# Application Analysis of BIM Technology in Metro Rail Transit

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**Abstract**: With the rapid development of urban roads, especially the construction of subway rail transit, it is an effective way to alleviate urban traffic congestion. There are limited site space, complex resource allocation, tight schedule, underground pipeline complex engineering problems. BIM technology, three-dimensional visualization, parameterization, virtual simulation and many other advantages can effectively solve these technical problems. Based on the project of Shenzhen Metro Line 9, BIM technology is innovatively researched throughout the lifecycle of BIM technology in the context of the metro rail transit project rarely used at this stage. The model information file is imported into Navisworks for four-dimensional animation simulation to determine the optimum construction scheme of the shield machine. Subway construction management application platform based on BIM and private cloud technology, the use of cameras and sensors to achieve electronic integration, dynamic monitoring of the operation and maintenance of underground facilities. Make full use of the many advantages of BIM technology to improve the engineering quality and construction efficiency of the subway rail transit project and to complete the operation and maintenance.

## 1. Introduction

With the continuous development of social engineering, urban traffic congestion is worsening. In order to solve this problem, all provinces and municipalities across the country have continuously increased their investment in urban rail transit construction to further enhance urban transport capacity. At present, engineering construction, especially underground transportation construction, has common engineering technical difficulties such as limited underground space, large amount of construction[1], tight construction period, multiple industries involved and complex resource allocation. Design and construction management mode often involves many structural design changes , Engineering changes, construction is not clear, construction delays, cost control and many other issues throughout the entire life cycle of the building. This seriously hampered the construction of rail transit projects, construction management and cost control. Therefore, adopting advanced technologies is more valuable in order to coordinate and solve many problems facing the entire life cycle of a building. Building Information Modeling (BIM) is a model based on a variety of information related to building engineering. Through the modeling software to establish a three-dimensional model and information data matching. Based on the 3D model, the animation is established during the construction of the whole life cycle to realize the effect of "rehearsal" before construction so as to guide the design, construction and maintenance of the construction. Based on the project of Metro Line 9 in Shenzhen, BIM technology is rarely used in underground engineering at this stage, and innovatively studies the application of BIM technology in the entire life cycle of rail transit construction.

**2. Shenzhen subway project overview and technical difficulties**

The construction of Shenzhen Metro Line 9 project is divided into two parts: the main structure of the station and the inter-station tunnel project. The part of the layout shown in Figure 1, the technical difficulties of the project are as follows:

1) Construction site is at risk. The project subway long-distance travel in the bustling area anddensely populated areas in Shenzhen.

2) time is tight, construction volume. The project involves up to 22 majors.

3) underground pipeline layout is complicated. Off-site pipelines, including water supply and drainage, gas, fiber optics, electricity, water supply and pipelines, are arranged in a crisscross pattern.



**Figure 1.** Rail transportation floor plan

At this stage in accordance with the traditional design and construction management methods is difficult to solve this problem[2]. Therefore, taking into account the three-dimensional visibility, simulation, coordination and integrity of data and other advantages of BIM technology, it is imperative to apply BIM technology to the entire life cycle of subway construction.

**3. BIM Technology in all stages of application**

*3.1 Design stage of the application*

1) BIM drawings will be examined

First, based on preliminary design drawings, the BIM team will create 3D models based on different professional drawings. Then, the model constructed by each professional is assembled to generate the final three-dimensional model. Finally, the collision detection occurs, and then the parameters are adjusted by the BIM technology component until the collision detection is qualified[3]. This process is also called BIM drawing review Process, the specific process shown in Figure 2.
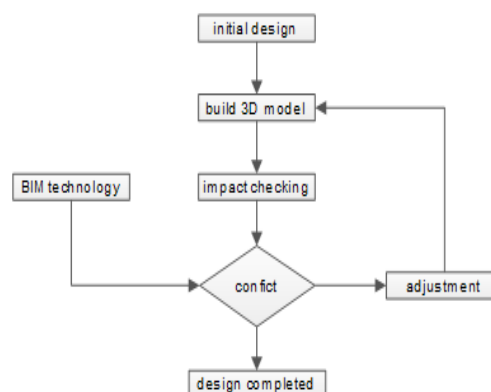


**Figure 2.** BIM paper review process

2) design synergies, improve design efficiency

For construction enterprises and design institutes, the application of clans is very important. Through the establishment of parametric clans, the whole model can be put into one-to-one correspondence with the clan. When one of the parameters is modified, the whole model will be automatically adjusted and reduced Unprofessional issues among professional models, thereby improving the efficiency of modeling and revisions.

3) to determine the pipeline integrated program

Through the collision detection of the model, BIM modifies the collision problem in the early stage of design to reduce the design change and rework of the later construction. Through the 3D visualized BIM model[4], designers can more intuitively detect the fitting degree of pipeline layout and prevent Each pipeline collision. Before the collision detection, the project ventilation pipe and the drainage pipe collided, the use of BIM technology to adjust the drainage pipe up to bypass the ventilation pipe to make the pipeline layout more reasonable to determine the pipeline of integrated programs, as shown in Figure 3 , Underground pipeline model after collision detection.
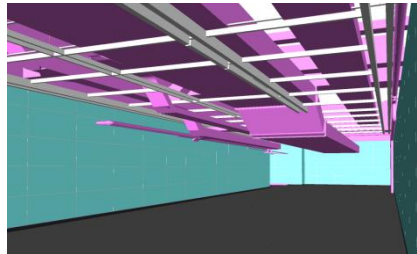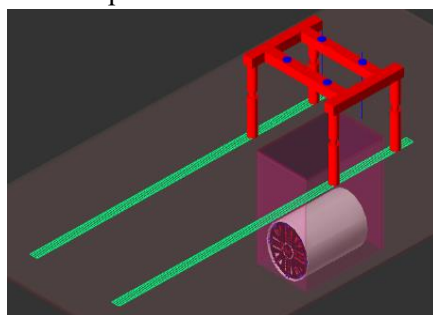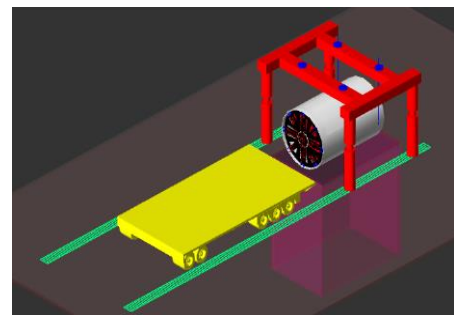


**Figure 3.** Underground pipeline model after collision detection

*3.2 Application of the construction phase*

*3.2.1 Determine the best construction plan.* The traditional construction program is based on the conditions of the construction site, resource allocation and construction methods. However, with the project progress, engineering changes, design changes and other issues, will inevitably delay the construction progress. How to determine the best installation of shield machine has become the project's largest technical problems. By establishing a three-dimensional model consistent with the construction process, the model information file is imported into Navisworks 4D animation simulation to determine the best construction plan[5].



a.Lift                                                        b.load
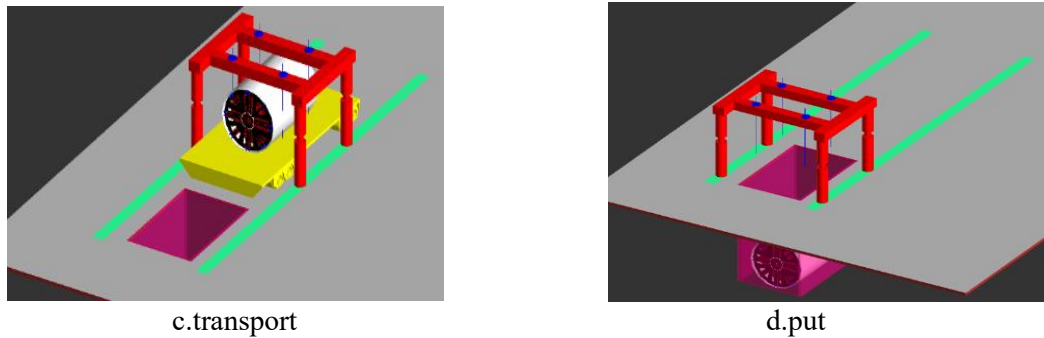
| c.transport | d.put |

**Figure 4.** Shield machine lifting construction program simulation

*3.2.2 Visual on-site construction.* During the construction of subway transit in the scene, construction nodes with high construction requirements may be encountered. There are a variety of construction nodes in Exit D of Xicun Station of Shenzhen Metro Line 9, in addition, the underground space is small and the construction has a greater impact on the surrounding soil. This will undoubtedly increase the difficulty of construction. Secondly, the traditional two-dimensional drawings have limited ability to express and the quality of construction workers is not high enough to understand the construction intention. In order to solve this problem, BIM technology is applied to three-dimensional visualization construction node, which can help constructors to understand the construction drawings better and finish construction under the premise of ensuring the construction quality. Shown in Figure 5, Nishimura Station D exit model.
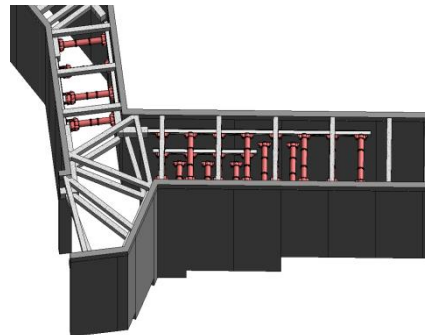


**Figure 5.** Nakamura Station Exit D model

*3.3 post-maintenance phase of the application*
The subway construction management application platform based on BIM and private cloud technology can ensure the building three-dimensional model and construction management information in one, to achieve BIM model display and building materials, progress and other related information, editing and development functions. Therefore, it can provide information management assurance for post-construction maintenance[6]. On the one hand, it can provide abundant information data for maintenance and post-maintenance. On the other hand, it can realize dynamic monitoring through cameras and sensors. BIM technology can achieve the following applications:

1) Dynamic monitoring

Through the real-time feedback of dynamic monitoring data, timely determine the underground seepage, deformation of underground soil and the destruction of underground structures, take timely measures to control the sources of risk, ensure the normal operation of underground rail transit, and give timely warnings.

2) space management

Metro rail transit space and space management is mainly used for lighting, fire and other systems and equipment for spatial positioning. In order to obtain the spatial location information of each system and

device, the original digital or textual representations can be changed to a three-dimensional model of the location that can be directly visualized and easily searched. Such as RFID access to the subway station security guards, fire alarm, BIM model rapid positioning of the location, you can quickly specify the evacuation routes around the subway.

## 4. Conclusion

The application of BIM technology in metro rail transit is analyzed. Revit software was used to establish the 3D model of D-exit support, underground pipeline and shield machine of Xicun Station of Metro Line 9 in Shenzhen. Based on the three-dimensional model, the construction simulation of the shield machine installation project was simulated and the best construction scheme was determined. Visible construction and display, so that construction workers to better understand the construction drawings and improve construction quality. Subway construction management application platform based on BIM and private cloud technology, the use of cameras and sensors for electronic integration, the dynamic monitoring of underground facilities and the operation of the situation for maintenance. It shows that BIM technology has more advantages than traditional construction methods in design efficiency and construction management.

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