Application of BIM Technology in Building Mechanical and Electrical Engineering Modeling and Pipeline Inspection

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Abstract. With the development of China's urbanization process, the development of China's construction industry is in full swing. There are more and more large scale and special shaped buildings, and the electromechanical engineering and construction projects are more complex. The traditional architectural design and construction technology level could not meet the needs. The BIM Technology can build the whole building model completely, and carry out collision detection and analysis optimization of various specialties design stage, a series of problems can be avoided in the later stage. In this paper, Shanghai Baoshan project is taken as the research object, and the collision between the building model and the electromechanical pipeline is analyzed by using BIM software.

Keywords. BIM Technology, electromechanical system, collision check.

1. Introduction

BIM is the direct application of information technology in the construction industry. The mainstream BIM design software represented by Revit not only combines the traditional two-dimensional design of AutoCAD, but also presents the three-dimensional parametric building information model. Moreover, BIM has the characteristics of simulation, visibility, optimization, correlation coordination, consistency, auxiliary management and so on, which makes it easy to find all the specialties in mechanical and electrical engineering The collision and conflict between components can reduce or even eliminate the problems of "error, leakage, collision and shortage" in mechanical and electrical installation, and carry out automatic inspection and adjustment to achieve the purpose of predicting hidden problems, deepening design scheme, optimizing engineering quality and improving engineering efficiency [1-3].

As a new science and technology, BIM is leading the construction industry information technology to a higher level. Its comprehensive and extensive application will have an immeasurable impact on the construction engineering field, bring huge benefits for the development of the construction industry, and significantly improve the quality and efficiency of the whole project [4].

2. The Concept of BIM

What is BIM? The full English name of BIM is building information modeling. At different stages of the project, different stakeholders (design, construction, management, owners, property) support and reflect their respective responsibilities by inserting, extracting, updating and modifying information in BIM. BIM brings a more rapid, convenient and intuitive design concept, which makes the design, construction, operation and management become an organic whole. BIM brings us higher construction quality, efficient construction process, intuitive and effective communication mode and real-time and...
efficient operation and maintenance mode.

3. Application of BIM Technology in Mechanical and Electrical Engineering

3.1. Project Overview
The project is the industrial transformation project of Shanghai Baoshan new town commercial complex (Baoshan wharf of Shanghai Port Group), and the overall development and construction project of Shanggang Binjiang City, including 01, 03, 04, jiefang03 (commercial), and For the 04 (commercial + residential) plot project, the total construction area of plot 03 is about 58000 square meters: there are three floors above the ground, with a total construction area of 22000 square meters; and there are three floors underground, with a total construction area of 36000 square meters, including 9000 square meters of commercial and 27000 square meters of parking and other supporting facilities, which belongs to the first class of important public buildings. The total building area of plot 04 is about 189000 square meters. The total floor area of the above ground podium + residential building is 77000 square meters. There are three floors underground with a total construction area of 112000 square meters, including 16 high-rise residential buildings above the ground, 2-storey podium building and B1 as commercial parts, B2 and B3 as garages, which are important public buildings.

3.2. Establishment of BIM Model
In the process of building model establishment, the main software used is Revit, which has more powerful use function than CAD drawing software. It has its own family library file, which is relatively more convenient for drawing. By drawing two-dimensional drawings, the Revit software can realize the transformation of three-dimensional model, which can clearly show the plane, vertical and sectional views of various parts of the building, respectively System, mechanical and electrical system modeling, and finally model integration to form the overall model of the building, which can save engineers’ drawing time, and the modeling workers of the Revit software greatly improve the modeling quality and work efficiency [5-9].

3.2.1. Building Structure Model. The mechanical and electrical system is not coordinated with the building structure system in the drawing design, so the building structure model is established to assist the collision inspection, net height analysis and reserved opening, etc. to establish the building structure model, the two-dimensional model should be established into a three-dimensional model according to the CAD drawings of the project. The building model includes walls, columns, doors, windows, floors and other components, and the structural model includes structural beams, slabs, columns, eaves, shear walls, etc. The following problems should be paid attention to when building structural model:

(1) It is generally or best to draw the elevation first and then the grid. If “grid first then elevation” will cause the plan view above a certain level not to see the grid, then it is necessary to open two elevation views and pull the two grids to the position intersecting with the elevation, so that all levels can display the grid. Elevation before grid saves adjustment steps.

(2) In case of variable cross-section beam, family drawing should be used to ensure the span number of a whole beam is correct.

(3) In the process of modeling, if there are problems in the drawings or the design itself, it is necessary to record and communicate with the designer to ensure the accuracy of the building structure model and lay a foundation for the establishment of the mechanical and electrical model.

As shown in figure 1, the results of the modeling of the building structure system by the engineer are shown.
3.2.2. Electromechanical Model Establishment. Electromechanical modeling includes water supply and drainage model, HVAC model and electrical model. The water supply and drainage model includes: domestic water supply system, hot water system, drainage system, automatic sprinkler system, and indoor fire hydrant system. HVAC model includes: air conditioning, fan coil unit, air conditioning water supply and return pipe, air duct, equipment, etc. The electrical system consists of strong current, weak current and fire protection. Select the established mechanical template file to create a new project in the Revit software. When drawing the mechanical and electrical model, the following problems should be paid attention to:

(1) When drawing drainage pipes and rainwater pipelines, it is necessary to pay attention to whether there is slope and slope direction in the pipeline, because this point is easy to be ignored. Forgetting to add pipeline slope leads to the engineers to adjust the slope of the pipeline in the later stage, consumes the engineering time.

(2) Due to the large amount of engineering drawings of the project, many different types of pipelines look messy on the same plan. We need to identify different colors for different types of pipelines. Each color does not repeat, and each color represents a kind of pipeline.

(3) In order to save time and make the pipeline clearer, when drawing a type of pipeline, we can click the keyboard "V V" to display the visibility, hide the remaining types of pipes temporarily, and only the one type of pipeline being drawn will be displayed on the plane.

The mechanical and electrical engineering of this project is large in scale, with heavy workload and responsibility. It is necessary to divide the pipeline into engineers according to the type of pipeline, and finally integrate the pipeline. The results of the modeling of the mechanical and electrical system by the engineer are shown in figure 2.
3.2.3. Project Collision Check. Through the visual browsing of Revit + NavisWorks, the scene situation can be simulated, and the potential problems can be found more easily. In the roaming model, real-time measurement and red line marking can be carried out for the problems of insufficient clear height and collision, which is convenient for synchronous adjustment combined with the Revit model to improve efficiency. When the collision between the pipe and the structure is found, the problem can be solved by local bending and pipeline bypass. When it is necessary to change the pipeline route, change the pipeline model and other major changes, through the coordination and communication with the design institute to find the optimal scheme. In these processes, many nodes need to be processed and the operation steps are complicated. The difficulty and pain point is that when changing the local position, sometimes we have to change other positions of the pipeline, and even a large area is affected. The collision detection report of electromechanical BIM model of this project is shown in table 1, and the collision types of management integration are shown in figure 3.

| Collision object                        | Quantity / location |
|-----------------------------------------|---------------------|
| Structure and pipeline                  | 1851                |
| Structure and Bridge                    | 449                 |
| Structure and duct                      | 406                 |
| Total (structure and management)        | 2706                |
| Pipeline and pipeline                   | 3804                |
| Bridge and Bridge                       | 245                 |
| Duct and duct                           | 357                 |
| Pipe and Bridge                         | 2318                |
| Pipes and ducts                         | 12282               |
| Bridge and duct                         | 246                 |
| Total (comprehensive internal)          | 19252               |
| Total number of collisions:             | 21958               |

The traditional manual method to find the collision point is inefficient, and it is difficult to be comprehensive. The hidden places between pipelines are easy to be ignored. Using BIM Technology to find the collision point has intuitive three-dimensional display effect, which can quickly, accurately and comprehensively analyze the pipeline.

4. Conclusion
With the improvement of the scale and complexity of building mechanical and electrical engineering, BIM Technology is becoming more and more valuable in China. To build a building's mechanical and
electrical system, the premise is to have a complete set of mechanical and electrical construction drawings. The construction drawing is the basis. The use of BIM Technology can efficiently and accurately complete the establishment of mechanical and electrical model. In this project, BIM Technology is used to establish and check the collision of three-dimensional mechanical and electrical models, and the pipeline conflict problems are found in the electromechanical system construction process, which leads to the delay of construction period and the waste of materials, which saves the cost and improves the efficiency of construction.

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