Case study on the landscape of Yuhang Entrance of Shanghai-Hangzhou expressway under the background of the park city

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Abstract. Constructing the "Park City" has become a new trend in urban construction and development. Under this background, as an essential part of the urban system, the expressway entrance plays a symbolic role in constructing park cities. In this case, building a park-style entrance of a city is the quickest way to exhibit the image of a park city and an important means to realize the concept of the park city. Yuhang Entrance of Shanghai-Hangzhou expressway is the main entrance in the north of Hangzhou city, where we have effectively and sustainably built an ecological compound welcoming park with strong identification and harmony between human and nature. Besides, the park at the entrance of the city blends in the life of citizens, thus human, the city, environment, and industry being harmoniously integrated. Therefore, it is shown that Yuhang Entrance has become a beautiful scenery line under the guidance of the concept of the "Park City", which can be a classic case and a valuable reference for other designers.

1. Introduction
The concept of the "Park City" was proposed by General Secretary Xi Jinping during his visit to Chengdu in February 2018 [1]. So far, the new direction of China's urban construction and development has been determined, and the urban construction has entered an advanced form under the guidance of the new development concept. It is the latest Chinese urban planning formation that inherits and improves from contemporary Garden City.

1.1. Brief on Garden City concept and history
Garden City concept was first developed by Ebenezer Howard in his book Tomorrow: A peaceful path to realm reform [2], where the novel combination of urban and rural space was devised. In 1925, the definition of Garden City was further distilled by Purdom as "a town designed for healthy living and industry; of a size that makes possible a full measure of social life, but not only larger; surrounded by a rural belt; the whole of the land being in public ownership or held in trust for the community" [3]. Later in the 1930s, Frederick Law Olmsted actively advocated a large area of park reservations for EastBay Cites development in United States. In 1946, Peter Bredsdorff and Sten Eiler Rasmussen develop a significant "Finger Plan", that later became the model of global ecological and sustainable development, for Copenhagen where a large area of natural and rural areas had formed high-quality natural parks and agricultural area, and bred diverse wildlife [4]. Further in 1963, Koenigsberger, an urban planning expert of the United Nations, proposed the "Ring Plan" concept of Singapore. A
complete pattern and island-wise ecosystem have been formed after 40 years of developments. By 1996, 13 scattered towns were connected by railway, and a large amount of land between the towns has been gradually developed into ecological corridors and diverse parks [5]. In 21st century, when ecologist Richard T. T. Forman carried out ecological planning in the Barcelona metropolitan area, he continued to utilize agricultural parks and natural parks as core tools to promote the harmonious development of humans and nature in urban areas [6]. In 2007, the "Science" magazine published the *Domesticated nature: shaping landscapes and ecosystems for human welfare*, which pointed out: "A more durable stewardship would manage tradeoffs among ecosystem services so that nature and people simultaneously thrive" [7].

1.2. The development of urban greening in China
In 20th century, "Shan-shui City", "Landscape Garden City", "Ecological Landscape Garden City" and "Park City" successively appeared in Chinese urban greening development [1]. The concept of Shan-shui city was put forward by Professor QIAN Xuesen in his letter to Professor WU Liangyong of Tsinghua University on 31st July, 1990, in which he said: Can we integrate China's Shan-shui poetry, Chinese classical landscape architecture and Shan-shui painting together to create the concept of 'Shan-shui city'? People left from the nature and would be back to the nature again. China can construct the urban area with Shan-shui idea [8]. As one of the unique spatial planning concepts in Chinese history, Shan-shui City combines the urban construction and the natural environment which is mainly composed of the mountains ("Shan") and the water ("Shui")[9]. It not only contains classical Chinese garden art and the philosophy of "Harmony between nature and people", remained also is the design concept or vision of integrating the natural environment and cities, which includes lots of aesthetics and human settlement ideas [10].

In 1992, the Chinese Ministry of Housing and Urban-Rural Development formulated the evaluation criteria for landscape garden cities to strengthen the construction of urban landscaping and create garden cities nationwide [1]; "garden city" solely inherited the form of "Garden City" and emphasized more on landscaping and greening beautification; In 2007, The Chinese Ministry of Housing and Urban-Rural Development initiated the development of ecological garden city nationwide, aiming to use ecological principles for afforestation, increasing biodiversity, and improving urban ecological functions on the basis of Garden Cities [1]. In addition to beautification, more ecological requirements were applied, where not only 30%-40% natural areas but also 60%-70% pseudo-natural urban ecosystems were required. In February 2018, General Secretary Xi proposed to build "Park City", which emphasizes more on the "Greening to the Doorway" on the basis of the former concept, and "serve all people". The conception of "Park City" is elaborated in Section 2.

1.3. The research related to expressways and the landscape of expressway entrance (city gateway)
In the post-World War II era, expressways were conceptualized and planned in many cities around the world, especially in China, where the total length of expressway ranks the first in the world. As a symbolic urban infrastructural component, the highway is capable to lead the modernization of cities, and meanwhile contribute to the urban scene. However, at the same time, the expressway was regarded as a force of destructive modernization that displaces communities, degrades the environment, facilitates suburbanization at the expense of the traditional urban environment [11]. Thus, previous researches focused on the ecological impact of expressway [12], yet seldom mentioned about how to seamlessly blend expressways with the surrounding context without creating additional incongruous landscape [13]. Also, few attentions have been paid to the landscape design of expressway entrance, except independent practical case studies [14-19]. Actually, as a tool for promoting global integration and urban gateway zones can attract significant amounts of capital accumulation, and lead the panoramic arrangements of cityscape [20]. In the meantime, the changing climate, degrading ecosystems and the loss of biodiversity, combined with rapid urbanisation and population growth, keep reminding us that new designs of retrofitting and living in cities are critically needed [21]. Therefore, as expressway entrance being a crucial part of urbanization, we advocate more
elaborated and in-depth researches are needed for landscape designing of expressway entrance to be more integrated, systematic, multifunctional, identifiable and environmental-friendly.

1.4. The relationship between the entrance of the expressway and the park city

The entrance of the expressway is the gateway of the city, the window for displaying the image of the city, and an essential component of the urban space. To be specific, it not only takes on the role of space definition for material, energy and information exchange, but also presents the social and cultural information and the urban image of the city. The entrance is considered as the fastest window of exhibition, and it is also an extremely active juncture and important growth point in the green urban space system. As the first landscape exhibiting the city image, the expressway entrance plays an important part in both the urban system and the construction of the “Park City”. In addition to that, as an indispensable part of the park city, the expressway entrance demonstrates the concept and image of the park city.

1.5. Background of the landscape construction of Yuhang Entrance

As both a famous historical and cultural city in China and a pivotal city in East China and the Yangtze River Delta, Hangzhou pays much attention to the landscape construction at the entrance of the expressway, and launched the entrance renovation project in April 2015 [22]. In 2018, as an important window of Hangzhou’s external links, Yuhang Entrance of Shanghai-Hangzhou expressway was profoundly carried out the “Park City” concept, which has not only relieved the poor transportation, beautified the environment, clarified traffic signs and achieved the eight goals of “Freedom, Cleanness, Greenness, Beauty, Brightness, Clearness, Culture, and Excellence” [22], but also built a welcoming park which welcomes incoming people and creates a sense of “the City in the Park”. As for the welcoming park, it is of an ecological composite type that highlights the environmentally friendly image of Hangzhou Shan-shui city with the composition of public leisure, cultural and commercial space, and shows the beauty of the cultural landscape and natural ecology. Furthermore, it becomes the benchmark and a new highlight for park city constructions and has great reference value.

2. The connotation and application of the “park city” concept

2.1. Cognition concerning the form of the park city

After the concept of the "Park City" was proposed, domestic scholars have made a lot of discussions about the "Park City". Besides, it is generally believed that the “Park City” is an upgraded version of the "Garden City"[23] and is also the combination of dwelling environment, urban infrastructure construction, urban space and the urban ecosystem. The park-style urban and rural ecological pattern enables citizens to live, work, transport and recreate in the park city. Apart from that, as the city is presented in the form of the park, the city is built in the park and blended into the park. Thus, the city is the park, and vice versa [24-27], or "urbanize in the park; reside in the park" [28]. Therefore, the "Park City" is a full play of the concept of the landscaping city and Chinese garden culture [25], and also an innovated concept of both urban-rural dwelling environment construction and an ideal city construction pattern [29].

2.2. Ecosystem cognition in park cities

The park city is a complex urban ecosystem [30, 31] that possesses rich public wealth, profound historical culture, and good ecological environment. Apart from that, it is also an ecological complex public space built upon the harmonious fusion of people, cities, environment and industry [32]. The "Park City" (1) emphasizes ecology, sustainability and human-nature harmony, (2) plays a role as an sponge city that enhances the tenacity and water-saving and energy-saving effect [33], (3) reserves more urban public leisure, cultural and commercial space while at the same time attaches great importance to the ecological restoration and low carbon design, ecological corridor [34], (4) creates a new growth pole, (5) builds the urban ecological formation, and realizes intensive, efficient and
sustainable urban development [1]. Based on the concept of the "Park City", the construction of the expressway entrance should gather wisdom of various industries, break the traditional ideas and methods, maximize the best ecological and social benefits, and build the expressway entrance into a beautiful park with great identification and harmonious coexistence of man and nature.

2.3. Urban construction practice of park city theory
At present, many cities have carried out the practice of park city construction. For example, in 2018, Tianfu District of Chengdu became the first experimental city in China to carry out the concept of "Park City". Chengdu has made an urban plan for a beautiful and livable park with a "whole-region park system", and determined the "ecological pattern of two mountains, two networks, two rings and six sections", as well as the ideas of the "three-level ecological corridor" and the "green traffic system"[35]. Hangzhou designed the urban spatial pattern of "one main city, three deputy cities, six groups, and six ecological belts"[24], and has devoted to creating a city of "green every 300 meters and garden every 500 meters". In addition, Nanning, Guilin, Yangzhou, Zibo, Taiyuan, Shenzhen, Yangquan, Chenzhou and other cities are all putting effort to explore the construction of park cities.

2.4. Application of park city theory to landscape engineering
The concept of the "park city" has been widely adopted in the landscape engineering of waterfronts [36], parks [37], communities [38], roads [39] and other projects, but there is no record concerning the application in the landscape construction of high-speed entrances. Therefore, for the first time, the concept of the park city was integrated into the landscape construction of Yuhang Entrance of Shanghai-Hangzhou Expressway, which has become a classic case of park city landscape.

3. Landscape construction concerning Yuhang Entrance of Shanghai-Hangzhou Expressway based on the “park City”

3.1. Landscape exploration of Yuhang Entrance based on the park city

3.1.1. Design concept. Hangzhou advocates natural landscape. As the window and bond of Hangzhou connecting Shanghai, Yuhang Entrance of Shanghai-Hangzhou Expressway defines itself as an ecological complex welcoming park. With the appearance of a park, it exhibits the form of the city and a picture of the park city with both humanistic landscape and natural ecological beauty. Therefore, people can appreciate "the grace of the forest in the prosperous city" and the highly enjoyable image of the "Park City" – city in the park.

According to the concept of the "City Park", the four elements of "Mountains, Water, Cities and Human" were fused (Figure 1). With the construction requirement of "Global Beauty", "Eight Entries, Eight Lines" in Yuhang District, and the design concept of the "Green Gateway, Urban Forest", Yuhang Entrance was constructed into parks using the "Half Image, Half Park" method, which means not only was the image of the city displayed, but also the multi-functional ecological park complex was built (Figure 2). Taking serving people as the core objective and nature as foundation, and implementing the concept of "Sponge City", ecological remediation and low carbon design, Yuhang Entrance was also built into the starting point of the city’s ecological corridor and the junction of the urban-rural ecological picture with further increasing spaces for leisure, social life, activities, fitness, culture and commerce. Yuhang Entrance has become the identifiable, human-nature harmonious scenery gateway, and carrying out the organic unity of ecology and the urban form, intensification, efficiency and sustainability of the city have been realized [15].
3.1.2. Design objectives and strategies. Yuhang Entrance of Shanghai-Hangzhou Expressway took the multi-functional ecological complex park as the main form, when its goal was to build an ecological complex park that highlights the "Shan-shui City" image of Hangzhou, featured with high recognition, public participation, low carbon design, and natural science unification. Yuhang Entrance Park integrated the ecological resources, namely mountains, forest, water and lakes, fused urban design strategy of sponges, exhibited the objective of "atmosphere, livability, culture, intelligence and leisure" in Yuhang District and the ecological pattern of "introducing mountains into the landscape, water diversion into the city", showed the temperament, culture and characteristics of Linping city, and created the scenery line that possessed the beauty of Hangzhou’s humanistic landscape and natural ecology.

The main design strategies included:

1. Integrity: connected insides and outsides, emphasized the entirety, reasonably arranged spatial levels and spatial sequences, and paid attention to the collocation of foreground, medium and distant perspectives [40] (Figure 3).
2. Characteristic: developed the distinct theme, and showed the city culture, city image and city characteristics.
3. Ecological aspect: took greening as the main feature, developed with low-impact, integrated function of the sponge city, constructed underwater forest, constructed, maintained and utilized existing vegetation, enriched vegetation from the perspective of biological habitat, and maximized the retention and reuse.
4. Humanistic aspect: with the people-oriented objective and overall consideration, created more leisure, communication, activity, fitness, culture and commerce spaces.
5. Compound: achieves multi-functional landscape, sustainable development, innovation consciousness, operability, ecological education and display, fixed-point display and integration of activities, and stimulates the environmental awareness of the public.
3.2. Design practice

3.2.1. Analysis of driving sight: image exhibition and sight range analysis. Spatial scenery provides an optimal ornamental surface or viewing angle for riders, when the best view is related to speed and view distance. Besides, pre-arranged view distance and view spots offer the best viewing effect to visitors. In the landscape architecture, when the car speed is 40km/h, the appropriate viewing distance is 150m [41]. Therefore, the gentle slope was designed in the front of the best viewing area, leaving more grassland space and providing a reasonable viewing distance for the landscape nodes and the overall environment.

3.2.2. Layer development: landscape integrity and spatial layer. Through different layers of sensory experience, three spaces were formed in Yuhang Entrance space design: "Identification– City Image"; "Welcome–Yuhang Impression"; "Entering City– Poetic New Town". Besides, different landscape was also created through sequentially changed layers.

The rhythm of spatial level was progressively and cleverly organized (Figure 4). Specifically, the three landscape sequences made full use of urban background, topography and vegetation collocation, created large-scale plant levels, formed foreground, middle-ground, background three dimensional spatial layers, sorted the existing phytoecommunity, reshaped the terrain and the relationship between plant community, built a total of three spatial layers with lawn in the foreground, scarce forest, grassland and the belt of flowers in the middle, forest and urban constructions in the background, and enriched and improved crown canopy lines and forest edge lines. Thus, a harmonious relationship and mutual interlacing with the urban crown canopy line were formed, thus highlighting the unique charm of Linping New Town as a "Shan-shui City".

3.2.3. Terrain treatment-enhance mountains and water. (1) On the basis of retaining a large background forest belt, two separate lands were combined into a whole by taking advantage of the current terrain of the site and making gentle slope grassland through micro-topographic treatment, which simultaneously solved the drainage problem inside the site.

(2) To ensure the optimal sight line at Yuhang Entrance, the current terrain was raised as a whole, which also provides space for the foreground.
Taking advantage of the depression, trimming mountains and water, following the natural law of "Mountains Have Veins; Water Has Sources", the urban landscape space framework of "light smoke, flowing water and quiet city scenery" was constructed with enriched spatial layers (Figure 5).

**Figure 4.** Get straight to the point-step by step, and organize a hierarchical rhythm.  
**Figure 5.** Terrain treatment-the elevation analysis chart of mountains and water.

3.2.4. **Symbol: The expression of regional characteristics.** The symbol is an important part of urban characteristics and images [42]. In the design of Yuhang Entrance, the landmark features were mainly reflected in the entrance square and the theme sculpture.

(1) Entrance square: a magnificent and elegant vegetative landscape was created through the specific design of vegetation and symbols. Between two forest belts, a corridor of sight lines was built to enhance the deep feeling of landscape. Besides, welcoming atmosphere was created with broad and grand vegetative space and ethereal in-season flowers.

(2) Entrance theme sculpture: the large-scale green sculpture with the themes of "Millennium Yuhang" and "Fashion Yuhang" artistically presented the beautiful face of Yuhang, and created a warm, joyful and grand welcoming atmosphere.

3.2.5. **Beautiful color: The expression of regional characteristics.** Effective color application has strong visual impacts of attracting attention and leaving a deep impression. In the vegetation space of Yuhang Entrance, flower belts were creatively laid out, and grand theme sculpture with rich characteristics was also introduced. Consecutive and characteristic colorscape was then formed, thus creating impassioned welcoming atmosphere. Apart from that, the portion of flowering tree species with colorful leaves was deliberately increased, and therefore, there is mass application of "ginkgo woods", "sakura woods", "sequoia woods", "Purple leaf plum woods" and "Malus and Chaenomeles woods". In this case, the infinite charm of natural seasonal change was unreservedly shown.

3.2.6. **Plants: Four seasons and four levels.** Adapting to the terrain and landforms, trees were widely planted. Therefore, people can enjoy the blooming flowers in spring, the cool shades of the trees in summer, the sunglow diluted by the mist in autumn, and the sunset through sparse forest in winter. Furthermore, it should be noted that plant configuration was divided into four levels: evergreen background forest, the forest belt with various leaves and flowers, lawn space with the plant community, and the characteristic flower belt with marking landscape.

3.2.7. **Improve facilities-people-oriented.** In accordance with the people-oriented principle and the so-called "City Face, Garden Heart" idea, and with ensuring transportation safety, park ancillary facilities were enhanced. Moreover, the organization of park roads was improved. Especially near the north side of the public buildings, a place was provided for people to wander. Thus, Yuhang Entrance has become a real "Park City" with recreation function.
3.3. New technology application and its innovation and advantage

3.3.1. Underwater forest construction. Yuhang Entrance was featured with a design that combines with the original low depression terrain for terrain reconstruction, forming a lake area of 8500 square meters. In addition to that, beautiful scenery was lined along the shore, and underwater overflows with vigour. Underwater forest construction technology and techniques including the water detection and treatment, soil improvement, and ecology-beneficial mineral were introduced. By planting the submerged plants such as Vallisneria spiralis and then putting in fish and benthic organisms, the underwater ecological balance system was constructed, and the water body was clear and transparent all the way to the bottom throughout the years.

3.3.2. Sponge city technology application. The project made use of the regulating and storing function of the landscape lake to effectively solve the problem of rainwater runoff discharge on the site, relieve the pressure of the surrounding municipal network, and eliminate the phenomenon of serious water accumulation on the road at Wangmei intersection. Besides, the regional "green sponge" will be established to recycle and utilize water resources for greening and watering of the whole garden, so that rainwater can fulfil a comprehensive service function (Figure 6, 7).

3.3.3. Compound function and strategy. In this design, the best conjunction point of urban image display and function utilization is put forward, when following the intensive and efficient land usage, revisiting the humanistic care, constructing the pluralist activity space, blending the park into the citizen's life, promoting the industry integration with some small commercial spaces, and realizing the maximization of garden comprehensive benefit.

4. Conclusion

4.1. The necessity of the application of the concept of park city at the expressway entrance

Xi Jinping’s call for “park at the doorstep” – the park city Coincides with Kaplan’s call for “nature at the doorstep” three decades ago, which were supported by strong evidence for a positive association between the size of green space around people’s living area and perceived mental health and mortality due to all causes in general adult populations. There are links between contemporary greening practice and study on related health benefits, wherein proximal greening emerges as a distinct form, and possible norm, for twenty-first-century urban design [43]. Park City is good for people's health, also with the parks at the expressway entrance, which provides repetitive and long-term exposures for people to greenery that can provide cumulative benefits through "micro-restorative opportunities." Also, Parks at expressway entrance raise people’s awareness to greening and health.
4.2. The success of the entrance park

Yuhang Entrance project adapted to the "Park City" concept well, and at the same time, a "City Face, Garden Heart" feature of the welcoming park was obtained. After the completion of the project, the four elements-the people, the city, the environment and the industry-were integrated into a harmonious communion. Considering that, the first impression of Hangzhou was directly exhibited in the form of parks at Yuhang Entrance, as well as efficient, intensive and sustainable construction of an ecological complex space (Figure 8 and Figure 9). Yuhang Entrance also applied low carbon design such as the sponge city and underwater forest. While building the ecological corridor, the city also provided people with living, work, transportation, recreation, culture and entertainment space, and created an ideal environment of "the city in a garden", known as "Building a Shan-shui City; Enjoying All-season Landscape”. Thus, it can be seen that the most vivid and poetic picture of the city’s dwelling was exhibited. Then, it was concluded that Yuhang Entrance was built into an identifiable, human-nature harmonious park and became a classic case of the expressway entrance landscape project that follows the concept of the "Park City".

![Figure 8. The Entrance Park of "City Face, Garden Heart"-a space of ecological complex.](image1)

![Figure 9. A close-up view of the Entrance Park of "City Face, Garden Heart".](image2)

4.3. The deficiencies of the entrance park and future study

Although the attempt to build a park at the Yuhang Entrance provide a “natural opening” for people, but the cost of construction and daily maintenance is high. The artificial traces are heavy and undesirable. How to Increase biodiversity, and to be more ecological and sustainable are the next problems to be solved. Agricultural parks and agricultural landscape is potentially one of the means to solve these problems, promoting the industry integration with agricultural production space and experiential commercial space, and "a more durable stewardship would manage tradeoffs among ecosystem services so that nature and people simultaneously thrive" [7].

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