

Application Strategy of BIM Technology in Municipal Road Design

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Abstract: The development of information technology provides certain convenient conditions in the design of municipal roads, and allow the achievements of high standards and requirements of current road design and construction. Among many information technologies, building information modeling (BIM) technology is more widely used in road design and has achieved good results. BIM technology can realize information sharing, allow the design of virtual models, discover design problems in time, and reduce the rate of design changes later or in late stage. At the same time, through the coordination and standardization of the design of road traffic and underground pipelines, it provides new design ideas for the development of municipal roads. This paper mainly analyzes the application advantages and status of BIM technology in municipal road design, and puts forward the application strategy of municipal road design.

Keywords: BIM technology; Municipal road design; Status quo; Application strategy

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1. Introduction

Construction of municipal roads are important projects in urbanization construction, and the quality of municipal road design is directly related to the effect of urban planning and travel safety. The current municipal road design and construction work is more complicated and difficult, especially in the case of large-scale reduction of urban land and complex building structures. It is necessary to consider comprehensive factors such as both sides of the municipal road and underground pipelines before designing the construction of the municipal road. Once a design error occurs, it will not only affect the progress of the project, but may also cause damage to the pipelines under the road, resulting in huge losses. The application of building information modeling (BIM) technology can form an intelligent virtual model. By inputting various design parameters, the life cycle of building products can be dynamically observed to avoid design problems.

2. Application advantages of BIM technology in municipal road design

BIM technology is a three-dimensional design mode, and compared with two-dimensional design mode, it can comprehensively display the content of architectural product design. The current municipal road engineering is facing more complex environment with more influencing factors. The design using BIM technology can realize visualization, comprehensively present the life cycle of road construction, and discover non-compliant design content in time through simulation, improving road construction efficiency

and effectively control construction costs. In addition, the requirements of different construction stages in municipal road are varied, and it is difficult to collect design information in some complex environments. Some use drones, laser radar, and other technical means to collect information ^[1]. According to the geographical environment survey information, BIM technology is used to verify the road route selection to determine the scientificity of the road route selection. At the same time, through the pipeline collision analysis method, damage to the underground pipeline can be avoided during the construction. In addition, the application of BIM model is conducive to the accuracy of engineering quantity calculation. Using BIM technology to make section and axonometric drawings, construct road models, and realize visual design product display can accurately convey design intentions.

3. Application status of BIM technology in municipal road design

3.1. Late application time

In China, the application of BIM technology in the design of municipal road engineering projects is relatively late. The rail transit road construction was the first to use BIM technology, which provides a certain basis for municipal road construction. Although the usage of the BIM application in municipal road construction started late, the development speed is relatively fast. With the ever-expanding scale of municipal road construction, new requirements are put forward for the construction quality and construction's effect of the project to ensure the safety of construction and improve the construction design standards. However, delay in using BIM application in municipal road construction will also lead to limited experience in the application of BIM technology, and there are still certain technical drawbacks in specific applications. For example, the lack of awareness of information sharing leads to the incomplete information collection, and the need to change design data repeatedly, further affects design efficiency.

3.2. Strong application expertise

In the construction of municipal road engineering projects, the construction system is complex and huge. It is necessary to do a good job in the connection of various construction stages and promote the collaborative design and development of various disciplines. In China, currently the design work of municipal road engineering projects, most of them are still accustomed to the two-dimensional graphic design method. In the early stage, technical disclosure meetings are held to effectively communicate municipal road engineering information and drawings, rationally allocate resources, and control construction quality. At present, the scale of municipal road projects in China is relatively large, and the construction requirements are high. It is necessary to shorten the design cycle as much as possible, and frequently exchange and share information ^[2]. However, due to the insufficient application of BIM technology, it affects information interaction and engineering design.

4. Application strategy of BIM technology in municipal road design

BIM technology can be applied to many aspects in market road design, including the design of sites, pipelines, special routes, and engineering quantity calculations. Through the construction of 3D models and the simulation of engineering quantities, it provides designers with more intuitive and three-dimensional design basis, reduces the probability of later design changes, and promotes the smooth development of construction projects.

4.1. Application in site planning

Municipal road site planning is the premise of design and construction, and it is also an important design basis, which directly affects the quality of subsequent construction. However, since the traditional municipal road design is mainly based on manual survey, the accuracy of the design needs to be further

improved. The application of BIM technology in road planning is conducive to the optimization of the design site. Specifically, it can be analyzed from the following aspects: Firstly conduct a three-dimensional analysis of the site elements. The application of BIM technology in site planning can combine the elements of the site to build a three-dimensional model, which is beneficial for designers to arrange and manage the site reasonably at each stage. Comprehensively consider the site transformation in different construction stages, and strengthen the optimization of the road site according to the site layout requirements, and avoid repeating operations, which can influence the design effect and quality. For the construction of the site model using BIM technology, it is necessary to strictly follow the elevation grid design, import the construction site data parameters into the BIM software, and plan the road elevation and drainage in advance. Earthwork excavation and filling can be avoided as much as possible by means of earthwork balance. Secondly, BIM technology can be combined with Geographic Information System (GIS) to optimize the overall layout structure of the road. Effectively solve the problem of inaccurate data collection and analysis, caused by large amounts of data and the influence of subjective thinking in municipal road planning. In addition, the application of BIM technology can also realize the simulation of urban road space, which is conducive to more accurate assessment of road traffic flow and crowd flow, reasonable planning of the number and structure of lanes, and scientific road planning [3].

4.2. Application in intersection design

In the design of municipal roads, it is inevitable that there will be intersection problems. The traffic flow and pedestrian flow at intersections are relatively large, and there are different road structures such as motor vehicles, sidewalks, and non-motorized lanes. If the allocation is unreasonable, it is very easy to cause accidents or cause traffic congestion, further affecting the normal traffic order. Therefore, BIM technology can be used to simulate the intersection before designing. To build a 3D model, firstly input terrain parameters, then perform horizontal and vertical design, channelization design, traffic facility design, and finally analyze and adjust as shown in **Figure 1**. After the construction of the 3D model is completed, the traffic flow at the intersection is observed, and subsequently traffic design is optimized accordingly [4]. For example, if it is found that there is a lot of left-turning traffic, it is necessary to increase left-turning lines and set up turning waiting areas to improve vehicle operating efficiency.



Figure 1. Application of BIM technology in intersection design.

4.3. Application in underground pipeline design

Underground pipelines are important factors to consider in municipal road construction, and professional elevation and plane coordination are required to avoid touching pipelines and causing construction accidents. In the design of road engineering, the radius, nature, and buried direction of the pipeline are first analyzed through geophysical prospecting to ensure the rationality of the pipeline. The application of BIM technology can carry out 3D simulation on the design of underground pipelines to form a virtual pipeline layout, as shown in **Figure 2**. For example, CAD software can be used to model the laying of underground pipelines, and combine different equipment to scientifically divide the pipelines in the construction drawings. In the modeling and design of pipelines, they should be arranged in order from large to small and from top to bottom, to avoid the difficulty of adjustment after a pipeline collision in the later stage^[5]. After the modeling is completed, collision detection is conducted on the pipeline, and automatically a collision detection report is generated to determine whether the layout of the pipeline is reasonable, and make adjustments for unreasonable problems. A large number of reserved and pre-buried holes are involved in municipal road engineering, which is also a common problem in construction, where leakage or misplacement often occurs in these regions^[6]. The application of BIM technology is conducive in ensuring the accuracy of pipeline hole reservation management, and subsequently reducing the difficulty of later management. The pipeline design method of design, analysis, and simulation is adopted to dynamically observe the engineering pipeline design situation. Different departments can be combined to analyze the pipeline design work from different angles, make decisions based on the model, and shorten the pipeline laying period as much as possible^[7].

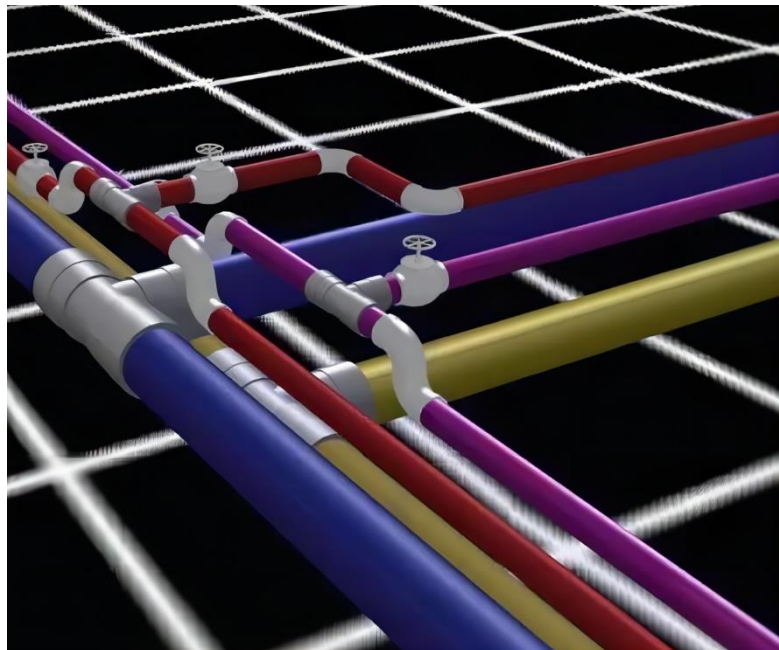


Figure 2. 3D simulation of underground pipelines based on BIM technology.

4.4. Temporary construction road design application

In the construction of municipal roads, there are a large number of construction equipment, materials, and personnel on the construction site. The temporary placement and stacking of a large number of equipment and materials is likely to cause traffic congestion, leading to certain safety hazards at the construction site^[8]. The application of BIM technology in the temporary construction of construction roads can make the planning of temporary roads and stacking locations through layout planning and collision experiments to

ensure the scientific nature of the scheme. For example, during the construction of a municipal road project, the construction site is narrow, with many buildings on both sides and a large flow of people. As a result, it is difficult to pile up construction materials and road construction. Before the construction starts, BIM technology is used to simulate the construction plan, identified the existing problems in the construction planning, and combine the construction progress and road characteristics to reasonably plan the temporary road construction ^[9].

4.5. Application in engineering quantity statistics

In the design of municipal roads, in addition to the design of the shape of engineering products, it is also necessary to pay attention to the cost of materials, construction progress, and quality and safety control of road design. It is also important to comprehensively plan the cost, analyze the feasibility of road construction, and strengthen the statistics of various components of the road to ensure the scientificity and accuracy of the quantitative statistics of the road design ^[10]. Additionally, rationally applying engineering calculation software to automatically analyze the physical engineering quantities to form a complete bill of quantities, which is conducive to the effective application of cost control work such as project pre-settlement and other later work. For example, the calculation function in the BIM software platform can be used to quickly calculate the road engineering project through one-click identification to ensure the accuracy of the material purchase data, which is conducive to shortening the project cost estimation cycle, and reducing the late budget change rate ^[11].

5. Conclusion

To summarize, urban municipal road construction is related to the overall planning effect of the city and people's travel safety. Therefore, road design must be done well before municipal road construction begins. The traditional two-dimensional design mode has been unable to meet the complex environment of current road construction and the accuracy requirements of road construction design. It is necessary to use BIM technology software to form a three-dimensional model, simulate the building body of the road construction, and simulate different construction scenarios and product structures in combination with different construction stages, to identify unreasonable design in time. Through pipeline collision test and traffic flow test, etc., the accuracy of road design and construction of various components is guaranteed. At the same time, through the application of data statistics and calculation functions, it can ensure the efficiency of project list and budget control, subsequently provide more accurate basis for the development of municipal engineering construction, and promote the healthy development of municipal construction projects.

Disclosure statement

The authors declare no conflicts of interest.

References

- [1] Xia Y, 2022, The Application of BIM Technology in the Design of Municipal Roads of a Certain Project. *Building Materials Development Orientation (Part 1)*, 20(8): 160–162.
- [2] Fu X, 2022, Methods of Applying BIM Technology in Municipal Road Design. *Intelligent Building and Smart City*, 2022(7): 161–163.
- [3] Zhang X, 2022, Application Research on BIM Technology Assisted Design of Complex Municipal Roads. *World of Transportation Managers*, 2022(8): 49–51.
- [4] Liu X, 2022, Application of BIM Technology in Municipal Road Design. *Juye*, 2022(2): 189–191.

- [5] Tian F, 2022, Research on Optimum Design of Municipal Roads Based on BIM Technology. *Traffic World (late issue)*, 2022(7): 105–107.
- [6] Yuan Y, 2022, Design of Municipal Roads and Bridges Based on BIM Technology. *Car Times*, 2022(7): 56–57.
- [7] Yu Y, Strategy Analysis of BIM Technology Applied in Municipal Road Design. *People's Communications*, 2022(1): 75–77.
- [8] Zuo W, 2021, Application and Guiding Value of BIM Technology in Municipal Road Design. *Building Materials and Decoration*, 17(19): 289–290.
- [9] Deng W, 2021, Optimization Analysis of Municipal Road Design Scheme Based on BIM Technology. *World of Transportation Managers*, 2021(26): 40–42.
- [10] Zhang Y, 2021, Exploring the Effective Application of BIM Technology in Municipal Road Design. *Low Carbon World*, 11(5): 273–274.
- [11] Jin M, 2021, Analysis on the Application of BIM Technology in Municipal Road Design. *Architecture and Decoration*, 2021(15): 120.

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