ISSN: 2710-0588

Application of BIM Technology in Water Supply and Drainage Pipeline Design of the First Phase of Wisdom Express Road, Second Ring West Road, Hangzhou Asian Games Supporting Project

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Abstract

Water supply and drainage pipeline is an important part of municipal engineering. It is necessary to ensure the rationality of pipeline design and improve the technical level of pipeline design. Taking the first phase of Wisdom Express Road, Second Ring West Road, Hangzhou Asian Games supporting project as an example, the application of BIM Technology in municipal water supply and drainage pipeline design is analyzed from the aspects of model construction, three-dimensional design, collision detection, pipeline planning, etc. the BIM model is constructed and the modeling analysis method is adopted to improve the design efficiency of the pipeline, make the pipeline design meet the requirements of the design specifications and ensure the application effect of BIM Technology.

Keywords

BIM Technology; Municipal Works; Water Supply and Drainage; Pipeline Design.

1. Project Overview

The first phase of the project grade of the Second Ring Road of Shaoxing is urban expressway(shown in Figure 1), which is the first batch of intelligent expressway projects constructed in Shaoxing city. The total length of the project is about 9.3 kilometers. The first phase of the project starts from the north of Fenglin West Road to the south of Yangshao Line, with a length of about 5.86 kilometers (including the control center of about 4489 square meters). The pipeline of the first phase of the Wisdom Express Road project of Shaoxing Second Ring West Road includes water supply, reclaimed water, sewage, rainwater, 110kV power, 10kV power and communication, etc. In the overall design, strict control is needed. BIM technology is applied in pipeline design to construct the three-dimensional model of water supply and drainage pipeline, test the rationality of the design, and reduce the probability of problems in pipe network design. The design of municipal water supply and drainage pipe network covers many fields, so it is necessary to conduct collision detection on the model to ensure that the pipeline design can proceed smoothly. There are many design nodes of the pipeline in this project. The application of BIM technology is convenient to control the overall design effect, make the whole design process more visible and transparent, contribute to the simulation of the design effect, and avoid the loopholes in the pipeline design. BIM technology is the key to the realization of pipeline design. It is necessary to adjust the parameters, input the pipeline design into the system, avoid the problems in pipeline design, and optimize the pipeline design to improve the planning and design effect of the pipeline.

ISSN: 2710-0588

Fig 1. Overall picture for the first phase of Wisdom Express Road, Second Ring West Road, Hangzhou Asian Games supporting project

2. Application of BIM Technology in the Design of Municipal Water Supply and Drainage Pipeline

2.1. Model Construction

(1)The design of municipal water supply and drainage pipeline is built on the basis of model, so it is necessary to build an accurate pipeline model and make a comprehensive analysis of pipeline design to improve the quality of pipeline design. The design of water supply and drainage network has certain complexity, so the BIM model should have the basic environment of hardware and software to ensure the drawing effect of the design model. This project is equipped with high performance computer system to ensure the design effect of 3D graphics. Glodon GMA software is installed inside the system to realize the statistics and simulation of engineering quantities, and carry out a series of calculations on data. The BIM model is located in a three-dimensional virtual environment, and samples and working sets are constructed. Revit software is used to label drainage pipelines, and pipeline information is comprehensively managed, so as to improve the informatization level of pipeline design. Model construction requires loading two-dimensional drawings, gradually transforming to three-dimensional models, scientific configuration of model views, and adjustment of model design [1].

(2)The design of municipal pipeline should pay attention to the modeling of pipe network, choose the modeling method reasonably, and ensure the applicability of the modeling method. The modeling method of drainage network is shown in Table 1.

Table 1. Modeling method of drainage pipe network under BIM technology

Pipe network modeling method	Applicable situation	Service condition analysis
Data import method	Pressure and gravity lines	Long pipeline mileage, short cycle, frequent change project
One-by-one design method	Gravity line	Professional 3D modeling and triangulation topographic projects
3D L ine conversion method	pressure line	Existing 3D linear project

ISSN: 2710-0588

It mainly includes data import method, one by one design method and 3D line conversion method, and summarizes the applicable conditions. This project mainly adopts the data import method to reduce the impact of the long distance of the pipeline, ensure that the pipeline can be completed in a short period, and improve the quality of the pipeline design. In addition, it can improve the ability to cope with pipeline changes, so that the pipeline can be better put into use, so that the pipeline design is more realistic, and improve the precision of pipeline modeling. Pipe network data, including elevation, pipe diameter, coordinates, etc., are compiled in Excel form to define pipe network model parameters to ensure that the pipe network model can be automatically generated.

2.2. Three-dimensional Design

(1)In the design process of municipal water supply and drainage pipeline, it is necessary to pay attention to the design of three-dimensional parameters, so as to control the core of model design and make pipeline design more three-dimensional. The three-dimensional design should be managed professionally to improve the effectiveness of the three-dimensional design method, the pipeline structure should be clearly marked, and the principle of file naming should be observed. In pipeline design, serial number and color should be marked to facilitate the differentiation of each pipeline and ensure that design nodes can be distinguished. With the aid of CAD technology, two-dimensional drawings composed of points and lines can be formed. Under the action of three-dimensional design, the internal structure of water supply and drainage pipelines can be understood, which is convenient to control the details of the drawings. A variety of views can be formed through three-dimensional design. It is necessary to conduct a comprehensive analysis of the views and manage the nodes and valves of the pipeline, so that the pipeline design process can get necessary support.

(2)This project includes water supply pipeline, sewage pipeline, etc. It is necessary to distinguish the pipelines to ensure that each part of the pipeline can operate independently and improve the design quality of the pipelines. In order to ensure the standardization of three-dimensional design, it is necessary to refer to the specification requirements of DG/TJ 08-2205-2016 "Application Standard of Municipal Water Supply and Drainage Information Model", so that the pipeline design has a unified standard, which is convenient to evaluate the quality of pipeline design, improve the design effect of three-dimensional model, and form a standardized three-dimensional pipe network.

2.3. Collision Detection

(1)Collision detection is the key to pipeline quality verification, which can conduct in-depth simulation of pipeline, ensure the effect of pipeline defect inspection, and improve the pipeline design process. Collision detection should be combined with virtual reality technology to adjust the BIM model, so that the pipeline model can meet the requirements of the design specification and prevent the defects in the pipeline design. Collision detection requires the export of NWC format files in Revit software to obtain the type, category and other information of collision detection, and form collision detection reports to correct defects through collision detection. In this project, the collision detection adopts the way of comprehensive investigation and analyzes the collision points according to the actual information, so as to make the design of the water supply and drainage pipe network meet the requirements of the actual environment and ensure the accuracy of the collision detection. After inspection, it is found that the number of collision points is 69. Adhering to the principle of avoiding art-flow pipeline and small pipe to large pipe, the pipeline design gradually becomes more reliable and the pipeline detection has an optimization basis. Collision points are marked with collision element ID to improve the normalization of collision detection, facilitate the description of collision points, and ensure the smooth progress of collision detection [2].

ISSN: 2710-0588

(2)Collision detection requires the combination of BIM model for analysis, to prevent the collision of components in space, and to improve the rationality of pipeline design. Pipeline collision can be divided into soft collision and hard collision. For soft collision, there is no direct contact between pipelines and there is a certain distance limit. For hard collision, there is parallel or poor between the pipelines, there is contact between the pipelines, the pipelines need to be strictly inspected. The key of collision detection lies in the configuration of critical parameters and the realization of inspection through standard parameters to prevent the deviation of pipeline design. Collision inspection is the key to avoid pipeline design problems. It is necessary to improve the effectiveness of pipeline design, optimize the design of pipeline structure, avoid the waste phenomenon in the process of pipeline design, and ensure the orderly development of pipeline design. Taking the water supply and drainage structure as an example, it is necessary to conduct collision detection on the strike and arrangement of pipelines to reduce the probability of pipeline problems and prevent the improper design of pipelines from causing rework phenomenon, which leads to the better use of pipelines.

2.4. Engineering Quantity Statistics

(1) The statistics of quantities can be realized through BIM technology, and the bill of quantities can be obtained to ensure the accuracy of project cost. Engineering quantity analysis needs to use BIM model to control the quantity and specifications of pipeline materials, improve the quotation level of pipeline materials, and make the cost control more scientific. The design of municipal water supply and drainage pipeline has certain complexity. The more complex the layout of pipeline, the more prone to errors in engineering quantity statistics. Therefore, compared with traditional engineering quantity statistics, BIM technology has significant advantages [3].

(2) In engineering quantity statistics, we should pay attention to the control of pipeline data, adjust the design parameters of the pipeline, so that the pipeline can be better put into use. BIM technology is helpful to engineering change control, determine the change of pipeline, so that the change of engineering quantity can be counted at any time, improve the statistical efficiency of engineering quantity. BIM technology can reduce the amount of statistical work, the amount of engineering is analyzed by software, improve the control effect of pipeline construction cost[4].

(3)Engineering quantity statistics need to use SUE tool to generate the engineering report of the water supply and drainage network, and export the data into the format of ".txt "or".xls ", which is convenient to save and view the data. Through the engineering report can be tested on the engineering quantity, determine the difference before and after the change of the engineering quantity, to ensure that the engineering quantity with the design change and adjustment. BIM technology can manage the pipe network data, so that the pipeline design and engineering quantity match, so that the pipeline design can play a full role.

2.5. Pipeline Planning

(1)The design of municipal water supply and drainage pipeline needs to be reasonably planned to improve the quality of pipeline design and make the pipeline design line more reasonable and efficient[5]. The application of BIM technology can reduce the error rate of pipeline data measurement, reduce the consumption of human resources, and improve the reliability of pipeline construction data.

(2)The municipal environment has high requirements for pipe network design to ensure the high-quality development of pipe network design. The combination of professional knowledge and BIM technology can improve the effectiveness of pipe network design. In the traditional design process, there is a cross between the pipeline, we need to pay attention to the coordination of the design, improve the planning effect of the pipeline. For example, the

ISSN: 2710-0588

pipeline design is divided into water inlet pipe and sewage pipe, etc., the pipeline design is used to distinguish the pipelines, avoid the mutual influence of the pipelines, reduce the difficulty of engineering construction, and ensure the effective planning of the pipeline design.

(3) Pipeline planning needs to pay attention to the coordination of processes to ensure stable implementation of processes, efficient operation of municipal pipelines, and gradual improvement of pipeline design [6]. In the process of pipeline planning, design verification should be carried out, three-dimensional design of water supply and drainage pipelines should be carried out to improve the rationality of pipeline design, and design nodes should be controlled to ensure the standardization of pipeline planning.

2.6. Construction Simulation

(1)BIM technology can simulate the construction process and test the pipeline construction design process to improve the rationality of pipeline construction design. Construction simulation is the key to verify the unstable factors. It is necessary to integrate the time dimension into the engineering analysis with the help of visual simulation methods, adjust the design planning process, and ensure the quality of pipeline design. Construction simulation needs to pay attention to cooperation in pipeline design to ensure the smooth completion of pipeline construction.

(2) Pipeline design can lay the foundation for the construction and maintenance process. BIM technology is used to display the pipeline design and facilitate the handover of the construction process. For the unreasonable part of the design, the construction process can be discussed to ensure the feasibility of pipeline design, and then the design parameters can be adjusted. BIM technology is built on the basis of a large number of parameters, which can support the construction simulation process, eliminate the obstacles of design factors to pipeline construction, and ensure the smooth development of construction simulation process[7].

(3)Construction simulation requires design data support. Combined with rendering animation and three-dimensional design, visualization means are adopted to conduct simulation and dynamic display of pipeline design [8]. By adjusting the design parameters, different simulation effects can be obtained, and the pipeline design scheme is compared to improve the rationality of water supply and drainage pipeline design.

3. Application Effect

In the application process of BIM technology, it is necessary to evaluate the application effect, ensure the optimization level of pipeline design and strictly grasp the key points of pipeline design. Application effect evaluation mainly includes the following aspects:

(1) Various parameters. Pipeline design is supported by data parameters, so it is necessary to ensure the rationality of parameter selection, prevent the deviation of parameter design and ensure the smooth connection between pipelines. Pipeline parameters include pipeline length, diameter, spacing[9], etc., and carry out a comprehensive test on parameter design to ensure the rationality of parameter configuration.

(2)Operation simulation. Combined with BIM model, the pipeline operation effect was simulated to determine the pipeline water supply and drainage quality, prevent the pipeline operation problems, and prevent the occurrence of faults through pipeline design.

(3)Parameter adjustment. Reasonable use of collision detection means to test the operating parameters of pipelines, improve the investigation effect of pipeline defects, and ensure the operation efficiency of pipelines.

(4)Stability detection. Water supply and drainage pipelines need to be stable, adopt a stable design form, optimize and improve the design scheme, reduce the frequency of pipeline maintenance and replacement, and reduce the adverse impact of pipeline design [10].

ISSN: 2710-0588

4. Conclusion

To sum up, BIM technology plays an important role in pipeline design. It is necessary to analyze the pipeline design process to improve the quality of pipeline design and prevent problems in the process of pipeline design. Through the application of BIM technology, the pipeline design can be comprehensively monitored, improve the quality of pipeline design and optimize the process of pipeline design. Through BIM technology, the engineering quantity can be analyzed statistically to ensure that the construction process can be carried out smoothly, the pipeline design changes can be judged, and the cost consumption of municipal pipeline can be reduced.

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