Application and Expression of BIM Technology in Industrial Building Reconstruction

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Abstract: This paper describes the application and practical characteristics of BIM technology in industrial building reconstruction and introduces the advantages of BIM technology compared with traditional infrastructure through introducing the BIM technology. In essence, BIM is a large database covering all aspects and all-weather information of decision-making, planning, construction, sales, and delivery in industrial building reconstruction. It also performs cloud computing on big data, and presents it in three-dimensional and four-dimensional maps to realize the full process data of supervision, operation, maintenance and disposal in industrial building reconstruction process. Thereby, we can reduce labor costs, improve the efficiency and quality of building reconstruction, and achieve forward-looking effects such as high efficiency, economy, convenience, and intuitiveness.

1. Introduction

China is a populous country and a major infrastructure country. At present, there are still various problems in industrial building reconstruction projects even the industrial construction is booming. First, the industrial transformation is time-consuming and laborious, and cannot meet the multiple demands of the surrounding environment. Second, the investors spend a lot of money and manpower in the decision-making stage about the original building reconstruction due to problems of old age, information missing, drawings lost or smeared, etc. Third, the traditional two-dimensional plane drawing mode limits the creative inspiration of the designer's three-dimensional space in the design stage; The lack of collaboration and communication platforms in various professions and the lack of technologies such as collision checking in the design process, have increased the uncertainty of cost, schedule and quality control; Fourth, in the traditional reconstruction mode, the design changes throughout the construction period, and there is a high degree of uncertainty in the control of construction period, quality and cost in the construction phase.

At the beginning of this century, the American magazine "Economist" found that there are nearly 25% to 40% of the waste of resources in the construction of buildings through research and statistics. Due to problems such as low efficiency, mistakes, and delays in construction projects, nearly $200 billion of losses were incurred of the US, $600 billion annual investments in construction industry in United States. With the launch of "Made in China 2025", smart cities and humanities cities have become the next step of development direction in China. Based on technologies such as the Internet, big data, and cloud computing, all the industries such asaerospace, electronics, manufacturing, and finance have gradually promoted to Informatization, digitization and automation, and the construction industry are no exception [1] . Driven by this background, BIM technology came into being, which fully consider all kinds of traditional defects in construction projects, go through the whole process of decision-making, design, construction, approval, and delivery in industrial building reconstruction, shorten the cycle of industrial building reconstruction projects and reduce costs and waste of resources, to promote the continuous development of industrial building reconstruction technology.

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2. Introduction of BIM technology

BIM technology is called Building Information Modeling Technology. It was proposed by Dr. Chuck Eastman of George Leah Polytechnic University in the United States. It is based on 3D technology, planning, starting, and executing in the construction project, and using the building digital model constructed by various related professional information projects to provide stable, scientific and consistent calculation information for planning and application.In recent years, building information model technology has become a design path often used in the constructionindustry. And comprehensive testing, control, distribution and application of the complete information model have been implemented in all aspects.

Due to its own advantages, Building Information Modeling technology in the whole process development of engineeringprojects, reduce engineering cycle, save materials, labor costs, ensure the normal progress of construction, and ensure the project from use to resource optimization, under the premise of ensuring the quality of the project. The application ofBuilding Information Modeling technology has gradually expanding, and the categories are complicated, presenting that this technology plays a very important role in building reconstruction [2].

The meaning of BIM should include the following three aspects:

(1) BIM is a digital display of all kinds of information on building reconstruction projects.

(2) BIM is the act of establishing, improving and utilizing the information electronic model of the facility based on open standards and versatility. At every stage of the project construction, every department can insert,acquire, update, and change information in the BIM model according to its own responsibilities.

(3)BIM technology is an open, repeatable, verifiable and sustainable collaborative work platform. On this platform, every project participant can communicate in real time and share the project information in the whole process of the project. Through the real-time share of information, effective management decisions can be made in time [3].

3. Advantages of BIM Technology Application

3.1 Parameterization

The BIM technology model is based on information technology, and each model has comprehensive information attributes of the buildings. In addition to visual effects, the model also contains geometric properties as well as physical properties such as material, price, date of manufacture, etc. If all building components have parameterized information, it can be fully intelligentin statistical and analysis of engineering cost, energy consumption and other information, and comprehensively improve the informationization degree of the project.

3.2 Visualization

Visualization can be described as “what you see is what you get”. In the construction industry of recent years, buildings with complex structures and different shapes have been increasing, and BIM technology has brought huge benefits to the development of the construction industry. The building information modeling visualization technology subverts the traditional two-dimensional showing mode, and presents the building in front of everyone in 3D form. Not only can the visualization between the same components be interactive and feedback, but also in the process of communication and decision-making of project implementation and operation can be carried out in a visualization state.

3.3 Coordination

During the construction period of the project, how to do a good job of coordination among various project departments is the core of construction project management. BIM technology can test the collision between various project departments and engineering categories in the early stage of construction project, and produce a coordination report. The coordinating report greatly reduced

the number of engineering changes and improved engineering efficiency.

3.4 Simulation

BIM technology is not only a 3D building model, but also can carry out 4D construction simulation, sustainability analysis simulation, safety fire simulation, etc. before construction. Through various simulations, not only can the construction quality be improved, but also the construction risk can be reduced.

3.5 Exportability

The BIM database is a parameterized database based on certain standards, and the form of information export can be diversified. For example, two-dimensional information drawings of buildings, collision detection reports, integrated pipeline optimization maps, engineering quantity lists, cost analysis, etc. Modifying any information in the model, it can immediately and accurately update a series of related information and then output a new information report, which greatly improves the work efficiency.

4. Problems in the Traditional Industrial Buildings Reconstruction

Industrial buildings are architectural forms with the characteristics of the times. The main building materials are steel structure, concrete frame and brick wall structure, which have strong plasticity, fusion and regionality. In the past 20 years, China is welcoming the trend of industrial building reconstruction, especially in coastal cities, which form a reconstruction case across the country. Although the Chinese government and related industries have paid great attention to the reconstruction of industrial buildings and the reconstruction project has been increasing, but the enthusiasm of investors for the reconstruction is not high. The following is an analysis and summary of the problems existing in the period of industrial building reconstruction, so that effective and refined management methods are adopted to solve these problems, so as to ensure the smooth development of the existing building reconstruction projects in China.

4.1 Limited investment

Since the reconstruction is a series of activities such as reinforcement, function replacement and equipment renewal that do not meet the comfort and functional requirements, which is unlike the new construction. Investors are reluctant to make sufficient funds to reconstruct. Instead, they hope to achieve high return with less investments.

4.2 Pay less attention to cost control before and during the project

In the process of cost control in industrial building reconstruction, managers tend to pay more attention to the cost of after-the-fact accounting. In the construction stage, this phenomenon is very obvious. It often neglects the impact of various factors in the prior andduring the project. When the cost control is to the final accounting phase, that is, the irreversible management state, it is only possible to find out the factors affecting the cost, but not to avoid.

4.3 Lack of scientific and information management methods

In the process of industrial building reconstruction, engineering management is chaotic. For example, in terms of cost management, often from the beginning to the end of the project, only the cost data of each phase starts and ends, and the data about cost control during this phase is not in place. And the data is not real-time update, dynamic monitoring, so that it is impossible to grasp the cost data at any time and correct it at any time. All in all, the construction progress of industrial building reconstruction lacks scientific and information management methods for fully-cycle.

4.4 Low information transmission efficiency

The particularity of industrial building reconstruction determines that the amount of information is large and scattered, and each participant of the project holds some important information, but the

transmission efficiency between these information is very low. Practice shows that the efficiency of information transmission in industrial building reconstruction projects occupies a very important position. The speed of information transmission can directly determine the control of the cycle, quality and cost of the project. Only by improving the efficiency of information transmission can we avoid ineffective labor, thus ensuring the completion of the reconstruction project on time and in good quality and quantity.

4.5 Complexity

The reconstruction of industrial buildings has certain complexity. Its completion requires the crossover and synergy of multi-disciplinary. It also requires the cooperation of various professional personnel, especially in the design stage of the construction period. Compared with the new construction, it is much more complicated and involves all aspects. Any factor may restrict the cost, quality, progress and safety of the reconstruction project [4] .

4.6 More uncertain factors

The industrial buildings that need to be reconstructed always have existed for decades or even hundreds of years. Many original materials have problems due to their age. For example, some original drawings drawn by hand are smeared; some drawings are incomplete between various professions, and some are modified in the process of construction or use, and they do not match the archived materials.Not only that, variability and uncertainty will always exist during the construction period of existing building reconstructions, especially the distribution of pipelines cannot be fully understood, the status quo of concealed works, the internal structural conditions, and other problems, such as construction drawings that cannot be constructed, etc.These uncertain factors are also the main reasons leading to design changes throughout the construction phase, resulting in construction project delay, waste of resources, and costs increased.

5. Advantages of BIM Technology Applied in Industrial Building Reconstruction

5.1 Introduction to advantages of BIM technology applied in industrial building reconstruction

Because of the application of “throwing off drawing board”, the first technological revolution in the field of architectural design in China was carried out. The computer technology was used in all aspects of the architectural design industry, which was previously only possible to draw by hand. Traditional engineering development software is a computer information platform mainly used for traditional design, which is mainly to maintain the traditional design right process. The biggest problem of the traditional software is information isolation and chasm. However, the second technological revolution using computer to simulate building information modeling technology replaced the 2D platform with 3D / 4D or even 5D, and has the incomparable advantages compared with traditional technology in industrial building reconstruction projects [5] .

5.1.1 High efficiency - design the best reconstruction solution, greatly reduce the engineering reconstruction cycle

In the preliminary design and start planning stage of industrial building reconstruction, the use of building information model technology can rationally deploy various professional engineers such as for architects, structures and equipment. Moreover, it can carry out various plate conflicts and impact tests in the building information model to improve the flexibility and ease of operation of the solution. On the other hand, the three-dimensional model can be provided to the owner and the constructor of the reconstruction project, which can facilitate the visual comparison to obtain the best construction plan, so that the engineering reconstruction cycle can be greatly reduced.

5.1.2 Economy - Control project costs and extend the use prospect of industrial building reconstruction projects

The platform of greatly reducing the engineering reconstruction cycle, created the five-dimensional relationship of time, space and process related to cost data. The control personnel can use the engineering dispatch system to optimize installation solution of the industrial building structure after the work division, and manage the cost control of the industrial building reconstruction and coordinate works. On the one hand, the cost relationship can be clearly demonstrated; On the other hand, it can provide accurate cost information, so that it can effectively process actual cost data, effectively control the cost of industrial building structural reconstruction, and extend the use prospect.

5.1.3 Convenience - update 2D drawings in real time, simplifying design of 2D structural

Using the building information model technology model, 3D building components and solutions can be changed in real time in the 2D design drawings. At the moment the design drawings changed in the model, the floor plan and profile views of each layer are also updated synchronously, and the two-dimensional structural conditions drawings are completed quickly. So that the detailed drawings assembly nodes of the industrial building structure can be complete. When updating the layout drawing, the modified content (such as structure position and size) in each view will be automatically updated at the same time, which greatly reduces the repeated design work caused by design changes and detail changes.

5.1.4 Intuitiveness – parametric and systematic matching, visual simulation of 4D models

The building information model technology can simulate the node system corresponding to the project by using the three-dimensional parameterization software and the related secondary development technology, and then systematically and massively carry out the design of the node model of engineering building structure. Furthermore, the structural components and node models are perfectly combined, and the integrated structural of building information model technology model is constructed to realize 4D stereoscopic visualization.

5.1.5 Safety – Full-process and round-the-clock monitoring, increase engineering safety

The safety performance in industrial building reconstruction project, based on building information modeling technology platform, simulation the industrial building project. It can use computer to collect and analyze all kinds of engineering data, round-the-clock monitor the construction details of the full- process of industrial building structural reconstruction project. Meantime, in the early planning stage, predict the various situations that may occur and prevent potential hidden dangers during the construction in the later stage. So that it can reduce unnecessary labor costs and waste of resources, and increase engineering safety in construction, practical application and post-maintenance [5].

5.2 Application case

By selecting typical reconstruction projects, there is a more intuitive understanding of the application of BIM technology in industrial building reconstruction. The project is a technical reconstruction of an industrial project, and the reconstruction content is the repair and transformation of the original structure of the work building. The building was designed by a British company and was completed in 1983. The main structure is an eight-story steel frame structure with a height of 47.81m, length of 20.50m and width of 11.00m.The in-door ground elevation of this work building is 6.40m, and the roof is a double slope roof with a slope of 10°. It adopts a triangular truss roof truss with a parapet wall around the roof. The current situation photo is shown in Figure 1.

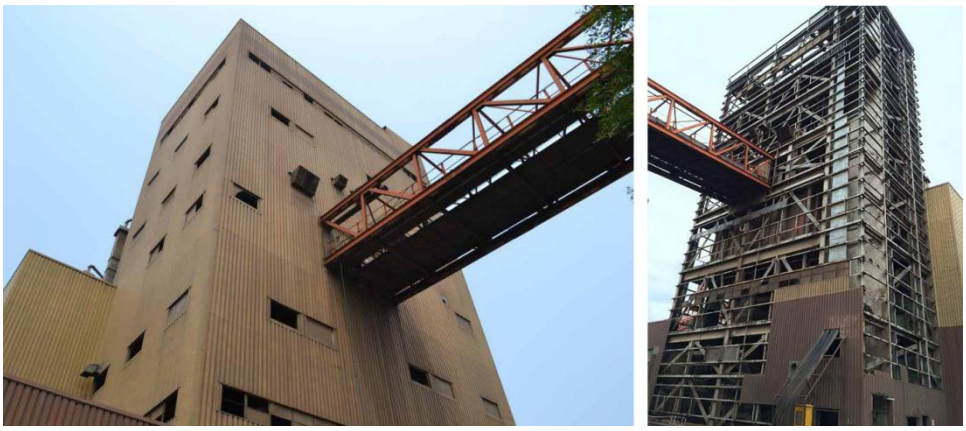

Fig 1 Appearance of the work building

All the original buildings of the work building are designed by British companies. Over time, the equipment and structure tend to be old. All process equipment needs to be updated and optimize and retrofit the process. Therefore, the principle of reconstructing design should satisfy the demands of all the process running smoothly of the work building. In the reconstructing design, the building professional, structural professional and process equipment professional are working in collaboratively through the Revit platform (Figure 2), and repeatedly check the model information to confirm whether the three professional have collisions or not (Figure 3). And finally, realize the collaborative work and design of different professions [6] . The overall model is shown in Figure 4, and the partial 3D section is shown in Figure 5.

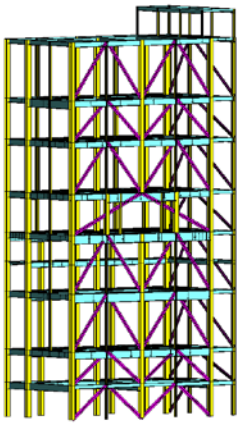

Fig 2 Internal structure Revit model

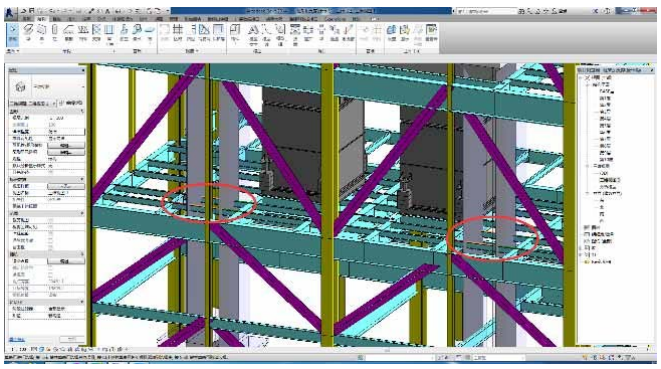

Fig 3 check collisions

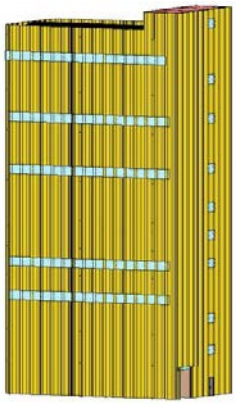

Fig 4 overall model

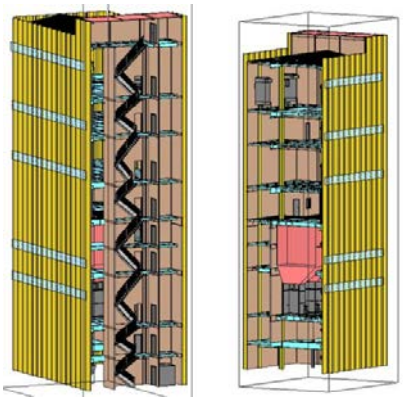

Fig 5 partial 3D section

6. Conclusion

BIM is a large database covering all aspects of decision-making, planning, construction, sales

and delivery information in the whole process of industrial building reconstruction. It also performs cloud computing on big data and presents it in three-dimensional and four-dimensional maps to realize the whole process data supervision, operation, maintenance and disposal of industrial building reconstruction process, thereby reducing labor costs and improving the efficiency and quality of building reconstruction. It plays a very important role in the industrial buildings reconstruction with its technical advantages of high efficiency, convenience, economy, intuitiveness and safety. In the long run, the design, construction and management of industrial building reconstruction projects with the computer simulation and BIM technology will have long-term development prospects [7].

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