Study on the development trend and practice of sponge cities with Chinese Characteristics

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Abstract. The design of sponge city is the innovation and development of theory of rainwater utilization, which provides a new idea for the city to solve the problem of waterlogging and water shortage. The paper expounds the "sponge city" concept of the origins, development and application in engineering construction, and puts forward some suggestions for future research of "sponge city" for our city construction.

1. Introduction

With the development of urbanization and the increasing area of hardened road surface, the problem of urban rainwater becomes more and more obvious, which mainly shows as follows: Large loss of rainwater resources; severe rainwater runoff pollution; increased risk of urban waterlogging; ecological damage to the environment and other aspects. The high urbanization process makes the surface of large area be covered by concrete and asphalt, which increases the runoff coefficient. Every rainy day, mainly rely on pipe drainage, pumping stations and other "gray" facilities drainage. With "rapid exclusion" and "end centralized" control as the main planning and design concepts, often result in heavy rains, droughts-floods abrupt alternation.

The roads of the city take up the woodland, grassland, lakes and wetlands that can conserve water and cut off the natural water cycle. Rainwater can only be discharged as sewage, and the groundwater is getting less and less. To solve the problem of water shortage in cities, we must conform to nature. For example, When we promote the urban drainage system, we should give priority to the limited rain and keep them to storage, give priority to more use of natural forces to drain away water, and construct a "sponge city" of natural accumulation, natural infiltration, natural purification.

¹Sponge City is through the construction of "green" measures for rainwater absorption, storage, water seepage, clean water, when necessary to use the storage. Starting from the ecosystem service, it is the core of "sponge City" to construct water ecological infrastructure by trans-scale, and to construct water ecological infrastructure with many kinds of concrete technologies. In this way, the problem of urban waterlogging will gradually disappear under the construction of Sponge City [2].

2. Technical development of Sponge city

2.1 Technology development Abroad.

The core of the construction of sponge city is rain flood management. In foreign countries, the concept of urban stormwater management mainly includes: (1) Low impact development, Best management practices (BMPs) and green infrastructure in the United States[3]. (2) British sustainable development
drainage system. (3) Australian Water Sensitivity City Design (WSUD). (4) New Zealand's low impact urban design and development (LIUDD) and multi-target flood-plains management\(^4\). As shown in table 1\(^5\).

| Table 1. Comparison of Technology Development of Sponge City Abroad |
|---------------------------------------------------------------|
| Take the management of rain flood as the target standard planning Model | Main content |
| Best Management Practices | The implementation of water control, including the contingency events such as flood and flood peak flow and the control and regulation of the smaller rainfall events, the corresponding control criteria for the implementation and the specific pollutant; multi-parameter control. |
| Low Impact Development | Control of surface runoff to reduce flood peaks, replenish groundwater, implement water quality protection, and replace the use of "pipelines and ponds in traditional civil engineering" by relying on water recirculation systems prior to site development. |
| Water sensitive urban design | Protect the natural water system, combine the rain and flood treatment with the landscape design, make the rainwater resources become the organic part in the urban landscape, and bring the social benefit into play; water quality purification, ensure water quality in the process of urban development, reduce surface runoff and flood. Reduce development costs. |
| Sustainable Drainage Systems | To protect and improve the quality of water, to coordinate relations with the environment, to take into account the needs of local communities, to provide habitats for wildlife in urban areas, and to encourage the natural recharge of groundwater under possible conditions. |

2.2 Domestic technology development.

Early domestic research on urban rainwater utilization is discussed in engineering and technical aspects, pursuing the advanced nature of the design and the refinement of the data. In addition, under the direct leadership of the housing department, since 2008, the guangming new district of shenzhen has conducted a pilot project of low impact development and construction, which has become a demonstration area of low impact development nationwide. Knowing that the "Sponge City" was explicitly proposed by Xi Jinping in the 2003 Central Conference on Urbanization, the public had more opportunities to focus on and understand the concept and concept. And then the building of a technical guide for sponge City--low impact development of rainwater system construction (trial) Plan. Since then, the domestic sponge-type urbanization hotspot has been actively developed \(^6\).

The low impact Development demonstration area of Shenzhen bright new area is the base of research and demonstration base of sponge city in China. By compiling and perfecting technical specification. Collect and infiltrate the road rainwater into the biological isolation zone on both sides. In this way, the surface water and groundwater resources are replenished. The Fujian province seeks to alleviate the serious problems of urban pollution and waterlogging caused by the impervious surface of the city, and improve the urban water permeability rate. Through the construction of urban wetland parks and other green landscapes to strengthen urban greening. The impervious hardening method is changed into permeable hardening method to make the outdoor ground, road, square and parking lot as permeable surface, so that rainwater can recharge groundwater. Zhejiang province requires that new or renovated areas and projects must be equipped with water runoff pollution control facilities to reduce the amount of pollutants caused by early rainfall. In some areas, the seepage mode is adopted to
collect rainwater. These practices further promote the research and development of the related theory of urban rain flood management in China.

3. Application of Sponge City in engineering construction

(1). The construction of rainwater infiltration green space: through building green roof can adjust the building temperature, reduce urban heat island effect. Sinking type green space, planting grass ditch and other ways to collect and use rainwater in all directions. Not only the infiltration ability, but also the plant root system can play a certain role in purifying suspended solids and impurities in rainwater runoff. Compared with the traditional drainage facilities, increase the connection between surface water and groundwater through the penetration of rainwater. And its not only has a strong drainage capacity, but also to supplement the groundwater resources. It can effectively relieve the declining water level, and can also reduce the surface water. With better urban landscape effect, it is convenient for residents to live and improve their environment.

(2). Road and square Construction: The large area of the square is also a place to collect rainwater effectively. The water quality of the rainwater in the square is different, and there are more pollutants. This requires the initial rain to be dumped. It can increase the proportion of water permeable ground in the city, reduce the peak of rain and delay the occurrence of flood peak by laying the water permeable brick and the establishment of reasonable drainage slope. In combination with other urban rainwater facilities, the water drainage of the site can be reduced, which can be used to solve the phenomenon of "watching the sea" during the rainy flood in the city.

(3). The construction of water supply and sewerage system: Through comprehensive planning and scientific construction, the construction level of urban water supply and drainage system can be effectively improved. In the process of urban planning, the overall planning of urban development must be carried out through the overall planning of the drainage system. In view of the control of rainwater runoff pollution, it is possible to maximize the utilization of water resources and solve the problem of urban water shortage by using shunt system and sewage drainage system.

(4). Water system Regulation: Urban water system is one of the four major systems of "Sponge City", which plays an important role in urban drainage, flood control and improvement of urban ecological environment. Through the construction of rainwater wetland, vegetation buffer zone and ecological areas and other facilities near the existing rivers, the regulation of water system can basically enhance the comprehensive flood control ability of river, realize flood peak adjustment and increase the groundwater level in the future.

4. Recommendations

The construction of Sponge city needs multidisciplinary and multisectoral cooperation. It is limited by individual departments or subjects. Overall arrangements for the construction of Sponge city, basin sponge and regional sponge should be taken into account. Sponge city construction, black-smelly water treatment, air pollution control, soil pollution prevention, ecological agriculture construction, water conservancy construction, etc. should be integrated in a platform for overall arrangements. In China, the development of sponge city construction is late and the development potential is great. The following research should be emphasized:

4.1 Coexistence pattern of green sponge and grey construction.

The country carried out the pilot work of Sponge city construction, advocated the concept of green drainage, But the original project construction project is still advancing, including the pilot city, Municipal Road, Square design, construction or in accordance with the centralized Express mode of construction. The hardening of the ground cement is still intensifying. The frequent occurrence of urban diseases such as waterlogging, haze, non-point pollution, sinkholes, heat island effect and urban extreme climatic phenomena has not been effectively curbed. At the same time, all kinds of transportation, water conservancy and other infrastructure construction has not implemented low impact development concept. The increment of Grey project is increasing unceasingly, and the inertia
effect on the urban and rural ecological environment is continuing \( ^{11} \).

4.2 The construction of Sponge City system has a certain degree of regional.

In the construction of the garden green space system, it is necessary to effectively cooperate with the sponge city system to build this feature Must be to ensure that the city's human and material resources on the basis of sufficient, according to different regions to make a different construction plan .

4.3 Lack of talent team and weak industrial system in Sponge City.

At present, there is a serious shortage of talents in the construction of Sponge city, and there is no leader and team in planning, design and education. University Sponge City Low impact development textbooks are scarce, the curriculum is very difficult to open, Talent training can not meet the needs of society. The engineering material industry system is thin, the operation management lacks the experience, the ecological engineering method is not enough to meet the sponge city construction need.

5. Conclusions

The infiltration, storage, filtration and discharge of the urban garden green space to the rain water, then flow into the natural purification of the constructed wetland, or to the natural ecological channel Flow to the urban landscape green, mountain, for soil and water conservation and rainwater savings, so that the city green to maintain a rich natural landscape. To achieve the same as "sponge" water absorption and timely drainage capacity, and natural disasters have a good coping force In the urban green space system to better assist the whole city to complete the evolution of the sponge city, to achieve sustainable urban development \( ^{12} \).

The construction of Sponge city is not a day's work, especially in the early stage of construction, the theory and practice of Sponge city construction is not enough. In the introduction of foreign advanced experience in rainwater utilization, the theory must be localized to local conditions \( ^{13} \). This means that the construction task of Sponge city is heavy and far, there is no shortcut to the construction of sponge city. In order to solve the problem of urban water shortage and water pollution in our country, we need to make unremitting efforts to continue our research and practice exploration. First of all, we need to start from the basic research, practice and scientific research closely combined, and constantly explore and improve the construction technology sponge city. Secondly, to strengthen exchanges and cooperation in all aspects to avoid detours. Finally, the most urgent task of the construction of sponge city is to scientifically and rationally layout, improve the planning and design and determine the flood control standards, in order to carry out practical work reasonably.

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