

## Research on application of BIM and RFID technology in prefabricated buildings of industrial plants

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### Abstract

With the promotion and deepening of the concept of sustainable development and green building, the prefabricated building of industrial plant has become a hot spot in the construction industry. According to the characteristics of the industrial factory building prefabricated construction, the building information model and radio frequency technology is applied to construction in the whole life cycle management, accomplish the stages of construction projects, the participants are timely information sharing and communication construction, the industrial plant prefabricated construction total life cycle management have a positive role, but also can further play a prefabricated buildings compared to traditional advantages in terms of quality, progress and cost management.

### Keywords

Industrial plant, fabricated building, life cycle, building information model, radio frequency identification.

### 1. Introduction

In March 2017, the action plan on prefabricated buildings of the 13th five-year plan issued by the ministry of housing and urban-rural development pointed out that by 2020, prefabricated buildings will account for more than 15% of new buildings in China, among which more than 20% will be built in key regions, more than 15% in active regions and more than 10% in encouraged regions [1]. Under the background that the country promotes the prefabricated building vigorously, the research about the prefabricated building also emerges one after another. Different from traditional cast-in-place structure buildings, prefabricated buildings produce building components in an industrial assembly line mode, which is transported to the construction site through transportation equipment and finally assembled in a process similar to building blocks [2]. Therefore, the transformation of this production mode makes prefabricated buildings very different from traditional methods.

Tianhua Li combines BIM and Rfid to solve the problem of the lack of key technology platform to link all phases in the life cycle management of construction project[3]. Zhonghao Qiu has played a supporting role in the life cycle management of assembled buildings through the effective operation of BIM and Rfid technology to the drawing and measurement of architectural engineering, the cost budget and the management of the whole life cycle[4]. From the point of view that the BIM technology is based on the computer three-dimensional digital model and the whole life cycle of the construction project is set up to be dismantled, all the specialties and all kinds of relevant information are integrated in the whole life cycle. This paper expounds the application of BIM technology in collaborative design of assembly architecture design stage, preliminary design stage, construction drawing design stage, interior decoration stage and so on[5]. BIM and Rfid are used in the construction process of assembly building, and BIM and Rfid are combined to establish the architecture of information sharing platform[6]. By using BIM and Rfid in the construction management of assembly construction project, Qi he and others carried out real-time inspection of the safety of inspection components and construction personnel, and so on[7]. Zheng Jingjing integrates BIM,Rfid technology into safety monitoring of construction site, which is beneficial to realize information automation, real-time visualization, multi-party cooperation in safety monitoring,

and applies BIM, Rfid technology to assembly building design, production and manufacture. Construction, operation, maintenance, life cycle management[8]. Guo Hong-collar studied the application of BIM and Rfid in construction safety management, and established a real-time positioning and safety early warning system model for workers in construction site[9].

The life cycle of prefabricated buildings in industrial plants includes four stages: planning and design, component management, on-site construction and operation and maintenance. In this paper, research will be carried out from these four stages to fully apply BIM and RFID technology to the assembly construction process of industrial plants, so as to ensure that the construction efficiency and quality of construction enterprises can be improved to a certain extent, and the economic benefits of enterprises can also be improved.

## **2. The basis of the basic theory of the research**

### **2.1 BIM technology**

BIM as the abbreviation of Building Information Model, The creation of this model is based on all kinds of data and information in the construction project, and then through the digital information virtual simulation of the actual real information of the building, the way of presentation is database + 3d model, which has the characteristics of visualization, simulation, coordination, optimization and mapping[10]. BIM technology through the parameterized model to integrate relevant information integration at various stages, including planning and design, component production transportation, construction, installation and operation maintenance of share and transmit the whole life cycle, and help to analysis and reference of various kinds of data, thus further complete industrial plant construction quality, progress and cost effective management.

### **2.2 RFID technology.**

RFID is a non-contact automatic identification technology, generally composed of electronic tags, readers, middleware, software system four parts, its basic characteristics is that electronic tags and readers do not need direct contact, through the space magnetic field or electromagnetic coupling to exchange information[3]. RFID technology is applied to the management of prefabricated building components in industrial plants. During the production process of components, information such as the production time and person in charge of components are implanted into electronic tags. During transportation, the position of the component can be located according to the GPS; In the construction process, due to the limited construction site of prefabricated buildings and harsh construction conditions, the adoption of RFID technology will greatly improve the lifting accuracy and construction safety coefficient, which is conducive to saving time and ensuring the construction .

## **3. Application of BIM technology and RFID technology in prefabricated buildings of industrial plants**

### **3.1 Planning the application of the design phase**

The planning and design stage is the stage in which BIM technology plays a key role. Industrial factory buildings are characterized by parameterization, interrelation and coordination. Therefore, it is required that all parties involved in the project should consult and share information during the design and planning stage. The application of BIM technology can improve the owners' satisfaction with building products under the traditional mode and reduce the design changes and other problems caused by the conflicts between different professional designs, as shown in figure 1 and figure 2.

BIM technology methods of parameterized design is the key to establish the model of information database, all components are controlled by parameters, so all components in the model are interconnected, when modifying one model parameters, the whole project model automatically adjust changes, reduce the fault of design drawings, lead to inconsistent information leakage problem, but also improve the efficiency of the modeling and modification.

It takes a lot of energy and time to count the quantity, compile the list and calculate the cost of industrial plant projects, and a lot of human errors often occur in this process. BIM technology is

applied in industrial plant projects. BIM model provides the engineering quantity of the whole industrial plant project, and the cost personnel reduces the work intensity and improves the cost accuracy with the help of BIM technology.

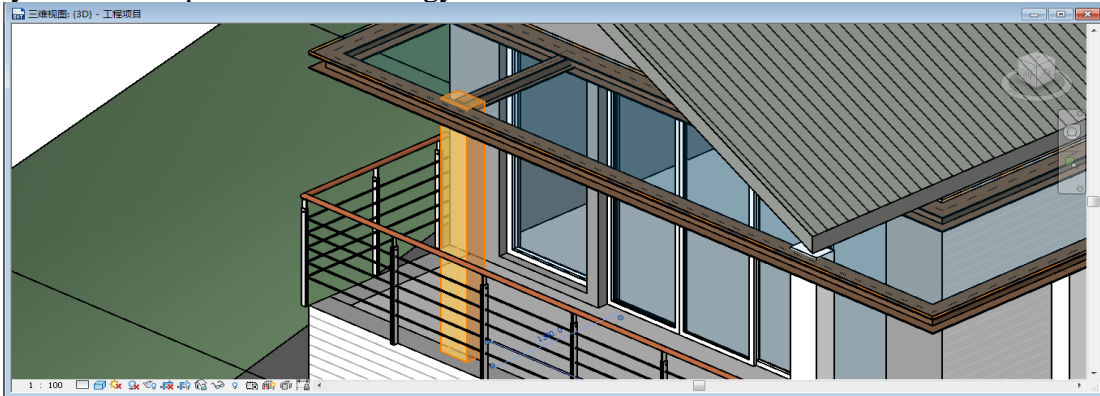


Figure 1 structure design conflict

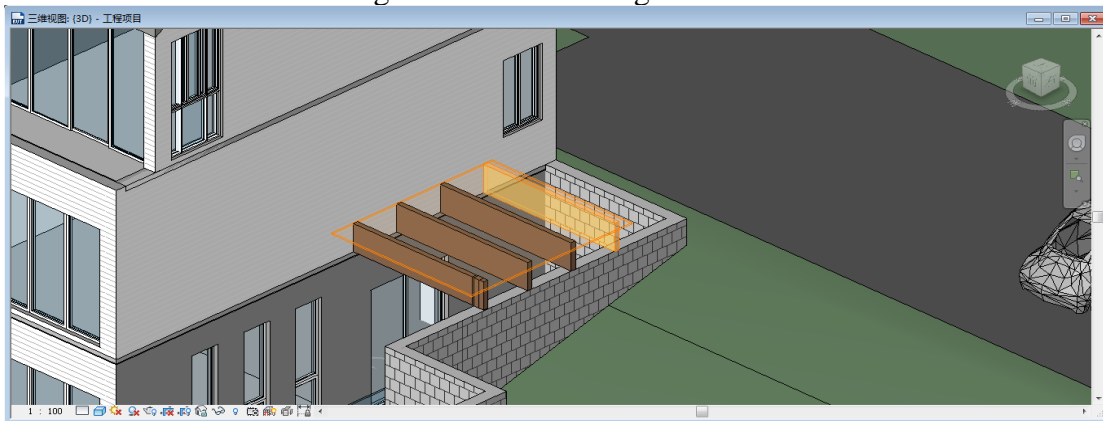


Figure 2 structure design conflict

### 3.2 Component management stage

#### 3.2.1 RFID tag placement

After the completion of the prefabricated components plant, the components of the industrial plant will be placed into the RFID tags, RFID tags contain the type of components, production date, quality certification, production personnel and other information, in order to facilitate the late in the transportation, storage, construction, lifting and other stages of the components for effective management. The unique coding of RFID tags ensures that each construction unit corresponds to a unique identification code, and ensures that the information of components in each stage of the construction cycle is accurate and reliable.

#### 3.2.2 Production and transportation planning of components

The BIM database can process the information transmitted by RFID tags. According to the actual construction progress of the construction site, the information will be fed back to the component factory in the first time. The component factory will adjust the production plan of prefabricated components according to the actual construction progress, so as to reduce the labor and material waiting at the construction site.

In the stage of transportation planning, the following problems are mainly considered: first, transport vehicles are arranged reasonably according to the size of components; Secondly, according to the storage location of the site, the component transportation route planning is carried out. Thirdly, planning the production and transportation plan of components according to the construction sequence<sup>[11]</sup>

**3.3 Site construction stage**

In the field construction management stage of prefabricated building, the problems of admission and storage management of components and accessories, and lifting and installation of components are mainly considered. When the components enter, the staff USES RFID reader to collect data of the transport vehicle and transport it to the designated area according to the established route. In hoisting phase components, the ground personnel and mechanical operation personnel to work together, hold a reader and display respectively, the ground staff shall be carried out in accordance with the assembly sequence of component information read, read the results through the control center immediately synchronous display on the screen, the mechanical operation personnel according to the display content on the display components hoisting in sequence<sup>[8]</sup>.

See table 1 for the comparison of several different situations in the combined application of BIM and RFID in construction projects.

**3.4 Operation and maintenance stage**

After the completion of construction equipment, in the operation and maintenance stage, the traditional way requires managers to manually collect and record maintenance information, and then query and compare two-dimensional drawings, operation manuals, maintenance records and other document information. This process has low efficiency and low accuracy <sup>[12]</sup>. If the component information is input and stored in the equipment operation and maintenance management system, and the equipment maintenance list and other related information are exported, the maintenance personnel can easily find the location of relevant equipment by using RFID reader. After the maintenance is completed, the maintenance situation will be recorded and the label information and database information will be updated. Through these measures, the operation of equipment in the building has a more intuitive understanding.

Table 1 comparison diagram of industrial workshop BIM and RFID technology combination and traditional mode

	Information collection	Information processing	Information application
Neither was used	Manually fill, photograph, scan and input	Doc files, Excel tables, images, folders, databases	Information is not timely, difficult to find, and the project schedule is not associated, can be archived, not easy to use
Not be used BIM Application of RFID	RFID, smart phone, Internet automatic collection	Doc files, Excel tables, images, folders, databases	The information is timely, difficult to find and has no connection with the project schedule. It is used for office automation such as procurement, logistics and inventory management. The information can be archived and inconvenient to use
Application of BIM Don't apply RFID	Manually fill, photograph, scan and input	BIM model	Information is not timely, easy to find, associated with the progress of the project, record the project information to facilitate the use of search
BIM and RFID Technology combined with	RFID, smart phone, Internet automatic collection	BIM model	The information is timely, easy to find and related to the project schedule. In addition to the traditional office and financial applications, it can also be used for the comparison of the actual progress and planned progress of the construction site, dynamic management of materials and equipment, quality control of key projects and concealed projects, etc

#### 4. Conclusion

Through the management application of BIM technology and RFID technology in the whole life cycle of prefabricated buildings in industrial plants, the following conclusions can be concluded.

(1) With the help of BIM technology, various requirements of planning, design, construction, installation and operation and maintenance can be considered to prevent a large number of errors, omissions, collisions, collisions and other problems, causing a large number of design changes and increasing costs.

(2) The production, construction and installation process of components are combined with RFID technology to track and manage the components, making the manufactured components more standardized; In the operation and maintenance stage, the tag information of the equipment can be updated in a timely manner by combining with RFID technology, which is conducive to mastering the operation status of the equipment.

(3) The introduction of BIM and RFID technology into the construction industry and their extensive application in the actual development have promoted the development and progress of the construction industry and laid a solid foundation for the healthy and sound development of China's construction industry.

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#### References

- [1]"13th five-year" prefabricated building action plan [J]. Construction supervision, inspection and cost,2017,10(02):11-13.
- [2] Hongjie Chen, Gaofeng Li, Yongfeng Wu. Research on informatization acquisition of construction progress of prefabricated buildings based on BIM and RFID technology [J]. Project management technology,2018,16(10):22-26.
- [3] Tianhua Li, Yongbo Yuan, Mingyuan Zhang. Application of BIM and RFID in life cycle management of prefabricated buildings [J]. Journal of engineering management,2012,26(03):28-32.
- [4]Zhonghao Qiu, Hang Ye. Application research of BIM and RFID technology in life cycle management of prefabricated buildings [J]. Building materials and decoration,2018(07):136-137.
- [5] Li dang. The key role of BIM technology in prefabricated building design [J]. Shanxi architecture, 2016,42(33):26-28.
- [6] Chunguang Chang, Feifei Wu. Prefabricated building construction process management based on BIM and RFID technology [J]. Journal of shenyang jianzhu university (social science edition) , 2015,17(02):170-174.
- [7] He Qi, Jiaqi Sun, Nan Wang, Yan Zhu, Yi Zhang. Research on construction management of prefabricated building projects using BIM and RFID technology [J]. Construction technology, 2018,47(07):4-6.
- [8] Jingjing Zheng, Zhi Zhou. Application of radio frequency identification technology (RFID) in construction industry [J]. Enterprise technology development,2018,37(05):70-72.
- [9] Hongling Guo, Yantao Yu, Wenping Liu, Weisheng Zhang. Integrated application of BIM and RFID in construction safety management [J]. Journal of engineering management, 2014, 28(04): 87-92.
- [10] Weixiang Zhu. Research on application of BIM technology in prefabricated buildings [J]. Shanxi architecture,2016,42(14):227-228.
- [11] Yingchun Zhang, Jie Pan. Application research of BIM technology in the whole life cycle of prefabricated buildings [J]. Chinese residential facilities,2017(03):47-49.

- [12] Tingkui Wang, Yijie Zhao, Ruiyi Zhang, Yang Li. Research on building equipment operation and maintenance management system based on BIM and RFID [J]. Construction economy, 2013(11):113-116.