

Research on Strategies for Enhancing Roadside Green-Space Plant Landscapes: A Case Study of Urban Arterial Roads in Hangzhou

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Abstract

Plant landscapes play an indispensable role in shaping the character of roads. Additionally, the construction of road plant landscapes can mitigate the impacts of urban expansion. Therefore, exploring the plant landscapes of road green spaces is of great value. This study focuses on urban road greening construction, investigating the road greening in Hangzhou city. Through field surveys of the green spaces along the main roads in Hangzhou's urban area, and using plant community research methods, this study aims to understand the plant health, species composition, and population characteristics of the main road green spaces in Hangzhou city. Subsequently, it evaluates the landscape of Hangzhou's main road green spaces and conducts specific analyses on typical roads. This provides a reference for future urban road greening construction, creating reasonable growth spaces for road greening plants and fostering better ornamental effects.

Keywords

Landscape Architecture, Urban Roads, Landscape Enhancement, Coping Strategies.

1. Introduction

Urban street greenery constitutes the backbone of a city's greening structure^[1]. As an integral component of the urban green space system, roadside greening also links and organizes other types of green spaces. Urban road green spaces are interconnected and deliver multiple functions, including ecological services, recreation, landscape enhancement, environmental protection, as well as economic and social benefits^[2]. At the same time, street greenery provides a highly visible representation of a city's public image and reflects its local cultural characteristics. With rapid urban development, many cities in China have actively pursued titles such as "National Garden City" and "National Ecological Garden City," making road greening an increasingly important element of contemporary urban greening initiatives. Hangzhou, in particular, has experienced successive waves of large-scale urban development associated with the establishment of an ecological garden city, hosting the G20 Summit, and the 2023 Asian Games. Along with administrative boundary adjustments and the expansion of the urban area, road greening construction has continued to advance. Therefore, it is especially necessary to conduct timely analyses and syntheses of the issues emerging in Hangzhou's urban street greening development.

2. Urban Street Greening Construction

Urban roads are commonly classified into four levels-expressways, arterial roads, secondary arterial roads, and local streets-and the design and construction of roadside greenery should correspond to the required traffic capacity and service level for each road class^[3]. Urban street

greenery can be viewed as a form of “living” public infrastructure and an engineered landscape primarily created through plants as the core medium^[4]. The development of urban street greenery is a long-term process that requires the participation of multiple stakeholders across sequential stages, including design, construction, and maintenance management. In practice, it is also subject to administrative interventions such as regulatory approval and construction supervision, which necessitate coordinated action among multiple departments and professional domains and is constrained by various contextual factors^[2]. Through joint efforts among construction entities and management agencies, it is possible to mitigate adverse impacts of road projects on greenery, create appropriate growing space for roadside plants, and support the sustainable development of road corridors, thereby better serving the functional requirements of the road network.

3. Current Status of Urban Street Greening in Hangzhou

3.1. Overview of Urban Street Greening

Hangzhou’s urban road network has expanded rapidly in recent years. The city completed the “National Ecological Garden City” accreditation in 2017. According to statistics, during the five-year period from 2018 to 2022, the total length of Hangzhou’s expressway network reached 480 km; approximately 287 km of new arterial and secondary arterial roads were constructed across the municipality; and about 200 km of roads were restored in association with metro construction^[5]. Alongside these infrastructure projects, road greening in Hangzhou has developed at a similarly rapid pace.

At present, the main urban districts of Hangzhou have formed a relatively robust street greening framework network. Along prominent corridors such as Beishan Street, Nanshan Road, and Yanggong Causeway, the predominant street tree species is *Platanus* (plane tree), which provides broad canopies, dense foliage, and strong shading effects, contributing to both thermal comfort and landscape quality. Major roads within the urban core—including Tiyuchang Road, Huancheng East Road, Fengqi Road, Jiefang Road, Jiangcheng Road, and Tiancheng Road—are also dominated by *Platanus* as the principal street tree^[6]. In addition, roads such as Longjing Road (where *Liquidambar formosana* is the main street tree) and Hupao Road (dominated by *Metasequoia* as street trees) together contribute to the overall greening structure of Hangzhou. In recent years, the landscape upgrading of Jiangnan Avenue has also substantially improved its greening performance, resulting in a relatively dense tree-lined corridor. Through the formation of this street greening framework network, Hangzhou has further cultivated green open spaces that are connected, integrated, and shared^[4].

Although Hangzhou has established a relatively strong greening framework, continuous changes in development requirements and ongoing construction have also generated a range of issues in urban street greening that remain to be addressed.

3.2. Greening Conditions of Major Roads in the Urban Core

3.2.1. Beishan Street

The plant landscape along Beishan Street exhibits distinct characteristics across different segments. From Hubin Road to Jinghu Hall, overall greening is relatively limited; vegetation on both sides is dominated by street trees, mainly *Platanus × acerifolia* (London plane) (Fig. 1), with only small amounts of shrubs and groundcovers in certain sections. From Jinghu Hall to Yue Temple, greening becomes more abundant, particularly on the lakeside where plant species are more diverse and vertical layers show clearer variation. From Yue Temple to the roundabout, commercial buildings become more concentrated and roadside greening decreases again.



Fig. 1 Street green space along Beishan Street (photo by Deng Yunxiu)

Overall, plant layering along the corridor is relatively diverse. Evergreen trees are mainly *Cinnamomum camphora* and *Michelia maudiae*, while deciduous trees are primarily *Platanus × acerifolia*, *Sapindus mukorossi*, and *Ulmus parvifolia*. Shrubs are dominated by *Fatsia japonica*, *Nandina domestica*, *Pittosporum tobira*, and other commonly used species such as variegated boxwood and small-leaved shrubs. Groundcovers are mainly *Ophiopogon japonicus* and *Liriope spicata*. In some locations, certain street trees show poor growth. Tree pits are mostly individual (isolated) pits, and in some segments severe root heave has occurred, substantially affecting the normal passage of pedestrians on sidewalks.

3.2.2. Nanshan Road

Nanshan Road borders the lake on one side and urban buildings and green spaces on the other (Fig. 2). Along the lakeside, the view is occasionally blocked by roadside green land in the Yuhuangshan Road segment, whereas in the Changqiao Park segment the road is adjacent to West Lake and offers open and unobstructed sightlines. On the opposite side, the road interfaces either with buildings or with urban green spaces; building frontage is mainly concentrated between Jiefang Road and Yuhuangshan Road, while the remaining sections are mostly adjacent to green land.

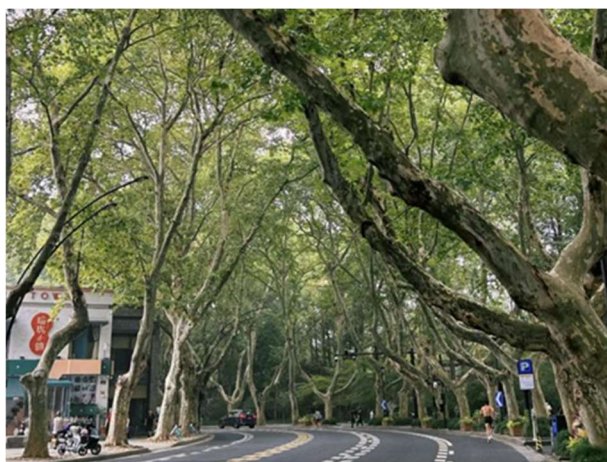


Fig. 2 Roadside green space on Nanshan Road (photo by Deng Yunxiu)

The vegetation structure is rich, and the plant landscape is generally coordinated with surrounding roads and the scenic area^[7]. Dominant tree species include *Cinnamomum camphora*, *Magnolia grandiflora*, *Platanus × acerifolia*, *Metasequoia glyptostroboides*, and

Pterocarya stenoptera. Shrubs mainly include *Lagerstroemia indica*, *Malus halliana*, *Acer palmatum*, *Fatsia japonica*, and variegated *Aucuba japonica*. Groundcovers include *Ophiopogon japonicus*, *Farfugium japonicum*, *Liriope spicata*, and *Hosta* spp. In the segment from Jiefang Road to Yuhuangshan Road, buildings are dense and commercial activity is intensive; however, the space available for roadside greening is relatively limited.

3.2.3. Yanggong Causeway

Compared with the other two roads, Yanggong Causeway is farther from the urban core, with a pleasant environment, and it connects multiple scenic attractions such as Jinsha Harbor, Hangzhou Flower Garden, and Maojiabu^[8]. Dense woodland–grassland spaces are commonly found along the route and provide effective visual screening. At bridge–causeway nodes, the view becomes more open. Vegetation on both sides of bridge sections grows vigorously, with high visual permeability and clear views toward the lake surface and distant hills (Fig. 3).



Fig. 3 Road greening on Yanggong Causeway (photo by Deng Yunxiu)

Evergreen species along this corridor mainly include *Cinnamomum camphora*, *Osmanthus fragrans*, and *Photinia* spp., while deciduous species are dominated by *Pterocarya stenoptera*, *Metasequoia glyptostroboides*, *Taxodium ascendens*, and red maple (*Acer rubrum*/related cultivars). Shrub selection is primarily evergreen shrubs such as *Fatsia japonica*, variegated *Aucuba japonica*, and *Pittosporum tobira*. Vegetation on both sides can form an “under-canopy tunnel,” creating a strong sense of naturalness. At major viewing points with high visitor density (e.g., Guozhuang and Hangzhou Flower Garden), seasonal flower borders are often arranged to guide sightlines and movement.

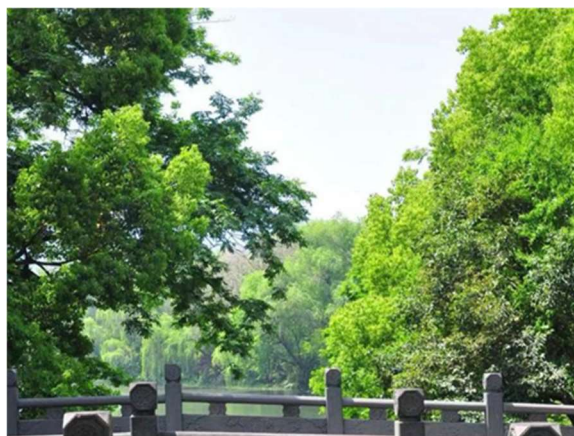


Fig. 4 Open view corridor at the bridge–causeway section of Yanggong Causeway (photo by Deng Yunxiu)

However, due to the relatively enclosed vegetation structure along parts of Yanggong Causeway (Fig. 4), spatial functions are somewhat single and insufficiently integrated with activity spaces. Only a small proportion of roadside green land includes internal paths or small areas for short breaks. In addition, linkage between Yanggong Causeway and West Lake is weak. Where the corridor connects to West Lake, it may be appropriate to reduce dense planting groups and open more view corridors to enrich visitors' visual experience while moving through the space.

4. Major Problems in Hangzhou's Road Greening Construction

4.1. Insufficient Sidewalk Width Along Streets

On some roads, sidewalks are only about 2.5 m wide, while an adequate effective width for pedestrian movement must still be ensured. In such contexts, tree pits often cannot meet the minimum width requirement of 1.5 m specified by the urban road greening design code^[3]. As a result, tree pits may be undersized, which is unfavorable for street-tree growth; some street trees grow poorly, and in certain cases root heave becomes severe, leading to uneven sidewalk surfaces. In addition, variations in sidewalk width can cause discontinuities in street-tree alignment.

4.2. Impacts of Municipal Facilities on Plant-Landscape Quality

Road greening and adjacent land parcels within building setback/red-line boundaries are often managed by different authorities and are therefore designed and constructed separately, which can result in inconsistent functions and uncoordinated styles^[9]. In some segments, underground pipelines and other municipal infrastructure encroach on planting areas, restricting planting and growth conditions. Moreover, overly tall traffic barriers and pedestrian guardrails can lead to an excessive number of barriers along the same road corridor, with inconsistent forms and heights, thereby weakening the overall greening and landscape effect.

4.3. Limited Tree-Species Diversity and Monotonous Landscape Effects

The three main lakeside roads generally adopt a planting configuration dominated by evergreen groundcovers, evergreen shrubs, small deciduous trees, and large evergreen trees, enabling seasonal scenery throughout the year. However, with the development of contemporary landscape practice, the construction of plant landscapes in these corridors often lacks distinctive features and may fail to leave a strong impression.

According to statistics from Hangzhou Smart Landscaping (provided by Hangzhou Survey and Design Institute), by the end of 2021, approximately 570,000 arbor trees (including street trees) had been established along built roads in Hangzhou, with camphor (*Cinnamomum camphora*) accounting for about half of the total; the next most common species include goldenrain tree (*Koelreuteria* spp.), plane tree (*Platanus* spp.), ginkgo (*Ginkgo biloba*), hackberry (*Celtis* spp.), soapberry (*Sapindus mukorossi*), and zelkova (*Zelkova* spp.).

Overall, the street-tree composition appears relatively homogeneous, and the development and application of high-quality native species remain limited. The most frequently used species include *Cinnamomum camphora*, *Koelreuteria* spp., *Platanus* spp., *Ginkgo biloba*, *Celtis* spp., *Sapindus mukorossi*, and *Zelkova* spp. Although the most dominant species, camphor, is a native tree and can reflect local characteristics, overall biodiversity and the richness of street landscapes remain relatively low. A high proportion of evergreen species in winter may reduce light penetration along east-west roads or sidewalks with limited width. In summer, roads dominated by upright species such as ginkgo and zelkova often provide insufficient shading because of their relatively small crowns. Meanwhile, *Sapindus mukorossi* produces abundant fallen fruits and grows relatively slowly, making it less suitable as a street tree for wider roads. By contrast, goldenrain tree, plane tree, and hackberry are regarded as excellent street-tree species, yet their proportion in the overall composition is comparatively low^[10].

In addition, unreasonable planting configurations can occur. For example, on segments where the distance between sidewalks and median green belts is small, plane trees (as street trees) and camphor trees (in median belts) may be planted simultaneously; due to limited spacing, competition between trees can emerge. Some median belts pursue overly complex vertical layering, resulting in visually cluttered planting that may obstruct sight distance and compromise traffic safety.

4.4. Lack of a Cultural-Thematic Foundation

Although the three surveyed roads are major corridors around West Lake, West Lake-specific cultural elements are rarely incorporated, leading to plant landscapes that remain largely superficial and standardized, with limited cultural grounding. Field investigations show, for instance, that the plant landscape along Nanshan Road pays insufficient attention to species associated with historical and cultural narratives. At key historical nodes, modern seasonal groundcover flower borders dominate the design. At both ends of Yanggong Causeway, green land is mainly configured as semi-enclosed spaces that are relatively closed, making it difficult to express cultural character.

5. Strategies for Enhancing Urban Street Greening in Hangzhou

5.1. Emphasize Integrated Corridor-Level Design

In the early stage of construction, all parties should comprehensively understand site conditions, and road cross-section design should simultaneously account for greening requirements, with multi-perspective review of proposed plans. In practice, municipal design may compress the width of medians and sidewalks, which can lead to unreasonable cross-sections, insufficient and discontinuous green space widths, and difficulty in achieving high-quality landscape outcomes^[4]. Therefore, greening professionals and municipal engineers should conduct joint reviews, and municipal departments should participate earlier in urban road planning and decision-making so that subsequent greening is not compromised and overall greening performance can be improved. During road utility maintenance, widening carriageways should also be avoided when it requires sacrificing green-belt width^[11]. Where feasible, widening along both sides of the road, reducing excessively narrow medians, and consolidating and widening median belts can better support the planting of arbor trees.

5.2. Strengthen Supervision and Coordination of Road Projects

Before construction, stakeholders should fully evaluate site conditions, and cross-section designs should consider greening conditions, with systematic comparison of alternative schemes. It is recommended that professional review by greening departments be conducted in parallel with municipal engineering review, enabling greening authorities to participate earlier in road planning so that implementation becomes smoother and outcomes improve. Unreasonable planting configurations may occur in segments with limited spacing between sidewalks and medians, where arbor trees in both zones are planted too closely and may compete for resources. Accordingly, widening the corridor where possible, increasing median width, and consolidating overly narrow medians can facilitate arbor planting and the implementation of greening construction^[11].

5.3. Configure Street-Tree Species Rationally

Street-tree selection for sidewalks should balance dense summer shade and winter solar access. For urban renewal corridors, east-west oriented roads, and similar contexts, deciduous trees are recommended as street trees^[11]. In Hangzhou, ten tree species are considered particularly suitable for roadside use: camphor (*Cinnamomum camphora*), plane tree (*Platanus* spp.), Huangshan goldenrain tree, hackberry (*Celtis* spp.), zelkova (*Zelkova* spp.), soapberry

(*Sapindus mukorossi*), thousand-head tree (*Ailanthus altissima* cv./related), wingnut (*Pterocarya stenoptera*), Chinese tallow (*Triadica sebifera*), and sweetgum (*Liquidambar formosana*)^[12]. The proportional structure of species in new roads can be adjusted, especially by reducing the share of camphor while increasing evergreen species diversity (e.g., *Phoebe chekiangensis* and wetland pine). Species selection should also be context-sensitive: for wide corridors, plane tree, Huangshan goldenrain tree, and hackberry can provide strong shading once established; for narrow corridors, zelkova and sweetgum can be adopted to avoid reducing daylight access to adjacent spaces.

Plane trees, often regarded as “the king of street trees,” have advantages such as strong shading performance, rapid growth, low soil requirements, high stress tolerance, and broad canopy coverage^[12]. In Hangzhou, the proportion of plane trees is currently increasing rapidly, while native species such as wingnut and Chinese tallow are also promising alternatives.

5.4. Showcase Local Cultural Heritage

West Lake embodies profound historical and cultural significance. Over nearly a millennium of evolution, countless literati and visitors have passed through the area, leaving poetry, paintings, and calligraphy^[13]. The cultural connotations of plant landscapes along the lakeside road green spaces remain to be further enriched, and the humanistic spirit of West Lake deserves stronger transmission. In terms of species selection, traditional famous flowers and trees with cultural symbolism and historical meanings can be incorporated so that roadside landscapes resonate with the historical atmosphere of West Lake. Regional landscape quality should be strengthened around key nodes along the route by creating culturally themed scenes and enhancing the integration of historical culture and related narratives in the construction of lakeside road green spaces.

6. Conclusion

The greening construction of Hangzhou’s major urban roads still requires proactive improvements in planting environments, scientific selection of plant species, and rational configuration of vegetation to meet aesthetic requirements. High-quality street greenery should not only satisfy transportation functions but also create road spaces rich in cultural character. Therefore, conducting on-site investigations and proposing enhancement strategies for urban street greening is of practical and planning significance.

References

- [1] X.J. Zhang: Study on Green Space System Planning in Urban Planning Areas (MS. Thesis, Beijing Forestry University, China 2006). (In Chinese)
- [2] C.Y. Li and X.C. Xu: Study on Planning and Design of Urban Road Cross-Sections, Urban Planning Forum, (2001) No. 2, p.47-52, 80. (In Chinese)
- [3] Ministry of Housing and Urban-Rural Development of the People’s Republic of China. Standard for Urban Green Space Planning: GB/T 51346-2019 (China Architecture & Building Press, China 2019). (In Chinese)
- [4] Ministry of Housing and Urban-Rural Development of the People’s Republic of China. Code for Design of Urban Road Engineering: CJJ 37-2012 (China Architecture & Building Press, China 2016). (In Chinese)
- [5] J. Zhang, P.Y. Wu and X.H. Liu: Reflections and Suggestions on Urban Road Greening Construction: A Case Study of Hangzhou, Chinese Landscape Architecture, Vol. 39 (2023) No. 3, p.78-81. (In Chinese)
- [6] M.Y. Zhang: Investigation and Scenic Beauty Evaluation of Road Green Space Plant Landscape in the West Lake Scenic Area of Hangzhou (MS. Thesis, Zhejiang A&F University, China 2022). (In Chinese)

- [7] C. Lin, Z.W. Wang and K.X. Zhao: An Ecological Discussion on Urban Street Tree Planning, Chinese Landscape Architecture, (1998) No. 6, p.41-42. (In Chinese)
- [8] X.R. Wang: Investigation on Plant Landscape of Road Green Space along the West Lake Ring Road in Hangzhou (MS. Thesis, Zhejiang A&F University, China 2021). (In Chinese)
- [9] Y. Wu, C. Lv, W. Wei, et al.: Investigation and Diversity Analysis of Street-Tree Resources in the Main Urban Area of Hangzhou, Forest Resources Management, (2019) No. 3, p.74-79, 93. (In Chinese)
- [10] K.L. Xiao and B. Yang: Current Status and Development Strategies of Street Trees in Hangzhou, Zhejiang Agricultural Sciences, Vol. 58 (2017) No. 11, p.1935-1936. (In Chinese)
- [11] J.P. Zhu: Issues Requiring Attention in Urban Landscape Greening: Road Greening, Zhejiang Landscape Architecture, (2017) No. 1, p.50-58. (In Chinese)
- [12] F. Luo, D.F. Shi, L. Guo, et al.: Selection of Excellent Tree Species and Plant Configuration Patterns for Urban Road Greening in Hangzhou, Zhejiang Landscape Architecture, (2021) No. 4, p.8-12. (In Chinese)
- [13] T.B. Chen, J. Fu and J. Liu: Study on the Outstanding Universal Value of the Cultural Landscape of West Lake, Hangzhou as World Heritage, Landscape Architecture, (2012) No. 2, p.68-71. (In Chinese)