Research on the Assembly Building Integrated Construction System Based on BIM

Yaxi Wang

School of Economics and Management, Leshan Normal University, Leshan 614000, China

Abstract

At present, the assembly architecture has become the focus of the construction industry. This paper summarizes the advantages and disadvantages of the assembled buildings and points out the problems in the management of the assembled buildings. The BIM technology is introduced into the assembly building integrated construction system, and the application of BIM technology in the integrated building construction system is described in detail, and the concrete case is analyzed. The results show that BIM technology has a great application prospect in design, production, construction and operation and maintenance of assembly building integrated construction system.

Keywords: BIM, Integrated Construction, Assembly of Buildings.

1. INTRODUCTION

Since the development of the construction industry so far, its output value has accounted for a large proportion of the gross national product (Motaw and Almarshad, 2013). The traditional architectural design and construction methods have been gradually not suited to the needs of industrial development. In the focus on green, economic, environmental protection and other ideas today, the traditional way of construction of a thorough change is imperative, the concept of building industrialization came into being (Vähä et al., 2013). Industrialization is the inevitable development of human society, and construction industry is the inevitable result of the development of social industrialization. With the development of industrialization, the development of the construction industry has undergone profound changes.

Compared with the traditional cast-in-place building, the assembled building has the advantages of environmental protection and energy conservation, green construction, labor saving and construction speed, and can meet the requirement of "four environmental protection" to the maximum extent. However, the assembly of the building itself and its supporting technology, norms also have many deficiencies, such as the relevant standards are not perfect, poor seismic performance and poor performance, the overall design planning ability is poor, supporting materials research and development is not enough, construction and construction management technology is not satisfied Requirements, the form of monotonous, component production process backward and so on (Irizarry et al., 2013). At present, most of our research on assembly-type buildings is concentrated on the technical level, such as the production process of structural components, on-site construction technology, construction system and construction method (Wang et al., 2014). However, in the construction of the construction process, exposed the more important issue is the management of backward, imperfect. As the assembly of the building in the design process did not take full account of the actual production and installation process components, resulting in access to component production, installation links often appear when the design and construction conflicts, as well as construction collision problems, and then design changes, resulting in construction Site downtime and other phenomena, thus affecting the construction period and quality (Kim and Teizer, 2014). Therefore, how to coordinate the relationship between design and construction, so that the various stages of the smooth flow of information between the parties to become the key to solve the management problem in the construction process.

2. BIM AND ASSEMBLED BUILDINGS

2.1 Introduction of BIM
BIM model is not only the integration of digital information, more importantly, the application of these digital information, and can be used for planning, design, construction, operation of the digital method (Merschbrock and Munkvold, 2015). In the whole life cycle of the construction project, the building information model can realize the integrated management, the building information model and the construction engineering management behavior model perfect combination, so that the construction process in its entire process efficiency, reduce the risk. BIM has the characteristics: 1) Visualization: Visualization is an inherent feature of BIM, BIM work process is three-dimensional geometric information, component attribute information (such as the width and height of the window) and regular information (such as the wall after the wall It will automatically deduct the volume of the hole) the formation process (Means and Guggemos, 2015). So that people will be the original line of the components to form a three-dimensional three-dimensional physical graphics displayed in front of people, WYSIWYG. 2) Coordination: coordination is one of the important tasks of project management, is to complete other objectives of the important guarantee. 3) Mimetic: Mimicry is not only a model of a building that can be modeled, but also can simulate things that can’t be manipulated in the real world, such as energy saving simulation, emergency evacuation simulation, sunshine simulation, thermal conduction simulation, construction simulation Wait. 4) Optimization: the complexity of the building to a certain extent, the ability of the participants themselves can’t grasp all the information, must use a certain degree of science and technology and equipment help (Choi et al., 2014). The complexity of modern buildings is much more than the competency limits of the participants themselves, and BIM and its various optimization tools provide the possibility of optimizing complex projects. 5) It can be out of the figure: BIM through the visualization of the building display, coordination, simulation, optimization, to help owners out of the integrated pipeline diagram, comprehensive structure of the whole map (embedded casing diagram), collision inspection report and recommendations improve proposals.

2.2 Assembled Building Analysis

The so-called assembly is the use of prefabricated components in the field assembled from the building (Abanda et al., 2015). Compared with the traditional building, the assembly of materials required for the construction site is small, the construction of small noise, standardized production methods conducive to conservation of resources and environmental protection. At the same time, the construction of the assembly-type construction of the foundation only after the corresponding treatment can be assembled, the construction speed, low labor intensity (Wetzel and Thabet, 2015). Another standardized, mechanized, high-precision production methods to protect the quality of the building (Wong and Zhou, 2015). Therefore, the assembly structure contains the traditional building can’t match the advantages. However, there are many problems with assembly construction. Construction progress by the manufacturers of components of the production speed, mode of transport and other factors. Changes in the construction process of the production of components unfavorable, the installation process prone to "wrong, leakage, touch, lack" and so on. The construction of the building is still in the initial stage, the lack of a group of industrial technology and familiar with the assembly of the professional type of talent.

![Assembled building structure.](image)

Figure 1. Assembled building structure.

3. RESEARCH ON BUILDING INTEGRATED CONSTRUCTION SYSTEM BASED ON BIM
Construction industry to subvert the traditional building production methods, the use of BIM information technology as the carrier, the design and construction aspects of integration, all of these make the design link to become the key, and take BIM technology into the manufacturing process and information integration, and deepen the BIM on the whole process of component management philosophy. Based on the visualization advantages of BIM technology, the design of the assembly standard, the supporting technology of the construction stage, the construction and other specifications and the construction plan are put into the design scheme, and the design scheme is used as the guidance document of the production standard and the construction assembly.

### 3.1 BIM integrated modeling

The building information model includes various product and process information of the whole life of the building, which is dynamically formed at different stages of the construction process. Therefore, the integrated BIM for the whole life period needs to be dynamically integrated and created during the construction process. The basic idea of integrating BIM is to build the BIM sub-model in stages with the progress of the project and the need to create the BIM sub-model in different stages, from project planning to design, construction and operation (Tibaut et al., 2015). Each sub-information model can be automatically evolved, which can be used to extract, expand and integrate the data of the previous stage, form the information model of this stage. And it could generate the application sub-information model for an application integration model data forming a complete architectural information model for building life (Kim et al., 2016). The integrated BIM modeling process for a business is shown in Figure 2. First, according to the business process, select or determine the sub-model view (sub-model view, model view, refers to the BIM data standard subset, such as IFC outline of a subset of a particular exchange needs of all sub-models of abstract expression) (Ibanez et al., 2016); For business processes that do not have established sub-model views, you need to build sub-model views based on IDM methods. Then, the sub-model view and the sub-model extraction technique are used to extract the BIM sub-model from the BIM database and exported as an IFC file for use by the relevant application system. Then, the application system imports the IFC file to realize the sharing of project information. On this basis, the related business process is completed, new project information is added, and the new information and original information are exported as IFC files. Finally, the sub-model view and the sub-model integration technology are used to integrate the newly exported IFC files into the BIM database and to incorporate the newly added information in the service into the BIM database.

![Figure 2. Integrated BIM modeling process](image-url)
BIM information management and modeling for the full lifecycle of a building requires consideration of the four elements of organization, process, information and systems, and the association between them. Organization refers to the construction process of the various roles, management, cooperation and the allocation of authority and so on. The organization in the construction process has the characteristics of multi-participant, project-based one-time cooperation, space and time. Process is from planning, design to construction, operation of the entire process, as well as the various processes involved in the work, resource inputs and so on. The construction process has the characteristics of "split". Information refers to the construction process of the various engineering information and its expression, organizational structure and so on. Construction engineering information is heterogeneous, discrete, massive, complex, professional and documentary and other characteristics. A system is a computer software and system that is responsible for engineering and creating and using information. Combined with the integration of BIM modeling process, for the full life of the integrated BIM application architecture shown in Figure 4. The architecture is a structural architecture that includes application layers, network layers, platform layers, and data layers.

Figure 3. Facing the architectural lifecycle of IBM's application framework

(1) Data layer: the construction life of the project data can be divided into structured BIM data, unstructured document data and used to express the project information to create the process of process and organizational information. For the structured BIM data using IFC-based database storage and management; document information using the document management system for storage and management; structure and organization information is also used to store the corresponding database. (2) The platform layer is the BIMDISP platform, which is used to read, save, extract, integrate, validate, unstructured information management, and organize and process information management and control of BIM data. BIMDISP platform to achieve decentralized AEC / FM application system and engineering information and integration between the BIM model integration, on the one hand to support the realization of integrated BIM to create. While the professional application systems and users do not have to pay attention to the specific details of BIM integration, and can try to keep its original application model. (3) The network layer through the Internet network will be discrete space on the integration of various engineering information, but also easy to distribute around the user to share BIM model. The network layer is the basis for the sharing and application of BIM models. BIM servers provide services to users as well as cloud servers, saving users' investment in IT. (4) Application layer from the construction of different stages of application software, including software, planning design software, architectural design software, structural design software, construction management software, property management software. In this application architecture, the process of establishing the integrated BIM is actually the process of accumulating, expanding, integrating and applying the engineering life data. By integrating each stage or sub-information model created by each application to form a complete BIM, BIM provides a viable way to achieve. BIM server, BIM database
and its corresponding data access and control mechanism, effectively solve the BIM data storage and distribution of heterogeneous data consistent, coordination and sharing issues. Process and organization management provides support for BIM information creation, access, and data maintenance.

3.3 The Conception of Applying BIM in Fabricated Construction Project and Concrete realization

Each stage of the life cycle of a building relies on the exchange of information with other stages of management. The ideal management of a fabricated building should be able to track the information of the entire life cycle of each building component. At the same time, the relevant information should be stored in a convenient way, so that all project participants to effectively access the data.

For the processing of data, there is a conception of adding structured data to the database and component tags, which contain relevant data about the components and can be obtained in a timely and accurate manner, improving management efficiency and Level. It is unrealistic to add labels to all of the assembly components in this concept, and it is not immediately realized. If you want to use this information in a large number of projects, the tags are stored and the type of components placed in the label must be selected, the criteria to be selected for the size of the item, the type and the components, apply to the specifics of these components Process flow, and the project owners and the required level of automation and management to adapt.

![Figure 4. System interaction design](image)

In the idea of this data exchange, the target component places the label at the manufacturing stage and scans at several points in time. The scanning process reads the stored data or modifies the data at system requirements. The scanned data is transferred to a different software application for processing to manage the component-related activities. The conceptual design of the interaction between the tag and the database is shown. Related application software through the interface to achieve the database and the label between the read and write specific information. At the design stage, these are part of the product information that will be added to the database.

3.3.1 Management of component at construction stage

In the process of construction management of assembly buildings, two aspects should be considered. One is the management of component admission, and the other is the management of component construction. In the actual construction site, there is little room to limit the scope of the area to store components, to make full use of effective space, often can’t find the components, or wrong parts of the situation. To prevent this from happening, the requirements for on-site management level is relatively strict, the general sites are manually fill out. The report, slow, delayed information, and manual methods are also prone to errors, especially in large quantities of the components of the acceptance, the improper placement of components. The staff may not be able to determine the real situation of the components, resulting in a variety of problems, affecting the overall efficiency.

3.3.2 Engineering progress control

In the progress control, BIM application can effectively collect the progress of the construction process data, the use of relevant progress software, such as, etc., the data collated and analyzed, and the construction process can
be visualized simulation. Then, the actual progress data analysis results and the original schedule compared to the progress of the amount of deviation. Finally, enter the progress adjustment system, take the adjustment measures to speed up the actual progress, to ensure that the total duration is not affected.

![Diagram](image)

**Figure 5.** BIM for progress control

In the construction site, you can use handheld or fixed reader to collect information on the components on the label, the administrator can obtain the information of the storage and hoisting of the component in time, and transmit the progress information through the wireless sensor network in time. The progress information can be obtained in the form of software files into the software to carry out the simulation of the progress, and the schedule progress comparison. It also can be a good grasp of the actual progress of the project situation.

![Diagram](image)

**Figure 6.** The information collection

### 3.3.3 Management of the operation and maintenance phase

Since the beginning of the modern construction industry, there are two-dimensional drawings, including the subsequent electronic version of the wood file and a variety of mechanical and electrical equipment operating manual. Two-dimensional drawings have three inherent defects abstraction, incomplete and unrelated, which need to use the time by the professionals themselves to find information, understand the information, and then according to the decision to make a proper action on the building. This is a time-consuming and error-prone work, and there also often will be decoration when drilling cable, Pipe rupture can’t find the nearest valve, the elevator did not change parts on time caused by the fall, the occurrence of fire evacuation does not cause casualties, etc., and so forth. Based on the combination of other related technologies to achieve the property management and model, drawings, data integration, if the owners of the corresponding property to establish
health indicators, then you can easily guide, record, to remind the implementation of the property operation and maintenance plan.

Operation and maintenance stage, the software use its stage design to achieve the transformation of the building, expansion, removal of the management, the design parameters of the room elements and the various attributes, such as name, volume, area, use, floor. And other collections within the model are combined with the Internet of things in the building security monitoring, equipment management. Other aspects of the application can be a good all-round management of the building. Although the life of electronic tags is not enough to meet the general requirements of the design of civil buildings in the use of the requirements of active electronic tags generally a life, passive electronic tags the longest life. But if the future is more mature technology, longer label life, we can extend the management to the demolition stage of the building, re-use the components that meet the reliability requirements of the building, reduce the energy consumption of materials and meet the needs of sustainable development.

3.4 Comparison between traditional methods and BIM design

![Figure 7. Difference between traditional and ideal design](image)

In this figure, PD: Design preparation, SD: Program stage, DD: Early stage, CD: Construction phase, PR: Pre-construction preparation, CA: construction stage, OP: Operational phase, A: Ability to influence cost and performance, B: The cost of designing the change, C: Traditional design process, D: BIM - based design flow.

Curve A said that the earlier in the previous, the greater the impact on the project to the late, the less the impact of this ability. Curve B said that the design changes to the less wood, and vice versa higher. Curve C indicates that the main time and resources of the traditional design work are spent at this stage of the construction drawing, and that the main performance of the building at this stage has basically been determined. Curve D said that the ideal design of the use of the state, should focus on the early stage of the program research, so as to get a good performance of the building. The diagram illustrates the different stages of the project and the state of information transfer in the ideal mode of the traditional model and application.
Figure 8. Comparison of two modes of information transmission

The sawtooth line B below represents the current state of communication, communication and transmission when the two-dimensional drawing is used as the engineering information storage medium. In the early stage of the project, when the owner passes the project information through the document and the form of the two-dimensional drawing to the designer, the information received by the designer is lost immediately because the internal contact between the drawing and the document is missing, and when the design is completed, Construction, the same information, the loss of the situation between the design side and the construction side to continue staged, after the completion of the delivery operator is also the same. Curve A is the ideal state to be achieved after the application, although the present implementation cannot achieve this state, but its appearance makes the construction industry to achieve continuous lossless information, transmission possible.

4. CONCLUSION

Based on the combination of computer integrated manufacturing, BIM and assembly architecture as the research line, we put forward BIM-based assembly building integrated construction system. The main work of this paper and the innovative achievements are as follows: Based on the comparison of manufacturing and assembly architecture, the concept of BIM-based assembly building integrated construction system and the overall frame structure of BIM are put forward; the BIM subsystem and support system components are also proposed. The design idea, structure frame and design principle of sub-system and support system are expounded in detail. In addition, BIM-based assembly architecture integrated construction system provides advanced equipment in the BIM technology platform. The use of advanced thinking CIMS management of the construction process of the program is important to promote the development of China's assembly-style building. Therefore, the practical application of the BM-based assembly building integrated construction system should cause the industry to pay enough attention.

REFERENCES