Research on Sponge Landscape Design of Primary School Campus Based on BIM Technology——Take Hefei Experimental School as an example

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Abstract. With my country’s vigorous advancement of the construction of sponge cities, the research on the sponge landscape design of primary school campuses has become a hot spot. This paper takes Hefei Experimental School as an example, through the investigation of the current situation of the school landscape, using BIM technology to assist modelling, summarizes the shortcomings of the campus landscape and proposes a sponge landscape design strategy. With Revit and Vectorworks2019 as the main tools and platforms, under the support of the whole process of BIM technology, according to the current situation of the primary school campus and the behaviour characteristics of the primary school students, a design plan for the sponge landscape of Hefei Experimental School is proposed, showing that BIM technology is fully used in the sponge landscape design of the primary school campus, and put forward deficiencies and prospects.

1. Research background

1.1 Research and application of BIM technology in landscape architecture
The Ministry of Housing and Urban-Rural Development issued the "Guiding Opinions on Promoting the Application of Building Information Models" in June 2015, the proportion of BIM used in some new projects will reach 90%. BIM is the abbreviation of "Building Information Modelling". It is essentially a parametric 3D building model that serves the entire life cycle of construction projects from design, construction, operation and maintenance to reconstruction\[1\]. The application of BIM technology in domestic construction projects is becoming more and more common, but its application in landscape architecture design and engineering is not in-depth.

1.2 Research on Sponge Landscape in Primary School Campus
At the Low-Carbon City and Regional Development Technology Forum in April 2012, as a new concept of urban storm water management, the concept of "sponge city" was first proposed. On March 5, 2017, Premier Li Keqiang clearly pointed out in the government work report: to promote the construction of sponge cities, so that the city has both "reputation" and "Connotation". According to the current campus situation and the behaviour characteristics of primary school students, combined
with the advantages of BIM software intuitiveness and multi-professional collaboration, it proposes suggestions for optimizing primary school campus landscapes, which can be used for other types at home and abroad the sponge landscape design of elementary school campus provides reference.

2 Subjects and Methods

2.1 Study Subjects
Hefei Experimental School is located at the intersection of Urumqi Road and Ningxia Road in Hefei City, Anhui Province. The main activity space for teachers and students in the experimental school is the north and south two courtyards, the south courtyard adopts irregular layout, three main landscape paths connect the northeast. The north courtyard adopts a regular layout, a corridor at the southwest corner, and vegetation in the rest of the courtyard.

2.2 Research Method
This study conducted a field survey of Hefei Experimental School through reading and collation of related literature. On the basis of completing the school BIM model, the school landscape part was modeled separately. This project uses Revit and Vectorworks2019 to analyse, and establish a sponge landscape BIM model. In the rain landscape architecture, the design theme of the life landscape architecture is deeply explained. BIM technology in the sponge landscape design of elementary school campuses are summarized.

3. Current situation of primary school campus and sponge landscape design concept

3.1 Current situation of primary school campus landscape
The landscape in the north and South courtyards of Hefei Experimental School is mainly made of plants, which is highly ornamental. However, the participation and experience of teachers and students are insufficient, so it is difficult to meet the rich activity needs of primary school students. The landscaping method is single, the plant species is not rich enough, and the landscape lacks hierarchy. Through field research on student activities, this space cannot meet the diversified activity needs of primary students and stimulate their innovative activities. Moreover, the space is paved with hard materials, which poses some safety risks to children.

3.2 Preliminary design of campus sponge landscape

3.2.1 Influence of site status on sponge landscape design
The project is located in the central part of Hefei, where the soil structure is compact and rigid, and the sticky weight of the texture and water is difficult to penetrate down. The project covers an area of 20000 square meters, surrounded by Xu Xiaohe River ecological water replenishment project. According to the classification of land use goals and objectives, to determine the project's total annual runoff control target is 70%, the corresponding design 18 mm rainfall, water catchment area of 2 hectares, bits of runoff coefficient 0.6, safety coefficient of 1.1, combine the following calculation formula: \( V = 10D\phi \beta \), it volume should experimental school rainwater detention facilities design is 237.6 m³.

3.2.2 Rainy season landscape and dry season landscape adapted to seasonal changes
Landscape green space as a green infrastructure will play a greater role in the sponge city. This project integrates the rainy season landscape and the dry season landscape into the rain landscape architecture. Rainwater landscape architecture, as the most common form of sponge landscape, is made more landscaped and artistic on the basis of rainwater collection and utilization. Natural rainfall and the treatment of water with different water quality can play a related role in landscape design.
4. BIM - based landscape design process and result analysis of sponge campus

4.1 Selection of design tools
BIM software series such as Ecotect2010 and Arcgis can intuitively show the sunshine conditions, geographic information and wind environment of the site through chart analysis. Revit, as the main software of BIM technology, is suitable for the hard pavement land based on geometric shapes. Vectorworks2019 integrates functions such as plane drawing, BIM Modelling, and typesetting, so this project choose the software combined with Revit, as the main tool of BIM technology in the sponge landscape of elementary school campus.

4.2 Design process

4.2.1 Daylight analysis
Ecotect2010 is used in the preliminary analysis of this project as an important analysis software in BIM supporting software. The geographic location is set as Baohe District, Hefei City, Anhui Province, latitude 31°48', longitude 117°20', calculation accuracy of 1', time accumulation adopts the method of accumulating all time periods, effective sunshine for 6:00-18:00. The analysis results: the north side of the site has longer sunshine, it is appropriate to arrange more activity space, the south side of the site has less sunshine, plant selection should be carefully considered.

4.2.2 Cross-disciplinary collaboration
The sponge landscape design of the experimental school is based on the completion of the construction of the building BIM model, the design of the rainwater system. The project involves landscape design, wastewater treatment, water circulation design, pipe network layout and other fields[3]. BIM technology can realize the interaction between various disciplines and coordinate them with underground rainwater system pipes, so that the ground landscape and underground pipes form the rainwater collection storage and recycling system of sponge campus.

4.2.3 Visualization Design
BIM technology makes the two-dimensional and three-dimensional design can be carried out at the same time, which is convenient to find out the problems arising from the interaction between the design and construction in the design process, and can be used in the design process. The most suitable solution can be explored in 3D mode. Combined with 3D visualization functions such as animation rendering and roaming, it can predict the ground landscape shape after the completion of the project and the combination with the underground pipe network, and improve it in advance to minimize rework, shorten the construction period and achieve material and energy saving. The visual advantage of the plant data carried in the model is that by classifying the fruit color, category and flowering color of the plant, the color matching and landscape effect of each area can be seen intuitively.

4.3 Design results and analysis

4.3.1 Design outcomes
Preliminary analysis using BIM found that due to the size of the site and the greening rate, the corresponding children's playground was relatively small. According to the age of the children, the grading design is carried out. The north courtyard is the activity area for upper grades, and the south courtyard is the activity area for lower grades. Through micro-topography transformation and calculation, the total storage volume of runoff control facilities is 285.1m$^3$, which meets the target of 237.6m$^3$ storage volume.
4.3.2 Analysis of design results
According to the actual situation of the project, the construction of roof rainwater, reclaimed water utilization, green space and rainwater pipe network system will be carried out to sponge construction. Combined with the green space system, construct rainwater control and utilization facilities in low-lying areas. The rainwater outlet is about 5cm higher than the design water level. The rainwater that exceeds the storage facilities is discharged to the rainwater pipe network through the overflow rainwater outlet, and then discharged to the rainwater pipe network and Surrounding storage facilities.

5. Conclusion
(1) The necessity and advantages of BIM technology in the sponge landscape design of primary school campus
Informationization is one of the main features of landscape modernization. As an important part of landscape informationization, BIM technology will greatly promote the transformation of landscape production methods. This digital technology has evolved from traditional handicraft to a systematic and informatized modern design logic construction and media expression. The sponge landscape construction of elementary school campus based on BIM technology is the application of information technology to all aspects of construction.

(2) The shortcomings of BIM in landscape design
The application of BIM technology in landscape architecture has just started, and there are still many shortcomings. BIM faces huge social, legal, educational, and technical constraints. Pietsch pointed out in 2011 that information exchange in landscape modeling can be improved by expanding existing standards and developing new standards [4-5]. More and more scholars and institutions in China have realized the bottleneck of BIM technology development and future development trends. The establishment of disciplinary and cross-domain multi-level linkage platform is the general trend and an important way for sponge city planning, construction, maintenance, management, and operation.

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