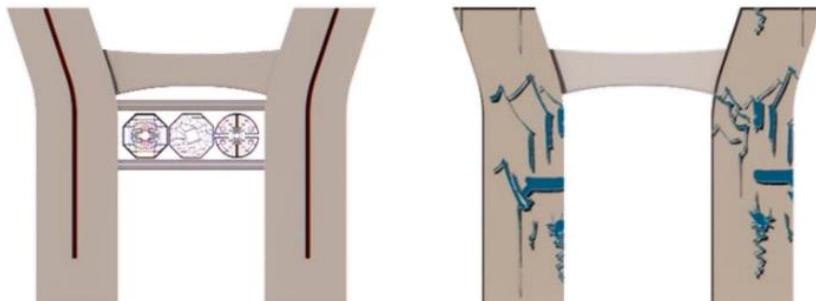


Figure 4-67 Regional element decoration on the bridge piers (Image source: Baidu)

(2) Color design

Color has emotional attributes and can affect people's psychological feelings and spatial experience. Reasonable color design helps to create a narrative atmosphere and enhance emotional resonance. The color of the space under the bridge should focus on coordination with the surrounding environment and reflect the regional cultural characteristics.

1) Conventional painting - using single-color cool colors for conventional beautification

Regular beautification and anti-corrosion coating can be carried out for social parking, municipal security, and bus stops. It is advisable to use conventional cool colors for painting, with monochrome being the main color.

2) Characteristic Coating Color Design - Achieving the Organic Unity of Urban Artistic Characteristics and Humanistic Spirit

The color design of painting is an effective way to enhance the overall aesthetic and recognition of the space under the bridge, which is dominated by leisure, sports, convenience, and landscape greening functions. The painting pattern and content reflect the theme of the space under the bridge, and can be combined with the surrounding cultural landscape, historical culture, and architectural style to focus on beautifying the painting.

3) Color guidance - integrating the overall color of the city, highlighting the publicness and openness of the space under the bridge

Design the painting color based on the overall color tone of the city. Color can be divided into primary color, auxiliary color, and accent color, with clear usage ratios for each level to enrich the color hierarchy of the space^[21].

Harmonious	Prominent	Blanking
The space under the bridge is harmonious with the surrounding environment and the color of the vegetation. Application scenario: Public parking and bus stops.	The important nodes of the space under the bridge and the urban furniture are prominent and clear in the space. Application scenarios: leisure, sports, landscape greening, and public service spaces.	The presence of the space under the bridge is weakened to integrate it into the surrounding environment. Application scenario: municipal support facility space.

Figure 4-68 Relationship between Space Under the Bridge and Environmental Colors

(Image source: Reference 21, modified in this article)

For example, the color range within the Beijing landscape protection area and the range of general colors for under bridges specified in the Beijing Under-Bridge Space Utilization Design Guidelines (as shown in the figure below).

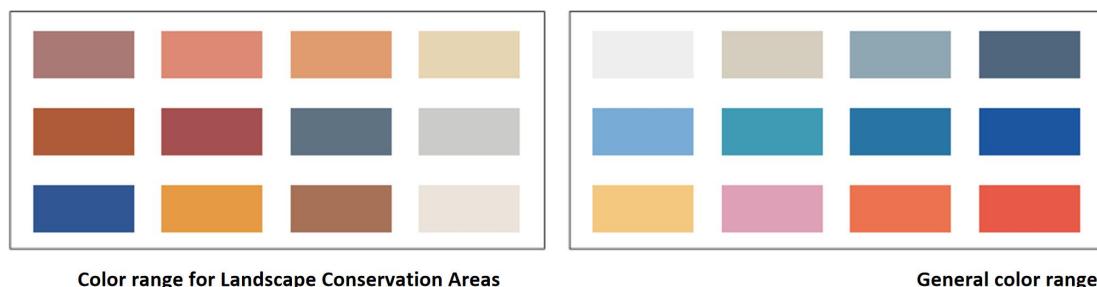


Figure 4-69 Color guidance table in the Beijing Under-Bridge Space Utilization Design

Guidelines (Image source: Reference 21)

For color-coating designs in areas outside or surrounding historical preservation zones where there are no obvious historical elements, one can refer to the vibrant color design of the Shenzhen Xiwang-Qianhai Bay pedestrian public space, which brightens the mood with its colorful spaces. The original state of the space under the

S3 riverside expressway bridge in this project was rather negative: the massive viaduct (over 36 meters wide, with piers 4-16 meters high), combined with the natural color of concrete, light obstruction, and enclosed fences, created a gloomy and cold impression.



Figure 4-70 Bridge pillar murals in the Shenzhen Qianhai Bay project (Image source: Youfang)

The core of its color intervention strategy lies in "activating grayscale with bright colors". The design introduces highly saturated warm-toned patterns to decorate the bridge pillars and connects the running and cycling paths in shades of blue and gray-blue on the ground. At the same time, it is supplemented with paving materials such as red bark and yellow gravel to enrich the visual layers. These strategies effectively reverse the negative mood of the site and inscribe local memories through cartoonish biological images, ultimately creating a vibrant and friendly landscape node.

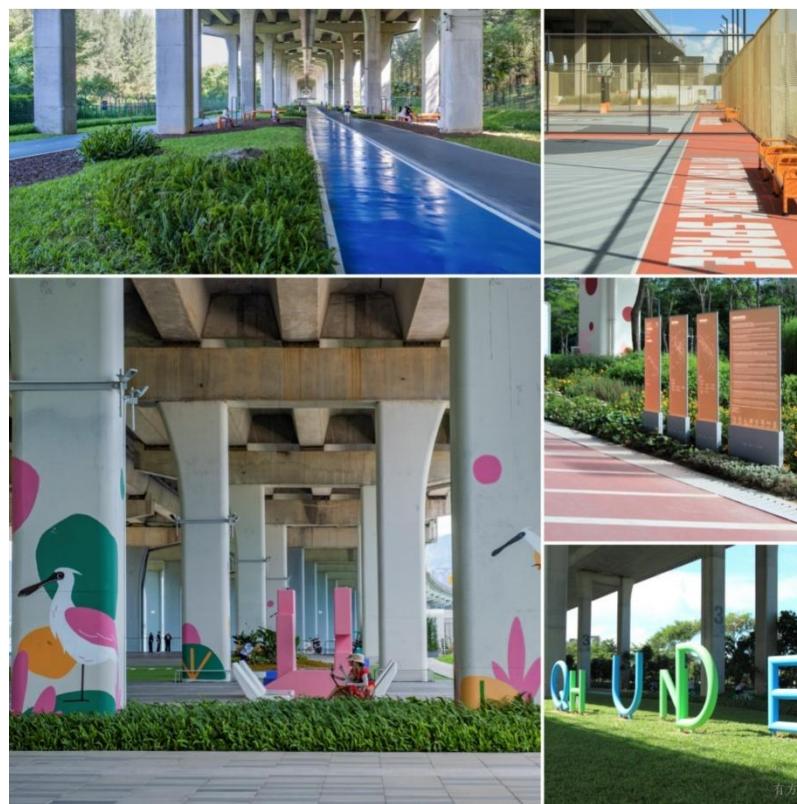


Figure 4-71 Colors under the bridge of the Shenzhen Qianhai Bay project

(Image source: Youfang)

(3) Changes in material and texture

The texture and grain of a material can effectively convey its physical properties and sensory characteristics, giving the space emotion and atmosphere through a multi-dimensional experience of sight, touch and even hearing. Texture itself is malleable and can be combined with color and shape to enhance the appeal of the expression, thereby reflecting regional characteristics and strengthening the narrative immersion of the place.

In specific design, appropriate ground materials should be selected based on functional requirements. For example, soft and elastic plastic pavement is suitable for sports areas to reduce the impact on joints during activities; while wear-resistant materials such as granite are suitable for passage areas and leisure trails, such as the Sky-Rail Community Sports Park (as shown in the picture below).



Figure 4-72 Material Change (Image Source: Archdaily)

(4) Art installations

1) Installation design carries culture and regional memory

After the renovation, the walls of the Shanghai super subway were opened, and the grey space was activated with unique interactive art installations and graffiti art, transforming it into a unique public space, a continuous pedestrian node.

To recreate the living imprint of the old industrial community along the Suzhou River, the project designed and purchased abandoned industrial pipes, innovatively transforming them into guardrails, rest seats, and landscape features. These pipes serve as the core design language throughout the site, fulfilling practical functions while echoing typical images of storage tanks and vacuum tubes in Shanghai's industrial history through their sculptural forms. At the same time, the vibrant pattern

combinations pay homage to the Memphis style while also conveying an unconventional and optimistic spirit. Through the intervention of color and graffiti, elements such as pipes, seats, and railings effectively divide and embellish the space, and combined with lighting design, further enhance the interactivity and recognizability of the venue. Ultimately, the space under the bridge was transformed into a public "stage" for impromptu activities such as street dance, band performances, and skateboarding.



Figure 4-73 Shanghai Super Pipe Landscape Project - The purchased waste brewery factory wine cans and pipelines are transformed into art installations, seats, safety fences, etc.

(Image source: Xiaohongshu)

2) Temporary interactive device

Temporary interactive devices, as a flexible and resilient intervention method, further expand the potential use of space under the bridge. These types of devices are usually quickly constructed through finished product combinations, hanging, or assembly, without the permanent nature of architecture, but can stimulate public participation and shape unique spatial events during specific periods of time. They are not only visual focal points of the landscape, but also physical carriers of community activities, creating rich sensory experiences and lasting emotional memories within a limited time, thus becoming effective tools for promoting the regeneration of urban grey spaces and social interaction.



Figure 4-74 Taipei street corner: temporary installation combined with bridge pillars
 (Source: Sohu.com)

4.4.3 Activity Organization and Community Participation

(1) Public participatory design and workshop system

In the early planning stages of the renovation of the space under the bridge, participatory design was key to ensuring the authenticity of the spatial narrative and gaining public recognition. Taking the Bentway project in Canada as an example, the design team closely integrated community planning with public space design through a two-year systematic participatory program. The project invited citizens to discuss venue-specific activities through various forms such as public meetings, site visits, naming events, and online platforms, effectively absorbing diverse cultural demands. This process not only transformed community memories into spatial narrative elements but also significantly enhanced residents' sense of belonging and willingness to use the space.

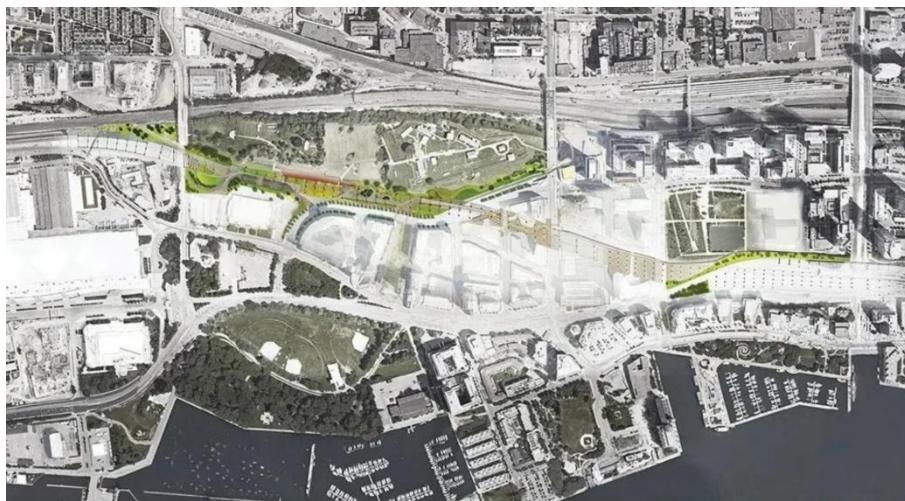


Figure 4-75 Site plan of the Bentway project (Image source: PUBLIC WORK)

(2) Community interactive participation facilities

In the completed space under the bridge, interactive facilities are an important medium to strengthen community interaction, maintain the connection between residents and operators, and promote community vitality.

The Chinatown community under the Manhattan Bridge in New York has set up an interactive bulletin board, which includes an activity calendar and community map, and publishes various activities, notices and recruitment information. Residents can make suggestions for activities or express specific needs in the message area, which not only makes it easier for the public to understand the community dynamics, but also helps the operators to optimize services based on feedback and form a positive interaction mechanism (see figure below).



Figure 4-76 Chinatown community interactive installation in the space under the Manhattan Bridge in the United States (Source: Reference 12)

Community installations are also an important carrier of community activities. The "Book Tree" in Mei Foo Sun Chuen, Hong Kong, is a prime example. Its operation is entirely based on resident self-discipline: people freely donate or borrow

books without any procedures. This model fully embodies the residents' agency, avoiding book waste while also revitalizing knowledge sharing and cultural exchange within the community.



Figure 4-77 Book Tree and Site Plan of Mei Foo Sun Chuen, Hong Kong

(Image Source: Architectural Drawings)

Through the configuration of the above facilities, the space under the bridge can break through the limitations of physical renewal and transform into a public domain that promotes community cohesion and sustained participation.

4.5 Ecological Technology and Sustainability Strategies

4.5.1 Sponge City and Ecological Planting

(1) Sponge City and Green Infrastructure

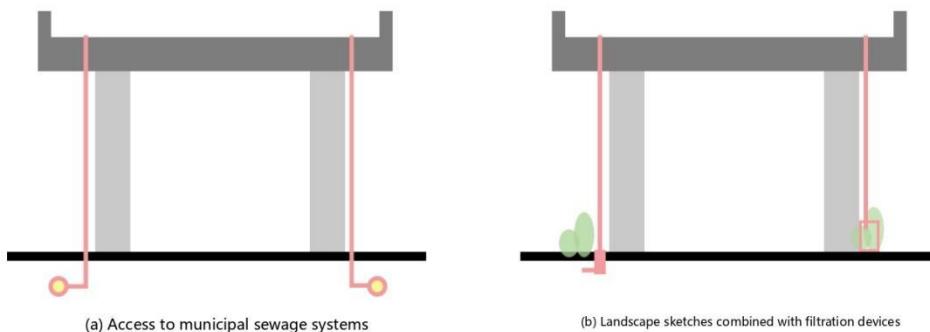


Figure 4-78 Rainwater Treatment Strategies for Spaces Under viaducts

(Image source: Author's redrawing)

For example, the New York Department of Transportation is promoting a modular, replicable above-ground green infrastructure system that can be used to collect rainwater runoff from elevated roads, bridges, and subway structures. This system helps achieve urban stormwater management goals and mitigate combined

sewer overflow pollution. For example, in the Sunset Park pilot project in Brooklyn, the above-ground flower pots can handle 1 inch of rainwater, combining rainwater collection, pollutant filtration, and spatial beautification functions; the iconic cone-shaped downpipes are both educational and sculptural.

The "Dune Landscape" planters in Rockaway, Queens, mimic the shape of natural sand dunes, combining local plants with recreational functions to effectively collect runoff from the nearby elevated subway line; Long Island City uses gabion planters, filled with galvanized steel baskets filled with stones, to slow down and filter runoff from the highway above. These facilities not only achieve rainwater management but also create urban landscapes with educational and artistic value.



Left: Ground planters in Sunset Park, Brooklyn, collect rainwater through cone-shaped downpipes
Right: The "Dune Landscape" planters in Rockaway, Queens, collect rainwater from the nearby elevated subway line (Rockaway Beach Union)

Figure 4-79 Brooklyn Sunset Park (Image source: El-Space_Toolkit)

(2) Ecological Planting and Habitat Restoration

The greening design of the space under the bridge should follow the principle of ecological priority, focusing on improving ecological benefits while meeting the needs of activities and landscape. Specific measures include: prioritizing the selection of shade-tolerant and semi-shade-tolerant plants to increase green coverage and enhance dust and noise reduction; preserving or transplanting existing vegetation to the greatest extent possible to minimize environmental disturbance. Furthermore, the design should respect biodiversity and maintain natural rainwater cycles. For example, the Shenzhen Xihai Bay project adopted a low-maintenance plant habitat restoration strategy, effectively achieving multiple goals of pollution mitigation, noise isolation, and ecological restoration by planting shade-tolerant, resilient ground cover plants capable of absorbing harmful gases.



Figure 4-80 Low-maintenance ecological plant planting and habitat restoration in the Shenzhen Xihai Bay project (Image source: Youfang)

(3) Characteristic protective green space and ecological leisure function on both sides of the bridge

Some domestic scholars have proposed some strategies and measures for the transformation of municipal protective green space into recreational and ecological green space based on a sponge park case^[46]; some scholars have proposed a new concept of characteristic urban protective green space, proposed to create a characteristic new urban green space landscape, construct an energy-saving composite ecological protective green corridor, and create a sightseeing area that combines a large-scale landscape with a relaxing forest leisure space^[47].

4.5.2 Microclimate Regulation

Microclimate regulation is an important technical means to improve the physical environment comfort of the space under the bridge. Due to the obstruction of the elevated structure, such spaces generally face problems such as insufficient lighting and noise interference, and need to be optimized through systematic technical measures.

(1) Lighting Environment Optimization

1) Lighting Devices

Under viaducts, due to the obstruction of natural light by the superstructure, the primary way to create a negative space lighting environment is to introduce artificial lighting. In the design of artificial lighting systems, differentiated solutions should be adopted according to the characteristics of different functional areas. Continuous strip lighting is recommended for walkways and fitness areas. Linear lighting such as LED light strips can provide uniform illumination and enhance spatial guidance through

light extension. Cultural exhibition areas require high-power point light sources to create focused lighting; spotlights can create dramatic effects through light and shadow contrast, effectively guiding the eye and pedestrian flow. Lighting in sports areas must strictly adhere to professional standards to ensure uniform illuminance and glare control meet requirements (see image below).



(a) Rest Areas: Strip Lights (b) Sports Venue Lighting (c) Performance Venues: Spotlights

Figure 4-81 Common Lighting Methods for Under-Bridge Spaces (Image Source: Arcdaily)

Under-bridge lighting devices can be divided into bottom-emitting, low-light, luminous sculpture, wall-washing light, and bridge-top light, etc. (as shown in the figure below).

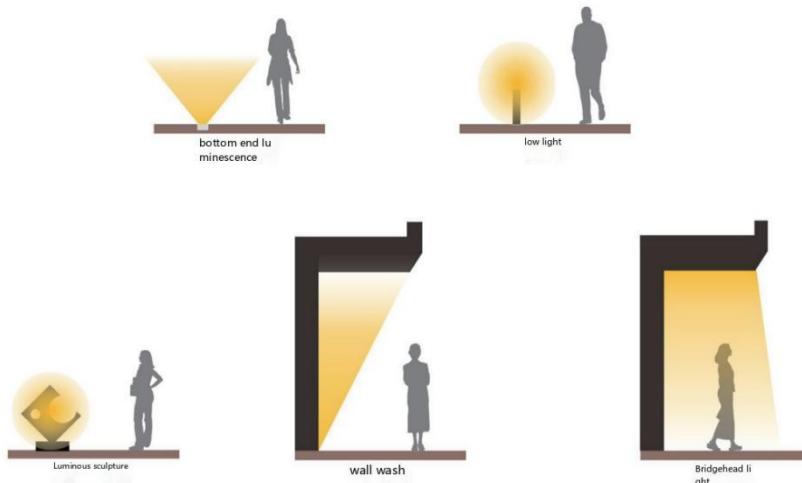


Figure 4-82 Schematic Diagram of Under-Bridge Lighting Devices (Image Source: Reference 21)

2) Design for Insufficient Light

For the unavoidable lighting disadvantages of under-bridge spaces, an effective design strategy is to turn the passive into the active, transforming the constraints of lighting into positive elements for shaping the atmosphere of a specific place. As shown in the case, this inherent dimness was utilized to successfully construct an immersive haunted house theme.

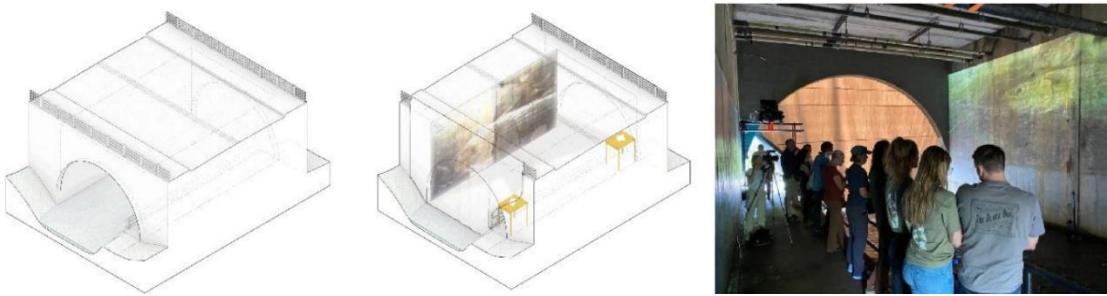


Figure 4-83 Utilizing the disadvantage of under-bridge lighting to create special functions, such as a haunted house (Image source: landing studio)

3) Lighting Compensation Design

To compensate for the lack of natural light in the space under bridges, an effective strategy is to use high-brightness colors and high-reflectivity materials to enhance light reflection within the space, thereby optimizing the utilization efficiency of limited natural light and artificial lighting, thus improving overall brightness and creating a pleasant atmosphere [48]. This optical compensation method has been verified in practice many times: for example, the Higashi-Koganei shopping street on Tokyo's Chuo Line uses white folded panels to enclose the space, utilizing their high reflectivity to enhance the brightness and transparency of the commercial environment; another example is the Underpass Park project, where the stainless steel ceiling panels effectively improve the lighting conditions under the bridge through reflection (see below).



Figure 4-84 Light-colored and reflective materials (Image source: Baidu)

(2) Acoustic Environment Optimization

Comprehensive acoustic optimization is needed to address noise issues. The Boogie Down Booth installation in New York organically combines acoustic technology with public facilities, placing directional sound sources around the bridge pillars to play local music, both mitigating traffic noise and conveying community

culture. The installation integrates seating and solar lighting to form a multi-functional service facility, serving as a bus stop and viewing platform during the day and transforming into a temporary dining area at night, embodying a collaborative design concept of acoustic environment optimization and functional integration.



Figure 4-85 Public installations combining acoustic technology and art facilities

(Image source: Reference 12)

4.5.3 Lightweight Prefabrication and Low-Carbon Construction

(1) Lightweight Building and Lightweight Assembly

In the project under the Oxford Road Bridge in Manchester, UK, shipping containers were flexibly combined as basic unit modules to create rich commercial spaces. The container design adopted a variety of combination modes: one group of pink containers was stacked vertically to form a two-layer structure, and the short side of the container was opened to create a transparent visual connection; another group of yellow containers was arranged in a linear parallel layout to form multiple parallel small shop units with independent entrances.



Figure 4-86 Container shops under the Oxford Road Bridge in Manchester, UK

(Image source: ZCOOL, <https://www.zcool.com.cn/article/ZOTI1NDcy.html>)

Advantages of container buildings: (1) Sturdy structure, wind-resistant, earthquake-resistant, and noise-proof. (2) Convenient and beautiful decoration. (3) Recyclable steel structure, sustainable use. (4) Rapid installation.

Disadvantages of container buildings: The space of a single container is limited, while large spaces need to be achieved by splicing multiple container bodies [49]. The container combination method and additional structure can be referred to in the following figure.

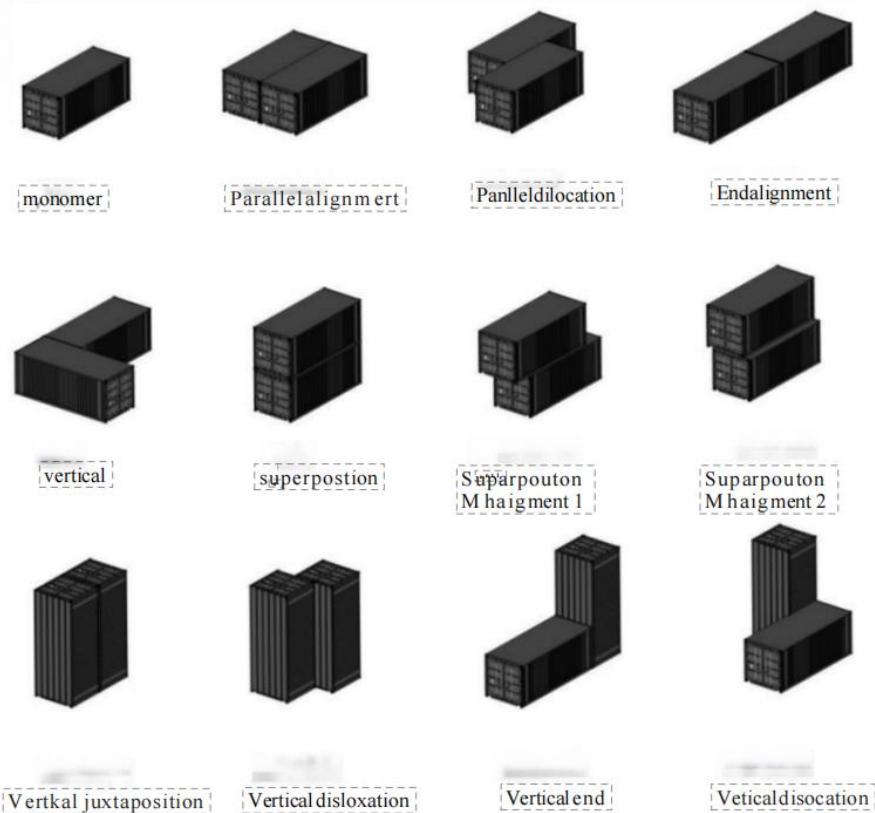


Figure 4-87 Container combination method (Image source: Baidu)

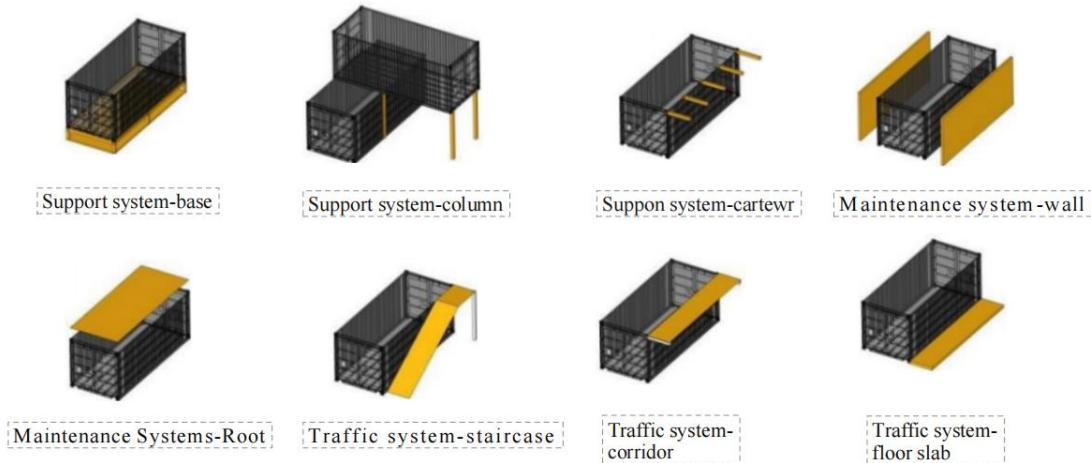


Figure 4-88 Schematic diagram of additional structure of container

(Image source: Baidu, author modified)

The standardized design and factory prefabrication of supporting service facilities (such as public toilets, seats, signs) can realize rapid on-site assembly and effectively improve construction efficiency. Its modularity also ensures the flexibility

and portability of the facilities, which can be rearranged in different locations or between projects according to future operational needs.

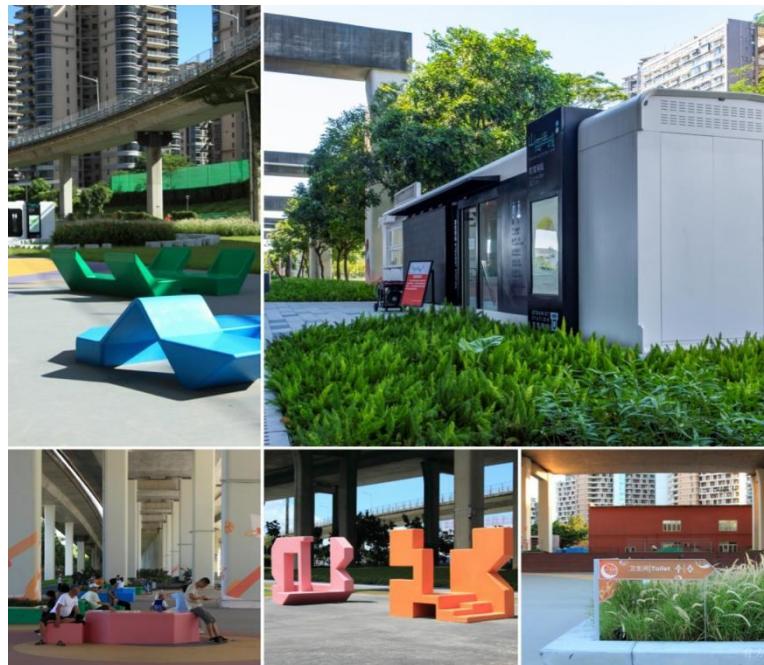


Figure 4-89 Prefabricated service facilities in the Shenzhen Xihai Bay project
(Image source: Youfang)

(2) Preserve existing site resources and control development intensity

The Shenzhen Xihai Bay project preserves existing site resources, avoids the pipeline network under the bridge, does not excavate earthwork, and leads the path to the shaded lawn outside the bridge, forming a differentiated slow-walking experience in different sections. The project needs to be designed with restraint, not to fill the space, but to complete the site, leaving space blank, leaving room for citizens to organize spontaneously, forming a versatile place.

We should make full use of the advantages of the space environment under the overpass, carry out low-carbon design, construction and management of the project, abandon the fancy and inappropriate design, respond to the call for high-quality development, explore low-cost development model, and guide citizens and tourists to perceive, practice, and live a low-carbon and environmentally friendly life after completion [44].



Figure 4-90 Restrained Design and Spatial Retention - Shenzhen Xihai Bay Project

(Image Source: Youfang)

(3) Use of Recycled and Environmentally Friendly Materials

The Shenzhen Xihai Bay project site extensively uses recycled and reused materials such as sleepers, tree branches and wood chips, and broken stones, which are transformed into paving surfaces and landscape facilities, reducing the project's resource consumption.





Figure 4-91 Use of Recycled and Environmentally Friendly Materials - Shenzhen Xihai Bay Project (Image Source: Youfang)

In summary, the ecological renewal of the space under the bridge should be promoted from multiple dimensions such as microclimate regulation, lightweight construction, and low-carbon operation. Through refined design and the application of appropriate technologies, these "remaining spaces" can be transformed into high-quality green public assets, providing new spatial resources for urban sustainable development and providing a technical path that can be learned from for similar renewal projects.

4.6 Shared Construction and Orderly Management

The renovation and transformation of the space under the bridge should establish a full-cycle collaborative mechanism from planning to operation to ensure that the project is scientifically promoted on the basis of fully absorbing public opinion and achieves efficient and sustainable utilization in the later stage.

For example, New York's "EL-Space" project provides an important reference for domestic cities to promote the systematic development of spaces under bridges. Launched in 2013, the program focuses on the areas beneath and surrounding elevated railways, bridges, and expressways (collectively known as Elevated Space). Its aim is to systematically renovate the vast amounts of space beneath bridges created by New York City's over 1,126 kilometers of elevated infrastructure, addressing the city's challenge of scarce land resources. Because ownership of these spaces involves multiple municipal departments, including transportation, environmental protection, and parks, and subsequent maintenance relies on community participation, it is difficult for a single agency to independently drive the overall transformation. Therefore, the EL-Space program does not directly undertake the development of all under-bridge spaces. Instead, it focuses on building replicable renovation models and policy tools, providing clear implementation pathways for both public and private

sectors. The program is divided into two phases: the first phase involved completing the "Under the Elevated" research report, clarifying the space's potential and renovation direction; the second phase launched the "EL-Space Toolkit," exploring specific implementation strategies through pilot projects. The project, led by the Public Space Design Trust and the New York City Department of Transportation, and jointly promoted by multiple public agencies, community organizations, and professional teams, encompassed the construction of a three-dimensional elevated road map system, the development of spatial assessment standards, urban collaborative development strategies, and public participation mechanisms, forming a globally valuable paradigm for the holistic development of under-bridge spaces^[50].

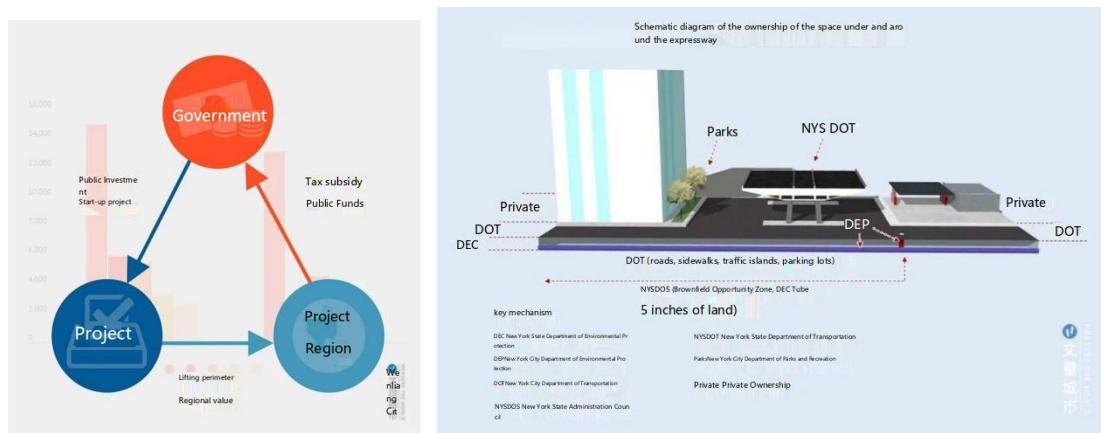


Figure 4-92 Schematic diagram of financing model Figure 4-117 Schematic diagram of cross-sectional ownership of space under the Manhattan Bridge in New York City
(Image source: Measuring the City)

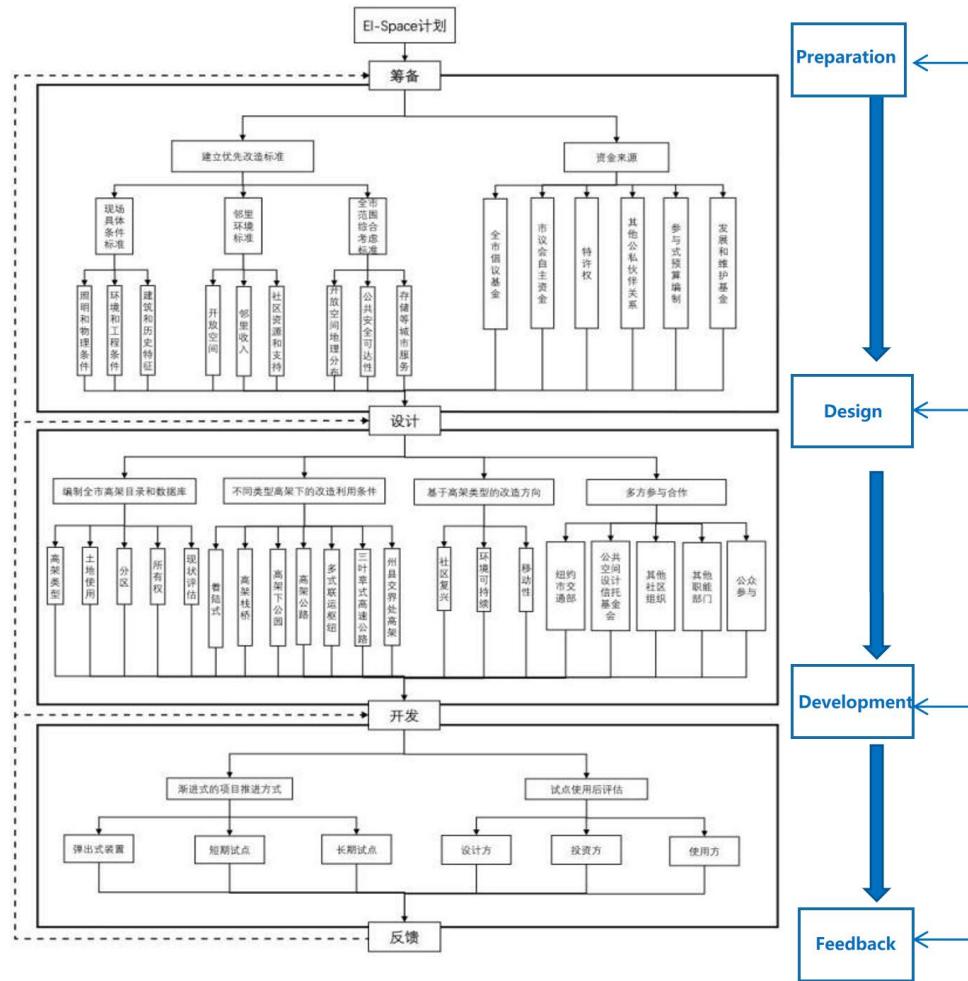


Figure 4-93 EL-Space Project's Full-Process Management Mechanism

(Image Source: Reference 50)

In Guangzhou, there have also been attempts at a mechanism for sharing and co-construction of space under bridges: Guangzhou Jingzhu Expressway Guangzhu North Section Co., Ltd. provided approximately 50,000 square meters of highway land under the Xinwei Viaduct free of charge, which was handed over to Huangge Town to be developed into a public space and activity space for sports, fitness and leisure (vitality corridor), improving the supporting public service facilities, thereby meeting the living needs and entertainment needs of more than 80,000 people in the surrounding area, and jointly exploring a new path of "using to help manage" space under expressway bridges through party building co-construction.

The "Qile Rongrong" New Rural Demonstration Belt Project not only aims to bring public infrastructure and supporting facilities to the people, but also to revitalize idle land resources, property resources and cultural characteristics through investment promotion and operation, bringing entrepreneurial and income-generating

opportunities to villagers, and gradually realizing rural revitalization by connecting the areas^[51].

4.6.1 Early Planning Mechanism and Multi-Party Participation and Co-Construction Mechanism

Before the project starts, a thorough survey of the needs of surrounding residents should be conducted to clarify the dominant function of the space under the bridge. Taking the Lijiao section of the Guangzhou Ring Expressway as an example, community questionnaires and interviews can be used to understand residents' actual wishes regarding fitness areas, market spaces, or children's activity areas, providing a basis for functional positioning.

Through public meetings, scheme publicity, and participatory design workshops, social opinions can be widely collected to make the design scheme more in line with the real needs of users. Resident representatives can be organized to participate in the landscape layout and facility selection for the Lijiao section renovation to enhance the public's acceptance of the scheme.

During the construction phase, citizens can be encouraged to participate in some aspects as community volunteers or co-construction partners, such as incorporating public opinions into ecological planting and street furniture selection. This not only reduces costs but also helps cultivate residents' sense of belonging.

Guangzhou is also actively promoting pilot projects for the renovation of spaces under bridges, striving to build a governance system of "co-construction, co-governance, and sharing." Related research suggests establishing a multi-party workshop system, where relevant departments, property owners, street offices, residents, design firms, and the media jointly discuss functional optimization plans and improve management processes. By selecting suitable sites for full-process participatory updates, public participation at each stage from planning to implementation can be strengthened, effectively building social consensus and enhancing citizens' sense of gain and security.

4.6.2 Collaborative Operation and Full-Process Management

After completion, in addition to the government's responsibility for basic maintenance, community organizations and professional institutions can be introduced to participate in operation. For example, the Lijiang Bridge under-bridge

market is managed daily by the Lijiang Village Committee, forming a positive operation and maintenance model of "government supervision + community self-governance."

Throughout the planning, construction, and management process, it is necessary to coordinate multiple management departments such as planning, municipal administration, transportation, and greening, strengthening institutional guarantees and process coordination. Full-process control of under-bridge space construction, with multi-departmental collaboration, improves project management levels. Multi-level needs assessments and satisfaction surveys are introduced during the project initiation, design, construction, and operation phases to form a comprehensive approach to under-bridge space construction^[21]. Simultaneously, after the government completes infrastructure and greening construction, market entities can be introduced for professional operation of commercial facilities and sports venues, achieving a dual improvement in efficiency and quality.

4.7 Chapter Summary

Based on previous research, this chapter, through a summary and analysis of domestic and international under-bridge space renovation cases, proposes universally applicable strategies for the renewal and reuse of urban viaduct spaces from six aspects: functional integration, spatial form, traffic flow, cultural integration, ecological concepts, and management mechanisms. It focuses on elaborating on design strategies related to functional integration, spatial form, and traffic flow.

Chapter 5 Design Practice of Space Under Viaducts in Guangzhou—Taking the Lijiao Section of Guangzhou Ring Expressway as an Example

5.1 Site Selection

1. Site Selection and Application Recommendations

When selecting a site, the suitability assessment for upgrading and utilizing under-bridge spaces should focus on accessibility, demand, and the environment. Scale conditions are a fundamental prerequisite for determining the dominant function. Regarding site conditions, priority is given to under-bridge spaces near residential areas, large public service facilities, and commercial and business districts; priority is also given to under-bridge spaces with good natural environments, such as those adjacent to natural rivers, parks, and urban greenways; and priority is given to flat, continuous, open, and spacious under-bridge areas [20].

2. Specific Site Selection

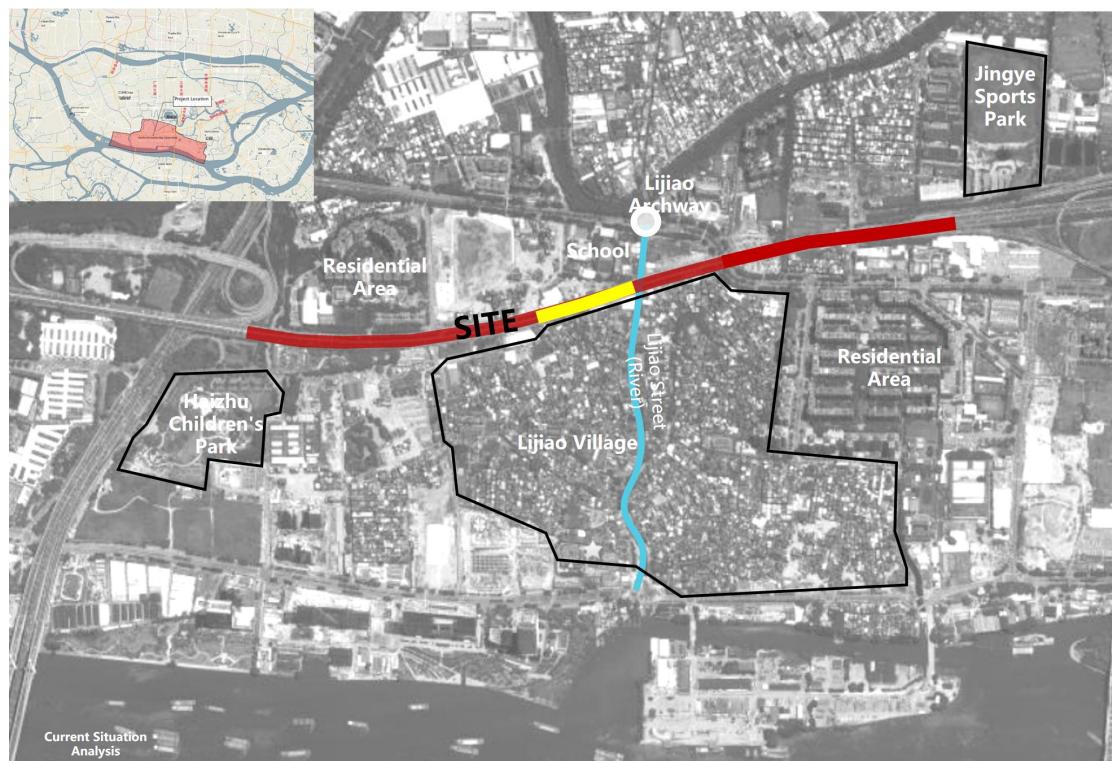


Figure 5-1 Site Selection and Surrounding Status Analysis Map (drawn by the author)

This design selects the under-bridge space of the Lijiao section of the Guangzhou Ring Expressway, located in the Lijiao area of Haizhu Innovation Bay, which is currently under higher-level planning and renovation. Dark red indicates the selected

bridge section. The under-bridge space of this section is bordered by Jingye Sports Park to the east and Haizhu Children's Park to the west, with a total length of 1.5 kilometers (bridge width of about 35 meters). The under-bridge space is open, flat, and continuous. The selected under-bridge projected area is about 52,500 square meters. The yellow section under the bridge was originally a spontaneous market run by villagers, and is now the largest temporary relocation area for mobile vendors in Guangzhou. The section of Lijiao Avenue that crosses the elevated road perpendicularly leads to the Lijiao Archway and largely coincides with the ancient Lijiao River channel. The expressway is adjacent to the ancient village of Lijiao and several city parks. This section is surrounded by residential areas and schools. Lijiao Village and surrounding land are currently undergoing higher-level planning and urban renewal, indicating a good foundation for future development.

5.2 Current Situation Field Survey and Analysis

5.2.1 Field Survey and Analysis of Space Under Bridges

On-site investigation revealed that the western half of the intersection of Lijiao Avenue and the elevated road was designated as Guangzhou's largest temporary relocation area for mobile vendors in 2011, covering an area of 8,190 square meters, and is currently managed by the Lijiao Village Committee. The western section is bordered to the north by schools and residences, and has already established small shops, open stalls, mobile stalls, and a vegetable market, with relatively high foot traffic. The eastern half is currently mainly combined with the open space to the north, used as parking and driving school land. Other spaces under the bridge are mainly parking lots and open spaces.

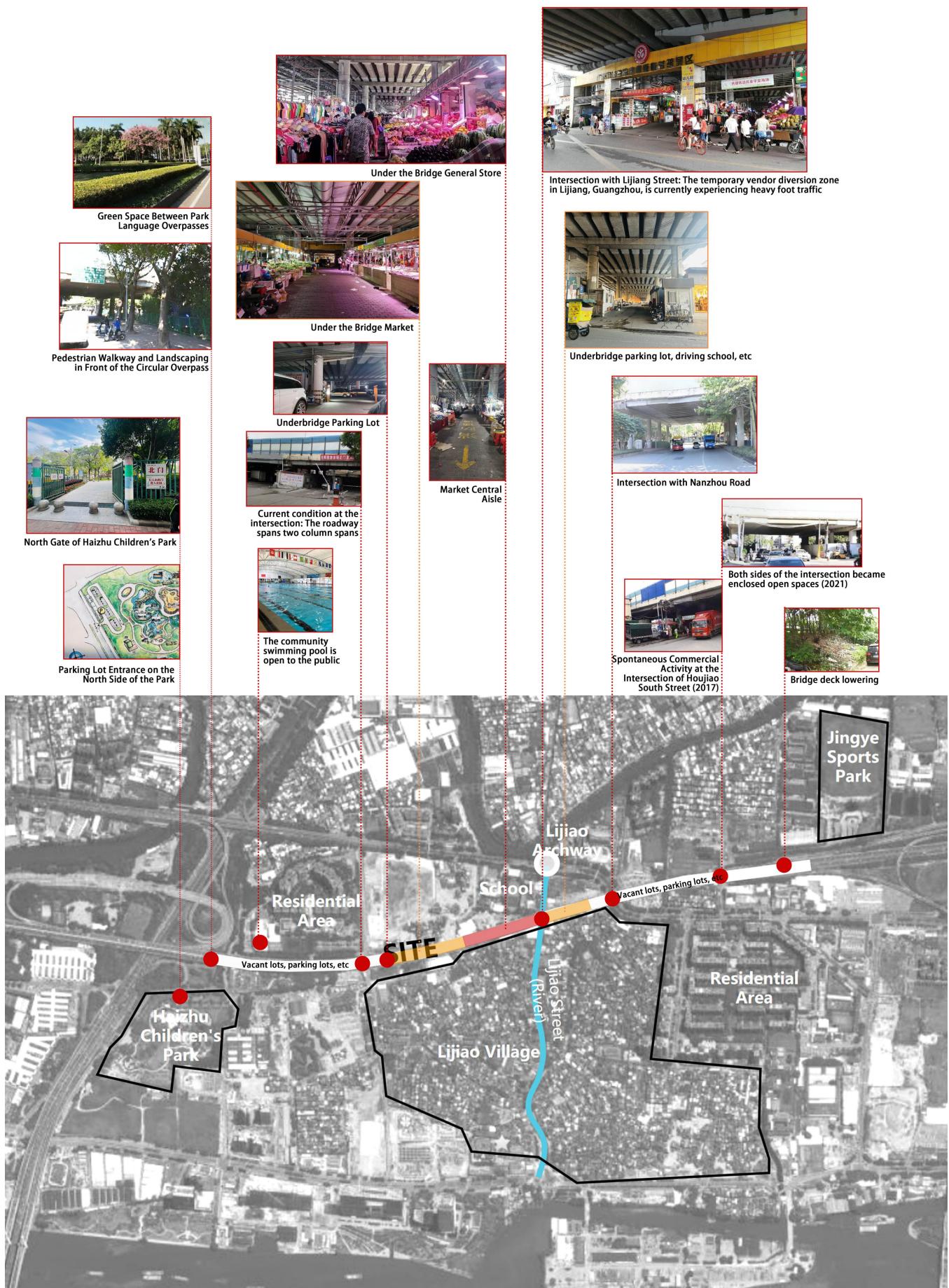


Figure 5-2 On-site survey and analysis diagram of the space under the bridge

(Image source: photographed and drawn by the author)

5.2.2 Survey of Usage Needs of Space Under Bridges

(1) Questionnaire survey and analysis

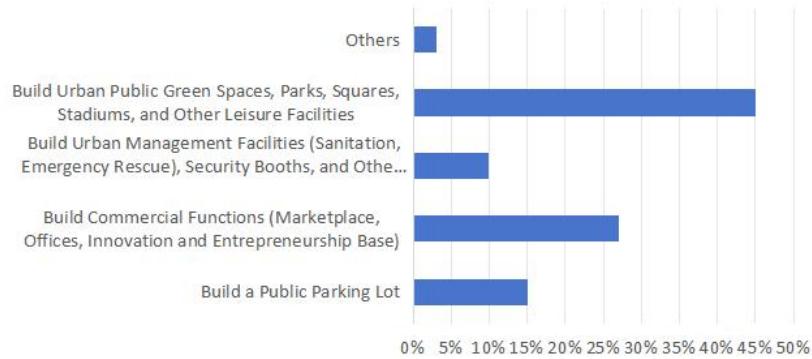
During the field research, random sampling and anonymous evaluation methods were employed. Surveys were distributed in September 2024 and April 2025, primarily at locations including the Underbridge Market, Lijiao Village's Lijiao Street, Lijiao Xinghuiyuan Residential Area. Participants included original Lijiao villagers, residents from surrounding neighborhoods, former vendors from Qiaoxia Market, local students and teachers, and tourists. A total of 95 questionnaires were distributed, with 89 successfully collected. The participants in the survey included original villagers of Lijiao, residents of surrounding communities, original stall owners under the bridge, students and teachers from the surrounding area, tourists, etc. According to the questionnaire survey, the public's willingness to renovate the space under the bridge of the Lijiao section of the Guangzhou Ring Expressway mainly focused on the following aspects: Functional needs: The most anticipated is the construction of public green spaces, parks and stadiums and other recreational facilities, followed by commercial functions; Place preferences: Respondents strongly hoped to set up commercial markets, sports and fitness, rest spaces and Lijiao cultural display places; Expected benefits: Outdoor entertainment, convenient shopping, physical fitness and parent-child interaction are the improvement directions that the public is most concerned about.

Regarding the necessity of integrating Lijiao culture into the bridge under the Lijiao section, about two-thirds of the surveyed population believed it was very necessary and should be considered; as for the transformation of the original market under the bridge, the general consensus was that it should be transformed, with the highest preference being to retain some of the businesses, followed by to continue operating after improving the overall environment.

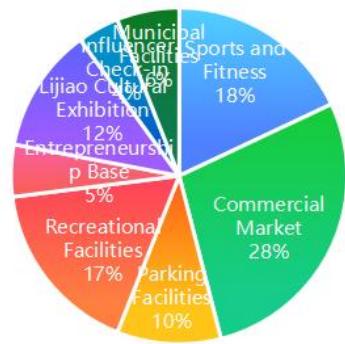
Statistics of the identities of the people participating in the survey



Utilization Intended for the Space Under the Lijiao Viaduct



Expected Use of the Space Under the Lijiao Viaduct After Renovation



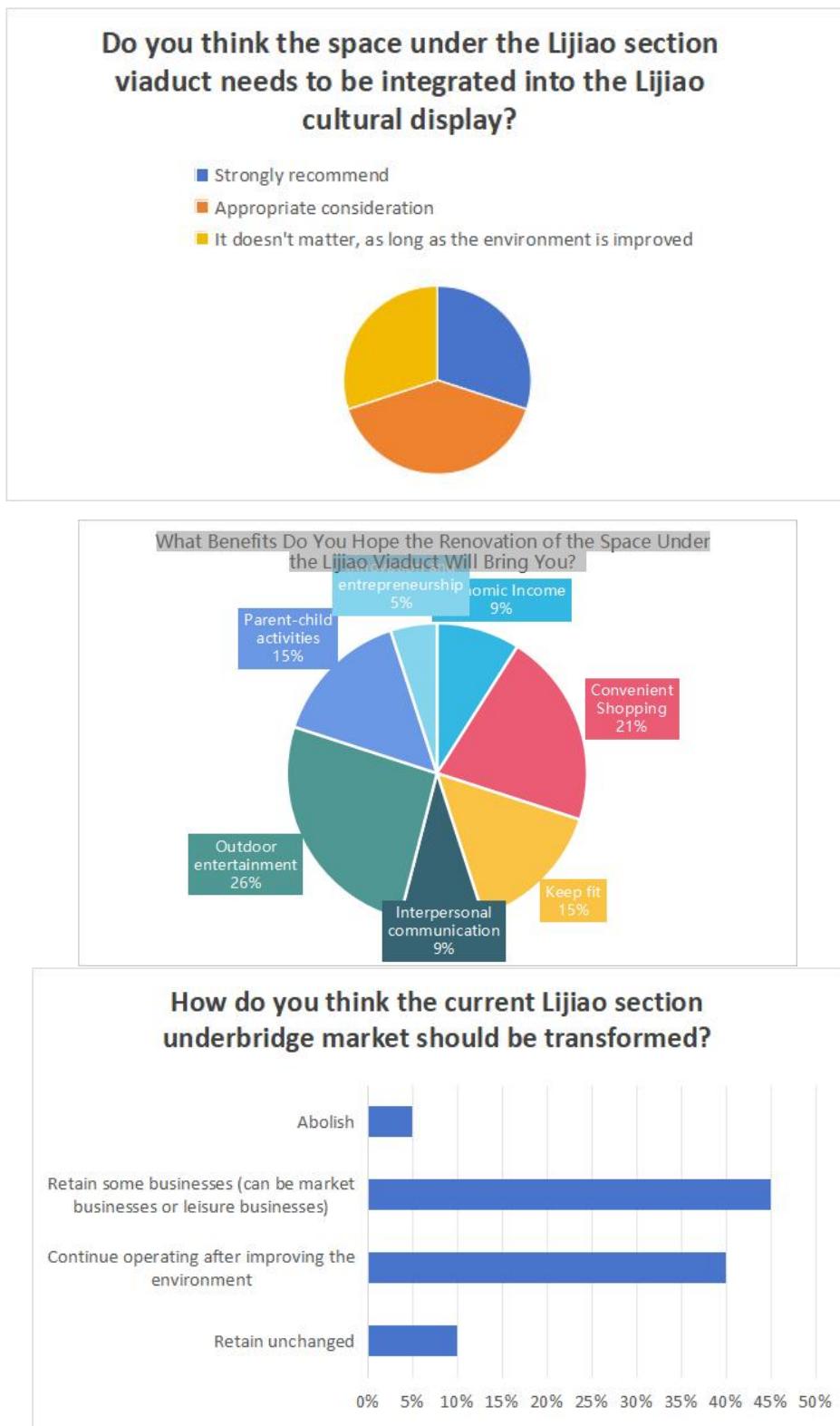


Figure 5-3 Questionnaire collection and analysis diagram of space use under the bridge of the Ring Expressway Lijiao section (Image source: author's own drawing)

(2) Related field surveys

(a) Underbridge Market Area(April 2025)

The author also conducted a field survey on market transformation. Based on the interview feedback from surrounding residents, villagers, students and original market stall owners under the bridge, it was learned that everyone hoped that the market under the bridge would be preserved as much as possible and renovated to improve the business environment. Some people suggested that it could be transformed into a fashion and creative market. The interview included the following:

Vendor (female, over 40 years old)

Q: How much is your stall rent?

1500 yuan

Q: How long have you been here?

Many years

Q: With the renovation of Lijiao Village, do you think this market also needs to be preserved or renovated?

A: The surrounding area has been renovated and made more beautiful and fashionable. It would be good if this place were renovated and made more beautiful, but I hope this market will not be shut down, and I hope the rent will not increase too much so we can still do business.

Lijiao Villager (female, over 50 years old)

Q: Auntie, have you ever gone to the market under the bridge to buy vegetables?

Yes, I've been almost every day. The vegetables are cheap, good, and convenient.

Q: Lijiao Village is going to be renovated. What do you think of this market?

A: Of course, I hope this market can be preserved. I just hope the environment is improved, cleaner, more attractive, and more fashionable.

The village is being demolished. Besides the ancestral hall, what else can be preserved? This market is a good keepsake. It's also a place where the produce is good, inexpensive, and there's a friendly atmosphere.

Lijiao Villager (female, 20 years old)

Q: Have you ever shopped at the market under the bridge?

Answer: The environment is a bit chaotic. My mom goes shopping, but I rarely do

Q: How do you want to renovate?

A: Fashion market, food market, anything is fine, as long as the environment is good and it looks nice.

Student (female, teenage)

Q: Do you like going to the market under the bridge?

A: The environment is not good, I rarely go.

Q: What suggestions do you have for its renovation?

A: A creative market that is both beautiful and fun.

(b) Indoor Badminton Courts at the Tuhua Section of Guangzhou Ring Expressway (with existing facilities such as sports grounds) (July 2025)

During the summer heatwave, on-site participants consistently reported inadequate air circulation within the indoor arena. Following high-intensity exercise, many experienced a stifling sensation accompanied by breathing difficulties. Some participants noted that when outdoor winds blew, other outdoor courts under similar conditions offered slightly greater comfort. Discussions with venue operators revealed that while efforts have been made to optimize air conditioning system layouts and improve ventilation designs, the large-scale structure and the heat-absorbing metal exterior walls significantly increase energy consumption during summer. This makes achieving ideal temperature and humidity control challenging. The survey also revealed that the vehicular roadway running parallel to the bridge lacks dedicated pedestrian pathways, resulting in mixed traffic flow. Given the substantial foot traffic attracted to this section of the bridge's underside, enhanced accessibility and traffic safety within this space are particularly crucial. Given these circumstances, the research sample selected for this study should fully incorporate existing practical experience to refine the design plan, enhancing functionality and comfort levels. Key design insights include: the sports field area should primarily feature well-ventilated, open gray spaces, while smaller enclosed structures serve as rest and supply zones. This approach conserves energy without compromising functionality. The field visit findings are as follows:

Q: It's been really hot lately. How does it feel playing here? Does the air feel stuffy?

Visitor (middle-aged man playing): Yeah, yeah, it feels pretty stifling. The AC isn't doing much either. Maybe it'd be better with the windows open. I played soccer on the outdoor court next to this bridge before, and that felt more comfortable.

Q: Do you feel it's hot everywhere, or is it worse in certain spots?

Visitor (young student): It's hot everywhere, but it's especially unbearable near the metal wall on the side. It feels like you're being roasted.

Q: Has the venue taken any measures to improve ventilation and cooling?

Venue Staff (Manager): We've adjusted the AC vents and modified the ventilation plan, but the results haven't been ideal. The main issue is the large space combined with the surrounding metal walls. When the sun hits them, they absorb heat intensely. The indoor cooling can't keep up, and energy consumption is extremely high.

Questioner: Is it convenient to access the venue from the roadside? Do you feel the mixed traffic poses safety risks?

Visitor (Mother with Child): Exactly. The road under the bridge lacks sidewalks, and with constant vehicle traffic, we have to be extremely careful with our kids. Many people come here for activities—a dedicated pedestrian path is really needed.

(3) Investigation and Renewal Thoughts on the Market Under the Bridge

The market under the bridge is located under a 35-meter-wide bridge. Although it was July and Guangzhou was experiencing high temperatures, the space under the bridge was spacious and well-ventilated, making the interior temperature more comfortable compared to the outside environment.

The market space was fully utilized, and the layout followed a common pattern: rows of brick and tile shops on both sides, and multiple rows of brick stalls in the middle, selling fruits and vegetables and meat and seafood respectively. In addition to fresh produce, the shops also included fruits, hairdressing, and groceries. Although the overall environment was somewhat messy, the lighting was basically sufficient. The survey revealed that the monthly rent for a single stall is approximately 1,500 yuan. According to stall owners, the market's business has declined compared to the past due to the ongoing demolition and relocation of Lijiang Village and the resulting decrease in the number of residents.

This under-bridge market has been operating for over ten years, its enduring vitality rooted in Guangzhou's rich local commercial culture and unique community spirit. Compared to standardized supermarkets, the prices here are more competitive, and the transactions are filled with emotional interactions between stall owners and customers, forming a distinctive "human touch economy." Even facing community changes, it is hoped that it can continue to exist through organic renewal. Its charm is similar to that of popular markets in Kunming and other places, its core being the

provision of a sense of community belonging and warm interpersonal experiences lacking in large supermarkets.

5.2.3 Commercial Survey of the Market Under the Bridge and Lijiao Village

(1) Overall Commercial Structure of Lijiao Village and Bridge Bottom Market

(a) Convenience vehicle: After the opening of the Guangzhou-Foshan line, the increase in passenger flow has also created many potential job opportunities. The convenient vehicles that once cost only 2 yuan to shuttle through the various alleyways, the pedicabs that were like modern-day rickshaws, the street vendors selling snacks... these modes of transportation, though simple, were indispensable tools for life here.

(b) Rental market: The low cost of living and cheap rent have made Lijiao the first stop for many people from other places in Guangzhou. Rental advertisements for all kinds of houses are everywhere as soon as you exit the subway, on walls and pillars. This once simple and direct way of renting houses, without middlemen making a profit, has become a tacit understanding between landlords and tenants.

(c) Textile and garment industry chain: In addition, due to the advantages of Lijiao's population concentration and proximity to the Zhongda textile circle, a garment industry chain has also been formed imperceptibly. Wandering casually through the streets, you'll find all sorts of garment factories, each offering different types of services. You'll also frequently encounter coded language that only those in the garment industry can instantly understand. It's said that clothing produced in Lijiao Village is sold both domestically and internationally. Therefore, many people in Lijiao have achieved their life's value through their own hard work.

(d) Under-Bridge Market: The Under-Bridge Market was once a "holy land" for the people of Lijiao Village, the most vibrant and lively place. With its inexpensive and casually displayed goods, you could find almost anything you could imagine here. The low prices allowed many recent graduates or those just starting out in Guangzhou to maintain their initially meager living standards. The vendors' shouts and the constant haggling created a real "street market" atmosphere, and the dim lighting even brought back the feeling of a long-lost night market.



Figure 5-4 Lijiao Bridge Bottom Market (Image source: Author's own photo)

The diverse people who construct this bustling street life are local villagers, tenants, small factory owners and individual business owners in the garment industry chain [52].

(2) Under-Bridge Mobile Vendor Relocation Area

The mobile vendor relocation area under the Ring Expressway Bridge in Lijiao Village, Haizhu District, was fully opened to the public in early 2012. This relocation area with 570 stalls covers an area of 8,190 square meters. Its construction costs were jointly funded by the city, district and village. The relocation area is equipped with basic supporting facilities such as fire hydrants and public toilets [53]. In addition to the more than 570 stalls built by the district, Lijiao Village itself is also expanding the relocation area, and the scale will be further expanded. The current Lijiao area was previously a temporary market. Due to its popularity and large size, it was designated as Guangzhou's largest mobile vendor relocation area in 2011.

This mobile vendor relocation area under the bridge is managed by Lijiao Village. Each stall has a frontage of about 2 meters and sells a wide variety of goods, including small appliances, clothing, shoes, socks, candy, biscuits, and many stalls also sell pirated CDs.

5.2.4 Related Survey of Lijiao Ancient Village

Lijiao Village, a thousand-year-old village in Guangzhou, is also the largest urban village in terms of renovation area in the subsequent urban renewal project of Haizhu District, Guangzhou City, Guangdong Province. It enjoys a superior geographical location, situated in the southern waterfront area at the southern end of the new urban central axis of Haizhu District. Historically, there is a saying in

Guangzhou: "Before Henan, there was Lijiao." Lijiao Village in Haizhu District has a history of over 900 years, which is quite ancient. "Li" means a large river, and "Jiao" means a three-way waterway. In ancient times, Lijiao Village was crisscrossed by rivers and had a dense network of waterways, which is a typical southern water town pattern [22].



Figure 5-5 Ancient map of Lijiao water town distribution "Wei Hede Hall Map Record"

(Image source: Baidu)

Lijiao is a traditional water town that once had 33 ancestral halls, which shows its former prosperity. There are still 12 ancestral halls in the village today, one of which is the famous Wei Clan Ancestral Hall. Built during the Wanli period of the Ming Dynasty, this ancestral hall is one of the few remaining ancient ancestral halls from the Ming Dynasty. As a protected cultural relic, it possesses historical value as an ancient building. The Wei Clan Ancestral Hall faces south and consists of a main gate, a memorial archway, a worship pavilion, a central hall, and a rear hall, exuding a majestic presence. During the late Qing Dynasty, when the British invaded Guangzhou, they mistook the grand ancestral hall for a government office and bombarded it; traces of the repairs to the cannon holes from that time can still be seen today.

Besides the ancestral hall, the Zhiyu Wei Ancestral Hall, the ancestral hall of martyr Wei Guoyao, also remains standing. Nearby are the martyr's former residence and a memorial primary school. Other ancestral halls have been restored in some cases, while others are abandoned and awaiting repair. Nostalgic street signs still adorn the street walls. The village also boasts many ancient buildings, such as the

Beidi Temple, oyster shell houses, the Guangzhou boundary marker, and old residences.



Wei Clan Ancestral Hall; Lijiang Archway; Lijiang Ancient Waterway; Dock Park Guangzhou Boundary Marker



Zhi Yu Wei Gong Memorial Hall; Wei Guoyao Memorial Primary School; Shell Houses; Roof Carvings

Figure 5-6 Collection of cultural nodes in Lijiao Ancient Village
(Photographed and drawn by the author)

5.2.5 Summary of Existing Problems Under the Bridge

- (1) The existing market diversion area under the bridge is monotonous, crowded and messy, with insufficient connection with the surrounding blocks, and the environment needs to be improved.
- (2) Apart from the market under the bridge, the other spaces under the bridge have low utilization rates and neglect spatial value.
- (3) Isolated from the surrounding environment, cut off from the surrounding cultural context, lack of overall planning, and exacerbating urban fragmentation and ecological breakage.
- (4) Lack of traffic diversion, mixed pedestrian and vehicle traffic at some intersections, lack of humanistic care, and safety hazards.
- (5) It is necessary to strengthen departmental coordination and deepen professional integration. The current management boundaries are blurred, management is extensive, and responsibilities are unclear.

5.3 Research and Analysis of Higher-Level Planning

5.3.1 Overall Blue-Green Analysis of Guangzhou Central Urban Area

The project is adjacent to the national wetland. With abundant green base and limited natural environment, the urban water network is seriously squeezed by gray infrastructure of transportation and municipality.

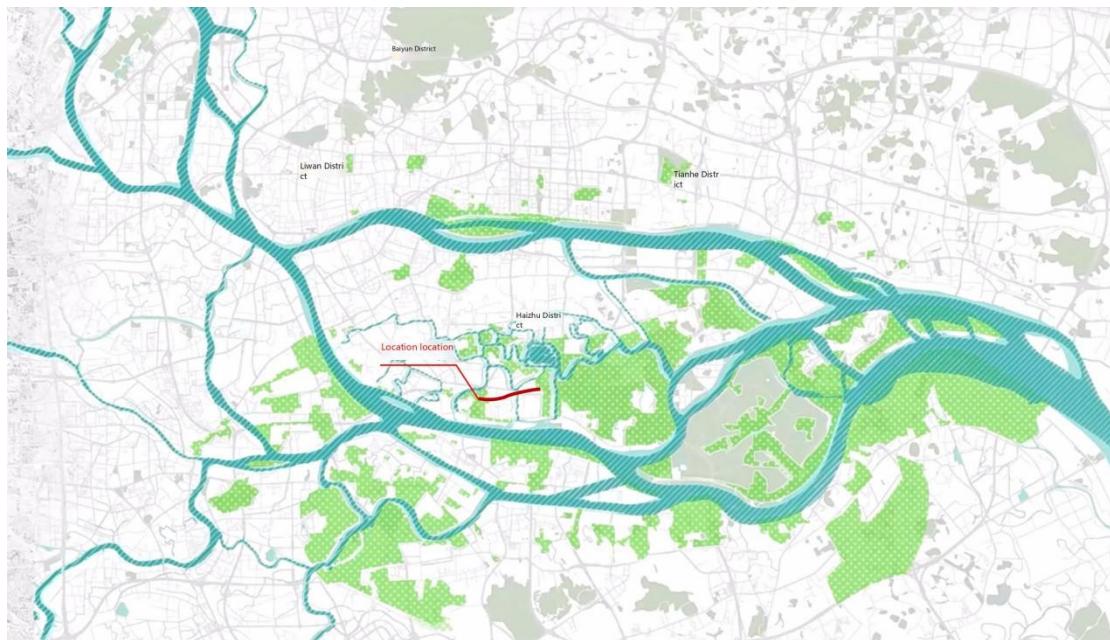


Figure 5-7 Blue-Green Analysis Map of Guangzhou Central Urban Area

(Image source: Author's own drawing)

Fish live by following water and grass, deer live on flat land, and Jiao, originating from the Cantonese dialect, means the confluence of rivers and streams, a place with diverse nutrients and ecology. Haizhu Innovation Bay Gateway Hub was originally the urban edge of the provincial capital era, but now it has become the urban cover of the southwest expansion into the city from the south bay, and the golden cross anchor point where the central city and the high-quality development belt along the Pearl River intersect.



Figure 5-8 Left: Dark green represents the Haizhu Wetland Area, and dark blue represents key waterways.

Figure 5-9 Right: Analysis of the entire city's ring expressway route and major traffic routes.
(Source: Author's own drawing)

5.3.2 Research and Analysis of Higher-Level Planning to Which the Site Is Located

The detailed control plan for the Lijiao area of Haizhu District was approved at the third meeting of the Fourth Guangzhou Municipal Planning Commission's Regional Planning Professional Committee. The plan incorporates design concepts from international competitions, creates a cluster of landmark locations, continues traditional elements, shapes innovative spaces, strengthens public service facilities, and effectively promotes high-quality development along the Pearl River and the construction of the central wetland value circle, highlighting the city's gateway image.

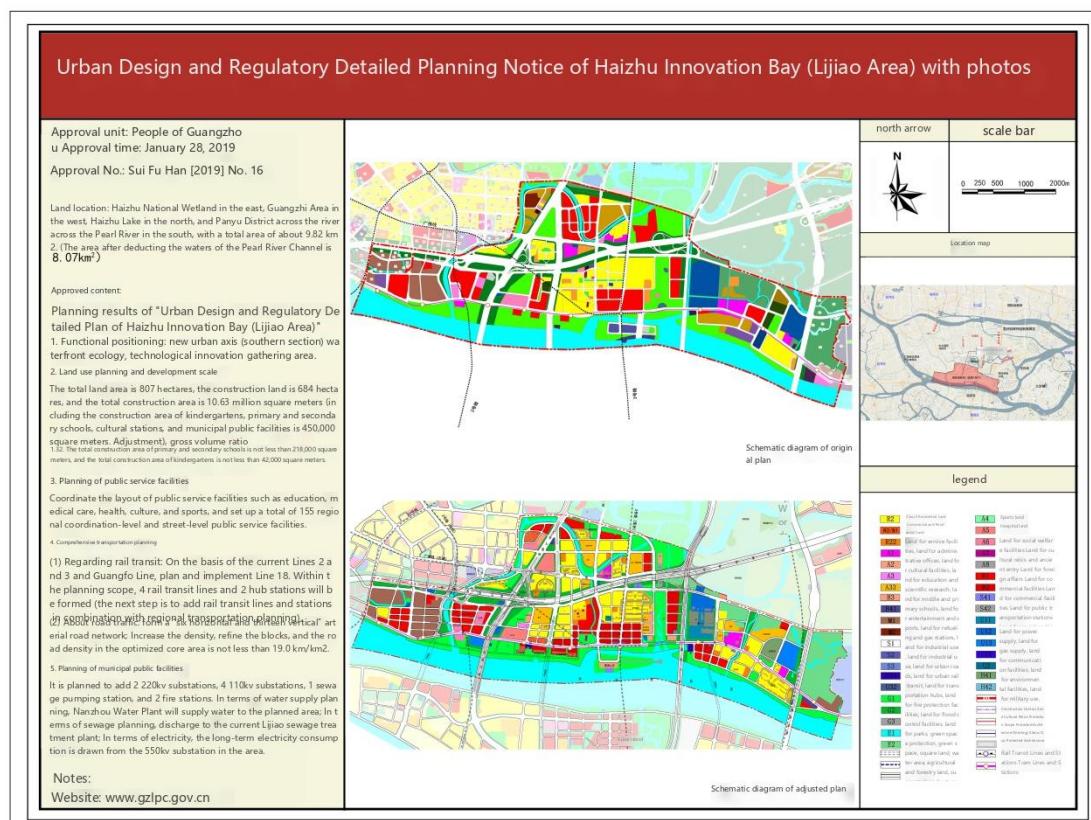


Figure 5-10 Schematic diagram of urban design and control detailed planning of Haizhu Innovation Bay (Lijiao area)

(Image source: Guangzhou Municipal People's Government website)



Figure 5-11 Schematic diagram of surrounding planning (excerpt from the overall plan)



Figure 5-12 Overall planning effect of Innovation Bay (photographed by the author on site)

This plan focuses on promoting regional construction in four major directions:

1. Construct a landmark building complex along the urban development axis, integrate the core ideas of the international design competition results, create the Lijiao Central Business District, and shape a new waterfront landmark with global influence.

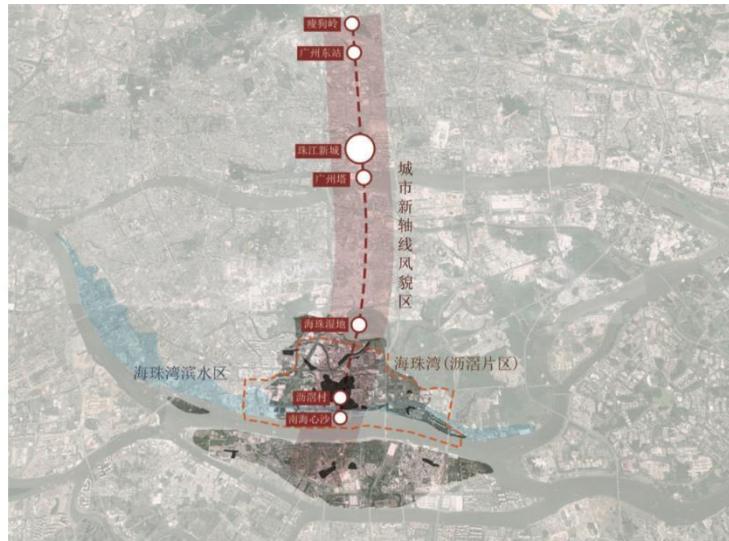


Figure 5-13 Urban strategic location of the project site in Haizhu Innovation Bay (Lijiao area)
(Image source: Reference 14)

2. In the Lijiao Cultural Experience Street, the authentic Lingnan water town scene will be continued, combined with folk customs such as Lantern Festival banquets, dragon boat races, Cantonese opera performances, spring flower markets and lion dance activities, to enhance the unique atmosphere of life and local customs of the area.



Figure 5-14(Left) Conceptual rendering of the Lijiao Historical Slow-Walking Commercial Street
(Source:Wangyi)

Figure 5-15(Right) Planned high-rise residential buildings (Source:Photographed by the author)

3. The original site protection of 39 cultural heritage sites in the district will be implemented to continue the thousand-year-old village lineage that has continued from the Song Dynasty to the present day, to prove the historical origin of "Lijiao existed before Henan", and to systematically inherit the profound cultural memory accumulated in Lijiao.

4. Guided by the concept of "People's City," a community living circle friendly to all ages has been constructed, with a total of 342 public service and municipal facilities, including 117 newly added facilities, adding 38,300 square meters of public service area. These facilities primarily cover education, healthcare, and cultural and sports fields, significantly optimizing the capacity of residential services and the quality of the environment.

In the next stage, Haizhu District will strengthen the coordination of the entire process of planning, construction, and management, promote refined management of urban space, enhance industrial function development, continuously improve regional vitality, and shape a landmark area representing the southern gateway of Guangzhou's central axis.



Figure 5-16 Future Transportation Schematic Diagram of the Lijiang Area in Innovation Bay

(Source: Wangyi)

5.3.3 Analysis of Surrounding Environment and Functions of the Site

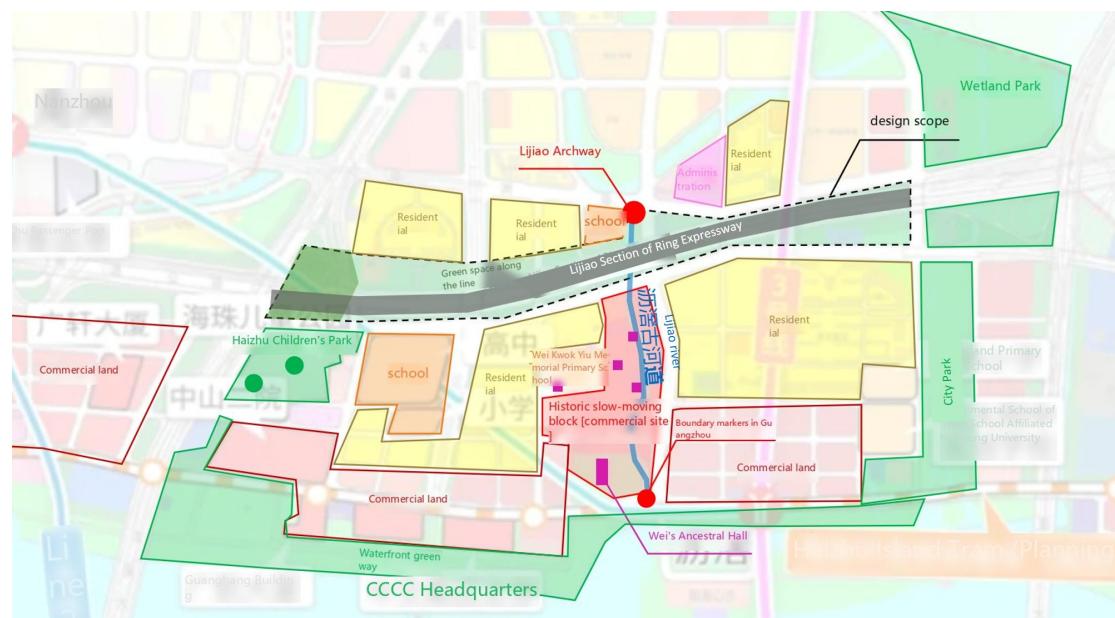


Figure 5-17 Analysis of Surrounding Environment and Functions of the Site

(Drawn by the author based on the superior planning)

Based on the future urban planning design of Haizhu Bay as the basis for the surrounding land use, this paper analyzes the space under the bridge and the surrounding area (as shown in the figure above), in order to achieve the goal of connecting the urban functions of the north and south sides in subsequent design practices, and to preserve the original site memory such as the under-bridge market and Lijiang culture as much as possible. The south side of the site is the Lijiang Historical Slow-Walking Commercial Street, and the north side of the bridge is adjacent to the Lijiang Archway. The north-south Lijiang Ancient River flows under the bridge; the surrounding area is mostly residential, school and commercial land, and both the east and west ends are adjacent to urban green parks; the area within about 30 meters on the north and south sides of the under-bridge space is the green space along the route, and the west end is the protective green space under the ring road overpass. Subsequent design practices can incorporate surrounding cultural elements; and combine the needs of surrounding residents, students, tourists and other groups to enrich the design of the public space under the bridge.



Figure 5-18 Analysis of the current status of blue-green spaces and major traffic around the site
(drawn by the author based on the superior planning)

According to the superior planning, an analysis of blue-green spaces and other land uses around the site, as well as the main traffic roads under the bridge, was conducted (Figure 5-18).

5.3.4 Analysis of User Groups

Combining the current status of the surrounding area and the superior planning, the main land use types are commercial land, residential land, educational land, and park green space. Therefore, the main target audience of the space is residents, tourists, students, teachers, and related vendors from the numerous large residential areas in the surrounding area.

5.3.5 Feasibility and Potential Analysis of Renovation

1. Scale and characteristics of the space under the bridge: The bridge is 1.5 kilometers long (about 35 meters wide). The space under the bridge is open, flat and continuous. The selected projected area under the bridge is about 52,500 square meters. The clear height under the bridge in this section from the market to the west side of Houjiao South Street is 9.3 meters at the highest and 2.5 meters at the lowest. The following is the cross-section of the bridge at Lijiao Street.

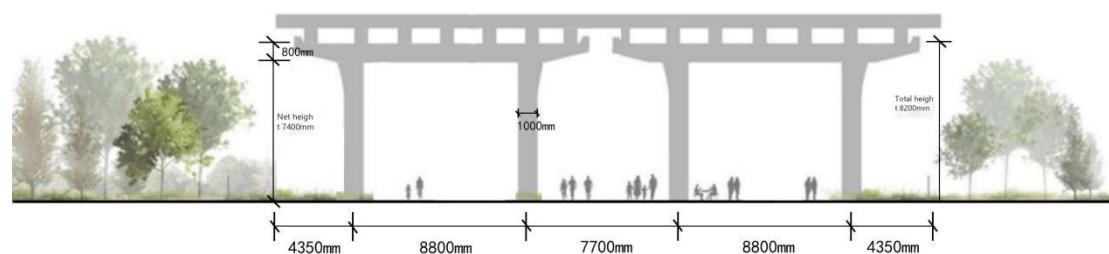


Figure 5-19 Cross-sectional dimensions of the bridge (taking the bridge at the intersection of Lijiao Street as an example) (Image source: author's own drawing)



Figure 5-20 Schematic diagram of the total height of each section of the bridge (excluding the height of the crossbeam) (Image source: author's own drawing)

Direction and potential for renovation: It is suitable to arrange different functions according to the different heights and functional requirements of the bridge, such as leisure, sports, and public facilities. Vertical layering design can be carried out in places with large heights.

2. Good accessibility: In the upper planning map, multiple roads connect the surrounding residential areas, schools and commercial areas, which can be reached by motor vehicles and buses.

3. Environment:

(1) Good surrounding natural conditions: The space under this section of the bridge is bordered by Jingye Sports Park to the east and Haizhu Children's Park to the west. In the upper planning, there is a green space of about 30 meters away from the surrounding area.

(2) The noise is a bit loud, and sound insulation can be strengthened.

(3) Lighting: Sunlight can partially penetrate under the bridge, and appropriate greening, especially indoor shade-loving plants, can be arranged.

4. Ownership: The market section is currently managed by the Lijiao Village Committee.

5. Use: It should be open to surrounding residents and citizens.

5.4 Overall Design

Using the elevated ring road as the axis, a linear sequence of spaces under the bridge will be created and connected with urban areas along the route, forming six major areas: children's entertainment, citizens' leisure, commercial market, cultural display, sports and sports, and ecological nature. This will promote social interaction between the areas on the north and south sides of the elevated road, connect the functions and spatial structure of the surrounding cities, and, on the basis of co-construction and sharing, create a high-quality public space with diverse functions, diverse spatial forms, good accessibility, and integration of ecological concepts and local cultural context.

5.4.1 Overall Function and Sequence Planning: One Axis and Six Zones

1、Site Plan

The project is approximately 1.5 kilometers long, with a projected area under the

bridge of approximately [missing information]. Utilizing the space under the bridge of the Lijiao section of the Ring Expressway, a continuous linear space is formed by connecting three lines: a walking path, a running path, and a cycling path. At the same time, based on the colonnade-like spatial characteristics under the expressway bridge and the conditions of the surrounding resources, each section is equipped with distinctive landscape nodes for gatherings of people (such as children's playgrounds, community living rooms, under-bridge markets, leisure commerce, cultural galleries, sports parks, and green walkways). Each section is connected by a greenway "breathing section" as a transition, forming a spatial rhythm of "continuous-gathering-recontinuous" to link urban life and natural ecological resources (as shown in the figure below).



Figure 5-21 Overall design plan (drawn by the author)

2、Overall function and sequence planning design: one axis and six zones

(1) Taking the elevated ring road as the axis, stitch together the fragmented land on both sides, optimize the flow lines, and improve the slow traffic system such as fitness walks and bicycle lanes; realize the integration with the surrounding green ecological corridor and waterfront ecological corridor system.

(2) In combination with the needs of the surrounding population (residents, students, tourists, entrepreneurs, etc.), the original commercial and parking functions under the bridge will be continued, and a linear space under the bridge will be created to connect the urban areas along the route, forming six major areas: children's entertainment, citizens' leisure, commercial market, cultural display, sports and sports, and ecological nature, to promote social interaction between the areas on the north and south sides of the elevated road and stitch together the functions and spatial structure of the surrounding cities (as shown in the figure below).



"ONE AXIS" - the ring road becomes a connecting axis, "SIX DISTRICTS" - functional diversity zoning

Figure 5-22 One Axis and Six Districts Design (drawn by the author)

(3) This diagram aims to illustrate the functional connections between the space beneath the bridge and the surrounding urban blocks:

For instance, in the westernmost red segment, the urban functions on the north and south sides include children's parks, youth centers, primary and secondary schools, kindergartens, and other facilities related to children and youth. Considering user needs and the spatial conditions beneath the bridge, this section's underbridge space is

designated for children's play areas. The green spaces on both sides and the added pedestrian bridges are designed to facilitate traffic flow in this area. Similarly, the blue section spans the ancient Lijiang canal connecting the southern waterway to the northern Sanjiao area (where the canal bed will be restored above ground on both sides per higher-level planning). Both the northern and southern urban blocks lie within the original site of ancient Lijiang Village, and this section occupies the central position of the former Lijiang Street. The master plan preserves ancestral halls and other historic structures on the south side, while the ancient Lijiang archway remains on the north. Consequently, the planning for the space, functions, and circulation routes beneath this bridge and along the north-south green belts aims to stitch together the urban cultural context here, extending the canal-side pedestrian commercial street system outlined in the southern master plan.

(4) The continuous space and functions under the bridge form a well-paced linear sequence:

Ecological Green Corridor (fast) - Children's Entertainment (half-fast, half-fast) - Community Living Room (fast) - Under-Bridge Market (fast) - Leisure Commerce (half-fast, half-fast) - Cultural Gallery (fast) - Sports Park (fast) - Ecological Green Corridor Walkway + Ecological Parking Lot (fast)

3、Design of Green Spaces Around the Bridge

The connection between the bridge and the residential area is a green space of about 30 meters wide (wider in some places) according to the superior plan. This part of the green space is also within the scope of this design. These green spaces are an indispensable part of building the ecosystem. They are also an important part of connecting the surrounding areas. The ecological strategy for the green spaces on both sides is to create a continuous leisure sponge landscape, such as pedestrian walkways and permeable paved plazas. In terms of transportation, based on the multiple motor vehicle lanes that have been designed from the surrounding areas to the area under the bridge in the higher-level planning, the space under the bridge will be further integrated with the surrounding areas, and the connection between important nodes under the bridge and the north and south sides will be increased (as shown in the figure below, landscape pedestrian plazas, pedestrian walkways, fitness trails, bicycle lanes, and the three-dimensional corridor under the bridge that connects to the extension of the urban pedestrian overpass).

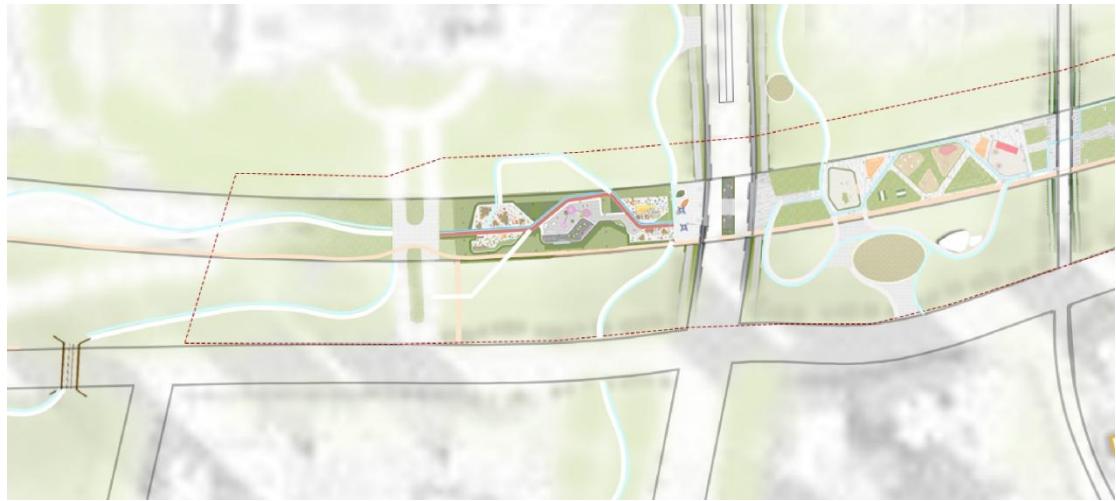


Figure 5-23 Enlarged view of the western half of the site plan (drawn by the author)



Figure 5-24 Enlarged view of the central half of the site plan (drawn by the author)

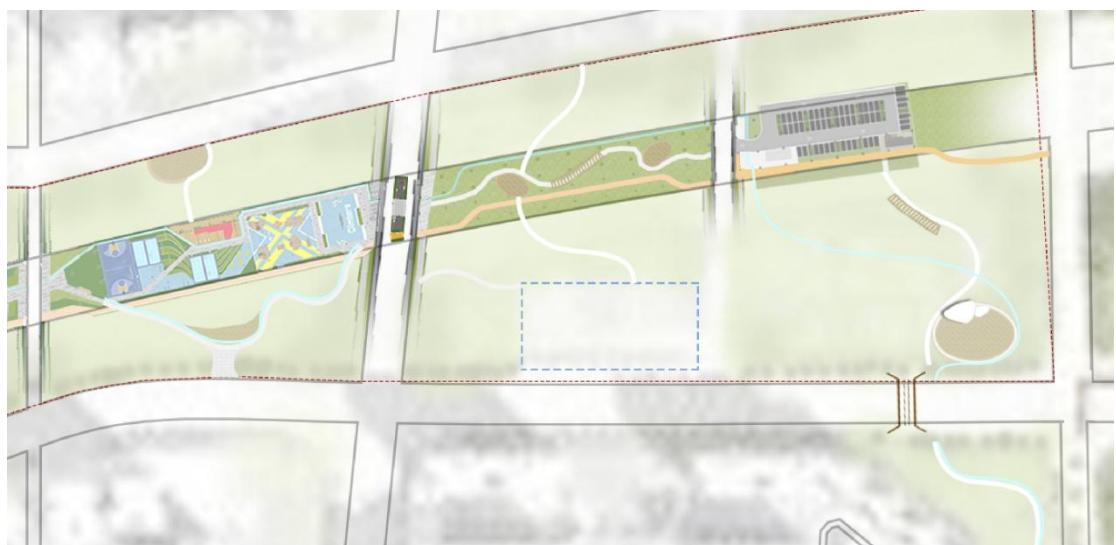


Figure 5-25 Enlarged view of the eastern half of the site plan (drawn by the author)

5.4.2 Overall Traffic and Flow Design

1. Microscopic three-way connection design

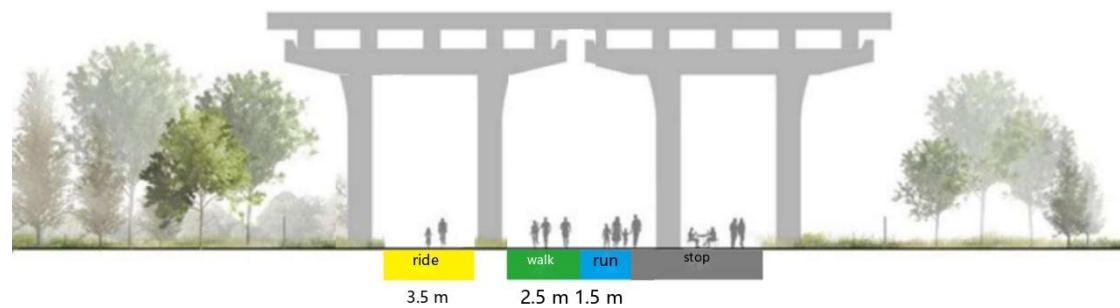


Figure 5-26 Three-way connection design—pedestrian path (2.5m), fitness running path (1.5m), two-way cycling path (3.5m) (self-drawn)

2. Corridor system planning and landscape axis and circulation design analysis

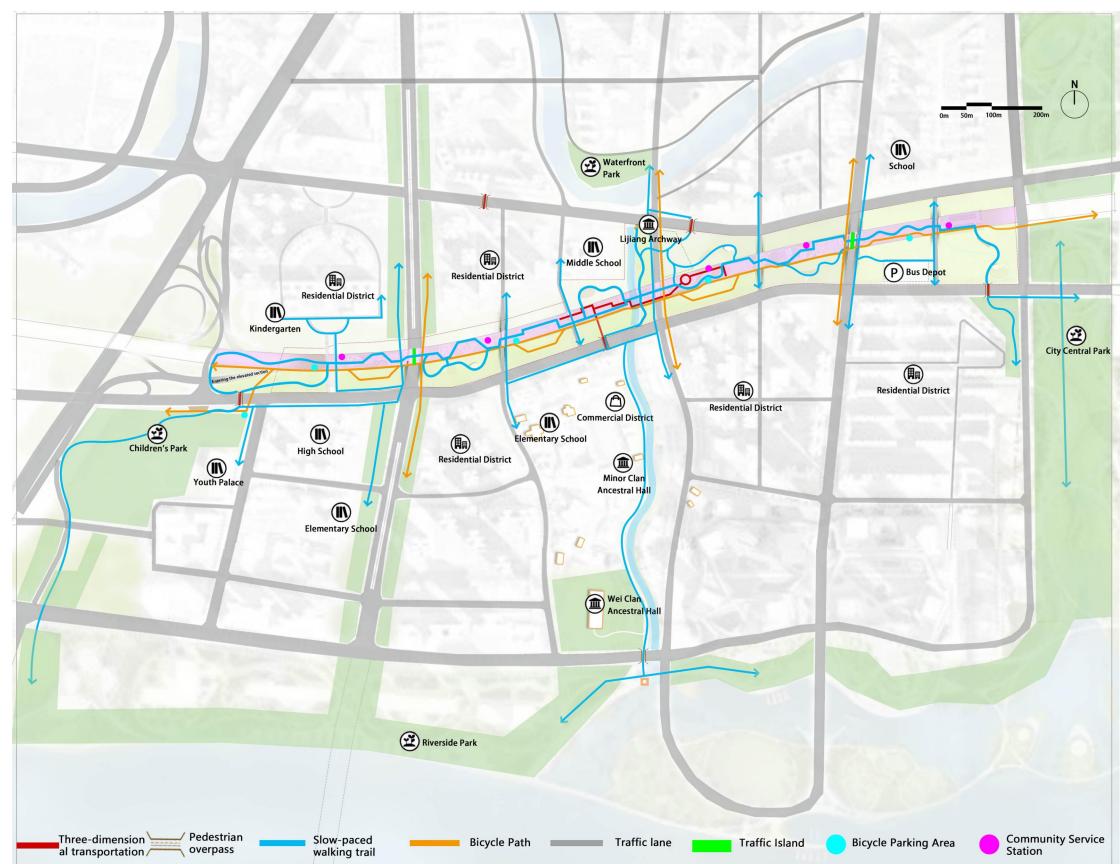


Figure 5-27 Traffic corridor system and traffic node design analysis (three-dimensional traffic, slow traffic system, cycling system) (drawn by the author)

- (1) Connect the surrounding children's park, waterfront green space, urban green space, etc., and combine the space under the bridge to build a systematic green slow traffic corridor system;

- (2) Combine the Lijiang ancient river channel, Haizhu Lake wetland, Pearl River back channel and tributaries to create a waterfront green slow traffic corridor system;
- (3) In conjunction with the historical pedestrian street in the future planning of Lijiao, we will construct an urban pedestrian walkway system, fitness trail, and cycling system. We need to pay attention to the connection strategy of traffic along the route.
- (4) Service facilities such as bicycle parking and convenience stations should be reasonably arranged along the route.



Figure 5-28 Landscape axis and design analysis of each circulation route
(drawn by the author)

The viaduct itself will be used as a landscape axis (leisure and entertainment line) and a fitness and slow walking system will be built to connect various functional areas along the route. In conjunction with the overall planning of the surrounding area, a landscape ecological line (landscape ecological corridor) and a historical and cultural line connecting the ancient Lijiao River and the Lijiao Archway will be built. In addition, a green two-way cycling line will be built by combining the space under the bridge with the adjacent green space.

5.4.3 Overall Ecological Strategy

The space under the bridge will continue the ecological concept based on the higher-level plan. Through ecological planting, permeable paving, rainwater drainage systems, and other sponge city strategies, an ecological space will be created under the bridge, connecting with surrounding children's parks, waterfront green spaces, and urban green spaces to construct a systematic green ecological corridor system. Simultaneously, based on the higher-level plan, a waterfront ecological corridor

system will be created by combining the Lijiang Ancient River Channel, Haizhu Lake Wetland, the Pearl River Back Channel, and its tributaries.



Figure 5-29 Overall Ecological Corridor System Planning and Design Analysis
(drawn by the author)

Furthermore, the connection between the bridge and residential areas on both sides includes approximately 30 meters wide (wider in some areas) of green space, which is also within the scope of this design. These green spaces are an indispensable part of constructing the ecosystem and an important link to the surrounding areas. This ecological strategy, based on the design of pedestrian paths and permeable paved plazas in green spaces, and building upon the existing multi-pathway system (including motor vehicle lanes) connecting surrounding residential areas to the area under the bridge, further integrates the space under the bridge with the surrounding area.

The specific ecological strategy for the bridge section is described in the section on the ecological walkway green corridor below, which mainly employs the concept of a sponge city, rainwater installations in the green spaces under and outside the bridge, and permeable paving.

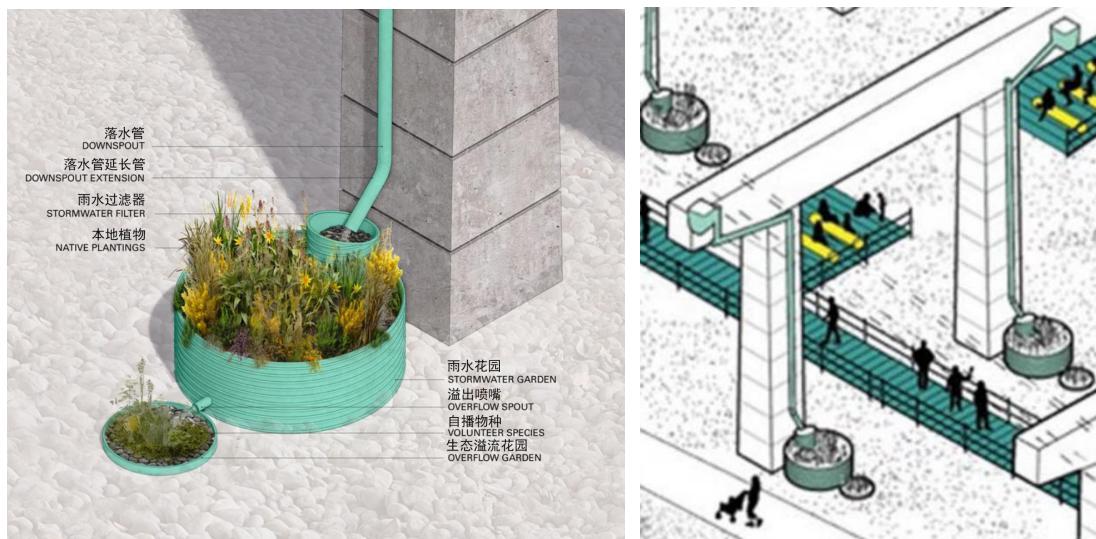


Figure 5-30 Schematic diagram of rainwater installation on bridge pillars

(Image source: author's redrawing)

In response to the characteristics of the subtropical monsoon climate in South China, characterized by "rapid rainfall and large runoff," innovative rainwater management facilities are proposed to be introduced around the bridge pillars. The device accurately collects rainwater runoff from the bridge surface and first directs it into a purification zone composed of "rain gardens." Within this zone, clusters of plants (such as wild peony, iris, papyrus, etc., which are both tolerant of waterlogging and have purification capabilities) effectively slow down runoff and filter pollutants. In the event of extreme rainfall, excess rainwater will safely overflow into the adjacent "overflow garden (ecological dry stream)," where native plants with strong root systems (such as foxtail grass and miscanthus) are mixed in to absorb flood peaks and enhance infiltration, significantly alleviating urban flooding pressure.

This design not only provides a resilient response to Guangzhou's frequent flooding problems but also transforms infrastructure into a vibrant node that promotes biodiversity and enhances public ecological awareness, constructing a breathing "urban sponge."

5.4.4 Overall Cultural Integration Strategy

Lijiao, a thousand-year-old water town, is undergoing a warm and transformative renewal. In the higher-level planning, cultural heritage such as clam shell houses, the Wei Clan Ancestral Hall, and the Guangzhou boundary marker have been carefully preserved. The riverbanks continue the authentic Lingnan water town scene,

integrating folk activities such as dragon boat races, flower markets, and lion dances to reshape a vibrant local atmosphere.

Against this backdrop, the project's cultural strategy aims to use the "under-bridge space" as a medium to create a cultural living room connecting history, the present, and the future. The space beneath the viaduct has been redefined as a "cultural corridor" connecting history and the future. Traditional elements are reconstructed using modern design language to create a public cultural space that is accessible, engaging, and memorable.

The main cultural design concept is to create a continuous north-south historical and cultural line along the Lijiang Ancient River and its historical architectural nodes. The design focuses on cultural nodes at the intersection with the bridge, supplemented by the Lijiang Ancient Archway, green cultural walkways, and cultural node designs on the river sections north and south of the bridge.

Specific designs for the cultural nodes under the bridge can be seen in the cultural gallery section design below:

The space under the bridge is designed as the Lijiang Cultural Plaza. Historical story reliefs and Lingnan clamshell walls are created on the bridge pillars and beams to continue the regional culture and urban context, enhance the historical value of the space, and strengthen citizens' cultural identity with the city. The plaza features a wave-shaped, three-dimensional leisure belt echoing the river's flow, along with the Lijiang Wei Clan Ancestral Precepts Cultural Wall. Furthermore, a bridge is built under the river to highly replicate the ancient Lijiang Bridge. Other nodes under the bridge can also be used to design cultural exhibition walls for Lijiao, hang cultural installations, design cultural archways using the bridge pillars, and design cultural micro-sculptures of Lijiao maps on the ground under the bridge.

In addition, three circular exhibition corridors are constructed with modern vocabulary for cultural display and community exchange, forming a narrative loop of "past-present-future". They are not only exhibition spaces, but also generators for resident interaction and cultural regeneration.

The entire space under the bridge becomes an exhibition hall for Lijiao culture and South China culture. This design attempts to achieve not only the preservation of history, but also the translation of cultural context—allowing the spirit of the ancient water town to flow into urban daily life in a new way, awakening everyone's cultural identity with the land beneath their feet.

5.5 Zoning Display

The following text mainly shows the design of the space under the bridge. For the specific design of the green space around the bridge, please refer to Figures 5-23, 5-24, and 5-25 in the overall functional design section above.

5.5.1 Design Strategy Analysis for Children's Playground Section

Main Strategies -- Entrance Guidance, Color Design, Semi-Enclosed Interface, Traffic Island Design

The total height under this section of the bridge is about 5.4m-6.0m. It is close to a kindergarten and a large residential area to the north, and adjacent to the Youth Palace and Haizhu Children's Park to the south. It aims to provide a sheltered playground for younger children, integrating functions such as a playground under the bridge, themed science education, educational games, and parent-accompanied leisure. To the west, it is adjacent to the entrance of a large residential area under the bridge and the westernmost ecological landscape area under the bridge, which can be connected by pedestrian and cycling fitness routes. To the east, it is adjacent to the main road under the bridge, so a traffic island for a leisure waiting area is set up on the east side to improve traffic safety when arriving at this area.

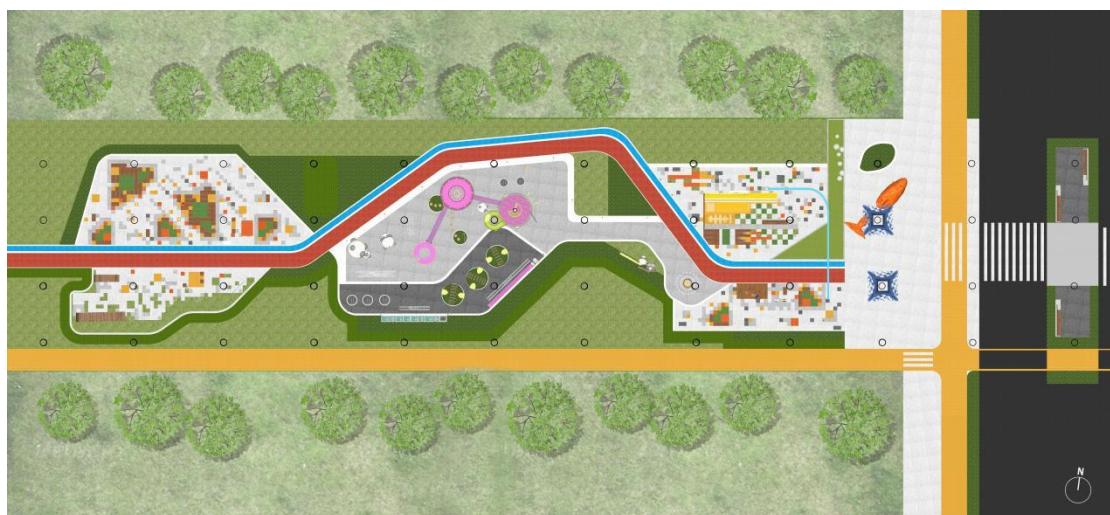


Figure 5-31 Children's Playground Plan (drawn by the author)



Figure 5-32 Axonometric rendering of the children's playground section (total height under the bridge: 5.4m-6.0m) (drawn by the author)

Specific Axonometric Effects and Application of Design Strategies: Refer to the following effects and analyses:



Figure 5-33 Effect of Children's Science Popularization Area + Parent Leisure Area under the Bridge (drawn by the author)



Figure 5-34 Effect of Children's Dynamic Playground - Slide Around Column Design, Facilities, Roads and Bridge Columns with Bright Colors (drawn by the author)



Figure 5-35 Early Childhood Educational Play Area (Semi-Enclosed Space: Play Wall) + Entrance Guidance Area (Sculpture, Bridge Column Guidance) (drawn by the author)



Figure 5-36 Traffic Island Design
(Passage Area + Rest Area + Bicycle Lane and Road Markings) (drawn by the author)



Figure 5-37 Rendering of the Entrance Plaza & Playground for the Children's Play Area
(drawn by the author)

5.5.2 Design Strategy Analysis for Community Living Room Section

Main Strategies -- Micro-topography (sunken, stepped), hanging, ecological planting, community interactive installations

The total height under this section of the bridge is approximately 6.3m-6.6m. The north and south sides are adjacent to large-scale residential communities, including many high-rise residential buildings. Therefore, the area under the bridge is designed as a community living room, including a pet park, chess and card room, community interaction and communication area, small theater, stepped leisure area, small square and community service station, etc., combining open and private spaces. In addition, this section of the bridge space is combined with the green space on the south side to create an open-air small square, simple leisure pavilion and sunny lawn camping area to meet the needs of many communities.



Figure 5-38 Community Living Room Section Plan (drawn by the author)

Specific Axonometric Effects and Application of Design Strategies: Refer to the following effects and analyses:

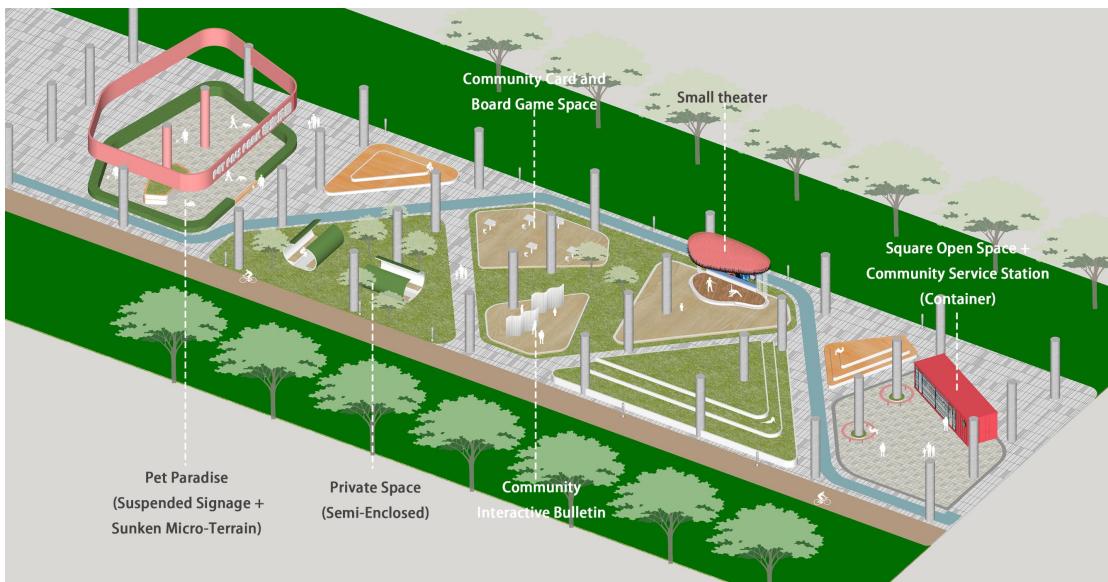


Figure 5-39 Axonometric rendering of the community living room section + brief analysis of node techniques (total height under the bridge 6.3m-6.6m) (drawn by the author)

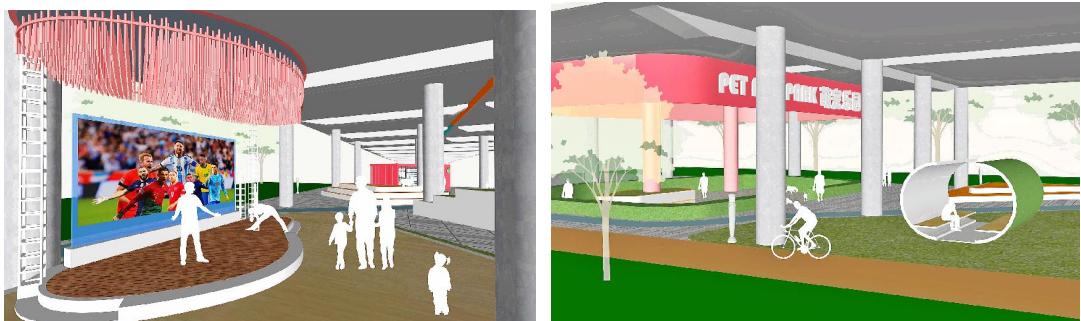


Figure 5-40 Rendering of the Community Lounge Segment's Small Theater & Pet Paradise (drawn by the author)

5.5.3 Design Strategy Analysis for Creative Market Section

Main Strategies -- Spatial Sequence, Lightweight Furnishings, Entrance Guidance, Color Design

The total height under this section of the bridge is approximately 6.6m-7.5m. To preserve the site memory of the vegetable market under the bridge, it is designed as a multi-functional creative market, including an entrance plaza, a circular pedestrian commercial street composed of modular stalls and containers, a central light plaza, etc., which can be used for creative retail, snack night market, community activities, recruitment and corporate exhibitions, festival flower market, etc. Similar market spaces are prone to excessive replication, giving people an endless experience; the

spatial sequence of this design from east to west is the opening scene - development (closing) - climax (opening) - closing scene (semi-closing), making the space varied and not boring to stroll through. On the east side, there is a circular staircase entrance to the sky corridor connecting the single lane under the bridge to the eastern section of leisure and commerce. The corridor guides the flow of people and integrates the creative market with leisure and commerce and other commercial functions.



Figure 5-41 Creative Market Section Plan (drawn by the author)



Figure 5-42 Axonometric rendering of the creative market section + spatial sequence + brief analysis of node techniques (total height under the bridge 6.6m-7.5m) (self-drawn)

Opening Scene (Open) -- Development (Closed) -- Climax (Open) -- Closing Scene (Partially Closed)



Figure 5-43 Creative Market Segment Entrance Plaza Perspective Rendering
(drawn by the author)



Figure 5-44 Commercial Inner Street Perspective Rendering (drawn by the author)



Figure 5-45 Creative Market Segment: Lighting Plaza Perspective Rendering
(drawn by the author)

5.5.4 Design Strategy Analysis for Leisure Commercial Section + Cultural Gallery Section

Leisure Commercial Section Main Strategies -- Vertical Layering and Traffic Design (Three-Dimensional Corridors and Second-Level Platforms), Lightweight Furnishings

Key strategies for the cultural gallery section: cultural strategies (restoring cultural scenes and adding new cultural installations and displays, etc.), vertical layering and traffic design, lightweight assembly, and hanging.

The total height of the space under these two sections of the bridge is approximately 7.5m-8.5m. The clearance meets the requirements of the three-dimensional corridor (minimum 2.6m above) and the passage of vehicles on the road under the bridge (4.5m). Therefore, the leisure commercial section and the cultural exhibition gallery section are connected three-dimensionally by a spatial corridor, with multiple pedestrian staircase entrances in between (as shown in the figure 5-46).



Figure 5-46 Plan view of the leisure commercial section and cultural exhibition corridor section
(drawn by the author)

The total height of the leisure and commercial section under the bridge is approximately 7.5m-8.2m. In order to preserve the site memory of the grocery market under the bridge and to echo and supplement the function of the historical pedestrian commercial street of Lijiao on the south side, this section is still for commercial use. It is set up with container shops in different combinations, such as coffee shops (two-part), bookstores (stacked), and tea rooms (parallel). All of them are combined with three-dimensional corridors and steel fittings to set up roof leisure platforms, which connect leisure and commercial spaces horizontally and vertically, and realize the alternation of indoor and outdoor spaces on two levels. It still has use value in the hot summer environment of Guangzhou (as shown in the figure below).

Containers have low construction costs, high construction and decoration efficiency, are reusable, sturdy and safe, and are more resistant to wind, earthquakes and noise, making them very suitable for commercial spaces under bridges.

The green area on the north side of this section is relatively large and can be transformed into a new type of leisure-oriented protective green space. It is proposed to set up a walkway and a small leisure platform facing the middle school to the north to meet the leisure and sightseeing needs of surrounding tourists.

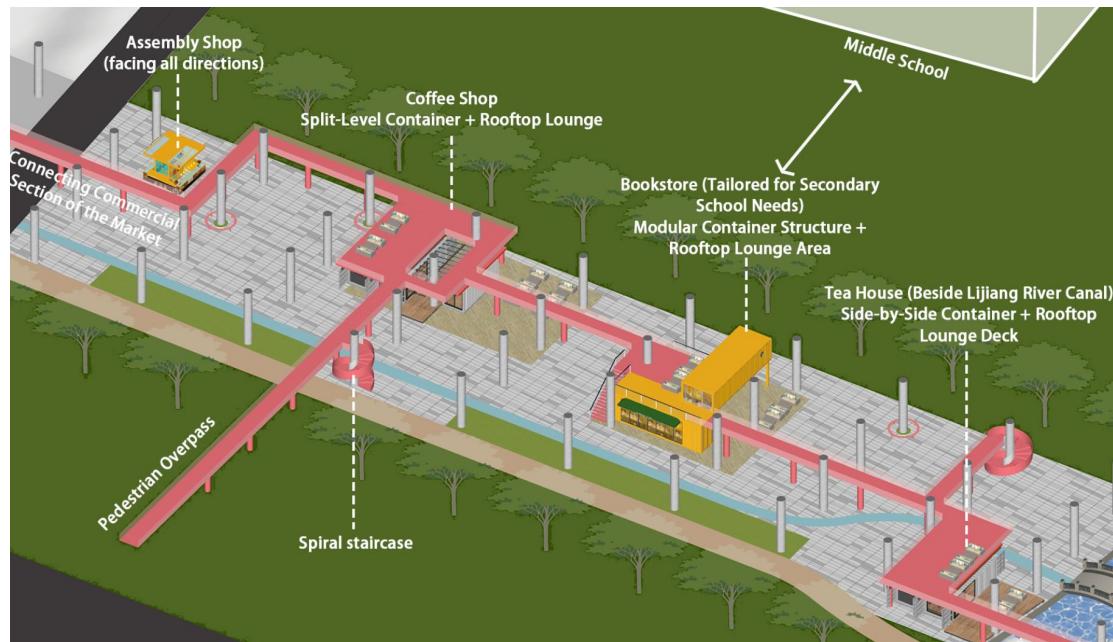


Figure 5-47 Axonometric drawing of the leisure and commercial section (corridor + commercial container space) (total height under the bridge: 7.8m-8.3m)

(drawn by the author)



Figure 5-48 Container Commercial Perspective Rendering (drawn by the author)

The clear height under the bridge in the cultural gallery section is approximately 8.2m-8.5m. The planned urban road (formerly Lijiao Street) crosses this section. The Lijiao Ancient River and its riverside greenway will be restored on the west side of the road, with an antique-style stone bridge and boat passage. The historical and cultural line will be connected through nodes such as the river, riverside greenway, and historical buildings along the route (there is the Lijiao Archway and a proposed new river viewing platform in front of the bridge on the north side; the Lijiao Street nodes on the south side include the Wei Clan Ancestral Hall, the Guangzhou City Boundary Marker and Wharf Park, various small ancestral halls, and newly built commercial nodes). The Lijiao Cultural Square will be set up between the river and the urban road. The bridge pillars and beams will be decorated with historical story reliefs and Lingnan clam shell walls, continuing the regional culture and urban context, enhancing the historical value of the space, and strengthening citizens' cultural identity with the city. The plaza features a wave-shaped, three-dimensional leisure belt echoing the river's flow, along with the Lijiang Wei Clan Ancestral Precepts Cultural Wall.

The east side of the road is a multi-functional exhibition plaza, which can be used for cultural exhibitions, leisure, etc., with flexible and adaptable space; on one side is a bookshelf device for citizens to exchange ideas under the bridge. Next is the circular corridor exhibition hall, which consists of a circular corridor, three container exhibition halls and a suspended mirrored ceiling panel, which can be used for cultural exhibitions and other activities in Lijiao (as shown in the figure below).

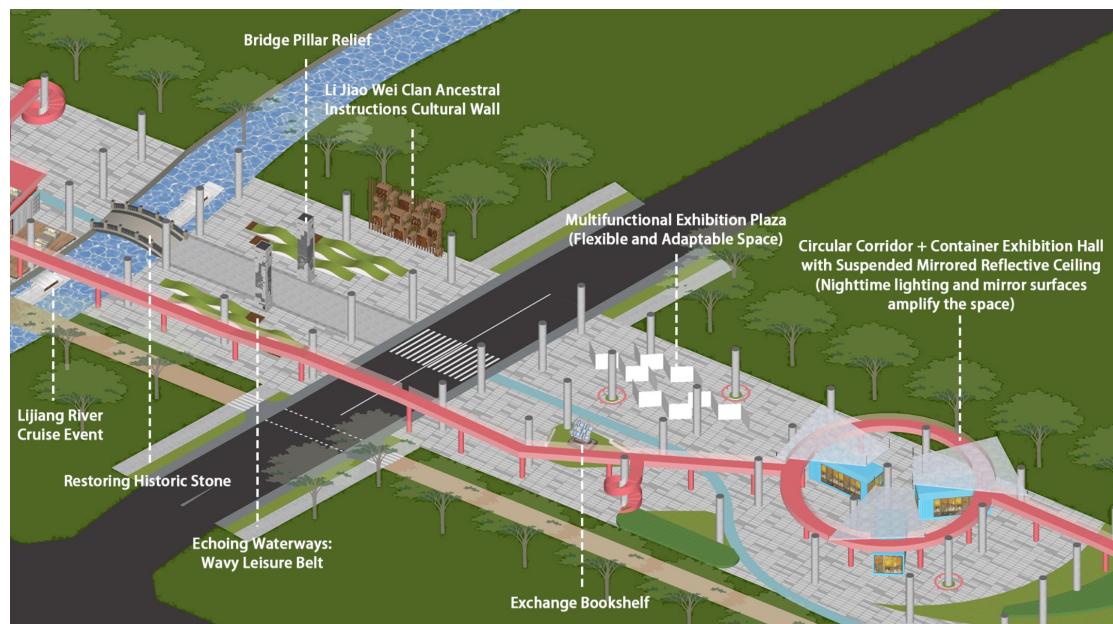


Figure 5-49 Axonometric drawing of the cultural exhibition corridor section (corridor + commercial container space) (total height under the bridge: 8.2m-8.5m)
(drawn by the author)



Figure 5-50 Rendering of the Lijiang Ancient Waterway Node (drawn by the author)



Figure 5-51 Rendering of Container Exhibition Hall and Circular Gallery Junction
(drawn by the author)

After a transitional leisure green corridor, the space expands, and a community multi-functional grand staircase and a large plaza under the bridge are set up. The grand staircase is a multi-functional space, serving as both a tiered theater stage and a viewing platform. A large screen can be hung in the center of the plaza for film screenings or seating can be provided. Below the grand staircase are auxiliary indoor spaces such as offices, changing rooms, and restrooms, achieving vertical layering of

the space. The plaza is divided into two plazas, a large one and a small one, by a gate wall displaying Lijiao-themed elements. The upper part of the large plaza can be used to hang calligraphy and cultural ribbons or other art installations, while the lower part is a multi-functional plaza that can serve different functions at different times. The small plaza's paving features a recessed relief of an ancient Lijiao map, which visitors can walk on and appreciate.

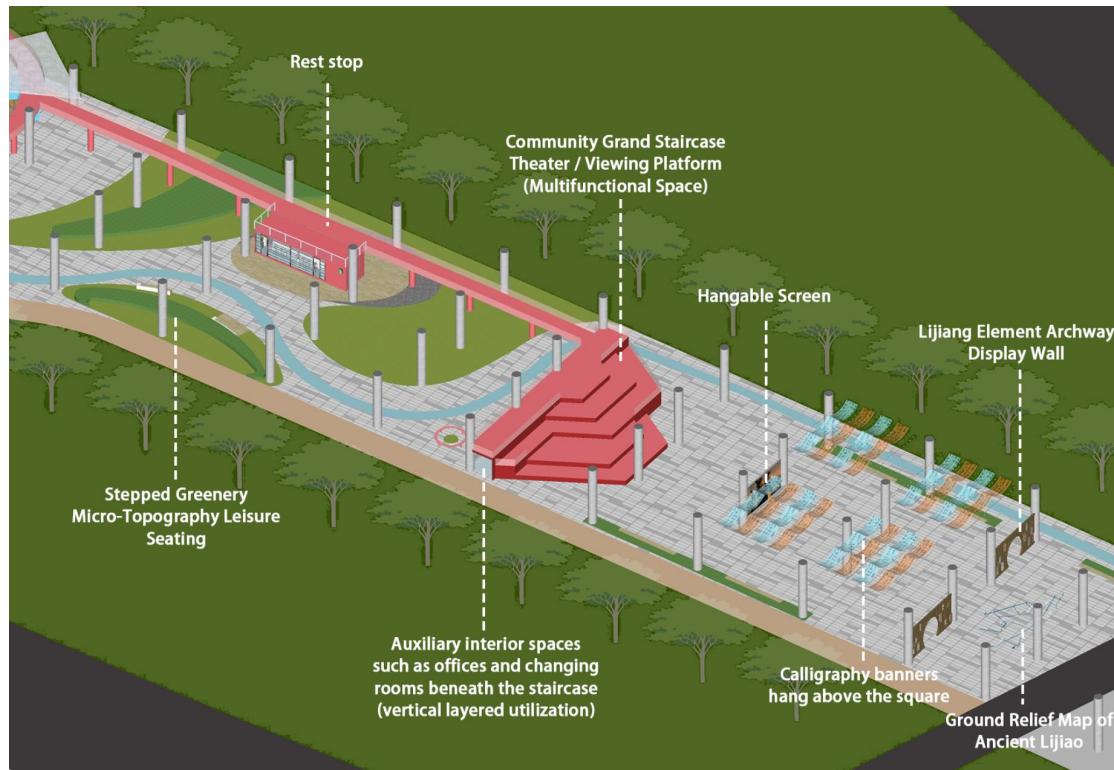


Figure 5-52 Axonometric drawing of the cultural exhibition corridor section (corridor + commercial container space) (total height under the bridge: 8.2m-8.5m)
(drawn by the author)



Figure 5-53 Rendering of the Grand Staircase Theater Node (drawn by the author)



Figure 5-54 Leisure Green Corridor
(Rest Stop Node and Ecological Landscape) Rendering (drawn by the author)

The above design realizes the protection and continuation of historical culture, while also realizing the development of regenerated culture and the collision and integration of old and new cultures. It is intended to add a new attraction to urban tourism, attracting other urban residents and even tourists from other regions, so as to promote and carry forward Guangzhou's historical culture.

5.5.5 Design Strategy Analysis for Sports Park Section

Main Strategies -- Spatial Division, Color Design, Ecological Planting

The total height under this section of the bridge is approximately 8.5m-9.3m, which is the highest clear height under the entire bridge section at the selected site. The column spacing is wider, and there are many surrounding communities, and it is far from the westernmost community swimming pool and shared sports field. Sports facilities are somewhat lacking, and the sports facilities in the surrounding parks are mostly open-air. Therefore, this section is set as a sports park under the bridge, and its functions are intended to realize the concept of sports for all ages. The central section features a fitness and refreshment station, a leisure platform, and a lawn, providing refreshments and equipment services for all sports areas. The west side includes badminton courts, green walkways, fitness equipment areas, and an enclosed basketball court; the east side features table tennis courts, a skateboarding area for teenagers, and a bridge-based climbing wall area.

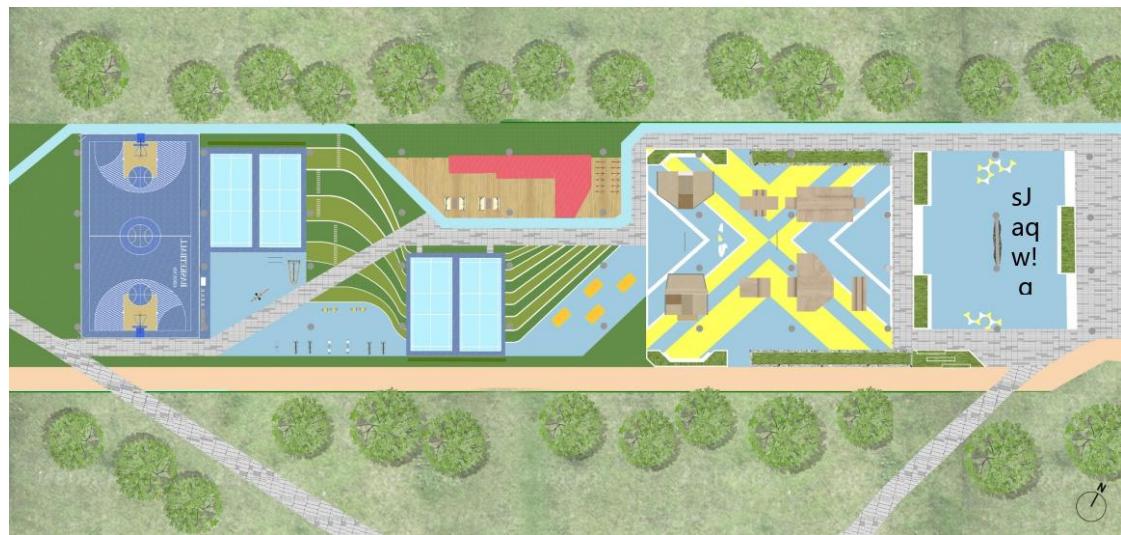


Figure 5-55 Plan of Sports Park Section (Drawn by the author)

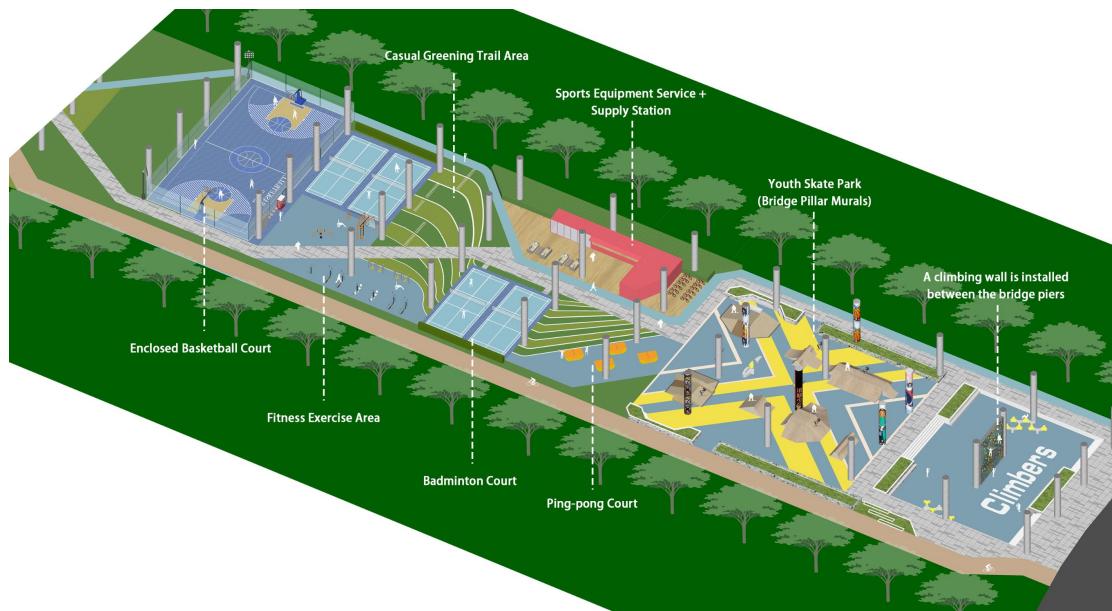


Figure 5-56 Axonometric drawing of the Sports Park section (8.5m-9.3m under the bridge) (drawn by the author)

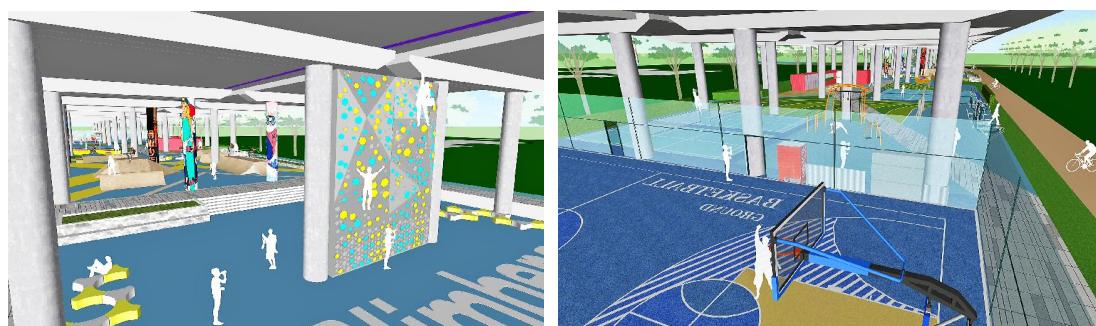
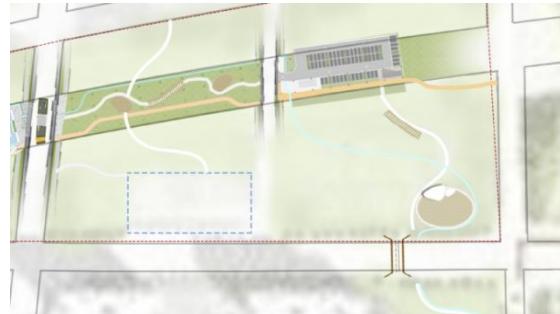


Figure 5-57 Rendering of the Rock Climbing Skate Area & Basketball Court in the Sports Park Section (drawn by the author)

5.5.6 Analysis of Design Strategies for Ecological Promenade Green Corridors and Parking Sections

Main Strategies -- Ecological Strategies (Sponge City Concept, Rainwater Installations, Permeable Paving, etc.)

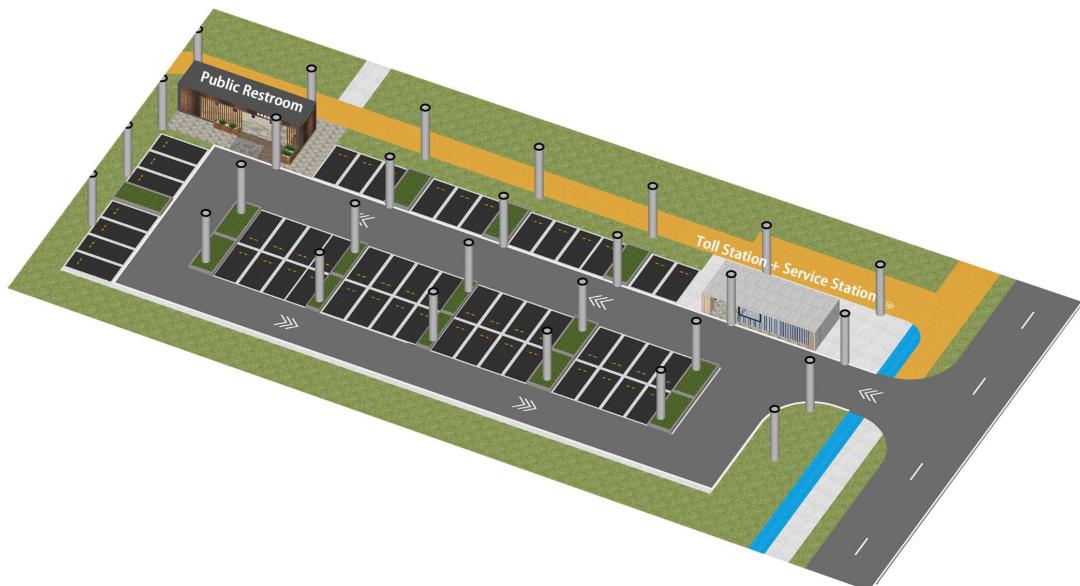
The ecological walking green corridor section mainly plants shade-tolerant and semi-shade-tolerant plants under the bridge. This section aims to create a continuous leisure sponge landscape. The section under the bridge receives rainwater from the elevated road surface—serving as an ecological sponge under the bridge. The green spaces on the north and south sides are also green space landscape sponges. In this way, each section (green planting, landscape features, rainwater installations, permeable paving, etc.) forms a sponge, collectively forming a large sponge to contribute to urban stormwater and the ecosystem. On the other side of the secondary road under the bridge is a smart bus station, realizing the project's bus + slow traffic mode;



The ecological parking lot has a clearance height of approximately 2.8m-3.3m under the bridge. The westernmost end could be combined with the parking lot adjacent to the bridge at Haizhu Children's Park, but the city's parking demand is huge, and this section is at the eastern end, with pedestrian traffic planned to be located in the green space outside the bridge, without interfering with the functions of other bridge sections. Based on these conditions, it is designated as an ecological parking lot, with the addition of public restrooms and a payment service station. The southern side of this section has the largest green area, and the adjacent city center park to the east directly connects to the north-south urban wetlands and the Pearl River's back channel green corridor. It is proposed to develop the southern green space into a leisure sponge landscape, jointly creating an urban ecological green corridor system.



Figure 5-58 Plan of Smart Parking Section (Drawn by the author)

Figure 5-59 Axonometric drawing of smart parking section (under bridge height 2.5m-3.0m)
(drawn by the author)

5.6 Chapter Summary

This chapter presents a specific design practice, selecting the space under the bridge of the Lijiao section of the Guangzhou Ring Expressway as the design practice object. Under the background of the higher-level planning of Haizhu Innovation Bay (Lijiao area) where the site is located, the design strategies proposed in the research section are applied through the survey and analysis of the current situation and people in the area under the bridge and the surrounding area, and the summary of the problems. Combining Guangzhou's policy advocating the construction of "ring parks" under the ring expressway, and considering the needs of the surrounding population

and environment, this study proposes a "one axis, six zones" design scheme. The goal is to enhance the quality and function of the space under the bridge, integrate the city, preserve the original market memories of the area, and organically continue the local cultural heritage of Lijiao. The scheme aims to create effective, high-quality public spaces for the people. Using the ring expressway viaduct as the axis, a linear sequence of spaces is created under the bridge, connecting urban areas along the route. This forms six major zones: children's entertainment, citizen leisure, commercial markets, cultural displays, sports and recreation, and ecological nature. This promotes social interaction between the areas on the north and south sides of the viaduct, integrates the functions and spatial structure of the surrounding city, and, based on co-construction and sharing, transforms the space under the bridge into a high-quality public space with diverse functions, varied spatial forms, good accessibility, and integration of ecological concepts and local cultural heritage.

Conclusion

With the rapid development of urban transportation infrastructure, a large number of negative spaces under viaducts are in urgent need of systematic renewal and revitalization. How to make these spaces play a positive role in ecological restoration, functional composite, landscape enhancement and social services through effective design transformation, and how to respond to the public's expectation for high-quality urban public space, has become an important issue in urban renewal.

On the basis of combining relevant concepts, research dynamics and theories, combining the summary of the characteristics of the space under the viaducts in China's cities and the field research and policy analysis of the typical under-bridge space in Guangzhou, this paper systematically summarizes the current situation and puts forward six design strategies with universality by drawing on the domestic and international practice cases: functional reorganization and composite use, spatial remodeling and sequential organization, traffic suture and flow optimization, narrative construction and cultural implantation, ecological technology and sustainable construction, and common sharing and orderly management. construction and cultural implantation, eco-technology and sustainable construction, sharing and orderly management.

Finally, taking the space under the bridge of Lijiao section of Guangzhou Ring Road as the practical object, based on the in-depth investigation of its spatial conditions and the needs of the crowd, the aforementioned strategy is transformed into a specific design program to verify the applicability and practical value of the research results.

The present study still has some limitations that need to be explored in depth:

- (1) The reuse of space under viaducts is a systematic project involving multiple dimensions such as land, planning, security, and constructability, etc. This paper mainly puts forward strategies and solutions from the level of spatial design, and the discussion of cross-sectoral synergy and institutional safeguards is still insufficient.
- (2) Although the study focuses on the needs of the crowd, there is still room for deepening the analysis of the type of users and their behavioral patterns. In the future, we should strengthen the combination of quantitative and qualitative crowd research in the pre-design stage, so as to enhance the scientific and humanistic aspects of space design.

(3) The renewal of the space under the bridge is a dynamic development process, with the technological progress and social change, should continue to explore the application of new materials, new technologies and innovative design techniques, in order to maintain the foresight and adaptability of the research.

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Appendix 2

2. The unveiling ceremony of the demonstration site for comprehensive utilization of space under bridges in Guangzhou and the urban question of space under bridges (6th revision):

Article release date: December 5, 2024 Source: <Guangzhou Land Consolidation Center>

More than 50 representatives from the relevant business departments of Guangzhou Planning and Natural Resources Bureau, Guangzhou Transportation Bureau, Nanhuaixi Street Office and Pazhou Street Office in Haizhu District, Guangzhou, and Guangzhou Transportation Investment Group Co., Ltd. attended. This event focuses on the theme of "Composite Utilization of Underbridge Space", jointly exploring the pain points and difficulties faced in optimizing and improving the implementation of under bridge space, actively seeking solutions, and creating a model project for composite utilization of under bridge space.

Zhou Qiaoyang, a first-level researcher from the Guangzhou Municipal Planning and Natural Resources Bureau, delivered a speech at the event: The report of the 20th National Congress of the Communist Party of China clearly stated that it is necessary to promote the composite utilization of urban space and pay attention to the three-dimensional development of space. As a pioneering city of reform and opening up, Guangzhou has always been at the forefront of exploration and innovation in this regard, actively exploring relevant work on promoting the planning and implementation of under-bridge spaces, including the practice of full-cycle management and transparent consultation mechanisms, actively promoting the composite utilization of under-bridge spaces, and realizing the co-construction, co-governance, and sharing of under-bridge spaces.

Subsequently, the Guangzhou Urban Renewal Land Consolidation and Guarantee Center awarded the Xinhua Expressway Under-Bridge Space Upgrading and Transformation Demonstration Project the plaque of Guangzhou Under-Bridge Space Comprehensive Utilization Demonstration Site, and will subsequently provide full-process planning and implementation tracking guidance services for the pilot project.

Following this, Wang Dewen, Director of the Guangzhou Urban Renewal Land Consolidation and Guarantee Center, delivered a keynote speech: The Guangzhou Urban Renewal Land Consolidation and Guarantee Center will provide service and support for the entire lifecycle management of under-bridge spaces—from the compilation and review of demonstration site renovation plans to the introduction of industrial planning and implementation evaluation—in three aspects, striving to create a benchmark for urban renewal and renovation in the province and play a demonstrative role in the overall planning of under-bridge spaces: First, building a high-quality professional team to promote planning implementation; second, strengthening technical services for under-bridge spaces; and third, organizing and establishing a mechanism to promote public participation in planning implementation.

Next, the activity will enter the discussion session of "Under the Bridge Space · City Inquiry". Representatives from Guangzhou Transportation Planning and Research Institute Co., Ltd., Guangzhou Transportation Investment Group Co., Ltd., Nanhuaixi Street Office in Haizhu District, as well as renowned experts and scholars, shared their insights on the implementation and promotion of the plan for the composite utilization of space under bridges.

Xiao Weizhi, a senior engineer at Guangzhou Transportation Planning and Research Institute Co., Ltd., proposed classification optimization guidelines based on the construction conditions and current utilization of the space under the bridge. Through the concept of "one bridge, one plan,

one bridge, one feature", he actively promoted the implementation of the plan from the aspects of safety, livelihood, function, and management, transforming the original "grey space" of the city into a "public vitality space" and making it an organic part of the urban public space.

Zhou Jienan, Party Secretary and Chairman of Guangzhou Jiaotong Investment Industry Co., Ltd., stated that in recent years, the group has comprehensively reviewed and verified the assets under bridges within its jurisdiction. Through measures such as strengthening daily inspections, improving safety protection, and implementing refined management, the group has promoted the effective control and management of the under-bridge spaces of approximately 780,000 square meters along the Ring Expressway, approximately 320,000 square meters along municipal bridges (annual pass projects) within the Ring Expressway, and approximately 2.35 million square meters along expressways outside the Ring Expressway. This has effectively improved the previously prevalent "dirty, messy, and poor" conditions of garbage accumulation, sewage overflow, and illegal construction, achieving a clean, beautiful, safe, and orderly environment for nearly 3.45 million square meters of under-bridge spaces.

Huang Zhifeng, a staff member of the Comprehensive Utilization Project of Under-Bridge Spaces in Nanhua West Street, Haizhu District, Guangzhou, detailed how the under-bridge space of the People's Bridge has created the "People's Bridge Olympic Charm Nanhua West" brand. By combining Lingnan, Cantonese, intangible cultural heritage, and modern cultural elements, the project has introduced diverse business formats such as Party building cultural spaces and the Nanhua West Cultural Exhibition Hall to meet the daily needs of citizens and contribute to the improvement of the city's image and quality.

Lu Yuan, former director of the Urban and Rural Construction, Environmental Resources Committee of the Guangzhou Municipal People's Congress Standing Committee, stated that in this era of transition from incremental to stock-based development, the space under bridges is shifting from a passive to an active space, and from a negative to a positive space. Against this backdrop, the integrated utilization of under-bridge spaces must adhere to five principles: the principle of classified disposal, the principle of safety bottom line, the principle of comprehensive utilization, the principle of advance planning, and the principle of people-centered design. Simultaneously, Guangzhou needs to establish a long-term and effective operation and management mechanism for under-bridge spaces, summarize an implementable technical path, and promote the practice of renovating under-bridge spaces.

He Chongming, former first-level researcher of the Guangzhou Municipal Planning and Natural Resources Bureau, proposed five characteristics of under-bridge space utilization from the perspective of revitalization and value realization: the diversity and dynamism of demand, the special nature of its ancillary aspects, the safety of utilization, and the accessibility of functions. Work on under-bridge spaces needs to focus on several mechanisms, including a pilot-first mechanism, a public participation mechanism, a long-term operation mechanism, and a joint promotion mechanism, to comprehensively promote the improvement and enhancement of the integrated utilization of under-bridge spaces.

Lin Chi, Director of the Road Administration Department of the Guangzhou Municipal Transportation Bureau, stated that the multi-functional use of under-bridge spaces can be explained from multiple dimensions, including demand planning and management, property rights operation, and revenue. Six aspects need to be considered in the multi-functional use of under-bridge spaces: first, the needs of the local government; second, the needs of public services; third, the needs of traffic safety; fourth, the balance between the ownership, management, and

operation entities of the space; fifth, pilot projects first, then establish a safety technical standard; and sixth, respect for historical context, especially respect for spaces that have already been revitalized. The Guangzhou Municipal Planning and Natural Resources Bureau and the Guangzhou Municipal Transportation Bureau will continue to strengthen their collaboration to jointly promote the environmental remediation and landscape improvement of under-bridge spaces.

Professor Fan Jianhong of Guangdong University of Technology proposed a mechanism for the participation of students, residents, and artists from the perspective of human behavior to expand the cultural connotation of under-bridge spaces. He also specifically pointed out that under-bridge spaces need to consider the needs of young people and surrounding residents, creating a number of popular photo spots and forming a number of vibrant and lively exemplary spaces.

Cai Jianbo, Director of the Fourth Design Institute of Guangzhou Municipal Engineering Design and Research Institute, traced the changes in the demand for under-bridge space from the past to the present from a historical perspective, proposing to seize the unique advantages of under-bridge space across rivers and lakes, and to adhere to a problem-oriented approach to rationally utilize negative spaces.

Conclusion:

The implementation and promotion of the composite utilization of under-bridge space, as the focus of this event, is of great practical guiding significance. It is an important action for Guangzhou, based on its core engine positioning in the Guangdong-Hong Kong-Macao Greater Bay Area, and to implement the work requirements of the Guangzhou Municipal Party Committee and Municipal Government at the High-Quality Development Conference regarding "focusing on major transportation corridors" and "promoting high-quality urban development through urban renewal." This event is the sixth session of the Urban Exploration Forum. We look forward to more insightful individuals gathering here to offer suggestions for the development of composite utilization of under-bridge space, jointly explore replicable and scalable Guangzhou experiences, and build demonstration sites into model projects for the revitalization and utilization of under-bridge space, effectively promoting the high-quality development of Guangzhou.

四、答辩委员会决议书

答辩委员会对学位（毕业）论文的评语（主要内容包括：1. 论文选题与综述；2. 学术水平与创新性；3. 论文综合能力表现；4. 学位（毕业）论文答辩情况；5. 存在的不足之处和建议等）

论文选题具有较为重要的理论价值和现实意义，论证过程逻辑较为清晰，结论合理，具备一定的实践指导意义。

答辩过程中，作者汇报表达清楚，回答问题较准确，达到了硕士学位论文要求，建议针对答辩委员会所提意见进行修改完善。

答辩委员会一致同意李文珊通过硕士学位论文答辩，同意其毕业，并建议授予硕士学位。

论文答辩日期：2025年11月26日 答辩委员会委员 5人

毕业表决票数：通过（5）票；不通过（0）票

学位表决票数：通过（5）票；不通过（0）票

答辩委员会决议（打“√”）：

毕业：通过（√）；不通过（ ）

学位：通过（√）；不通过（ ）

答辩成员 签名	苏平 (主席) 王伟杰 王立波	吴晓军
答辩秘书 签名	吴任之	