Application of BIM in Urban Rainwater Operation and Maintenance

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Abstract: This paper briefly introduces the application and feasibility of BIM technology in urban rainwater management system construction. The traditional rainwater collection and utilization system is prone to defects in the design and construction. In case of sudden heavy rain, the drainage pipe network will be seriously overloaded, making the city face waterlogging. BIM technology is applied throughout the whole life cycle of urban rainwater collection and utilization system, from design and construction to construction management to operation and maintenance. Through the model in BIM, the collected data and information are visualized and analyzed by using the rainwater runoff calculation software in the platform, so as to prevent timely dealing with urban waterlogging.

1. Introduction

The acceleration of urbanization process in recent years, industrialization of developing, the city covers an area of more and more big, in the face of the urban rainwater having prevent waterlogging facilities, many management unit of the first through artificial field investigation, the traditional way, such as CAD drawings refer to to census data, then these artificial census income data input city operations management platform in the rain. In this traditional way, a large number of data are prone to be missing, and new information cannot be replaced on the platform in a timely manner. In case of heavy rainfall, the urban flood control and disaster prevention management department may fail to carry out the dispatching work due to inaccurate data information, leading to urban waterlogging and economic losses. This traditional mode of operation and maintenance management can no longer meet the requirements of smart city construction and management. Therefore, in the management of urban drainage and waterlogging prevention facilities, it is necessary to integrate energy conservation and emission reduction with information technology, apply the concept of operation and maintenance management of new technology, and establish an information data collection, storage, computer operation and analysis, and three-dimensional visualization operation and maintenance supervision platform. Preliminary implementation of physical facilities and BIM model docking supervision, information collection of data using computer operations, statistics, analysis and later visual operation, the scheduling of emergencies in the whole life cycle of systematic control, to provide accurate, timely, systematic information support for urban flood prevention and disaster prevention management department.

2. Urban rainwater collection and utilization system

2.1. Rainwater collection and utilization system

General drainage organization design scheme: roof and road rainwater runoff → sewage interception and abandoning flow → concave green land, grass ditch, rainwater garden → rainwater filtration → rainwater storage tank → terminal water point.

2.2. Technical measures of urban rainwater treatment

Greenbelt is the most important drainage channel in the city, the best channel for rainwater collection and utilization, and the main belt of rainwater drainage, and plays a vital role in the sustainable development of ecological environment restoration. The technical control measures of

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rainwater can be divided into three levels: the source control measures, the midway control measures, the terminal control measures. See Table 1. The source control measures are aimed at rainwater runoff, rainwater infiltration or temporary storage to peak cutting, emission reduction, purification and utilization of rainwater; In the process of stormwater runoff transmission, the measure of midstream control can prolong runoff discharge time and reduce runoff discharge. The end control measures are to collect rainwater to the end of the drainage system for centralized treatment and multi-function regulation and storage of rain flood [1].(SeeTable 1)

Table 1 Technical control measures of rainwater

Site location	The rai facilities	characteristics
source	Green roof	Retention, purification of building roof rainwater runoff, reduce the urban heat island effect, building insulation
	rain garden	At the same time of retaining and purifying rainwater, the landscape functions of buildings, parking lots and small green areas near roads are enhanced
	Recessed green space	The simplest structure of biological detention facilities, the main function is purification, infiltration of rainwater
	Permeable pavement	A form of pavement consisting of a permeable material or a permeable structure, as of straw, gravel, or pebble.
midway	Vegetation shallow groove	Ecological measures for collecting and transporting rainwater can be used in combination with rainwater pipelines, which can be replaced in some areas
	Infiltration ditch	The rain water slowly penetrates into the ground through the gravel layer around the infiltration ditch
At the end	Ecological embankment	In the range of lakeside and river, natural embankments designed by planting, wood or stone are used to improve the self-purification capacity of water by relying on the purification capacity of plants
	Preparation buffer	Zonal vegetation area between surface runoff pollution area and surface water plays a role in purifying, reducing runoff and preventing soil erosion
	Rain wetlands, rain ponds	Artificial structures with functions of rainwater storage and utilization to create a good ecological landscape
	Multi-function storage	Make efficient use of urban green space, use green landscape, park, parking lot and other functions in non-rainy season or light rain, and regulate and store rainwater in rainstorm

3. Application of BIM technology in urban rainwater transportation and maintenance management system

3.1. Urban rainwater collection and utilization system database established

The network layout of urban rainwater utilization system not only covers a large area, but also matches and integrates with the basic service facilities of the city. In order to avoid the disadvantages of the traditional design method to the construction stage. In pipes of the feasibility study, preliminary design stage, construction drawing design phase of BIM technology and integrated application of GIS technology and drainage pipeline network, rainwater collection pipe network, abandon flow sewage equipment, rainwater collection pool, filtration purification equipment, recycling system, and network infrastructure services, such as traffic, collect data information and make a comprehensive design and drawing, in the later operational management platform, the establishment of the comprehensive technology application on the basis of the critical[2-3].

GIS is the abbreviation of Geographic Information System, which is a technical System that

collects, stores, manages, calculates, analyzes, displays and describes the Geographic distribution data in the whole or part of the earth's surface space. Firstly, a large number of surface, spatial and urban terrain data were collected by GIS for input, and then an attribute database of spatial geographic data of urban rainwater utilization system was established by Arc GIS.

Finally, GIS data is imported into BIM to establish more accurate 3D information model. Meanwhile, BIM data is applied to GIS as the most basic data source to conduct macro scale analysis of spatial geographic data of urban rainwater utilization system established by Arc GIS and provide support for GIS attribute database management.

3.2. The three-dimensional visualization platform for urban rainwater collection and utilization.

The visualization platform is mainly the model establishment of urban rainwater collection and utilization system. Specific ideas:

(1)GIS data is imported into BIM, and Autodesk Map 3D is used to integrate spatial information of urban rainwater collection and utilization system to create urban rainwater system Map. The 3D model design of rainwater drainage, collection and utilization pipe network and rainwater pumping station is conducted in Autodesk Civil 3D software.(as shown in Figure 1)

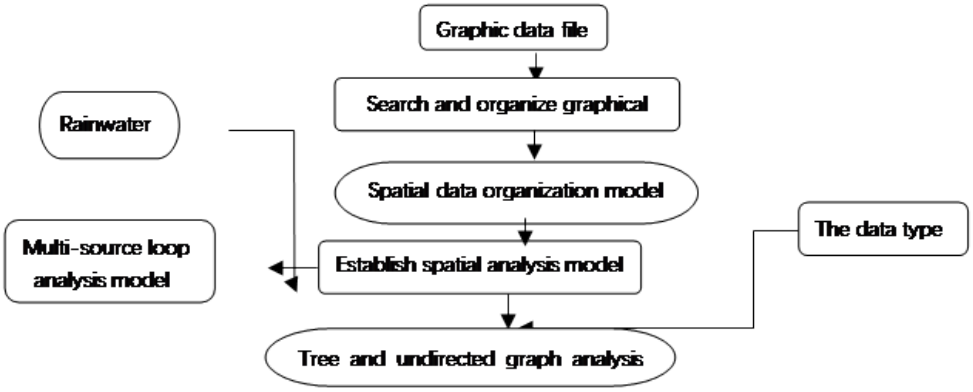

Fig.1. GIS spatial data modeling process

(2) Use SWMM software to conduct data analysis of 3d model, conduct simulation demonstration of rainstorm-runoff performance, and realize 3d visualization of virtual reality scene of rainwater collection and utilization system.

(3) Use Revit software to carry out three-dimensional visualization of urban green space, road and rainwater pumping station, and realize the creation and parametric drive of complex curve modeling.

(4) Use Fuzor software to instantly transform BIM model into a vivid BIMVR scene with data, so that all project participants can conduct in-depth data and information interaction in this scene.

4. Urban rainwater transportation and maintenance management system

Bim-based urban rain water operation and maintenance management platform is equipped with 3d browsing and positioning, information query, intelligent detection, intelligent analysis, emergency management, maintenance management, asset management, administrative management and other functions. Through 3d visualization platform, urban rain water collection and utilization system is operated, maintained and managed. Through the service end of the central control station, the rainwater data obtained by GIS is integrated with BIM model to realize the function of bim-based urban rainwater operation and maintenance management platform. Through the private network, the server and the client are connected, so that the regulatory department, operation and maintenance center and other participants can timely handle the warning information of urban rain water operation and maintenance management platform. Each party shall extract, input, modify and analyze the data and information uploaded by the urban rain water operation and maintenance management platform according to its own authority, so as to realize the supervision department's

control over the urban rain water operation and maintenance management platform, and timely prevent and control flood and prevent urban waterlogging. Urban rainwater transportation and maintenance management platform is divided into five levels[4] :(as shown in Figure 2)

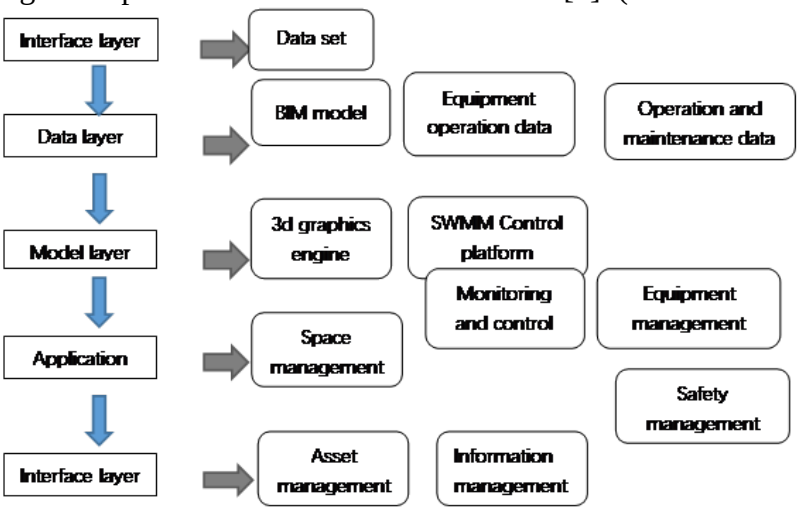

Fig.2. BIM-based urban rainwater operation and maintenance management platform

(1) Transfer all kinds of data to the platform data layer through the interface layer by means of mobile Internet and remote monitoring LAN;

(2) The platform data layer collects various information data as the basic database (including: basic rainwater information data, extended attribute information data, maintenance and repair information data and other information data);

(3) Analyze, process and improve the three-dimensional model in SWMM by collecting data, so as to satisfy the use of urban rainwater transportation and maintenance management platform[5-6].

For example: pipe network convergence simulation - is based on the hydrodynamic method of pipe network convergence model. Its main content is the saint venant equations. The saint-venant equations are composed of continuity equations and energy equations. Since energy equations can be simplified into different forms, various saint-venant equations and solutions can be obtained.

$$\frac{\partial A}{\partial t} + \frac{\partial Q}{\partial x} = q$$

$$\frac{1}{gA}\frac{\partial Q}{\partial t} + \frac{Q}{gA}\frac{\partial}{\partial x}\left(\frac{Q}{A}\right) + \frac{\partial h}{\partial x} - (S_0 - S_f) = 0$$

(A refers to the area of the water-flowing section; Q refers to the flow; Q refers to the input flow per unit length; T is time; X refers to the length of pipes and channels along the flow direction; G is the acceleration of gravity; H refers to water depth; S0 finger canal bottom slope; Sf refers to resistance slope).

(4) Real-time review of BIM model by the application management, and display of rainwater collection and utilization system and surrounding environment. By combining real-time operation and maintenance data with model, real-time analysis can provide support for management decisions.

(5) The platform interface layer meets the management needs of relevant participants. Each participant USES its own management authority to enter the unified operation and maintenance management platform. The working mode of mutual cooperation improves the management efficiency of relevant participants.

5. Conclusion

Based on the current situation of urban rain water transportation and maintenance and the practical problems of urbanization development, under the support of BIM and other information

technologies, this paper explores the objectives and functional requirements of urban rain water transportation and maintenance management, and proposes the implementation path of urban rain water transportation and maintenance platform. This is also an exploration and attempt for the application of BIM technology in urban rainwater transportation and maintenance management. The visual demonstration effect of operation and maintenance can not only maintain the basic data resources of urban rainwater collection and utilization system, but also provide scientific and intuitive control for management participants. Visual auxiliary management can improve the efficiency of operation and management department, and realize information and data sharing among different stages, platforms and subjects, so as to improve the comprehensiveness and accuracy of operation and maintenance information data. Based on BIM technology of 3 d visualization management overturns the traditional urban rainwater collection use system management, the control mode, but in the urban rainwater operational phase research and application of visual management still needs further research and discussion, fully cover the different functional requirements of visualization, intelligent, integrated in the urban rainwater collection system operational management still has long way to go.

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