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Strategies for the Application of BIM Technology in the Collaborative Planning and Design of Urban Roads and Pipelines

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Abstract: Urban road construction and the laying of underground pipelines are both important elements in the improvement of urban infrastructure, while the construction of the two may affect and restrict each other if they are not planned systematically. Therefore, a synergistic design of urban roads and pipelines is needed to ensure the synergy of urban road construction and underground pipeline laying. This paper mainly analyzes the necessity of building information modeling (BIM) technology application in the collaborative planning and design of urban roads and pipelines, and explores the application strategy of BIM technology.

Keywords: Urban roads; Pipeline collaboration; Planning and design; BIM technology

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1. Introduction

Building information modeling BIM technology is a relatively advanced engineering information technology model, which integrates the information of the whole life cycle of the project by constructing a model to form a visualization form, and has been widely used in construction projects. The application of BIM technology can form an integrated model for project management and reduce the risk of project construction. In urban road construction and pipeline cooperative planning, it is necessary to ensure the synergy of construction between the two to avoid the construction of one party affecting the construction quality of the other party. BIM technology coordinates and optimizes urban road construction as well as pipeline cooperative construction through the advantage of visualization model to ensure the quality and efficiency of construction.

2. Analysis of the characteristics of BIM technology

2.1. Mimetic

The application of BIM technology in construction design can be used to observe the effect of urban road construction distribution, the impact on the surrounding environment, and the effect of traffic after operation, and many more by modeling the construction project. Combined with the simulation of underground pipelines, it can determine the pipelines that may be affected in the road construction and analyze how to avoid the pipeline location through the adjustment of the design scheme and other ways. Through the modeling of the project, a visualization of the engineering dynamic study could be formed to ensure the smooth implementation of the project.

2.2. Optimality

Municipal road construction requires good planning from design, construction, to post management. Although the application of BIM technology cannot directly optimize the municipal road design, but it can improve the design. There are many more aspects involved in urban road design, and it is complex, and the integrated information needs to be considered. To some extent, it is understood that the key issue of urban road design is to ensure the accuracy and scientific nature of each data design and to improve the effect of urban road design [1].

2.3. Coherence

In the construction of municipal roads, it is necessary to coordinate the work of various parties, including the communication among project units, design units, construction units, and owners, so as to achieve a well-organized construction process a good construction effect. However, under the traditional working mode, many staff members do not do a good job of prediction and communication in advance, and are ignorant towards the problems that may appear in the future. The application of BIM technology can effectively solve these problems, especially in the collaborative planning of urban roads and pipelines. With this technology, the possible intersection problems in the two projects and other potential construction problems can be predicted, and is able coordinate all parties well to avoid any problems in the later stage. At the same time, the application of BIM technology in designing is conducive to the timely discovery of construction design problems and timely correction, so as to ensure the feasibility of the design; for the owner, they can have a picture of the construction process, and understand the deviation that may occur when the project is completed, so as to avoid the problem of rework in the later period. The problems and opinions of all parties can be combined and adjustments can be made using a three-dimensional model to ensure the efficiency of the construction

3. Current status of BIM application in municipal road as well as pipeline construction

BIM technology was first introduced in China's construction engineering industry, and with the development and improvement of BIM technology, the scope of application of the technology has been expanding and penetrating into different engineering fields. Currently, the main applications of it in the construction field include architectural design, road engineering design, construction, and other aspects. The application of BIM technology can maximize the advantages of municipal road design and improve the design of urban roads and pipelines layout. China's municipal construction has developed well with the application of BIM technology, but from the specific application of technology, it still needs to be further optimized and improved [2]. Therefore, it is necessary to use maximize role of visualization of BIM technology to strengthen planning and promote information communication in the construction of municipal roads as well as pipelines. Different engineering content needs to be combined to ensure complete data collection and good data processing. Next, the municipal planning data is used as the basis for the formation of pipeline layout network, which effectively prevent the construction of pipeline crossings and other problems like pipeline damage or reduce in quality and efficiency of engineering construction. The application of BIM technology can transform the traditional two-dimensional plane model into a three-dimensional model (see **Figure 1**), so as maximize the advantages of construction technology and obtain greater economic and social benefits in future urban road planning.

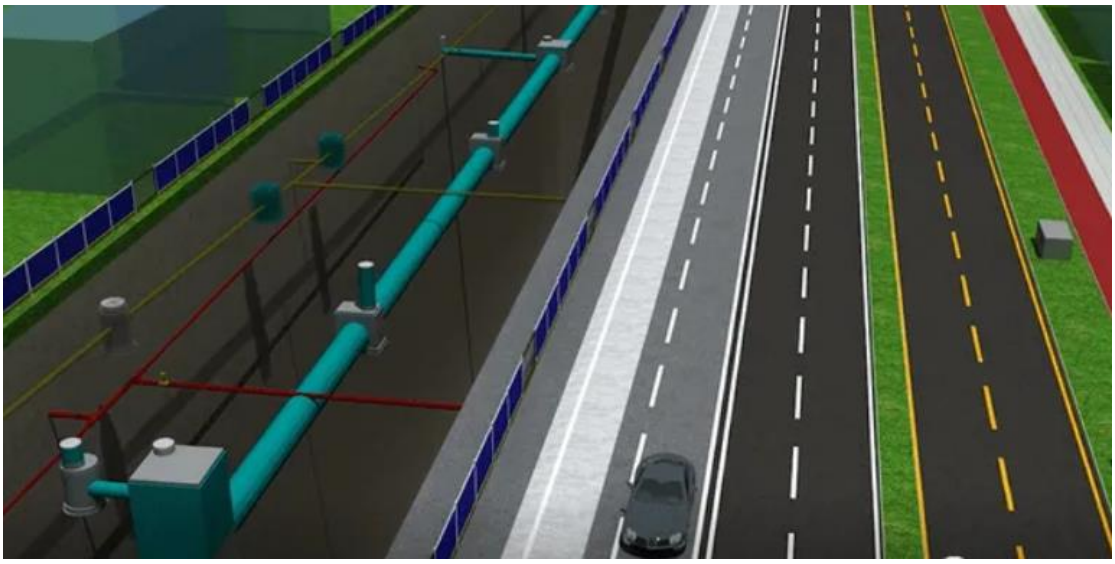

Figure 1. BIM underground pipeline 3D model

4. Strategies for the application of BIM technology in collaborative planning of urban roads and pipelines

4.1. Methodology of BIM technology in collaborative planning of urban roads and pipelines

In the planning and design of urban municipal roads and pipelines, it is necessary to consider all the factors that may affect them, including the existing buildings and the construction of various infrastructures. In order to ensure a scientific design, it is necessary to use BIM technology to collect and process the information of roads, pipelines and buildings, and to combine the information to do the planning and design of municipal roads. Data analysis should be done for existing buildings and pipelines, and data statistics and storage should be done in combination with various parameters and geometric information of the building body. BIM technology software takes the parameters of the original building as the processing standard, analyzes the engineering projects in the municipal road construction, especially the high piles and bridges of the project, and more, and can carry out collision detection on the project, so as to ensure the accuracy of building structure positioning, determine the specific distance between buildings, so that the road pipeline positioning is more accurate and more reasonable. Based on the existing engineering information, the road planning information and the pipeline structure information are timely compared. According to the spatial distribution of roads and pipelines, a three-dimensional simulation is constructed to ensure the rationality of the spatial geographical location design of roads and pipelines. In addition, economic cost analysis is done based on the road and pipeline design and earthwork volume to ensure the scientificity of the route planning and pipeline layout scheme [3].

4.2. BIM technology in collaborative planning model of urban roads and pipelines

The purpose of collaborative planning of urban municipal road construction and pipeline is mainly to coordinate of road and underground pipeline network distribution, which involves more types of projects, including roads, bridges, pile foundations and many other projects. The engineering model is constructed through the collection of existing building information and information stored in the database. The model of Structured Query Language (SQL) database is used in the construction of the model, and the existing database is used for collecting, storing and applying various parameters and data in the project, and designing the operation process and method of the project with the information model [4]. A road pipeline can be drawn based on an engineering base map [5]. First of all, the engineering information is imported, and the municipal unit collects the information of design drawings and processes the information of the

construction model. Based on the original construction situation, the distribution of road pipelines is determined, and the building properties are determined based on the materials, pipe elevations and parameters of the building body. In determining the position of the construction, factors like the construction of each component, the distribution of the components, and possible collisions are considered. The construction drawings is then converted into two-dimensional drawings as well as three-dimensional model settings [6].

4.3. Application of BIM technology in the collaborative design of urban roads and pipelines

The application of BIM technology in the collaborative design of urban roads and pipelines needs to be carried out in conjunction with specific operational processes and applications. The specific operational processes are as follows.

The first step is the import of information. The planning and design drawing of pipelines is obtained, the information of key buildings is extracted from the internal information of municipal units, and is stored in the corresponding database, so that information management can be achieved in the model processing stage [7]. The existing building model is used as a base to draw the road and pipeline line diagrams. At the same time, the building materials, specifications and elevations and other information are marked.

Secondly, the location of the municipal road and pipeline is set scientifically, including the possibility of collision between the components of pipeline laying and the original components, and whether the distance between the two is reasonable, and so on. The possible collisions between old and new components are found in time. Combined with the plane and three-dimensional drawings, the relationship between the two can be identified and analyzed [8].

Thirdly, the corresponding collision inspection results are obtained. The results of the inspection can be combined with different color markings for each design component so that the results are clearer (as shown in **Figure 2**. Adjustments can then be made after understanding the specific cross and contradictory positions. Locations that have minimal impact negligible and locations which requires rectification is determined in a timely manner, makes the results of the collision testing more scientific and enables synergy between urban roads and pipelines [9].

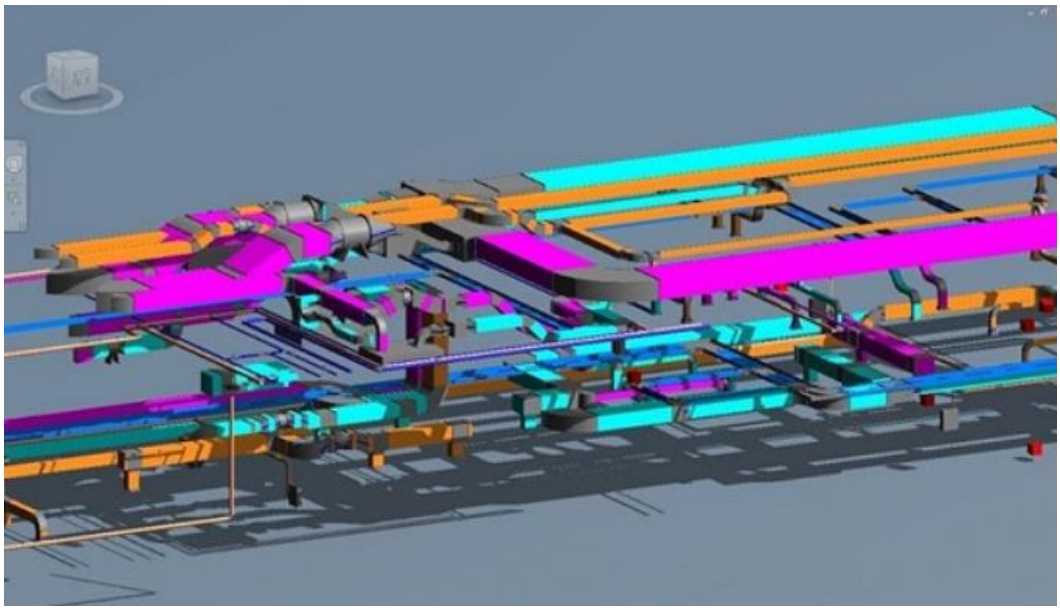

Figure 2. BIM pipeline collision analysis test diagram

Fourthly, the collision position is adjusted. Adjustment of the completed road and pipeline distribution

diagrams are carried out to optimize the specific collision position, including the adjustment of both elevation and horizontal direction, so as to maintain good coordination between the road and pipeline lines [10].

Thereafter, further adjustments are made in conjunction with the project cost. After the completion of the adjustment in terms of engineering construction, it is also necessary to analyze the cost of the project in combination with the changed model and material quotations to determine the adjusted cost of the project [11]. If the adjusted design can meet the construction requirements, but the cost far exceeds the budget, further adjustments need to be made to the design, so as to ensure the smooth construction of the project while achieving cost control [12].

Subsequently, based on the viewing the spatial layout according to the model, a suitable method and process needs to be selected depending on the conditions and requirements of the project, and the design needs to be screened to ensure the effective application of construction technology and construction method. If it is found that the construction technology is limited and the condition of the site is unfavorable, it is necessary re- re-adjust the design of the urban road [13].

In the final step, an optimized road and pipeline design scheme is created through the combination of a three-dimensional design model, drawing of the plane construction, and the allocation of construction materials for each component, specifications and other information [14].

4.4. Synergistic application of BIM technology in urban roads and pipelines

The implementation and application of BIM technology needs to be emphasized in the collaborative planning and design of urban roads and pipelines. The theory of collaboration is fully applied in software construction, including collaboration between different designers in the same software, and collaboration between different software [15]. Using a combination of different software, designers can build different model structures and merge various sub-models. Data software such as SKP and FBX are mainly used and combined with software such as 3DMax and InfraWorks to form model data. For example, in the planning of roads and pipelines, the data such as elevation and location of each pipeline as well as wells can be analyzed and a merged model can be formed using RoadLead software.

5. Conclusion

In conclusion, if the municipal roads and pipelines are not designed properly in the planning stage of the project, it is easy to collide or damage the pipelines and cause other problems in the subsequent construction. Through the application of BIM technology, all data of the project can be collected and a visual design model can be formed to prevent pipeline collision and to do a good job of cost control. It is necessary to ensure the effectiveness of road and pipeline design, and promote the synergistic development of urban roads and pipelines.

Disclosure statement

The author declares no conflict of interest.

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