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The research of gray space design of architecture based on green stormwater infrastructure application

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Abstract

Green stormwater infrastructure has become an important issue in the development of modern ecological city. However, the research about green stormwater infrastructure combined with architecture is not sufficient, for which usually focus on community planning in meso scale or landscape design in micro scale. The green stormwater infrastructure associated with building can be as green roof, vertical greening and gray space etc. Through data collection, case analysis and field research, the paper combined with architectural ecology and aesthetic mainly studies the public space closely connected with building easily accessible to citizens, which can be called gray public space. Based on the introduction to concept, principle and composition of green stormwater infrastructure and the basic connotation of gray space, the wisdom of the Chinese traditional architecture and building group in the rainwater utilization is draws out. Chinese traditional courtyard, alleys and garden not only build landscape utilizing stormwater and related infrastructure, but also collect rainwater for recycling or seeping directly into the ground. After the comparison of traditional gray space and the one based on stormwater utilization, three gray space models based on green stormwater infrastructure are summarized, such as separation-association based on the landscape function, half-association based on purifying stormwater to drainage and complete association based on recycling stormwater. Finally, this paper explains and confirms the three models through the rain and sewage separation system and purification system in the courtyard of Sidwell Friends School.

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1. Introduction

Green infrastructure is defined as a stormwater management approach that simulates the processes of natural hydrology at the site and building scale, namely the Green stormwater Infrastructure (GSI), which refers to various ecological measures for stormwater management. GSI is different from traditional municipal pipe network, which includes a series of stormwater management elements that consist of plant, soil and rain-related gray infrastructures. The stormwater is managed in the process of receiving, gathering, transporting and discharging stormwater; the storm runoff and pollutants are reduced through various sources control mechanisms, such as evaporation, infiltration, storage, filtration, purification and reutilization. Therefore, GSI generally consists of three components: the source measures of receiving stormwater like the tree pool, green roof, rain buckets, bioretention ponds, rain gardens and permeable pavement, the stormwater transport measures composed of grass-planting ditches, ecological ditches and water-conducting facilities in buildings and structures, water collection measures consisting of landscape water, stormwater ponds, stormwater wetlands and storage facilities for multi-purpose.

GSI has become an important topic in the development of contemporary eco-city. However, the study on GSI in micro scale is usually associated with landscape design and site drainage, but the study with it combined with buildings is not sufficient. This paper focuses on the gray space combining stormwater utilization with gray space design. Gray space within building proposed by the Japanese architect Kisho Kurokawa is an important part of urban public space. If the space regarded as color, indoor space as “black”, outdoor space as “white”, then the transition space within indoor and outdoor will be called “gray space”. Gray space is also the transition space from inside to outside of building and from private space to public space, which consisted of a series of architectural elements like garden balcony, building entrance, opening sided-courtyard and bottom overhead space. Traditional gray space based on urban context and spatial perception ignores the ecological significance of itself. The grey space based on GSI treats the relationship between nature, architecture and human, with the emphasis on stormwater treatment, respecting the urban context and satisfying the basic functions.

2. Ecological utilization of stormwater in ancient Chinese architecture

Ancient Chinese architecture has its own experience and wisdom in stormwater management and utilization. The rain starts from the pitched roof, and drops through the space under the eaves into the courtyard, then flows through the open ditch or blind drainage to directly drains into the spring water along the streets, or into the underground, or directly into the moat in the palace. Stormwater in ancient China not only as the landscape function and symbolic role, it has some other recycling functions such as laundry, storage, drinking and irrigation. Ancient people regarded rain as a part of organic life in the building group was mainly reflected on the wisdom of stormwater utilization for ancient living houses and royal buildings.

2.1. Utilization of stormwater by ancient dwellings

The treatment of stormwater in ancient dwellings is closely related to the blessing and daily life of local residents. Generally there are three kinds of gray space using stormwater: patio, water courtyard and water lane (Fig.1). Firstly, there are sinks for directing stormwater generally surrounding the patio in the courtyard of the south of China. When it rains, the rain drops from the roof into the trench of patio, after guided and then into the fish pond and garden in the patio, and finally discharged into the river ditch, known as the “all the water collected into the courtyard”. “All the water collected into the courtyard” not only in geomantic omen has the moral of collecting money, but has the function of regulating the temperature in courtyard. Secondly, the pond combined with courtyard usually refers to as “water courtyard”. Water courtyard is usually connected with the ditches in the village, which has the function of stormwater collection, drainage and microclimate regulation. For example, two drainage sets of stormwater and sewage water were set up in the wells of Dou Village in Nanjing. The stormwater and domestic sewage were discharged into the “rainwater wells” and “sewage wells” of the villages respectively and finally used for irrigation. And so on, the water system often runs through the whole village to form a “water lane” in many villages in the south of China. Take Hong Village in Anhui as an example, every household uses the patio, water

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