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Application of BIM Technology in Techo International Airport Project

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Abstract: In airport-type large-scale engineering projects, BIM technology can play its own advantages to maximize the relief of large-scale airport construction, long cycle, multiple specialties and quality requirements and other challenges. Taking Phnom Penh Tak Chong Airport project as an example, this project maximizes the information value of BIM by applying BIM technology to deepen the design of contract drawings in the early stage and applying BIM technology to construction management in the construction stage, and at the same time, applying Dynamo, 3D scanning, P6 and independently researched and developed construction interactive platform and other methods. At the same time, for the airport project construction difficulties and key content, based on software simulation analysis to ensure the structural stability of the construction process. It has been proved that the application of BIM technology can reduce the drawing changes, effectively shorten the construction period, reduce the construction difficulty and save the cost to ensure the smooth construction of the project.

Keywords: Airports; Deepening Design; Building Information Modeling; Construction Management.

1. Introduction

Cambodia Phnom Penh Tak Chong International Airport is located in the southern part of Phnom Penh City, the capital of the Kingdom of Cambodia, in Kampong Rasdan District, mainly composed of passenger terminal building, north finger corridor, energy center, viaduct, outdoor roads and outdoor landscape area. Among them, the terminal building has a construction area of 160,000 m2, with a 4-story main building and a 1-story basement and terminal connecting bridge, the length of the main structure is about 324 m, the width of the terminal building is about 212 m, the highest point of the metal roofing is about 41.3 m, and the lowest point is about 29.4 m. The vertical structure is a reinforced concrete structure and a section steel structure, and the floor slabs are post-tensioned pre-stressed girderless slabs, and locally prefabricated hollow-core slabs. The terminal building as a whole is very simple and smooth, and the roofing system adopts individual curved surfaces connected into multiple steel structures and mesh shell metal roofs. Aerial view of the terminal building is a small "U" shaped arrangement, the annual passenger flow can reach 15 million, the overall architectural effect of the project is shown in Figure 1.

Fig 1. Cambodia Phnom Penh Tak Chong Airport Project Overall Effect

2. Project Focus and Difficulty Analysis

2.1. Project Complexity

Phnom Penh Duc Chong International Airport has more than 40 subcontracts entering the construction site at the same time during the largest period of the construction of the number of workers, and the management of the general contractor and the external performance conditions are very complicated; at the same time, the subcontracting methods of block subcontracting, labor subcontracting, self-employment and other subcontracting methods are ubiquitous, and the implementation of the general contractor's management of the subcontracts is complicated; it is a systematic and comprehensive project, involving more contents, including civil construction (building, road and landscape), installation (electromechanical , drainage, BHS and ICT), decoration, facade and so on [1].

2.2. Cultural Diversity

The official language of the project is English, and some documents and reports have to rely on the local staff, which significantly reduces the working efficiency. The proportion of local staff in the project is >20%, among which the proportion of localized staff in the design/BIM department is >70%, which makes the integration difficult. Due to the low efficiency of local staff, most of the work that needs to be completed quickly can only be done by the Chinese staff under the pressure of the project schedule and the emphasis on results in the management.

2.3. Drawing Approval Process Factors

The project needs to submit for review more than 3848 drawings, 132 materials for review, 229 programs for review, according to the owner's consultant's version of the review, the number of copies required to submit, it is expected that the final review of the huge number of information. In

addition, the review needs page number chapter, project chapter, handwritten page number, the review process for the general contracting unit → architectural/ structural/ electromechanical consultant → design institute → owner's construction office → owner's committee, the whole process is extremely cumbersome, and the completion of the whole process will take nearly 28d.

2.4. Labor and Material Resource Factors

Cambodia is rich in local labor resources, and if the labor resources are not enough, it can hire third-country laborers such as those from Myanmar and Laos. However, most of the workers are imported by small labor companies, and the work efficiency is extremely low. In terms of material supply, although there are many suppliers of turnover materials, the supply capacity is small, the scale of professional subcontracting is small, and subcontracts such as steel structure installation, curtain wall subcontracting, roofing subcontracting and decoration subcontracting have the risk of not being able to complete the work on time during the rush phase.

3. Master Plan

According to the owner's contract, the contractor is required to apply the BIM system to simulate the building information for the preparation of construction drawings, construction plans, and progress reports for each construction phase until the final construction process, and deliver the final as-built BIM model. For model accuracy, the owner's contract stipulates that the building information model must be refined to be used for building management and utility management in the later stages, so the final as-built BIM model delivered must reach LOD500 and above [2].

Combined with the contract requirements and the actual situation of the project, in the initial stage of the project BIM application of overall planning, the development of the corresponding implementation standards for the project focus, difficult parts of the analysis of BIM technology application entry point, set the use of BIM technology to achieve the streamlining of the process, efficient information transfer, process management, such as a series of goals, as shown in Table 1. Specific BIM application implementation process shown in Figure 2.

Table 1. Objectives of BIM technology application in Phnom Penh Duc Chong Airport Project

Implementation goals	implementation method
Realization of efficient process information transfer	BIM model-based design and construction coordination meeting system to improve the quality of information transfer, enhance the efficiency of communication under cultural differences, and accelerate problem solving
Improve the quality of design in the deepening phase	Assist in deepening the quality of the design, improve the rate of passing the review to achieve the optimization of the scheme, cost savings, shorten the construction period to achieve accurate modeling, efficient drawing, perfect delivery
Realization of fine control of the construction process	Plane planning, rational use of resources model delivery, improve work efficiency, improve quality BIM model and P6 plan combination, to achieve the construction progress of fine management
Enhancement of general contracting management capability	Combining BIM technology and P6 program management software to form a new type of project management tool and enhance the general contracting management capability.

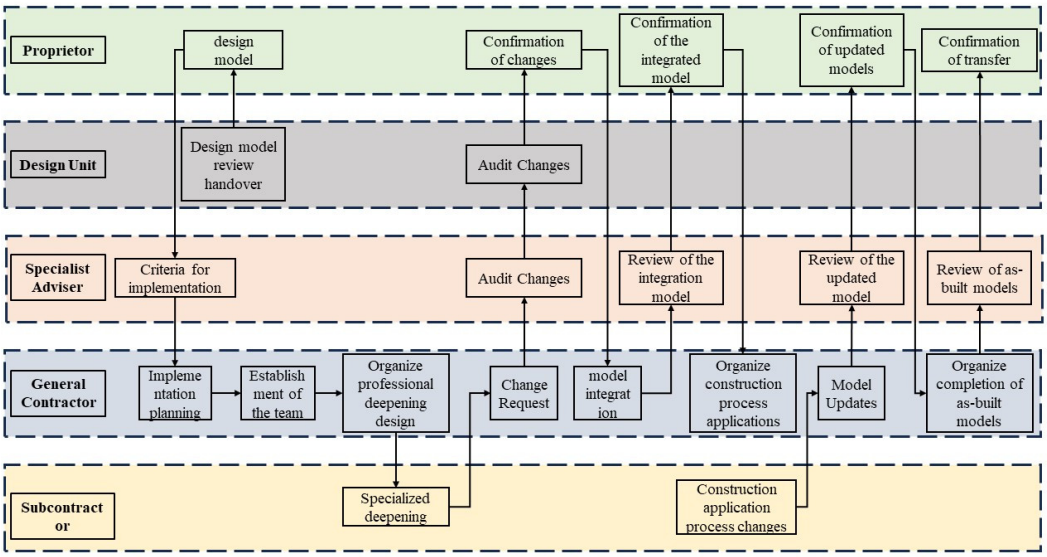

Fig 2. Implementation process of BIM technology application in Phnom Penh Duc Chong Airport Project

4. Deepen Bim Application in Design Phase

4.1. Application Mode

This project adopts the semi-positive deepening design mode of CAD first, BIM second and synchronization in the middle of the deepening design process. This mode ensures the speed of preliminary drawing review, improves the quality of mid-term drawing design and reduces the number of late drawing changes.

4.2. Collaborative Approach

In order to avoid problems such as elevation and component dimensions not meeting the requirements after on-

site construction. Through the internal nail and Revit cloud platform, CSCI Malaysia carries out the teaching of construction process and design deepening delivery, relying on the CCYR-BIM interactive platform operated and maintained by the enterprise independently, sharing the construction of the already built model, as shown in Figure 3, to ensure that laborers from different countries carry out the construction according to the unified standard, which accelerates the progress of the construction.

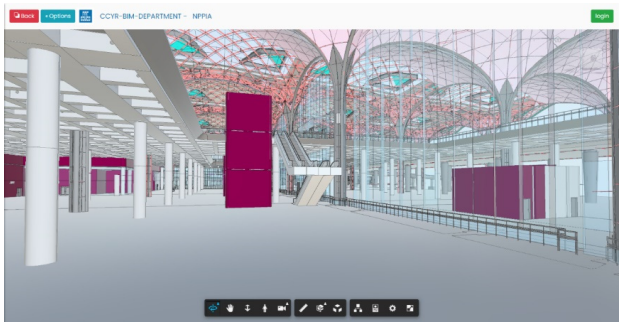

Fig 3. BIM construction interaction platform

The synergy in the deepening design process of this project is divided into 2 aspects: internal and external. Among them, the internal is the specialties of structure, steel structure, architecture, curtain wall, roofing and interior decoration. It is realized by using the form of central file plus model link, i.e. central file is used within a single specialty, and model link form is used between each specialty. Collaboration between the above specialties and M&E systems and other contract packages is realized through the CCYR-BIM platform. In addition, the supervisory unit can also understand the project BIM work progress, problems, etc. in real time, and timely feedback to the owner's side, realizing the efficient transmission of information [3].

4.3. BIM Model-based Design Coordination

The BIM model is used to show the problems in the design coordination meeting held regularly in the project, with the help of BIM technology to let the decision makers of each participant obtain information and make decisions quickly, to ensure that the difficult problems become obvious and get the unanimous understanding of different participants, to improve the communication efficiency, and to make the project design coordination work simpler [4].

4.4. Collision Checking and Design Optimization

The large roof ceiling of this project is mainly coconut tree-like steel structure columns and multi-curved metal ceiling panels, all of which are hyperbolic modeling, among which the multi-curved metal plate ceiling elevation changes are complicated, and the curvature of each grid surface is inconsistent, which leads to errors in continuous splicing of continuous surfaces in a tall space. For this reason, Revit, Tekla, Dynamo and other software are used to create the metal plate ceiling and three-dimensional model, integrate the steel structure Tekla model and the electromechanical system model to carry out spatial positioning of the ceiling, node design, and comprehensive arrangement of components, and produce drawings to realize the deepening of the design and ensure the quality of deepening. The structural displacement and stress field distribution of the glass curtain wall under wind pressure is shown in Figure 4, and the wind pressure simulation of the glass curtain wall is shown in Figure 5.

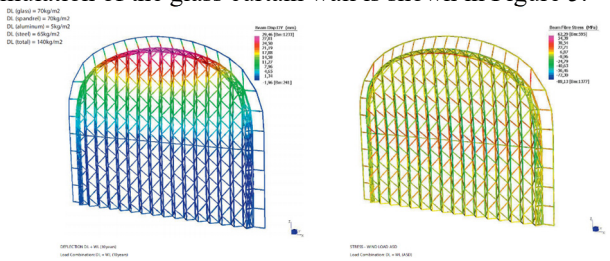

Fig 4. Structural displacement and stress field distribution of the glass curtain wall

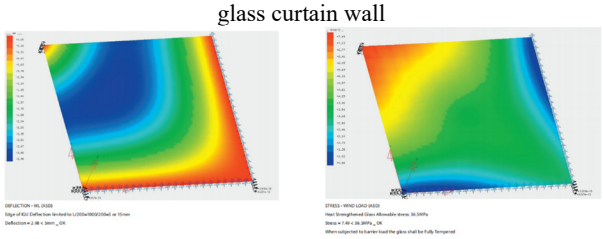

Fig 5. Wind pressure simulation of glass curtain wall

Take the glass curtain wall wind pressure test as an example, set the type of load for wind load, wind pressure unit load intensity of 945Pa, sound insulation glass thickness and thickness determined by the level of sound insulation requirements. In compliance with the acoustic code requirements, the test glass used in the test is 6mm heat-strengthened glass and 1.52mm acoustic PVB glass panels, the test sample shape is square with a side length of 1 m. It is divided into two test methods: two adjacent sides are supported, the other two sides are unsupported, and two unsupported sides are tested.

On the sides and rear façade of the headquarters building, the wind pressure was restrained on the two adjacent sides of the square glass, with a dotted support at one corner. Design glazing edge deflections should be examined under 50-year return period wind loads, and since the two edges of the glazing are unsupported, the glazing deflection limitations apply only to the edges of the glazing, not to the center of the glazing. The criteria for the simulation test were to limit the edge deflection to L/200 or 15mm to prevent damage to the main seal at the edge of the insulating glass assembly. The final results show that the use of adjacent triangular splicing structural form, the glass edge deflection can withstand a maximum of 2.98mm, can withstand wind load stress of 7.49, less than the glass material bearing limit of 36.5MPa. Therefore, the use of square glass and two triangular panels than a single piece of triangular glass stabilization effect is better, so design optimization, choose the latter program for construction.

After analysis and statistics by professional and technical personnel, this project uses BIM technology in the process of model creation, integration and collision checking to discover more than 2,300 errors and omissions in the drawings in advance, reducing rework by about 5%; through the design optimization of roof steel components, curtain wall steel beam settings, and extended end points of the interior aluminum composite panels and other parts of the project, cost savings of nearly 3% are achieved; through Dynamo, Auto Lisp, Autodesk, Recap and other BIM-related software applications [5], improving the modeling speed of complex furniture, artwork, interior landscaping, and shaped components and the efficiency of entering information such as doors, windows, rooms, equipment openings, material practice information and standard marking styles, enhancing

the overall BIM modeling and drawing efficiency and saving about 8% of the time cost of the drawings.

5. Deepen Bim Application in Design Phase

Combined with the project's important and difficult points and the actual needs of the site, this project has launched many aspects of BIM technology applications in the construction phase, such as complex node simulation, major construction program simulation, 4D construction progress simulation combined with BIM and P6, etc. Through the combination of BIM technology and project management theory, it realizes the rational planning of resources, the efficient transmission of information, and the fine control of progress in the process of project construction [6].

5.1. Terminal Building Steel Frame Construction Simulation

The construction content of the scope of the terminal hall of this project has a complex internal environment, many hidden problems, difficult coordination and organization, and difficult implementation. In the process of steel structure lifting, three-dimensional laser scanning technology can be used to scan the control points of steel structure and metal roofing, and the collected data will be compared and analyzed with the design model, and the three-dimensional scanning points of the steel frame are shown in Figure 6.

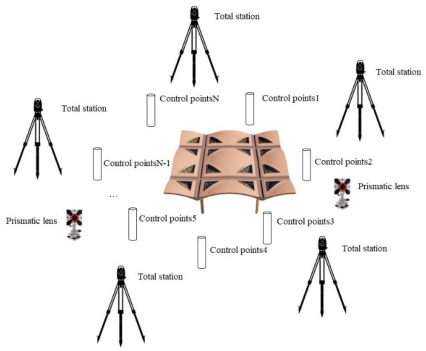

Fig 6. Arrangement of 3D scanning points of the steel frame of the terminal building

5.2. Simulation of Complex Nodes and Major Programs

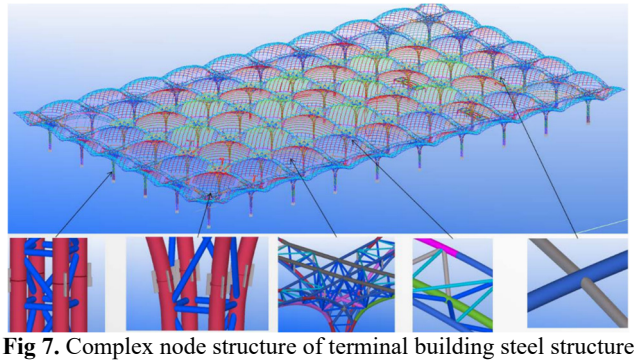

Fig 7. Complex node structure of terminal building steel structure

During the application of BIM technology in this project, 3D modeling is carried out for the complex design nodes and major construction schemes existing in the project, and the contents of the node schemes are displayed finely and intuitively in the form of models, pictures, animations, etc., which helps to verify their accuracy and implementability, and improves the efficiency of communication while reducing the number of communications, and realizes the efficient transmission of the design and scheme information among the parties involved in the construction [7]. The complex node structure of the terminal building steel structure is shown in Figure 7.

5.3. Construction Progress Control by Combining BIM and P6

This project uses Oracle Primavera P6 management software in the whole process, and combines it with BIM technology, applying Navisworks, Sketchup, etc. to simulate the construction process, update the progress of the project in real time, and carry out the management of schedule, resource and cost control. Combined with foreign advanced management concepts and models, we deeply analyze all data to promote scientific project management and realize fine progress control.

The daily production meeting system based on BIM model and P6 plan updates the daily construction progress in real time into BIM model, realizes the macro display of construction progress, plan execution, and professional cross-problems in each area, and promotes the communication and coordination with Cambodian staff, partners and subcontractors. The construction completion statistics of different elevations of the main terminal building of the project are shown in Figure 8.

Fig 8. Statistics on the completion of the construction of the main terminal building by elevation

6. Conclusion

The project of Phnom Penh Duc Chong International Airport has obvious advantages by comparing with the traditional construction process and project management methods. In carrying out the practice of all-employee and all-process BIM application, this project has well realized a series of goals such as improving project management level, reducing project cost investment, and improving efficiency. With the gradual deepening of the project construction, it completes the transformation from simple technical support to the role of serving the refined project management, and

realizes the all-round refined control of project management.

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