Research on Urban Riverside Landscape Design under the Perspective of Sponge City

-- Take the Hun River in Shenfu New City as an Example

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Abstract. With the acceleration of urbanization flood disaster gradually intensified, the river as the discharge terminal of urban rainwater flood system, flood control problem is increasingly serious. This study analyzes the sponge city and low impact development concept, based on the Shenfu New City Hun River as an example of the design of the riverfront landscape, combined with the landscape quantitative calculation method, the use of low-impact development measures from the source reduction system, the midway transmission system, the end of the storage system in three parts of the application of technological measures for the relevant sponge city landscape design provides the basis for the sponge city landscape design.

Keywords: Urban Riverside Landscape Design; Perspective of Sponge City; Hun River in Shenfu New City; Flood Control Problem; Urbanization Flood Disaster.

1. Overview of Related Theories

1.1 Development Status of Sponge City Concept at Home and Abroad

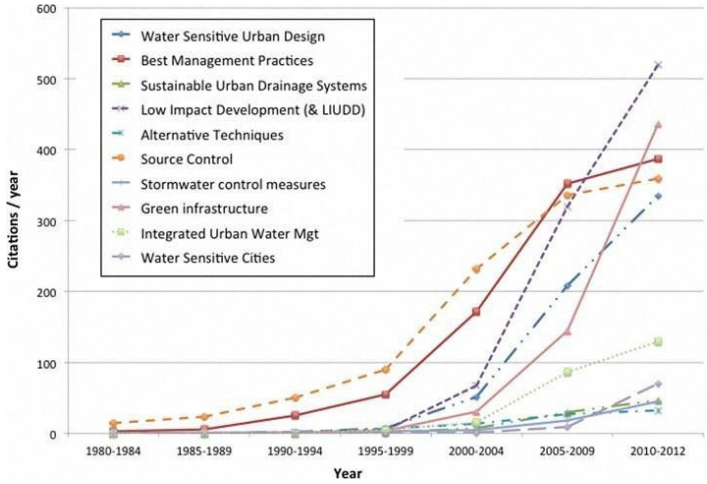


Figure 1. International developments in terminology related to urban stormwater management

Foreign research results on stormwater management are abundant, and since 1970, researchers in different countries have put forward different technical concepts to solve the corresponding stormwater problems according to the current conditions in different countries, among which the most representative ones are: Best Management Practices (BMPs), Low Impact Development, LID, Water Sensitive Design (WSUD), Sustainable Urban Drainage System (SUDS), Green Stormwater Infrastructure (GSI), and Water Sensitive Design (WSUD). The most representative ones are: Best Management Practices (BMPs), Low Impact Development (LID), Water Sensitive Design (WSUD), Sustainable Urban Drainage System (SUDS), Green Storm-water Infrastructure (GSI), and so on. Fletcher et al. (2015) state the combined planning approach of LID and GI is more focused on macro-planning and its development needs. According to the recent development of research in this field

(Figure 1), it can be seen that the research of low-impact development, best management practices, and green infrastructure has become the mainstream of urban storm-water management models. The concept of sponge city in China is precisely a Chinese expression based on these international advanced experiences, combined with the actual development needs of China (Sui-Jinling et al., 2017).

Compared with developed countries, China's research on sponge city is relatively late. 2003 Yu Kongjian first proposed the concept of "sponge" to compare the flood regulating ability of the natural system, pointing out that "the natural wetlands on both sides of the river are like sponges, regulating the abundance of the river water to alleviate droughts and floods. "(Yu Kongjian et al., 2003), and has been continuously applied in the ecological planning of Taizhou, Weihai, Beijing and other cities; China's first batch of sponge city construction pilots Suining City, Qian'an City and Xixian New District have practically applied the theory and technology of sponge city construction in their planning (Yu Kongjian et al., 2015). The concept of "sponge city" is clearly put forward by the state, which represents the ecological rainwater management idea from the academic to the management level, and provides a reference basis for this planning and design.

1.2 Concept and Categorization of Low Impact Development

Low Impact Development (LID) is the core concept of sponge city, which refers to the use of source and decentralized measures in the process of site development to maintain the hydrological characteristics of the site before development. Broadly speaking, low impact development refers to the use of source abatement, midway transfer, end storage and other means in the process of urban development and construction, through infiltration, stagnation, storage, purification, use, discharge and other technologies, to realize the benign hydrological cycle of the city, to improve the infiltration, storage, purification, utilization and discharge of runoff rainfall, and to maintain or restore the sponge function of the city. Low-impact development measures mainly include: sunken green space, permeable paving, green roofs, grass-planted ditches, rain gardens and various other small-scale measures (Qiu Baoxing, 2015). According to the different functions of the measures, combined with the connotation of sponge city low and impact development, this paper divides the sponge technology landscape planning system into source reduction system, midway transmission system, end storage system and summarizes the corresponding technical measures.

1.3 Theories of Riverside Landscape

Riverside landscape zone is a natural landscape and urban humanistic landscape integration of the region, with a unique ecological structure and function, but also by the human activities of the largest impact of the region, in the design should not only focus on the creation of the landscape, but also to meet the needs of the urban stormwater management, integrated into the sponge city's construction concepts, to achieve the integration of the design of the riverfront sponge landscape.

2. Overview and Analysis of the Study Area

2.1 Overview of the Study Area

Shenfu New City is located in the Shenfu connection zone in the east of Shenyang city and the west of Fushun city in Liaoning province, which is a new type of area to promote the integration of Shenyang economic zone in recent years. The Hun River flows through the center of Shenfu New City, and the riverfront area is a transitional landscape zone between the city and the Hun River waters, which is an important part of the urban landscape design. The overall planning area of the riverfront landscape zone in the study area is 20.64km^2, and the water surface area of the Hun River is 6.59km^2, with an average width of the main river channel of 300m, and a length of the river of about 18.17km. The base is rich in natural landscape, and the water surface of the Hun River is relatively wide, with large-scale water features and natural wetland landscapes. Generally speaking, there is enough space for development on both sides of the river, the development degree is not high, and the landscape

substrate is better, which is convenient for the formation of natural ecological low-impact development of landscape style, and provides a good space and conditions for the implementation of sponge city construction.

Terrain conditions have the characteristics of high in the north and south, low in the middle, the Hun River in this area belongs to the typical downstream river, the river as a whole for the rectangular, irregular shape, the north and south side of the city planning roads, along the road are paved with municipal water supply and drainage network facilities, and there are a number of rivers converging into the Hun River, heavy rainfall, resulting in a great pressure on the drainage of the Hun River. Hun River on the east side of the mountains, the terrain is high, both sides of the main gentle slopes, local slightly steeper, the terrain height mainly from the north and south sides to the Hun River, the east side to the west side of the decreasing height, the design of the overall path of surface runoff should follow the direction of the existing drainage, and then landscaping treatment.

2.2 Methodology for Quantitative Calculation of Landscape Schemes

According to the relevant norms and the research of Ding Nian et al. (Ding Nian et al., 2013), combined with the actual situation of the study area, the study area is divided into eleven control subdivisions according to the function of each control subdivision from the perspective of low-impact development, and the integrated runoff control rate of each control subdivision varies from 70% to 80%, and the corresponding thickness of the rainfall ranges from 17.5 mm to 25.0 mm. The storage volume of each control subdivision in the study area is equal to the sum of the storage volume and infiltration volume of each low-impact development facility, where the storage volume of each low-impact development facility is equal to the product of the area of the facility and the depth of storage, and the storage volume is equal to the product of the number of storage facilities and the volume of the storage facility.

The total annual runoff control rate for each control subdivision was determined using the total annual runoff control rate as a function of design rainfall. The total annual runoff control rate for the stormwater system within the study area was obtained by weighting the total annual runoff control rate for each control subarea with the catchment area of each subarea. Repeat these calculations until the target of 75 percent of the total annual runoff control rate within the study area is met, and then determine the volume of storage and the size of the low-impact development measures for each control subarea.

3. Riverfront Sponge Landscape Design

3.1 Riverfront Sponge Landscape Design Objectives

According to the status quo of Hun River riverfront landscape and rainwater management, the design objectives are determined: First, disaster reduction, low impact development measures are arranged in the Hun River riverfront section to improve the rainwater storage capacity of the riverfront landscape, cut down the runoff volume, reduce the pressure of rainwater on the urban infrastructure, and reduce the occurrence of disasters; second, resources, the water used for landscape water and plant watering can be reused through the collection of rainwater, and the goal of rainwater utilization is realized; third, landscaping. Landscaping, water purification and control of rainwater generated by hard paving along the riverfront to improve the ecological environment, and natural barge treatment on the banks of the Hun River to enrich the landscape type.

3.2 Riverfront Sponge Landscape Design Program

The study area is located in the downstream of the Hun River section of Shenfu New City, in order to protect the existing wetlands and large areas of woodland, and minimize the negative impacts of man-made construction on the natural resources of the site. Considering the large area of roads and squares paved with impermeable paving in the landscape design, which causes the problem that rainwater runoff can not be seeped underneath the site, the green drainage way of integrating low-

impact development measures should be integrated on the basis of this, and rainwater infiltration and retention should be prioritized, and then transmitted to the measures that have the capacity of storage and purification, so as to maximize control of negative impacts on the environment caused by rainwater runoff. The realization of the riverfront sponge landscape construction is mainly through the following points:

- Paving permeable paving in small and medium-sized sites and local roads in parks, and designing low-impact development measures such as sunken green areas and rain gardens around the periphery of the lower terrain, so as to collect and treat the rainwater that cannot be infiltrated and retained within the site;
- Designing ditches and other water features in the park's main roads and grass-planted swales in secondary and side roads can initially detain and infiltrate the rainwater on the roads before transferring it to large-scale storage facilities for final treatment;
- Focus on the design of storage facilities such as rain gardens and wet ponds to achieve a combination of stormwater management and landscaped recreational sites, and naturalistic design of riverbanks.

The catchment area of rainwater generated in the study area mainly consists of squares, roads, parking lots and green areas. Among them, the rainwater runoff generated by the plaza and roads can be transmitted to the rain garden through the surrounding grassing ditch, and can be discharged into the Hun River after treatment; the initial runoff from the parking lot is more seriously polluted, so it is necessary to supplement the groundwater with a part of the embedded grass paving and other infiltration, while the other part of the rainwater flows into the surrounding set of sunken green space for purification and infiltration; for the rainwater runoff generated by the green space in the study area, since this part of the rainwater runoff is less polluted, it can flow directly into the Hun River through the grassing ditch. For the rainwater runoff generated from the green space in the study area, since this part of the rainwater runoff is less polluted, it can directly flow into the Hun River through the grass-planted ditch.

4. Technical Application of Low-Impact Development Measures

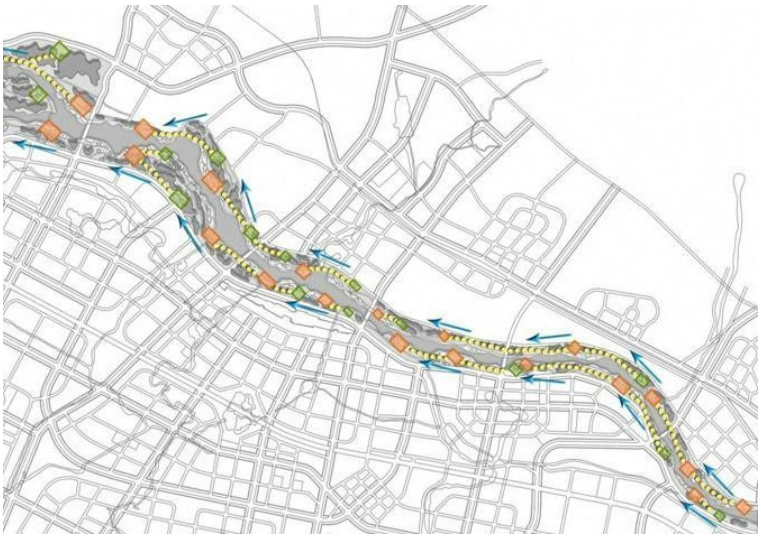


Figure 2. General framework for technical application of low impact development measures

Landscape design of the Hun River riverside landscape zone, forming a complete sponge landscape system, realizing rainwater infiltration, storage, stagnation, purification, use and discharge in different areas, enriching the landscape of water bodies on both sides of the Hun River, and realizing the maximization of ecological benefits on both sides of the river. Comprehensive

comprehensive utilization of rainwater in Shenfu New City overall model and the characteristics of low-impact development technology and facilities, all kinds of measures will be arranged at the landscape belt on both sides of the Hun River, according to the function of each low-impact development measures, combined with the stage of realization of the measures will be divided into three parts: the source of the reduction measures, the midway transmission measures, the end of the end of the storage measures (Figure 2).

4.1 Source Stormwater Infiltration and Retention Measures

- Pervious pavement design

In order to increase the rate of rainwater infiltration and reduce runoff in the study area, the recreational plazas, secondary roads and parking lots in the study area will be paved with permeable paving, and the permeable materials will be selected according to the site conditions in the study area, including permeable tiles, wooden paving and pebble paving. The drainage slope of the plaza needs to be controlled within 1%~3% to facilitate the timely discharge of impermeable rainwater to the surrounding sunken green space and other rainwater management measures. In order to accelerate the rate of rainwater infiltration in the permeable road gravel layer buried conduit, used to infiltrate the rainwater collection and transmission to the Hun River.

- Sunken Green Space

Sunken green space is the most widely used, can be dispersed and set up in the study area where the rainwater runoff is higher, and directly on the hard paved site or around the site combined with the design of greening, which according to the different sites on both sides of the river also have different forms, such as the design of wooden paving in the site, through the elevation of the site paving, so that the rainwater in the site can naturally flow into the green space flush with the road, the green space is sinking relative to the site The green space is sunken relative to the site pavement; in addition, it can also be set directly in the site downward depression, so that the site and the road rainwater flows into the sunken green space at the same time, to promote rainwater infiltration, and play a rainwater collection and purification of rainwater to improve the utilization rate of the role of the best ecological benefits.

- Vegetative buffer strips

Plant buffer zone is mainly set up in the study area and the green space of the city's main road, the city's main road due to a large number of cars passing through every day caused by the initial pollution of rainwater is extremely serious, appropriate plant buffer zone transformed into two forms, one for the terrace garden, set up bioretention facilities and roads in different terrace layer, layer by layer to purify the water quality, so that different layers of the different quality of water, the lower the terrace layer of the cleaner the quality of water; the second for the sloped garden, set up ramps and steps at the same time to solve the traffic problem. Set up ramps and steps while solving the traffic problem, rainwater through the outermost is composed of perennial grass plants buffer filter belt, not only to reduce the flow rate and the initial purification of pollutants, and then into the combination of slow-growing trees and shrubs by the secondary filtration belt, further purification, and finally into the water and wet trees and aquatic plants by the filtration belt, the final purification of the inflow of the river. At the same time can also be combined with grass ditches, rain gardens set up, or in localization will be planted gravel beds, grass ditches and other scales exaggerated set up, the initial collection of rainwater purification and transmission has a good effect.

4.2 Midcourse Stormwater Conveyance Measures

Grass-planting ditch design on one or both sides of the road and part of the site around, the main purpose is to target the source infiltration measures cannot control the rainwater and retention of infiltration of road rainwater so that it is transmitted to the water body. In order to increase the grass ditch on the transmission of rainwater retention capacity, the design of a certain slope and the configuration of native wet plants, so that the natural infiltration of rainwater retention to replenish groundwater, while the initial purification of rainwater, or in the local design of pebbles and gravel

paved dry stream, increase the landscape effect. In the appropriate sections of the use of wooden boards or permeable paving design of walkways and rest platforms, the arrangement of connecting grass ditches do not affect the effective control of rainwater, while for people to rest and play. According to the current situation in the study area of seasonal rainfall in the north, the design of dry grass-planted ditch, its summer rainfall control ability, other seasons combined with the plant configuration to form a unique landscape, the slope design for the curved form, to improve the landscape effect of the study area, the width of the bottom of the 1.2 ~ 1.5m, the depth of 300 ~ 500mm, the slope is controlled at 30%.

4.3 End-of-pipe Stormwater Storage Facilities

- Rain gardens

Rain garden as the main application of low-impact development measures in the study area, there are different landscape effects in the period of abundant water and dry water, mainly according to the status quo of the study area is divided into two aspects of the setup: on the one hand, in the study area entrance plaza as well as the center of the large-scale activities around the site for the setup of the pollutants in the rainwater are intercepted by the garden of the plants and the soil, such as filtration, through infiltration of rainfall into the soil, rainfall, the garden When the rainfall is large, the garden can accommodate part of the rainwater, and the rest is discharged to the urban drainage system through the diversion system, or diverted to the grass-planted ditch to be discharged into other storage facilities. The earth generated in the design process can be combined with certain plant collocation nearby design, forming micro-terrain, and planting a rich variety of ornamental plants, forming a landscape effect of high and low.

- Wetlands

The wetland in the study area is mainly designed along part of the riverbank, which can be used as an end-of-stream storage facility to purify, collect and store a large amount of rainwater collected in the study area. A large number of natural ecological barges are used along the riverbanks, and their slopes are maintained at about 5%~10%, and native plants are used in the barge plants, which can form a riverfront plant community combining wet-tolerant plants - aquatic plants - floating plants, and form a plant filtration zone to purify the confluent rainwater. The plant filtration belt can purify the rainwater. The wetland can also form a buffer zone to prevent rainwater from washing away, and has a certain degree of filtration of pollutants in the water, combined with wooden platforms for recreation and viewing.

5. Conclusion

On the basis of traditional landscape design, the riverfront landscape design of Shenfu New City puts forward the riverfront landscape design with the perspective of sponge city, which not only focuses on landscape creation, but also meets the demand of urban rainwater management. In this planning and design, for the current situation of Hunhe land, sponge landscape program design, and based on the quantitative calculation of low-impact development measures, to determine the scale of low-impact development measures of the riverfront landscape zone, and at the same time according to the function of the low-impact development measures are different, the specific is divided into three stages of realization, including the source of the rainwater infiltration and retention measures using permeable paving, sunken green space, plant buffer zone, midway rainwater transmission Measures adopt grass-planted ditches, and end rainwater storage facilities adopt rain gardens and wetlands, which are compatible with the natural ecosystem of the city at the macro level to build a complete sponge city landscape system.

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