Research on urban waterfront landscape design based on sponge city theory

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Abstract. This paper introduces the relevant concepts of urban waterfront landscape and sponge city. Based on the development status of urban waterfront landscape in China, it puts forward the strategy and method of urban waterfront landscape design transformation to give full play to the ecological improvement and aesthetic advantages of sponge city, which provides a useful idea for improving a series of ecological and urban environmental problems caused by the rapid development of urbanization in China.

Keywords: Urban waterfront landscape; Sponge city theory; Design strategy

1 Introduction

Sponge city theory is a commonly used ecological landscape construction theory at present. This design method can not only effectively alleviate urban water logging disasters, reduce urban river drainage pressure, but also alleviate urban heat island effect and optimize urban ecological environment, so it can be fully applied in urban landscape construction. The application of sponge city theory in the construction of urban river waterfront landscape can optimize urban water circulation system, make full use of rainwater resources, reduce water pollution, ensure the beauty of urban waterfront landscape, and make urban ecological environment healthier.

2 Related concepts

2.1 Urban waterfront landscape

The intersection of rivers, lakes, oceans and other water bodies with urban land is called urban waterfront area, which can realize the organic combination of ecological water features and historical culture, and is an important open public space of waterfront cities [1]. Water body, revetment and plants constitute the urban waterfront landscape, its basic function is to beautify the urban environment. According to the different types of water bodies, it can be divided into river waterfront landscape, ocean waterfront landscape and lake waterfront landscape, and revetment construction also has different characteristics and feelings. According to the different geographical

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conditions such as latitude, longitude and altitude, the plants in the waterfront landscape also change. Urban waterfront landscape has the functions of beautifying urban environment, conserving water, purifying air and regulating urban microclimate. It can also be combined with urban culture to continue and deepen urban cultural heritage and create a vibrant and unique urban open space [2].

2.2 Sponge city

The concept of sponge city is to build a city as flexible as a sponge, which can effectively cope with seasonal changes and urban waterlogging and other natural disasters caused by heavy rain, and effectively adapt to the environment. It is a new urban stormwater management concept, including roof gardens, constructed wetlands, rain gardens and other forms. This design method can store rainwater in the rainy season, use the stored water resources in the dry season to alleviate drought, and achieve the purpose of recycling water resources. The rainwater collection and utilization system is the center of gravity of the construction of sponge city system, which mainly relies on six methods of "strengthening penetration, reducing the speed of rainwater collection, using water conservancy facilities to save rainwater, purifying rainwater, using rainwater resources, and building a reasonable urban drainage and waterlogging system" to achieve this goal, solve the problem of urban rain and water logging, and ensure the rationality of water resources utilization. The urban water body can be ornamental in the dry season and reasonably drained in the rainy season to avoid the urban inland, and finally build a safe, green and ecological urban waterfront space.

3 Existing problems of urban waterfront landscape design in China

3.1 Hard revetments harden the river banks

Traditional urban river water conservancy construction projects usually adopt the form of hard revetment and the use of concrete and other materials to pave the original river and drainage channels. Although this method can prevent soil erosion, it will harden the river, cause damage to the river ecological environment and biodiversity, and can not play the role of flood control and waterlogging. The repeated use of hard materials to strengthen revetment and riverbank not only can not solve the flood season flood and urban waterlogging problems, but also will destroy the river penetration and undertake capacity.

3.2 Improper plant allocation affects river drainage

Vegetation in urban river waterfront landscape has important landscape and ecological functions. Improper allocation of aquatic and terrestrial plants will make the river community unable to establish an effective ecological cycle, and the natural ecological environment will be destroyed. The vegetation on both sides of the river is not

rationally allocated according to its own form, growth conditions, ecological characteristics and other factors, which will lead to chaotic landscape plants and even large areas of death, so that urban rivers cannot play the function of flood control and drainage, and do not have the ornamental function that landscape plants should play.

3.3 The participation of residents is low

The main users of urban river waterfront landscape are urban residents, so the design and construction should be people-oriented, and fully consider the life and entertainment needs of surrounding residents. At present, China's urban waterfront landscape construction has an effective integration with the concept of sponge city, but the participation of surrounding residents has not been paid attention to, and the utilization rate and social benefits of waterfront landscape have been affected. In the construction of urban waterfront landscape, the needs and opinions of surrounding residents should be fully taken into account, and reasonable and effective design planning should be carried out to achieve the highest utilization rate and the best landing effect of urban river waterfront landscape.

4 The role of sponge city theory applied to urban waterfront landscape

4.1 Optimize the urban ecological environment

In recent years, the concept of environmental protection has gradually been deeply rooted in people's hearts, and the quality of urban ecological environment has been paid more attention by more people. Urban rivers are not only the places of hydrophilic recreation for urban residents, but also play an important role in optimizing urban water resources and regulating urban microclimate. Sponge city theory advocates the protection of natural ecological environment, harmonious coexistence between man and nature, organic integration of man and nature, creating a beautiful and comfortable living environment, and effectively alleviating various problems caused by the deterioration of ecological environment. Therefore, scientific application of sponge city theory in urban river waterfront landscape can alleviate the contradiction between human beings and urban ecological environment, improve residents' living and resting environment, and have important significance in optimizing urban environment.

4.2 Relieving urban waterlogging pressure

Flood control and waterlogging is one of the most important considerations in urban river waterfront landscape design. Modern cities are built on water, and most production and living activities gather along urban rivers. Therefore, flood control and waterlogging should be paid great attention to. The sponge city theory is used to build urban river waterfront landscape, and natural water systems such as rivers, lakes and

ponds are used to permeate, store, purify and utilize rainwater in the rainy season with green Spaces, gardens and permeable pavement facilities. The remaining part is distributed through pipe networks and pumping stations to effectively relieve the pressure of urban waterlogging.[3]

4.3 Alleviating urban heat island effect

In modern cities, the dense population, less green water area, industrial production and other factors increase the difficulty of heat volatilization, resulting in urban heat island effect.[4] Urban buildings are mostly made of reinforced concrete and other materials with tight structure, and roads are mostly paved with hard materials such as asphalt and asphalt, which absorbs and stores a lot of heat, which will also produce a greenhouse effect and accelerate the formation of urban heat island. The sponge city theory is applied to the construction of urban waterfront landscape. By expanding the water area, increasing the green area, and setting lawns and green vegetation on both sides of the road around the water area, the bottom of the urban road can store rainfall. The green vegetation can effectively reflect and absorb heat radiation, reduce the urban temperature, and alleviate the urban heat island effect.

4.4 Beautify the city image

Urban river waterfront is an important hydrophilic leisure place for urban residents. The application of sponge city theory in its design and planning can effectively increase urban green area, enrich landscape effect, improve urban image, enhance urban residents' cognition of urban river and sponge city, make urban residents willing to participate in hydrophilic activities, and improve the utilization rate of urban waterfront landscape. Build a good urban environment and social atmosphere.

5 Application of sponge city theory in urban waterfront landscape

5.1 Rain Garden

The concept of rain garden is a naturally formed or artificially dug shallow concave green space, which is used to gather and absorb the surface rainwater, purify the rainwater through the comprehensive function of plants and sand, and gradually penetrate the surface water into the soil, which can effectively conserve groundwater or provide recharge for landscape water. It is an ecological and sustainable stormwater control and rainwater utilization facility. The rain garden consists of an inner layer of gravel, sand, planted soil, mulch and aquifer. (see fig.1) At the same time, a perforated pipe is provided to collect rainwater, and an overflow pipe is provided to remove water exceeding the designed storage capacity.[5]

Fig. 1. Rain Garden

When designing rain gardens, the surrounding terrain and landform should be fully considered, plant types should be selected in a targeted manner in the construction style, and plants that are drought resistant, labor resistant and easy to survive, such as marmot, calamus, reed and other plants, and suitable landscape purchases should be selected, such as wooden trestle and landscape walking path, to facilitate tourists to enjoy and play. Considering the urban river waterfront landscape construction should take into account the needs of urban flood control and drainage, should set up enough waterways and drainage facilities, improve the slope of rain garden to ensure the drainage and utilization of rainwater.[6]

Donald Creek Park in the United States combines the rain garden landscape with the local natural water features in the design and planning. In the rainwater collection system, the site is gradually lowered from the south to the north to collect rainwater from the surrounding roads and squares. The leaf-shaped pavilion is a rainwater collection facility, and its unique shape is the most innovative design of Donald Creek Park. In terms of plant configuration, the types that adapt to the change of terrain slope and soil water content are selected. These plants absorb, filter and purify the rainwater flowing through the ramp, and finally the remaining rainwater will enter the park in the form of streams and fountains.[7]

Rain garden technology can not only effectively manage and use rainwater, but also has a rich landscape, providing a new area for urban residents to play close to.

5.2 Cavernous road

Road plays an important role in urban river waterfront park. Therefore, in the process of waterfront ecological landscape design, the design of road landscape sponge should be strengthened. The meaning of sponge road is to use permeable materials to lay the road surface, so that rainwater can be effectively stored and penetrated through the road surface, and run through the drainage facilities under the road surface. (see fig.2)The microorganisms in the underground soil layer grow normally to achieve the

purpose of purifying water pollution, and the purified rainwater can also be used to irrigate the roadside green vegetation and improve the utilization rate of water resources.[8]

Fig. 2. Cavernous road

A large number of spongy roads are used in the Jiaomeng Shui Yun Project of Sanlihe, Jiaozhou City, Qingdao. The pavements in the park are made of pervious Parmia-porous concrete with excellent water permeability. This material has high porosity, and its pervious efficiency is several times that of ordinary pervious materials, with high stability. An ecological dry stream made of gravel is set up beside the road, which enriches the visual landscape while effectively collecting and filtering rainwater.

5.3 Ecological corridor

Ecological corridor design can effectively connect or isolate multiple waterfront ecological plates in urban waterfront parks. In urban river waterfront landscape design, sponge city theory should be applied, the surrounding environment should be fully considered, supporting facilities should be effectively utilized, and a perfect water circulation mechanism can be built, including artificial wetlands, ecological grass ditches, seasonal ponds, etc. It plays the role of increasing rainwater permeability, purifying resources and utilizing rainwater. Reasonable application of sponge city theory to construct ecological corridor can also play a role in regulating runoff, storing rainwater and reducing the drainage pressure of urban rivers. (see fig.3)

Fig. 3. Ecological corridor

The Sanya Mangrove Ecological Park Project in Tianya District, Sanya City, Hainan Province, China, uses the sponge city theory to build an ecological platform and an ecological corridor. The project uses the height difference of nearly ten meters between the riverfront road and the water surface to shape the ecological terrace landscape, and combines the ecological corridor to trap and purify rainwater from the urban road and the ground, while setting activity Spaces at different heights. The viewing walk changes with the terrain of the site, linking different viewing spots together, providing visitors with landscape pavilions for bird watching, shade and viewing.

6 Design strategies

6.1 River water purification strategies

River water quality is one of the important factors affecting the effect of waterfront landscape. The sponge city theory can be used to recycle river water purification, strengthen the treatment of urban surface runoff and rainwater water, solve the problem of river water pollution, and make river water quality meet the demand for viewing.

There are many methods for water purification, such as soil piling method, which uses crops to absorb different eutrophic compounds in sandy soil, repair soil quality, and purify water. Or the use of pond purification method, the use of different height and depth of the pit to create artificial concave green space, precipitation and filtration of water, to achieve the purpose of optimizing water quality. When selecting the water purification plan, the sponge city theory should be combined with the site situation, and the water conditions and the basic conditions of the site should be rationally applied to achieve the ideal water purification treatment effect.[9]

6.2 Optimizing plant configuration policies

When selecting green plants in the river waterfront area, the specific situation of the river water body and the living characteristics of the plants should be taken into ac-

count, as well as the ecological relationship between different types of plants, so that the plants can give full play to the ecological regulation function, and provide suitable living space for aquatic animals while playing the ornamental role of plants.[10]

In the planting planning, it should be adapted to local conditions and reasonably match the density and level of plants. The waterfront area is dominated by water-tolerant and wet-tolerant plants, such as weeping willows, pinus salicifera and other trees, and rhododendrons, south bamboo and other shrubs. In the aquatic plant area and wetland landscape area, floating water plants, rising water plants and revegeting plants, such as calamus, reeds, water lilies, etc. Give full play to the ecological and ornamental functions of waterfront plants, reduce ecological problems, and achieve the best design effect.

6.3 Onstruct a water-permeable bank protection strategy

The construction of permeable revetment can fully apply the concept of sponge city to the waterfront landscape construction of urban rivers, and make full use of green space, river and wetland to build permeable waterfront, which can effectively play the flood control and drainage functions and ecological functions of urban rivers. The use of gravel and other permeable materials to build revetment, while the use of stones to protect the river bank, the gaps of stones also cooperate with aquatic animals and plants to form a small ecosystem, which can not only carry out landscape construction, but also prevent soil erosion and purify the environment. (see fig.4)

Fig. 4. Onstruct a water-permeable bank

7 Conclusion

Starting from the application of sponge city theory, this paper analyzes and discusses the design and construction of urban river waterfront landscape, and analyzes and studies the application of sponge city theory in urban waterfront landscape. The existing problems in urban waterfront landscape in China are summarized: hard revegeting leads to river hardening; Improper plant allocation affects river drainage and low participation of residents. The application of sponge city theory in urban river

waterfront landscape is summarized. A rain garden; Ecological corridor and spongy road, analyzed the relevant cases at home and abroad, integrated some research results, put forward the design strategy based on sponge city theory, to provide a certain degree of reference for the future design of urban waterfront landscape.

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