Comprehensive application system of BIM technology in MULTIBAY project

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Abstract. With the rapid development of urbanization, the number of super high-rise buildings with increased building volume and scale is gradually increasing. At present, there are still problems such as inconsistent engineering information transmission and low efficiency of collaborative management among various participants in the construction of international super high-rise buildings. Because of this, based on engineering practice, using the advantages of BIM technology such as visualization, simulation, and collaboration, this article explores the application process of BIM technology in the design stage of super high-rise buildings, such as multi-disciplinary detailed design and drawing collision inspection, as well as in the construction stage, such as visual technical disclosure and scheme selection. It also constructs a BIM whole process management system, enabling BIM technology to better participate in the whole process of project construction, improving the level of project information technology, and providing engineering reference for the application of BIM technology in similar super high-rise buildings.

Keywords: BIM technology, super high-rise building, design stage, construction stage, comprehensive application.

1. Preface

Building information modeling technology (BIM) is defined as a management technology that facilitates project management, communication, and information collaboration during the construction process from project planning to project closure. Due to its advantages of 3D modeling, visualization, and multi-department communication and coordination[1], BIM has been widely applied in the construction industry in recent years and has gained recognition from a large number of practitioners.

The application of BIM covers the entire life cycle of a construction project, including design, construction, operation, and maintenance stages, as well as diverse areas such as site analysis, design scheme display and comparison, and multidisciplinary collaboration[2,3,4]. In the design stage: collision detection of drawings, construction scheme simulation, schedule simulation, and site planning during the construction stage[5-8]. As well as visualization operations and maintenance, asset management, maintenance, and emergency management in the operation and management stage[9,10].

To promote the information and intelligent construction management of super high-rise buildingsControl modeThe development of BIM technology in prefabricated buildings, from design, and construction, to the entire process of project management organization structure, data transfer mechanism, and workflow[11].

Because of this, this article explores the comprehensive application system of BIM technology in

super high-rise buildings, which can provide new ideas for the comprehensive management and application of BIM

technology in similar super high-rise buildings, and provide a reference for similar engineering project management.

2. Project Overview

The Kuala Lumpur MULTIBAY project is located in the core area of Tun Razak Exchange (TRX) in Kuala Lumpur. The total area of the project is approximately 8225.84 m^2, with a total construction area of approximately 175,820 m^2, including a 56,092 m^2 podium building and a 119,728 m^2 tower building. Structural form: Block A office building has 28 floors; Block B hotel has 37 floors with a total of 259 rooms; Block C apartment has 60 floors with a total of 490 apartments; B1 to 12F belong to the podium building, and 13F and above are the tower building. The podium building and office building are frame structures, while the hotel and apartment structures are shear wall structures. The effect of the MULTIBAY project is shown in Fig 1.

Fig. 1 Rendering of MULTIBAY project

3. Stage application of BIM technology

In the traditional project management process, detailed design is only applied during the construction phase. To better control the progress, quality, and cost of the project, the detailed design can be advanced from the construction phase to the design phase. During the design phase, based on the principle of "simulating construction in advance and designing in advance", the feasibility analysis of design and construction drawings can be jointly promoted with the BIM technicians of the construction unit, to quickly adjust the design scheme and ensure the quality of the design blueprint. During the construction phase, the BIM technical team will conduct collision detection and detailed design in advance, make full use of BIM to control the clear height, optimize the pipeline routing, and provide visual monitoring for the construction process in complex areas and key locations. After the comprehensive application of BIM technology in the whole process of the project, the owner will review and confirm the BIM construction model, and the BIM technical team will finally produce the BIM construction drawings.

Currently, BIM technology mainly uses AutocadRevit, and Navisworks uses software such as 3DSMAX to conduct design verification, construction simulation, project cost management, and project scheduling[12]. The software and platforms used in this article are shown in Table 1.

Table 1. List of application software and platforms

Software platform	Application:
Revit	Creating models of building structures, electromechanical systems, etc.;
Navisworks	Construction simulation and collision detection;
3DSMAX	Modeling, visual optimization, animation production;
Cubicost	Calculate the project quantities;
CCYR-BIM	BIM technology integration management platform;

3.1. Application of BIM technology in the design phase

review.

To ensure the reasonable application of BIM technology in various stages of the project, it is necessary to effectively link BIM modeling, detailed design, and on-site construction based on the characteristics of the project before the project begins.

In the design process, BIM three-dimensional modeling technology is used to arrange the building structure in both horizontal and vertical planes and to verify and optimize key parameters of the drawing design.

(1) Multidisciplinary Deepening Coordination

In high-rise buildings, the drawings of multiple disciplines are intricate, and before construction, it is necessary to conduct collision checks between architecture, structure, electromechanical, and other disciplines according to the design drawings to prevent rework caused by design errors, as shown in Fig 2, Fig 3, Fig 4, and Fig 5.

Fig. 2 Structural Model

Fig. 3 Coordination Model of Structural, Architectural, and Mechanical and Electrical Specialties

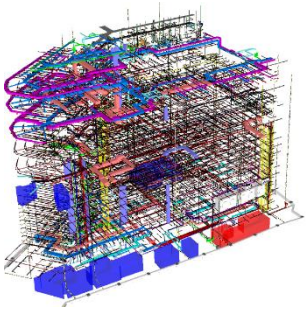

Fig. 4 Mechanical and electrical discipline Deepen the model

Fig. 5 Structure, electromechanical Professional coordination model

(2) Collision Report and RFI

The project uses BIM technology to model the structure, electromechanical, and decoration in a coordinated manner, produces coordination diagrams, and sends collision reports through the self-built CCYR-BIM platform. Design consultants can interactively respond on the platform to identify problems in advance, which is more intuitive than traditional drawing collision and reduces the occurrence of rework.

Based on the collision report obtained from the collision detection of the drawings, an RFI summary three-color diagram was submitted, and 1023 crossings were found in the drawings. Through the deepening of the drawings, 906 items have been resolved, leaving 118 unresolved items, saving management fees and hidden rework costs. The CCYR-BIM platform is shown in the figure, and the collision report is shown in Fig 6 and Fig 7.

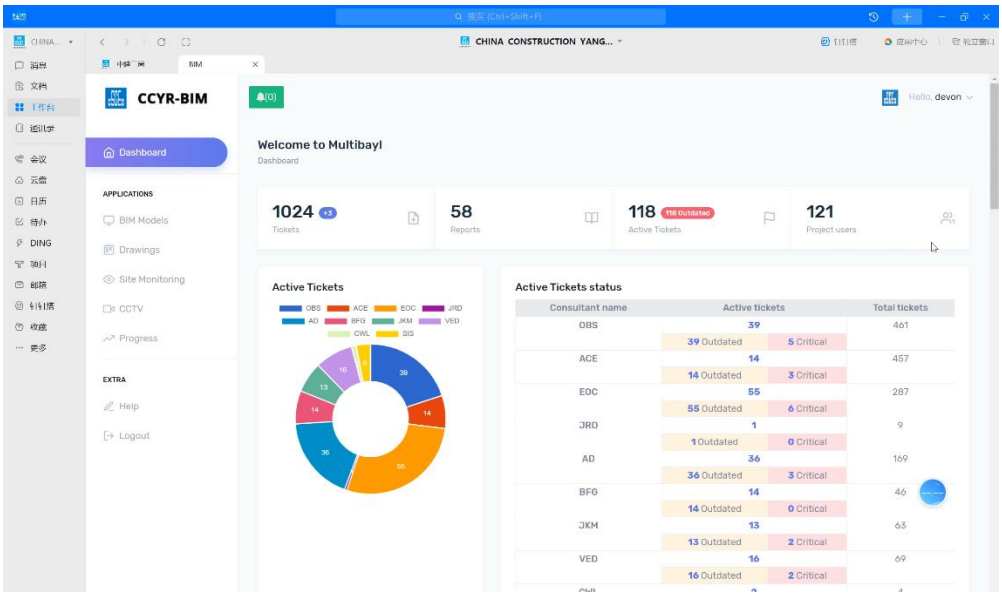

Fig. 6 CCYR-BIM Platform

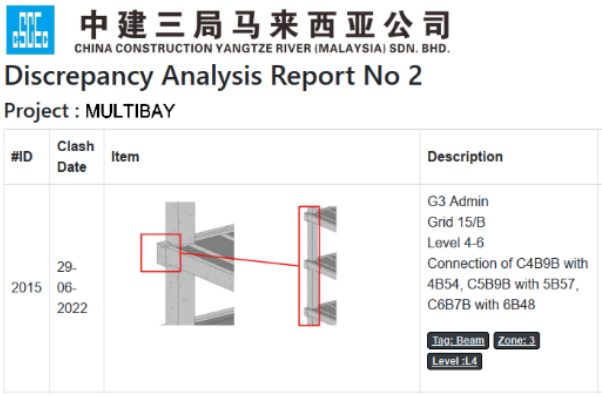

Fig. 7 Collision Report

3.2. Application of BIM technology in the construction process

During the construction phase, BIM and drone technology can be combined to accurately collect image information on the site, strictly control the construction schedule, and select appropriate equipment construction plans for 3D visualization technical disclosure.

(1) BIM technology + UAV

Using BIM technology and drones to collect geographic information images, monitor on-site construction, and track progress on the construction site. Conducting reverse 3D modeling of on-site physical scans to create realistic modeling scenarios with multiple perspectives, enabling accurate control engineering various spatial digital information of the site, as shown in Fig 8.

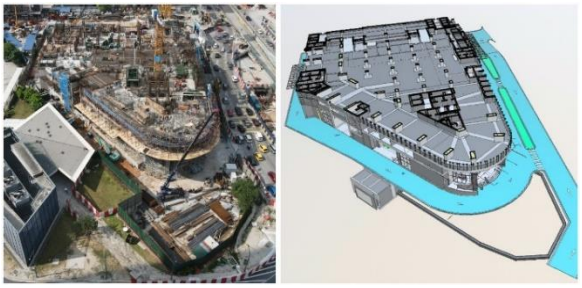

Fig. 8 BIM + UAV integration

(2) Selection of equipment construction plan

Using BIM technology, for the installation plan of construction elevators and the special installation plan of tower cranes, and cloth machines by comparing installation schemes analyzing the site layout, and simulating the site layout during the construction stage, the most reasonable arrangement of elevators, tower cranes, cloth machineThe special installation and construction plan for mechanical equipment can reduce equipment vacancy costs, material turnover costs, improve equipment utilization, and reduce construction costs. The construction plans are shown in Fig 9, Fig 10, Fig 11, and Fig 12.

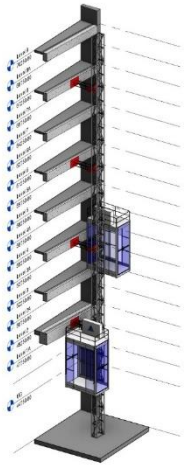

Fig. 9 Personnel elevator Installation plan

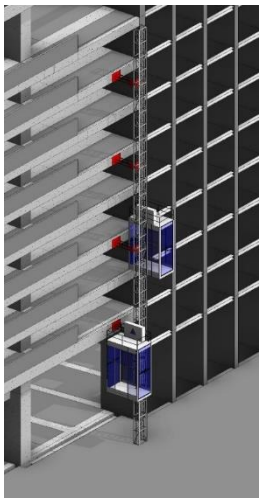

Fig. 10 Freight Elevator Installation plan

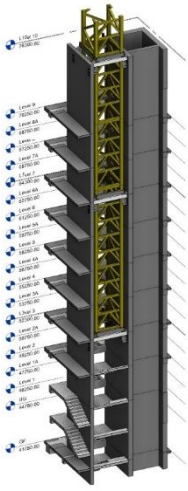

Fig. 11 Tower crane installation Special plan

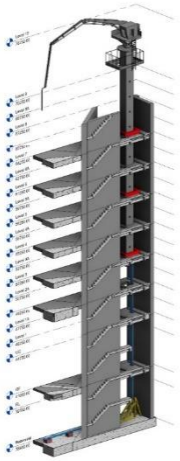

Fig. 12 Cloth machineInstalling Special plan

4. Comprehensive application system of BIM technology

The comprehensive application system of BIM technology mainly involves various optimization designs and 3D construction process simulations for the project construction process. Based on the simulation results, corresponding optimization strategies for the construction period are sought. Before the commencement of key and difficult points in the project, relevant management personnel are provided with animation construction disclosure to deepen the understanding of the on-site construction personnel on the key and difficult points of the project.

Technicians can add construction progress data to the 3D model to form a 4D model, which can accurately control the input plan of labor, materials, and machinery within a certain period. Adding cost data to the 4D model to form a 5D model can control the capital investment plan within a certain period.

4.1. Application of BIM Project Process Management

(1) Site layout stage

The first month is the mobilization period. After the commencement of the construction, the kick-off meeting will be held to start various works, including applying for JKKP, CIDB, MPSJ, night construction, reviewing drawings, temporary power, water supply, etc. The on-site management team will be mobilized to communicate and coordinate the pile foundation works, prepare the labor force, materials, and work equipment, actively communicate with subcontractors, suppliers, etc., and implement the site layout and construction plan, as shown in Fig 13.

(2) Ground completion stage

The time is the second month, and with the completion of the ground floor construction, the related production supporting facilities have been completed, as shown in Fig 14.

(3) Preparation stage of tower crane foundation

The time is the third month, and the preparation work for the foundation pouring of tower cranes TC #1 and #2 is completed, as shown in Fig 15.

(4) Tower crane installation completion stage

At the 6th month, tower cranes (TC) #1, #2, and #3 have been installed in place. The material feeding arms (PB) #A1, #B1, and #C1 have been installed, as shown in Fig 16.

(5) Structural and construction stages

The time is the 14th month. Building A: The structure of the 12th-floor prestressed beam has been completed. Building C: The structure of the 12th-floor prestressed beam has been completed, as shown in Fig 17.

The time is the 16th month, the building structure reached L15/conversion layer, and the C building structure reached L13/conversion floor. The TNB substation is handed over to the ground floor of the remaining platform, as shown in Fig 18.

The time is the 21st month, Block A and the remaining platforms: the structure reaches the roof height. The laying arm of A1 and P1 is removed. Block B: the BIM model of the L16 floor has been completed. Block C: the BIM model of the L13 floor has been completed, as shown in Fig 19.

The time is the 24th month. Building B: The curtain wall project is in progress, and the remaining platform construction work has been completed, as shown in Fig 20.

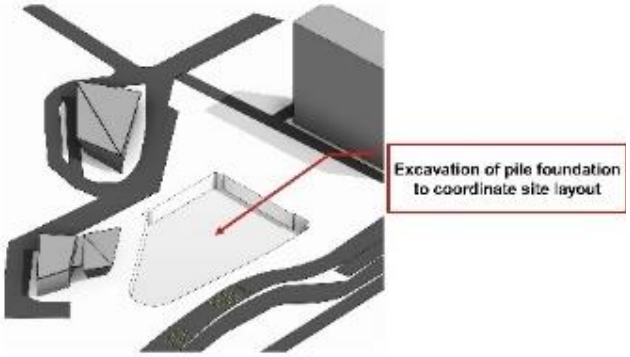

Fig. 13 Site layout

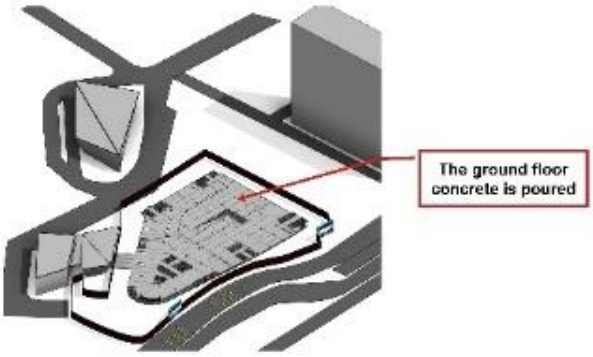

Fig. 14 Ground completion

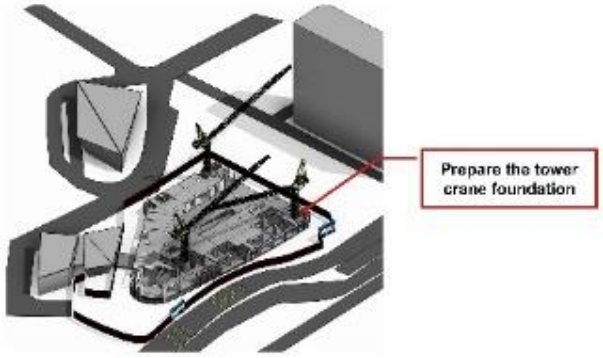

Fig. 15 Tower crane foundation preparation

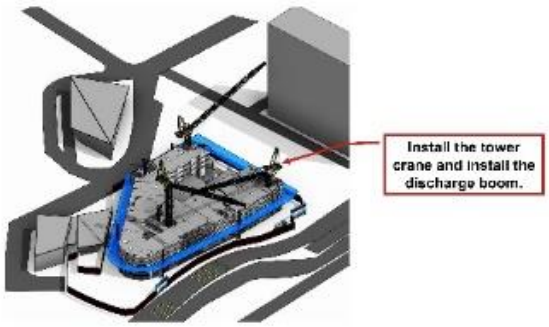

Fig. 16 Tower crane installation completed

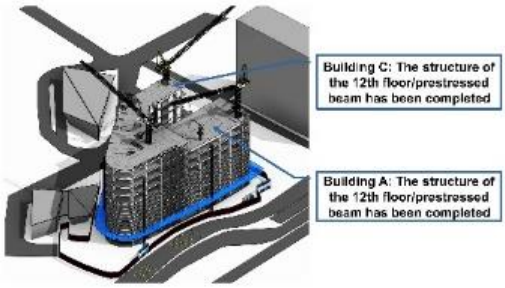

Fig. 17 Prestressed beam construction

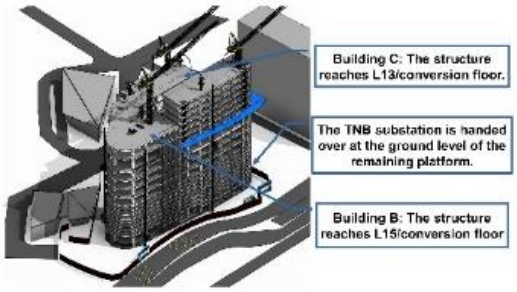

Fig. 18 Construction of conversion layer

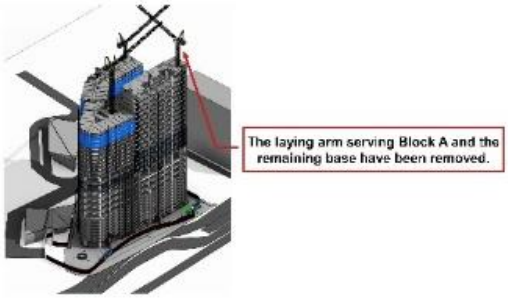

Fig. 19 Completion of remaining platform structures

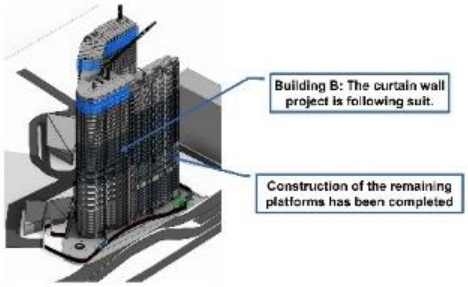

Fig. 20 Completion of remaining platform buildings

4.2. BIM project quantity statistics

The project is entering the final stage. After the BIM model is completed, the quantities of various design elements can be obtained, including concrete quantities, decoration element quantities, and electromechanical element quantities. This can greatly save time in calculating project quantities, thereby improving the efficiency of project comprehensive management, as shown in Fig 21 and Fig 22.

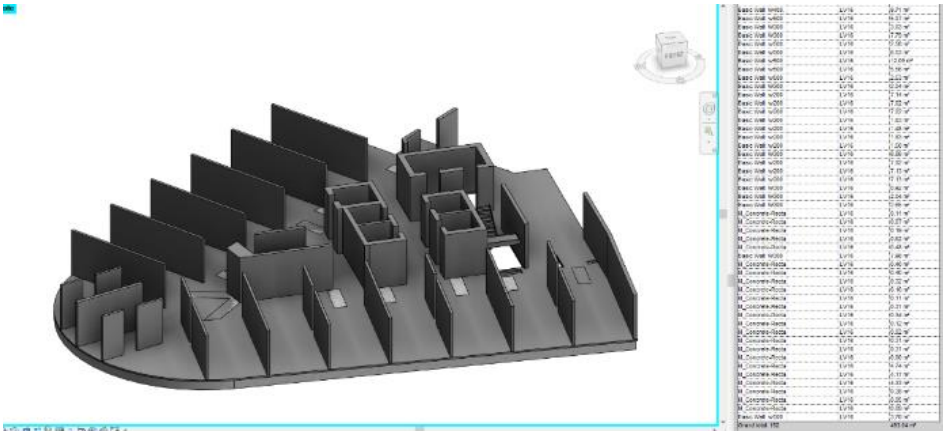

Fig. 21 Statistics of concrete quantities

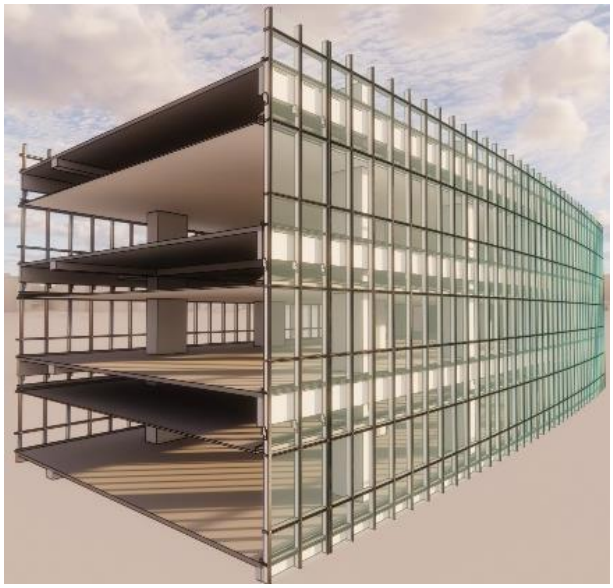

Fig. 22 Statistics of curtain wall quantities

4.3. BIM front-end platform application

Through the self-built website https://www.ccyr-bim.com/ or DingTalk Mini Program (BIM), both PC and mobile

terminals can access the platform, as shown in Fig 23. Because various professional drawings in Malaysia are designed by different architectural design institutes, there are many problems of "collision" in the design of various professional drawings. In response to this problem, we have developed a lightweight BIM design management front-end platform based on Autodesk-forge. The specific functions of the platform are as follows:

(1) Lightweight building model;

By roaming, and Familiarize yourself with the section for building structures, it is possible to view the location, elevation, distance, and other related attribute information of components, and strictly control the accuracy of construction.

(2) Intelligent classification

The platform has been added to the collision report submission, design consultant approval, and other processes, which can intelligently detect the approval status of collision reports and automatically generate weekly and monthly reports of RFI related to collision reports;

(3) Submission of BIM drawings

All collision reports on the platform can be automatically generated, including collision report response status, collision weekly and monthly reports, and an early warning mechanism for handling BIM drawing issues, all displayed in both text and graphic formats.

Fig. 23 BIM front-end platform application

5. Conclusion

As the construction industry gradually shifts from extensive development to intensive development, the traditional BIM application model of design—build—manage—operate cannot meet the needs of future urban super high-rise buildings for refinement, efficiency, comprehensive benefit development direction, and market demand.

In addition, the comprehensive application of BIM technology runs through the entire construction process. It can be used for the organization, reporting, and cloud backup of evidence and data such as expediting, claims, and changes, avoiding work handover blind spots caused by various personnel movements, job transfers, and other reasons, and reducing conflicts and disputes during the completion settlement stage.

By comprehensively applying BIM technology, management personnel can select reasonable construction plans and solve construction problems in advance through construction simulation. Therefore, establishing a comprehensive management system for BIM projects can enable BIM technology to better share engineering data at all stages of the project, achieve comprehensive information management of the project, minimize the risk of project schedule delays, and optimize its construction costs.

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