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The Application Practice of Green Building Technologies in Landscape Design

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Abstract. In recent years, green building technologies have been developed greatly and quickly in China. While the green building technologies have been gradually matured, the application practice of green building technologies in landscape design has been increasingly widespread. Combined with the case study on the design of Tianlu-lake Forest Park entrance area, this paper is introducing the green building technologies in landscape design mainly from two aspects: Site design and construction detail. The green building technologies applied in this case were included: (1)Site Analysis: interpretation of the status quo; (2)Site Planning: conform to the terrain; (3) Architecture design: hidden in the earth; (4) Vertical design: suit local circumstances; (5) Vegetation design: the big trees plaza; (6) permeable ground; (7) greening parking lot; (8) Roofs Greening; (9)Retain the ecological corridor. Furthermore, this paper is reflected on this design practice, in order to benefit regional landscape design and study.

1 Introduction

1.1 Development Overview of Green Building Technologies

In the past two decades, there's a great deal of researches in the field of green building technology in China. It could be said that the green building technology has already promoted from the phase of theoretical research to the application practice. The use of Green building technologies has been increased widely with the government's gradually increased efforts to promote the development of green buildings. And people's interpretation of the connotation of green building was continuing to expand and deepen with the further development of the green building's exploration and practice. The authors could analyze the below connotation of the concept of green building from a large number of the researches of the green building principles and techniques:

(1) Response to the environment for energy-efficient:

This point was reflected in the protection of the environment, making full use of energy resources and reducing pressures to the environment which could be sum up as "saving water, saving materials, saving energy, saving lands".

(2) Focus on the means of implementing the green building:

This included the research and practices of green building technologies, project construction management, building maintenance and other aspects of measures and methods.

(3) Emphasis on the relationship between the green buildings and the human beings:

The purpose of the architectural design is for human using. The design standards of the comfortable environment (which includes sound environment, thermal environment, light environment, wind environment) and its implementing measures constituted the main part of the green building technology.

(4) Concerned on the whole process of the building activities:

In addition to focus on the building activities in space, it should examine the building's influence on the surrounding environment as well as the global ecological environment through the process of "the whole life" of building (including raw material extraction, transportation and processing, construction, using, maintenance, transformation and demolition. [1]

1.2 The application of green building technologies in landscape design

According to the author's current researches, the relevance study about the application of green building technologies in landscape design was usually in the sub-section of the green building practice theoretical system, such as the chapter "the plant system design and organization of green building" in the book named "green building". That chapter introduced the basic concepts, the main function, the design methods and specific techniques of the plant system in green building. It also introduced the design methods of various types of outside roof greening, walls greening and interior greening. What's more, in the chapter "Ecological reconstruction and ecological restoration of green building" has discussed the concept, the connotation and technical measures of the land ecological renovation. One of the practice case of is Juneau garden which in the south of Miami, Florida, USA. Because the regional climate in there was hot and humid in summer and mild in winter, summer cooling was a major factor for consideration in the plants system design at the site. [2] Another case was an office building site design in Beijing. In this case, plant system acted as the wind gallery in the site, and computer was using for analyzing outdoor wind environment. [3]

The authors believed that there were two main levels of green building technologies in landscape design: The first level was inspired in design ideas, which was the soul and the core of the design, such as the understanding of sites and responding to the environment; the control of the planning layout; and the inspiration and breakthrough in the architectural conception design. The second level was the specific application of green building technologies in detail, such as sunshade-design, passive evaporative cooling design, the permeable pavement design, etc.

2 Practice case of green technology application in landscape design

2.1 Project profile

The Tianlu-Lake Forest Park, formerly known as the Tianlu-Lake country park, was established in 1996. The Tianlu-Lake Forest Park is located in the North-East of Guangzhou, and it was in the key ecological safety zone of the eastern district of Guangzhou. The main entrance area of the Tianlu-Lake Forest Park was located in north-west of the forest park, with an area of approximately 64,300 square meters. This site was near the water reservoir, located in the east of Yi-Huan road (the Tianlu-Nan Road) in Guangzhou. The Tianlu-Lake Forest Park main entrance would be a landmark and would provide an interesting and beautiful open space to the public. (Figure 1)

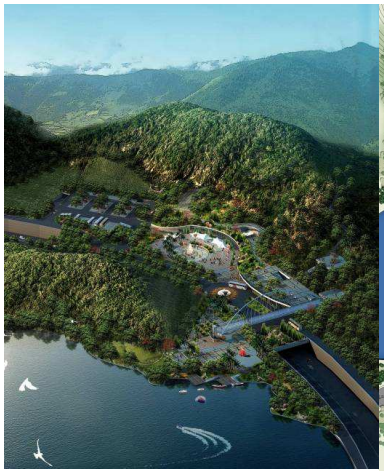

Figure 1: The bird view picture of the Tianlu-Lake Forest Park Entrance area (Source: designed by writers)

Figure 2: The master plan of the Tianlu-Lake Forest Park Entrance area (Source: designed by writers)

2.2 The application practice of green technologies in landscape design

2.2.1 Site Design

(1) Site Analysis: interpretation of the status quo

After acceptting the design task, the authors analyzed the status of the site at first, which mainly from 4 aspects such as transportation analysis, elevation analysis, vegetation analysis and construction analysis:

1) Transportation analysis: The status of the site was that Tianlu-Nan Road was across through the west of the park and this section of Tianlu-Nan Road would be dig as tunnel, so that the passing traffic would mainly get through the tunnel, while the traffic which reaching the main entrance square would be led to above roads. In the land planning, this requires the reasonable organization to the traffic line and considering the best position of the entrance parking area.

2) Elevation analysis: Elevation of the site varied from 120m to 143m high. The elevation of the main entrance square area of the park was about 130m high and could see the Tianlu-Lake at west side. The site mainly sloped down from the northwest to the Southwest. And the western part in the site was catchment area. Meanwhile, the tunnel completed-surface's elevation of the Tianlu-Nan Road would be 133m high which mean that there would be 3 meters higher than the flat part of the site of which the elevation is 130m high. The main challenge of the vertical design was how to deal with the height difference between these areas.

3) Vegetation analysis: The site was mainly planted of fruit trees and the vegetation was mainly trees-shrubs mixed. And at the foot of the hill site where was 130m high, there're more than ten perennial Litchi trees. The design should retain the original landscape features of this site. In addition, there was some artificial ground excavation and slope protection at the site needs to be beautified through landscape design.

4) Construction analysis: There's a concrete pouring platforms in the 143m elevation at the southwest corner of the site, with an area of about 400 square meters. It was well preserved and could be used as a wonderful rest space through the landscape design .

(2)Site Planning: conform to the terrain

Based on the analysis of site, the concept was to conform to the terrain of the mountain, and using natural curves as the main design element, which emphasized the visual effect from mountains to the lake. There's a landscape road to organize the traffic. In the northern site, an ecological parking lot was set there. (Figure 2)

Figure 3: The photograph of the Tianlu-Lake Forest Park Entrance area (Source: taken by writers)

The authors made full use of height difference in the site by designing the square as a sunken plaza, which solved the interface problems between the tunnel completed-surface's elevation (133m high) and the elevation of the site (130m high) and saved lots of earthwork while shortened the construction time. Meanwhile, a backyard of the square was designed to retain the Litchi forest by combining with the scenic water at the foot of the mountain.

(3) Architecture design: hidden in the earth

In the main entrance area, the authors tried to avoid the design ideas that highlights the entrance like many other urban parks. The entrance had been designed as a public open space to the people around, and the artificial construction and the nature mountains should be able to combine organically each other in this place in order to highlights the Park's country interest. One of the design ideas was the pursuit of " harmony with nature". The architecture was designed from the view to create a landscape of the earth, and to hide the building body in the square in order to make the building from tangible to intangible. The authors tried to combine organically the building with the mountain and the surrounding environment as much as possibles.

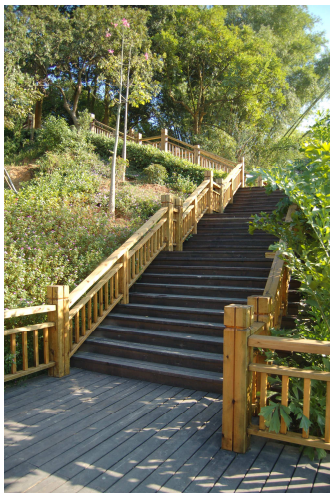

Figure4: The photograph of the Boardwalk in Tianlu-Lake Forest Park Entrance area (Source: taken by writers)

(4) Vertical design: suit local circumstances

The principle of vertical design was "less is more", which mean minimizing the transformation and disturbance of the original terrain on the premise of meeting the functional requirements. In the design, the authors tried their best to make the scope of artificial development and construction in flat site where at the foot of mountains and the gentle sloped section. Meanwhile, according to the terrain, the forest park entrance was designed to be the platform form, which made the site to suit the terrain and mountains. There's two main flat land in the site, and these two land were set to be the ceremonial assembly-square and the entrance-parking area. The plan set the flood interception trench at the edge of the mountain in order to safeguard the security of entrance square zone of the park.

(5) Vegetation design: the big trees plaza

Taking into account that the ceremonial assembly-square has a larger area of hard paving, many flower beds were interspersed set in different elevation which combined the platform design of the sunken plaza. On the premise of applying enough using area in the square, the authors tried to maximize greening area of the square, matching trees, shrubs and ground cover plants with each other and created " the big tree plaza" (Figure 3). The vegetation in the square could be the "heat buffer layer" so that to adjust microclimate of the site, and it could enhance the site landscape quality at the same time. According to the onsite measured data throughout the day, in the measuring point where the square was in the shade of the trees and surrounded by green space, the highest temperature of the measuring point there could be lower than the highest urban temperature of Guangzhou about 5.5 ° C on the same day in summer. [5]

2.2.2 Construction detail

(1) Outdoor paving: permeable ground

Combined with the hot-humid climate characteristics in subtropical areas, the main leisure space in the entrance area such as the backyard, the lotus pond was used the permeability pavement. There were three reasons: first was to build the thermal comfortable environment. The permeable ground could make the water through the soil and keep the soil wet. Under the action of solar radiation, it could make the thermal environment of the park be better in summer by cooling the air temperature, increasing humidity and reducing dust. The second reason was the permeable ground conducive to the drain. Because of the structure of the permeable ground, it had the good water permeability, which could be effective in reducing surface runoff, especially suitable for subtropical areas. The third reason was that the permeable ground conducive to ecological. The permeable ground has ecological significance for the surrounding plants and water; and Eco-design was also one of the guiding ideology and principle of the design. Therefore, the authors believed that the permeable ground would be suitable for the pavement and park road design in subtropical country parks, which has broad prospects in landscape design.

(2) Parking area: greening parking lot

Considering the climate in subtropical areas, the open-air car park's thermal environment needed to be improved urgently. So the authors designed the car park as an ecological and greening parking lot. The pavement of the parking spaces was all covered with grass grid except the driveway. The trees pool between the parking strips was one meter deep (the ground green parking lot was above the underground car park), where shade trees like Lagerstroemia speciosa and low shrubs could be planted. The reason why the grass grid was chosen instead of the grass brick was that the grass grid's greening rate was higher than grass brick; what's more, its load carrying capacity, durability of use, flexibility of installation, and comfortable walking experience was better than the grass brick.

(3) Roofs Greening: using sedum lineare roof planting

There were a few buildings in the park entrance area such as service management center and public toilets. In the site design, the service management center was combined into the plaza, so the authors tried to design the "greening roof" to the single building - public toilets. There were two goals for that: firstly, the public toilet was a naturally ventilated building. By setting the green roof as insulation layer, it could effectively reduce the thermal effect from the solar radiation to the roof and get the effect on insulation and cooling. This could make the comfortable feeling indoor under high

temperature. Secondly, as the public toilet was at the foot of the mountain, when people climb the mountain along the wooden plank road, they could see the green roofs of the public toilet through the forest. The green roof helped to improve the fifth facade of the building and increase the visual pleasure of visitors. In this design, the technology of roofs greening is sedum lineare roof planting.

(4) The mountaineering boardwalk: to retain the ecological corridor

Visitors would pour in the park during the Mucuna birdwoodiana Flower Festival. In order to meet the demand of large numbers of people at that time, the mountaineering boardwalk was built in a high standard and it was 3 meters wide. In the design of wooden plank routes, we abandoned the way that paving reinforced concrete layer along the routes and uplift the wooden plank along the climbing routes. First, three column bases were set horizontal in the wooden plank routes basic section. And then the keel was set up on the column bases. Finally the keel is paved with panel as stepping. This way could firstly save the cost and shorten the construction process of the project, and secondly retain the original mountain ecological corridor and the original ecological environments (Figure 4).

3 Conclusion

Now the main entrance of Tianlu-Lake Forest Park has been put into use. During the Mucuna birdwoodiana Flower Festival, the park entrance area was received about 100,000 visitors and obtained the high praise. As the whole process was so urgent from design to construct and till it put into use, some details of the design and construction of the project was still not so perfect and satisfied. But to the authors, it was a meaningful effort to apply the green building technology in the landscape design, which would be the foundation for further exploration and study in the future.

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