

# Preliminary discussion on "Internet +" sponge city modular construction system

Jinhui Yang, Sijun Kang, Weizu Luo, Yanghong Dai, Bing Yang

School of Civil Engineering, Hengyang, University of South China, China

**Abstract:** To promote the construction of ecological civilization and the process of urbanization in China, in 2013, the government propose to build an innovative rainwater system, which is characterized by nature accumulation, natural penetration and natural purification—low impact development of rainwater. This article Summarizes the research status of sponge city. It can be help the sponge city to become intelli-gent and modular creatively by adding the intelligent concept of “internet+” and the modular concept into the sponge city. This article first introduces the “internet+” concept of sponge city, and then discussed the application of the “internet+” and modular concept in sponge city from the three stage of construction, management and performance evaluation, in order to provide some reference and revelation for the development of modular of “internet+” sponge city.

## 1 Sponge City Instructions

Sponge city is Low impact design or development, or LID for short. Namely: the urban ecosystems, like sponges, have excellent "resilience" in coping with environmental change and resistance to natural disasters. When rainfall low impact development infrastructure module can absorb water, water storage, water seepage, water purification, and in need of accumulation of water will be released for reasonable use<sup>[1]</sup>.(Fig.1). Sponge city construction conforms to our country construction the five one of the general layout of socialism with Chinese characteristics, contribute to promoting the construction of ecological civilization and the urbanization process, is a product of man and nature in harmony, to strive to build a green China, beautiful China is of great significance.

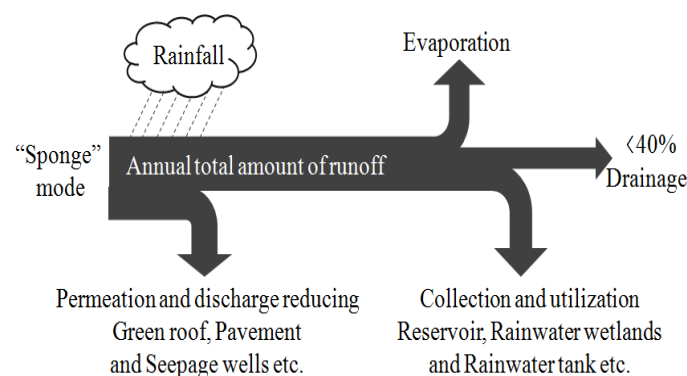


Figure 1. Sponge city drainage pattern.

### 1.1 *Background of Sponge City*

With the acceleration of urban construction, the construction, the increasingly dense structures, the impervious pavement area and the reduction of urban vegetation cover area caused the urban ecosystem water cycle process to be seriously blocked, the amount of rainwater infiltration decreased, surface runoff increased and municipal drainage system of the increase in the load, resulting in flood water, river water ecological deterioration, water pollution and a series of ecological problems. As Engels once said, "We do not over-reduce the victory of our humanity to nature, and for every such victory, nature has retaliated against us, and every victory has indeed achieved our desired results at the beginning, and then there is a completely different, unexpected effects, often the initial results and eliminated<sup>[2]</sup>". Through the study found, USA, Britain, France and other developed countries to explore the development of sponge city after learning about the deteriorating ecological environment caused by excessive urban construction.

Xi Jinping, general secretary of the central town in 2013 working conference clearly pointed out: Addressing urban water problems, it must adapt to nature, to give priority to the limited rain left, giving priority to greater use of natural forces drainage, construction of the sponge city being characterized by natural accumulation, natural infiltration, natural purification. November 2014, China's Ministry of Housing and Urban learn from its many years of experience in building low-impact development by studying the American theoretical results (LID) storm-water system by the actual situation of the organization prepared *the sponge City Construction Technology Guide - construction of low-impact development storm-water systems (trial)*, for the construction of the urban system of the sponge provides a more authoritative theoretical guidance system<sup>[3-4]</sup>. April 2015, the official website of the Ministry of Finance publicized the list of the first batch of national urban construction pilot cities sponge, Qianan, Baicheng, Zhenjiang, and other 16 cities will receive central government subsidies for urban construction sponge, sponge point of urban construction pilot fully carried out. Nowadays, the overall economic situation of China's cities into a new normal, this series of policies fully embodies the party's ecological civilization construction, conservation of resources and the protection of the environment attaches great importance.

### 1.2 *Characteristics of Sponge City*

Sponge city broke the traditional "row-based" urban storm-water management philosophy, emphasizing the development and the total amount of storm water runoff before and after the peak flow substantially unchanged<sup>[5]</sup>. By infiltration, stagnation, storage net, use, discharge and other ecological technology to build low-impact development, with natural circulation of "green sponge," storm-water systems to reduce urban construction on the local ecological disturbance of the water cycle, so that the city suffered water after the disaster can recover quickly realize the city elasticity to adapt to environmental changes and natural disasters<sup>[6]</sup>.

Sponge has the connotation of urban construction features three aspects<sup>[7]</sup>: First, from the perspective of resource utilization, the characteristics of the original water resources of the city and the objective law of the building and structure can't be violated during the construction of the sponge city. The drainage system should be built, and the roof of the building - the permeable road - the landscape wetland Drainage - Urban River Five - in - One to Guarantee Urban Low Impact Development Rainfall Realization; Second, from the perspective of urban waterlogging and disaster reduction, the low impact of urban development The rainwater system helps to realize the harmony of urban construction, structure and natural rainfall, harmony between man and nature, and can better control and deal with urban floods to reduce disaster losses; Third, from the perspective of ecological and environmental protection, Marx believes that people can naturally understand the natural transformation of the natural process can't ignore the natural reaction to the people, the city is a natural product of natural transformation In order to reduce the ecological risks of urban construction, the city should also Must be harmonious development with nature.

### 1.3 “Internet+” Sponge City

"Internet +" refers to the use of ICT industry and B2B, B2C, C2B and O2O other new mode of operation, the "cloud" (cloud computing and big data infrastructure), "Network" (Internet and Internet of Things), "terminal" (direct services to individual devices) constitute the three aspects of Internet technology applications in the economic and social fields<sup>[8]</sup>. "Internet +" sponge city is a new generation of information technology, such as sensor network, Internet, cloud computing and large data infrastructure, to analyze, analyze and integrate various kinds of centralized or distributed energy, green facilities and low-impact development storm-water data base module of the city, thus making it fast, intelligent feedback to work together to improve the efficiency of city operations sponge, and strive to achieve a better city, better life. The general idea: First, monitor the collection of information, networking and smart sensor system is based on a variety of sensors for the carrier, can get all kinds of information needed; Secondly, the data transmission of information, using the Internet, high-speed transmission network 3G / 4G, etc., the information to the cloud server; Then, processing and analysis of information that can take advantage of cloud computing, data analysis, data through a variety of models to simulate the optimal solution for the problem results; Meanwhile, managers quickly and accurately directing the execution of the program to solve various problems in practice; Finally, the performance evaluation is comprehensive and reasonable, and the feedback and correction of the results play an important role<sup>[9]</sup>. "Internet +" sponge city to help achieve the intelligent operation and management of sponge city, through the analysis of various data analysis, so that the decision-making program more scientific and reasonable, China's sponge city construction has important guiding significance.

## 2 Modularity of “Internet+” Sponge City

Modularity refers to a kind of network hierarchical structure with high degree of mutual independence and high interdependence between modules. Therefore, it is possible to realize complex sponge city system construction by modularization [10]. Modular in the construction, industrial design and other fields for many years, its related design, construction of modular derived mature applications: Container building, BIM, modular combination of furniture, three-dimensional green and so on. This provides some inspiration for the "Internet +" sponge city low impact development of rainwater infrastructure modular research: Functional unit, formal style, constitute a network, the construction of a combination of operational visualization, etc.<sup>[11]</sup>. Low Impact Development Rainwater infrastructure Modularity isn't a "apply" and "blind" to other disciplines and Subjects. But to seek a new method of flexible, multi-dimensional and intelligent sponge city construction, make full use of its standardization, network conditions, integration, matching large data, Internet of things and other emerging technologies, designers, builders, the needs of urban resident close interaction, contact, advancing with the times to explore the sponge city modular "innovation 2.0" construction<sup>[12]</sup>.

### 2.1 Modular Construction of LID Infrastructure

Low Impact Development Rainwater (LID) Infrastructure Modular is defined as: Through the large-scale data, cloud computing, computer-aided design and other emerging technologies, to achieve design - construction - management in one of the standardization of LID infrastructure construction, combination, split, replace the sponge city construction of new methods.

Modularity is a logical language. Low Impact Development Rainwater base modules should include the following features: First, it is standard: Consisting of a series of basic units and structurally stable; Second, it is fast-constructive: Factory prefabricated module, field installation; Third, it is flexible variability: Detachable, easy construction, restructuring and maintenance characteristics.

Sponge city adopt the penetration, retard, storage, purification, forthputting, drain a variety of technical means from the rain, rainwater to rain to achieve full control of rainwater runoff, so as to meet the city to restore the ecological, environmental protection requirements.

(1)"Penetration" project basic module, it mainly includes green roof, pavement and seepage wells and other construction and transformation, the main purpose is to reduce the rainfall runoff, clean the initial pollution of rain.

(2)"Retard" project basic module, it mainly includes the construction of ecological grass ditch, concave green space, rain garden, etc., the main purpose is to delay the peak rainfall runoff time.

(3)"Storage" project basic module, it mainly includes the construction of artificial rainwater pond and other rainwater collection and storage facilities, urban natural rivers and lakes and wetlands. The main purpose is to reduce the rainfall runoff peak flow, and create a reasonable use of rain conditions.

(4)"Purification" project basic module, it mainly includes comprehensive river regulation, coastal ecological gentle slope, sewage treatment facilities and pipe network and biological detention facilities. The main purpose is to solve the problem of rainwater pollution and improve the urban water environment.

(5)"Forthputting" project basic module, it mainly including landscape fountain, garden irrigation and other rainwater utilization facilities, the main purpose is to alleviate the urban water shortage per capita to achieve sustainable development.

(6)"Drain" project basic module, it mainly including the transformation of urban rain and sewage diversion pipe network, low-lying water points drainage facilities. The main purpose is to use the artificial mechanical facilities in the construction of sponge city to realize the combination of ground drainage and underground rainwater pipe, artificial drainage and waterlogging prevention facilities and natural river channel synergy.

Designing the rainwater module of LID, whether the main function or form as the main body, have followed the unique logic of modular. It refers to "Simulation City" and other electronic games to build a modular design platform [13]. The design process is roughly: The basic data of the project (site type, scale, requirements, etc.) are collected and uploaded to the platform for preliminary analysis. Based on the large data, the module grid is generated according to local conditions, and the corresponding design elements (water permeable materials, plants, the latter unit organic combination, the final completion of the modular design. The modular design with a simple, public participation, social networking features, people can through the PC directly involved in the design and upload it to the "cloud modules", the designer by integrating various programs, compared with the modifications, the final program. The traditional sponge city design to designer-centric design model into a city-centered design model(Fig.2).

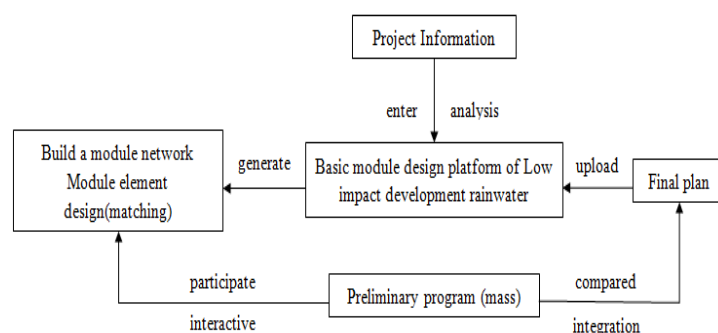


Figure 2. LID base module design process.

## 2.2 Modularization Management of LID Infrastructure

China's sponge city construction is the government-led urban ecological restoration and transformation, some cities have carried out some exploration, some pilot cities on their own actual situation and the "Internet +" sponge city modular construction work and other cognitive problems, resulting in Construction needs and control indicators planning improper; There are some pilot cities appeared "built" "tube" serious deviation from the problem, only emphasis on the construction, without focusing on planning and management<sup>[14]</sup>; Meanwhile most of the pilot cities in urban construction in the pres-

ence of sponge duplicate construction, the new green facilities is poor, construction progress lags behind other issues, the reason is very little idea of the new generation of information technology with the traditional combination of techniques and methods<sup>[15]</sup>.

LID infrastructure modularization, based on the modular grid structure, the urban LID infrastructure is divided into a number of grid modules, combined with the Internet of things technology, in the various modules on the various types of sensors (flow sensor, sensors, soil sensors, humidity sensors, etc.), real-time monitoring low-impact development storm-water infrastructure sophistication, safety, conservation of vegetation pipe network traffic conditions; Real-time monitoring of the inlet or overflow port in time to respond to the rain pipe network is blocked or leakage; To realize the wisdom of water pollution control and governance, the need for water pollution monitoring; The rain and water conditions in real time monitoring, in order to achieve flood control and drainage warning control; Intelligent control of water consumption, efficient use of rainwater. For example, the use of MATLAB and other software to analyze and deal with a large number of data, the distribution of real-time monitoring of the flow, and through the hydraulic model calculated by the point of traffic compared to the larger difference between the flow point of warning, analysis of traffic changes Cause, and immediately send the maintenance staff of the module to repair; Monitoring the precipitation, soil moisture content, plant growth and so on with the combination of rainfall forecast information, planning watering time, frequency and water consumption, to achieve the module's intelligent irrigation.

"Internet + "sponge city modular construction system of intelligent and efficient, safe and environmental protection of the full role of the full play can't be separated from the supporting operation and management model. Some sponge city can't effectively play a role, and may even occur water ecological damage, water pollution, rainwater resources and other phenomena, and low impact development of rainwater base module operation and management is a very good solution to these problems a new model.

### 2.3 Modular Evaluation of "Internet + " Sponge City

"Internet + " performance evaluation is based on the city Sponge certain criteria and procedures to benefit low-impact development storm-water infrastructure, efficiency, effectiveness and value of the evaluation carried out an act of judgment, the purpose is to obtain information on these aspects as management repair and maintenance of those facilities, improve operation and management mode, the construction of new urban development of sponge basis for policy. At present, China's current sponge city construction performance evaluation and assessment methods (Trial) on the water ecology, water environment, water resources, water safety module of some quantitative indicators still do not provide a specific assessment method, that is, the construction of the demonstration project has not yet cover the full and effective operation can be practiced using the performance Evaluation system. Therefore, it is very important and urgent to study the development of a system effective and effective performance evaluation system to solve the problem of the operation of the evaluation of indicators. The modular assessment model is based on the analysis of key aspects such as water ecology, water environment, water resources and water security of sponge city, and decomposes key links and factors into several independent evaluation modules. In the sponge city ecological effect the assessment process may be based on the above analysis, select the desired module, evaluate, make the evaluation more targeted and more efficient.

In accordance with the sponge city construction performance evaluation and assessment methods (Trial) requirements sponge city construction area of water supply pipe network leakage rate of not more than 12%. This is an encouraging quantitative indicator of the water resources module. The method of assessing the leakage rate of water supply pipe network can be carried out according to the following steps: First, according to the relevant design drawings for the site survey to understand the situation of specific facilities, and use of the Internet cloud technology to extract the project graphics, statistics, analysis integration; Then, the use of Internet of things intelligent sensor system to obtain pipe network and layout and other data; Use MIKE, SWMM, ArcGIS, CAD and other software to obtain the layout and direction of the water supply network; Pipe network segment number, and marked

pipe network diversion, convergence and other special points; The flow sensor is set up at the appropriate location of each segment and at some special points to monitor the flow of pipes and upload data in real time; Finally, using the cloud computing software technology such as MATLAB combined with the hydraulic model to calculate the flow rate and monitoring point of real-time monitoring of the flow of the comparison analysis, the point of the rainwater leakage, and then get the entire water supply pipe leakage rate, thus assessment and feedback to make amendments(Fig.3).

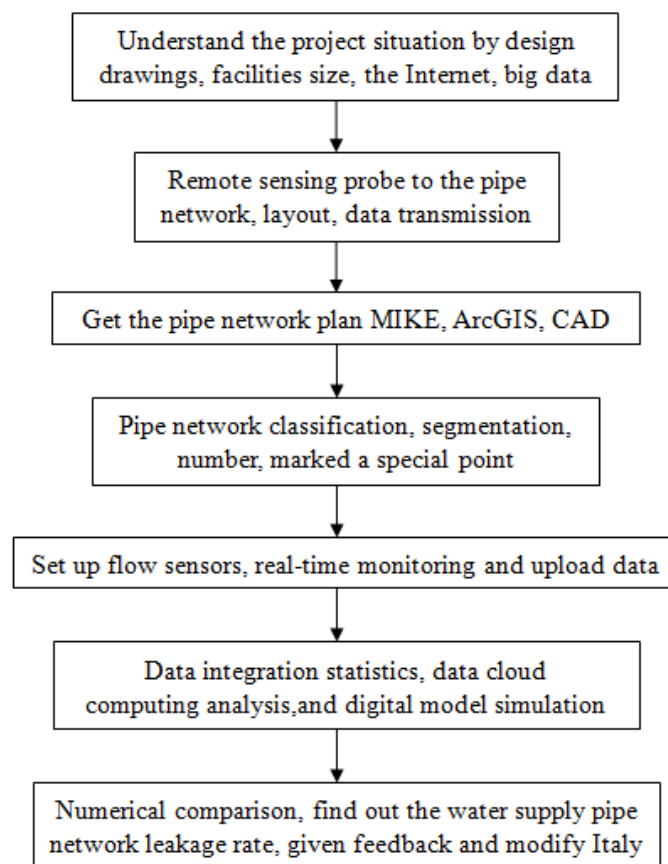


Figure 3. Water supply network leakage rate assessment flow chart.

### 3 Peroration

This article introduces the background, connotation and construction method of sponge city, and combines the concept of "traditional innovation" with "innovation 2.0" - "Internet +", and puts forward "Internet +" sponge city. And in the low impact of the development of rainwater infrastructure planning and construction, operation management and evaluation of the performance of the three stages of the introduction of modular ideas. It gives full play to the Internet in the information collection and processing of organic integration and the concept of optimal solution and modular concept of the simple, convenient and efficient features. The Internet's innovative achievements and modular theory of deep integration in the construction of sponge city, put forward the "Internet +" sponge city modular construction of new ideas to the smart and efficient "Internet +" sponge city modular system development some reference and inspiration.

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