

## Application of BIM Technology in the New Phnom Penh International Airport Project

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**Abstract:** With the continuous development of the economy and civil aviation industry, the construction of high-standard airports has become an important part. Taking Cambodia's New Phnom Penh International Airport as an example, as the first internationalized airport in Cambodia to fully implement BIM technology in the entire project lifecycle, it is characterized by large-scale investment, tight construction schedule, many participating units, complex organization, high pressure on schedule management, and complicated professional works. This project summarizes the main contents of BIM technology application in airport projects and analyzes and summarizes the main application scenarios of BIM technology in complex airport projects. The actual application of this project shows that: 1. in the planning stage, BIM technology is utilized to refine the tender and improve the presentation of technical tender, quantity calculation, and quotation. 2. in the design stage, BIM technology is employed for the analysis of the performance of the building environment, collision checking of the drawings, spatial coordination, and professional conflict checking, and supplemented by the deepening of the three-dimensional model, height analysis, deepening of the design of complex nodes and optimization of the comprehensive pipeline. 3. During the construction stage, BIM technology is applied to the deepening of the drawing. In the construction stage, the BIM technology application is mainly used for model demonstration, auxiliary program and drawing submission, BIM model auxiliary quantity calculation, and prefabrication processing of electromechanical pipeline support.

**Keywords:** New Phnom Penh Airport; BIM technology; planning phase; design phase; construction phase.

### Project Overview

One of the 19 bilateral cooperation documents signed by Chinese Premier Li Keqiang during his visit to Cambodia on January 11, 2018, was China's financing of the new airport, a project that is of great interest to China and Cambodia, and will promote the comprehensive strategic partnership between the two countries and the Lancang Mekong cooperation to a higher level in terms of politics, economics and trade, and humanities.

Cambodia's new Phnom Penh International Airport is located in the southern part of Phnom Penh, the capital of the Kingdom of Cambodia, in

Kampong Rasdan District, with a flight area of 4F,

and will be one of the largest airports in the world after completion, covering an area of about 2,600 hectares, which is the largest airport in Cambodia in terms of domestic passenger traffic, and at the same time will lead to the emergence of the surrounding 1,900-hectare "airport city". The airport is one of the largest airports in Cambodia, which covers a construction area of about 210,000 m<sup>2</sup>, including the terminal building, the north finger corridor, the energy center, the viaduct, the outdoor road, and the parking lot. The overall architectural design project is shown in (Fig 1).



Fig 1 Overall effect of the new Phnom Penh Airport project in Cambodia

## I. PROJECT CONSTRUCTION LIFECYCLE UTILIZING BIM TECHNOLOGY

### A. Application of BIM technology in the planning stage

The new Phnom Penh International Airport project consists of 3 main areas: domestic cargo area, international cargo area, and international freight forwarding area. The project encounters construction challenges, including a demanding timeline, substantial building volume, complex logistical organization, and numerous intricate steel structure processes. To solve the various engineering difficulties and complete the project in quality and quantity, the project technical department adopted the BIM technology to serve as a comprehensive and dynamic database to carry out virtual construction and construction simulation under a visualization environment [1]. BIM not only improves the design quality and project management level, maximizes the scientific

construction, and ensures the smooth implementation of the project, but also provides various data to help the owner's project with the high-quality operation and maintenance management level.

#### 1) Refinement of technical bids

The New Phnom Penh International Airport project is a systematic and comprehensive project with many components, including civil (building, road, and landscape), installation (MEP, drainage, BHS, and ICT), decoration, facade, etc [2].

Through BIM technology, planning is refined and managed with precision. BIM technology is used to construct a model of the building and the site to obtain real and accurate results, to realize the evaluation of the project in the planning stage, and finally to plan the building site according to the evaluation results to realize the layout of the elements. The refined model of this project (Fig 2).



Fig 2 Refinement model for project planning

#### 2) Enhancing Technical Bid Presentations

In our technical bids, we harnessed the full three-dimensional potential of BIM models along

with the embedded engineering data. The BIM model allowed us to present engineering information with precision and clarity. Additionally,

leveraging the three-dimensional model, we created construction animations to vividly illustrate the construction process and organization to project owners. This transformation makes complex construction schemes accessible and visually appealing. It not only showcases our company's

proress in BIM technology but also significantly augments our bid-winning potential. The construction process of concrete slab pouring is shown in (Fig 3) while (Fig 4) shows a shoot from the animation video of the steel structure installation.

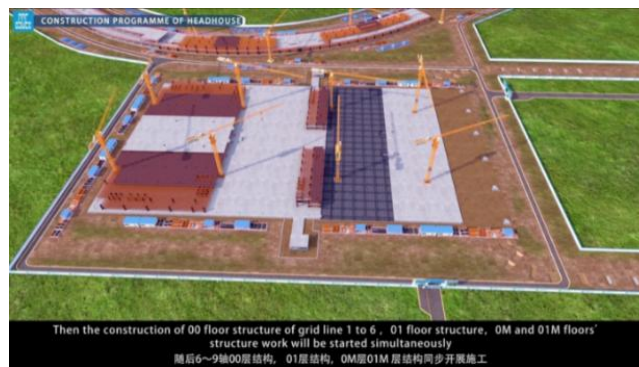


Fig 3 Construction process of structural slab casting

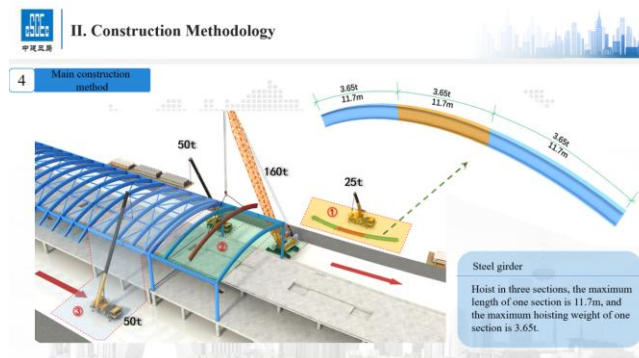


Fig 4 Construction process of finger corridor steel structure installation

### 3) Quantity Calculation and Quotation

Refined modeling also aids the commercial department in conducting precise quantity calculations and generating quotations. The greater the modeling accuracy and the wealth of

information regarding components, the more efficiently we can address challenges in quantifying specialized construction works, such as the distinctive steel structures found in airports (refer to Fig 5 and Fig 6).

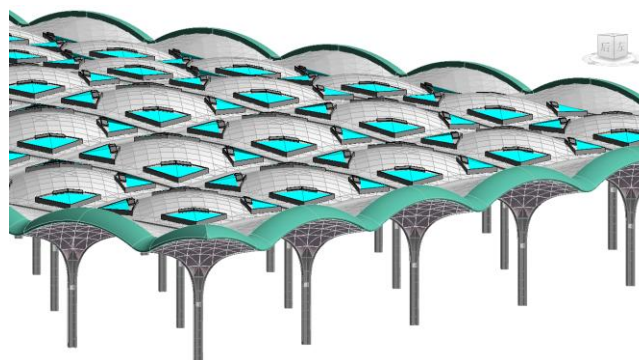


Fig 5 Calculation of the number of shaped components using the model

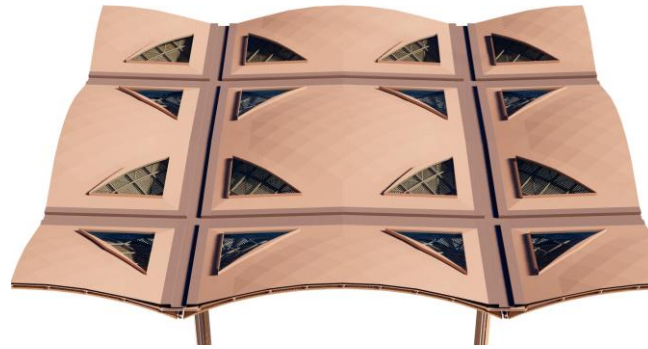


Fig 6 Calculation of quantities using the BIM model

A. Application of BIM technology in the design phase

1) Building Environment Performance Analysis

The environmental performance of a building usually refers to the environmental performance of the building during operation and the resources consumed by the building operation, as well as the impact on the environment, etc. These performance indicators are directly related to the comfort of the users, the construction cost, the operation and

maintenance cost, and the energy consumption. BIM technology contains a large amount of multi-dimensional building model information, which allows architects to simulate and analyze the building environment indoors such as acoustic performance (Fig 7) and outdoor energy-saving design (Fig 8) at an early stage of design, and to adjust the design scheme according to the results of the analysis, to improve the efficiency and quality of the design.

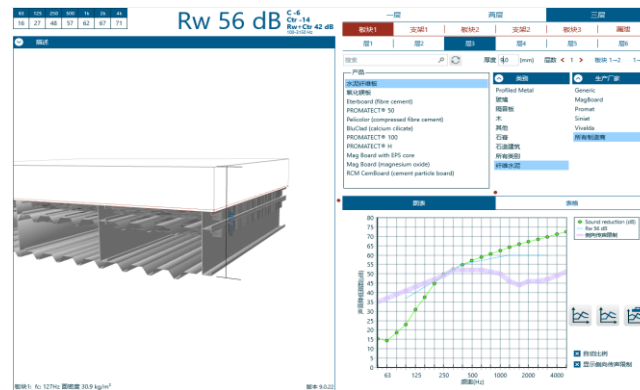


Fig 7 Analysis of sound insulation performance of building interior

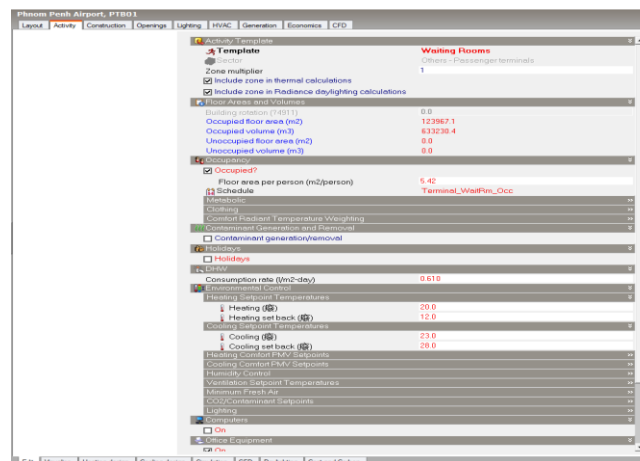


Fig 8 Energy efficient design of building outdoor roofing

## 2) Inspection of drawings

Once the general contractor receives the construction drawings, the construction engineer will employ software like Revit and other relevant BIM tools for modeling. During this modeling process, any incomplete drawings and potential clashes within the profession are identified. Upon completion of the overall modeling, Navisworks software is utilized for comprehensive collision checking. This includes

pinpointing and resolving issues such as structure-structure collisions, discrepancies in structural elevations, clashes between building elements (Fig 9), conflicts between different parts of the building, issues with clear height requirements, constraints related to installation space, clashes between Mechanical and Electrical (M&E) components, and clashes between M&E systems and building structures, among others. [3].

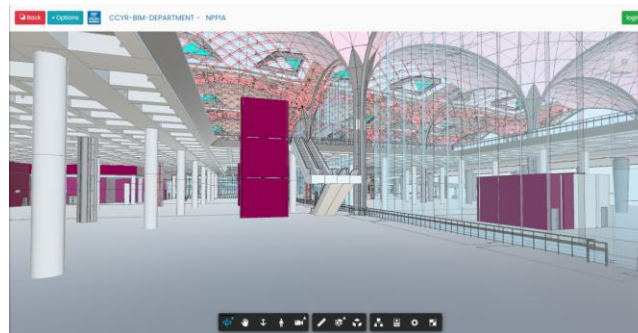


Fig 9 Building structure collision check

To avoid holes, elevations, and component dimensions that do not meet the requirements after on-site construction, secondary virtual construction is required. Through the BIM cloud platform, CSCEC Malaysia shares the models that have been built for the employees to use online, and through the access and roaming function, they use their professional knowledge to find the unreasonable places of the design to be perfected. CSCEC BIM platform provides access to all project stakeholders to share the project's data and information for all disciplines.

## 3) Space coordination and professional conflict checking

Using the three-dimensional technology of BIM software, collision detection is carried out before

construction to optimize the engineering design, improve efficiency, and reduce the loss of errors and rework in subsequent construction.

The model checking software can also be found in advance and fire codes, construction codes, and other norms conflict with the problem, etc., to reduce the construction of rework, cost savings, shorten the construction period, to ensure the quality of the building, and at the same time to reduce the consumption of construction materials, water, electricity and other resources and the environmental issues brought about (Fig 10).

Item no	Location	Clash ID	Clash Description	Minor/Type	Specific Location	Clash Lines	3D View of Clash Detection	3D View of Solution	Status				Final Remarks	
									Status	2nd Meeting	3rd Meeting	4th Meeting		
<b>Mechanical to MEP</b>														
1	HH00	CD 4187720	Piping interference	Major	EDR	ED and AA			C					
2	HH01	CD 342388	pipe to duct	Major	MEDH/MEDC	151-CD and 20B-AB			C					
3	HH01	CD 4218422	Structural column to duct	Major	MEDH/MEDC	2 and B			C					
<b>ARCHITECTURAL TO ARCHITECTURAL</b>														
1	P1 00		The wall between mechanical TV room and LV room is removed	Major	TV room and LV room	PA031 and PE1			C					
2	P1 00		The wall between mechanical TV room and LV room is removed	Major	TV room and LV room	PA016 and PE2			C					

Fig 10 Space coordination and specialized conflict detection

## 4) Review of Design Changes

In BIM application technology, design changes related to architectural finishes can be compared by establishing a 3D model and rendering, which can

visually react to the decorative effect of the design scheme for the owner's side to choose [4]. The original design of the terminal building curtain wall is a folded glass curtain wall (Fig 11), after the owner

requests replacement, the design effect can be compared through the BIM model. Avoiding the unsatisfactory effect of the construction after the decision; by comparing the rendering effect of the 3D

model, the owner's side chose the ordinary plain glass (Fig 12).

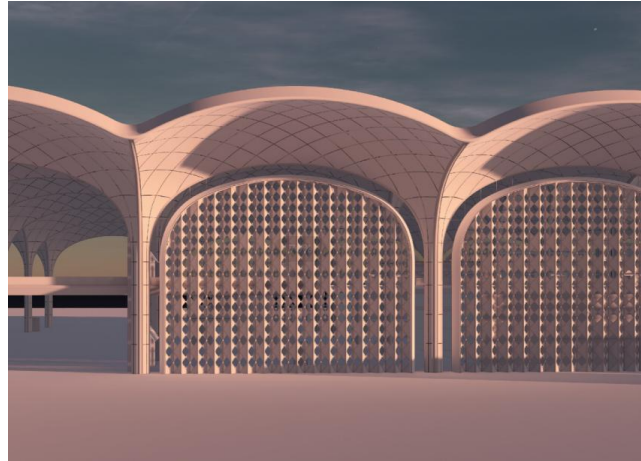


Fig 11 Folded glass curtain wall effect



Fig 12 Ordinary Plain Glass Effect

5) Three-dimensional modeling out of the deepening of the drawing

According to the actual size of the modeling, and input component information, the model is built using a three-view principle projection, section-derived component model information deepening map (Fig

13), to ensure the completeness and accuracy of the drawings, and subsequent modifications can be made by adjusting the model, "a key to complete", saving a lot of deepening the drawings to amend the time to improve the efficiency of the revision.

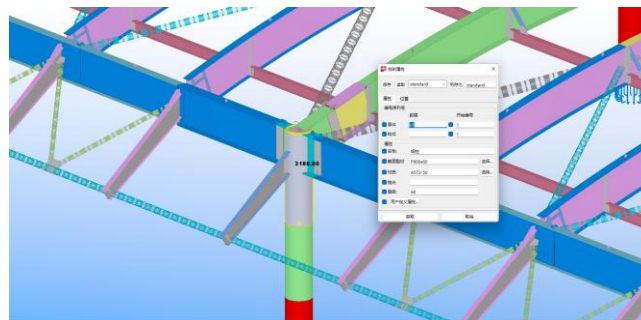


Fig 13 Column 3D model information

#### 6) Net height analysis

In Revit software, we can utilize the 3D model analysis capability of the software to do the net height check, the principle is similar to the collision check of the software. In the common airport mechanical electrical and baggage system inspection, we can add the net height analysis of

mechanical and electrical pipelines and baggage system, which is conducive to the discovery of the use of safety issues that are not easy to detect during construction and optimize the airport baggage system in advance to ensure that it can operate normally after the airport is open to the air (Fig 14, Fig 15).

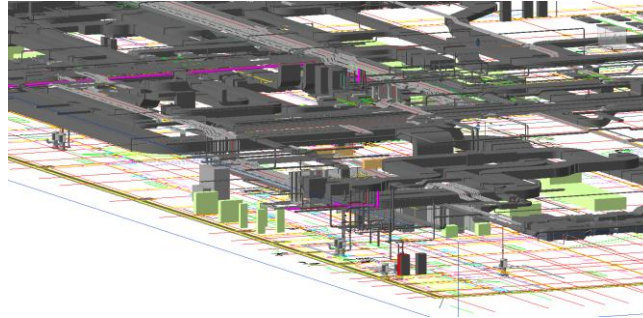


Fig 14 Electromechanical and baggage system equipment collision check

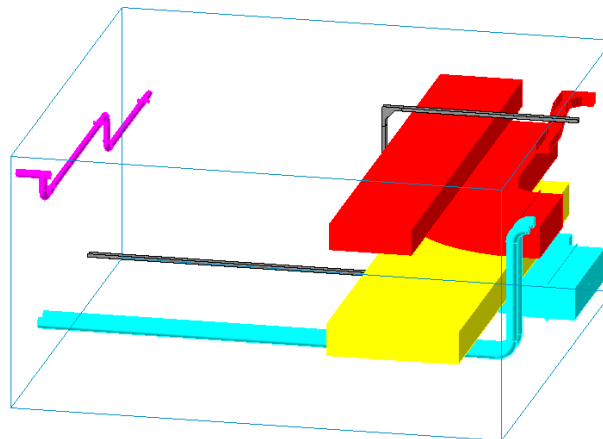


Fig 15 Electrical and Mechanical Piping and Baggage System Clearance Inspection

#### 7) Complex node deepening design

For the more complex nodes in the BIM design process, relying solely on CAD drawings can not clearly express the information and positional relationship of each component, it is difficult for the reader to understand the specific form of its construction, the use of BIM technology can provide visualization of the idea of three-dimensional physical graphics displayed in front of the construction engineers [5].

The steel reinforcement arrangement of the

viaduct in this project is dense, and it is quite difficult to distinguish the rebar type and location through CAD, which is not conducive to guiding the construction. So using BIM software to model, construction engineers can provide a full range of three-dimensional models, through the observation and analysis of the three-dimensional model, which is conducive for engineers to make reasonable drawings to deepen the modification and node optimization design (Fig 16).

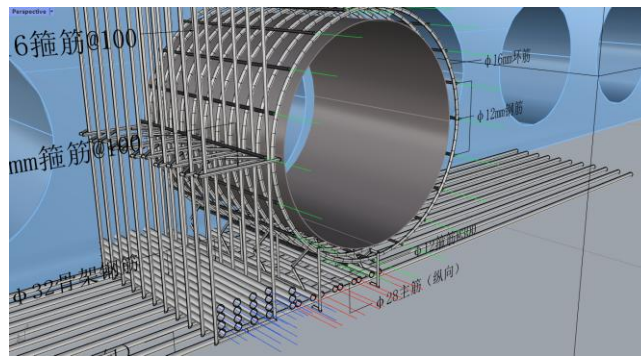


Fig 16 Complex node modeling design

#### 8) Integrated pipeline optimization

The airport depot cargo station construction process mainly follows the airport cargo transportation of various major business modules of the operational process and requirements of the system for the design, the requirements of the airport cargo station to facilitate the collection of goods, warehousing, and loading and unloading and fast, while the distribution of cargo working rooms is reasonable, whether the freight vehicle transportation routes are smooth, monitoring equipment and personnel are reasonably allocated, etc., are likely to be on the cargo station operations and management process of the normal operation may have a direct impact on the normal operation management process [6]. Therefore, it is especially important to carry out virtual operation of the Air China Cargo Terminal under construction.

Through Revit and other software design to create a three-dimensional BIM model of each professional system, the integration of the

professional model of each system for collision detection and net height analysis and research, the modeling process through collaborative work to achieve the integration of each professional model, modification, adjustment, and collision detection. The final report obtained from the collision detection is fed back to the designers for the comprehensive optimization of pipelines. According to the professional specifications and the engineering experience of the adjustment designers, the feasibility and rationality of pipeline optimization are fully considered based on the principle of pipeline comprehensive optimization and adjustment [7]. Combined with the actual requirements of the project for the various professional pipelines in the installation space to meet the net height of the integrated arrangement, so that its space utilization rate is high, the space arrangement is economical and reasonable (Fig 17, Fig 18, Fig 19), to facilitate the use and maintenance of pipelines in the later stage.



Fig 17 Optimization of integrated pipelines in energy centers

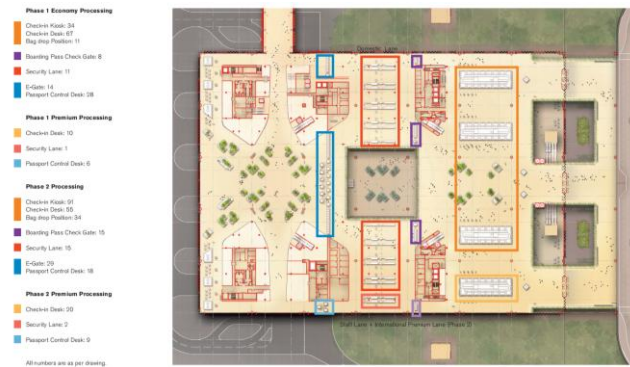


Fig 18 Optimization of integrated pipelines in energy centers

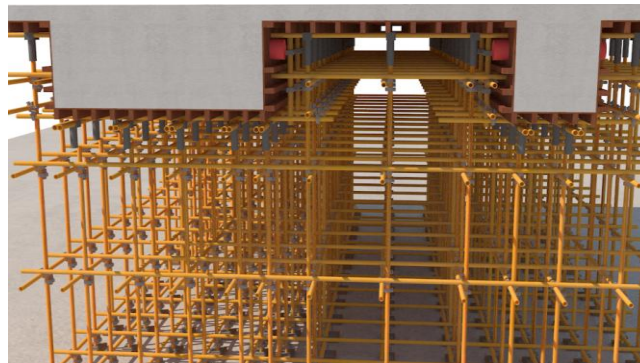


Fig 19 Energy Center pipeline model

#### A. Construction phase BIM applications

1) BIM model demonstration to assist scheme and drawing submission

According to the construction organization, drawing design to establish a three-dimensional model, in the model marks the relevant technical parameters, and shows the construction process, to strengthen the exchange of information with the construction personnel, at the same time provides access to view the model through the company's BIM cloud platform. Through BIM 3D modeling, subcontractors and engineers can understand the content of technical submissions more quickly. Apart from that, the BIM team produces sophisticated CSD (coordination services drawings)

which presents a master plan that combines all systems in an easy way to be read by even fresh engineers. ISD drawing which represents each system with all information and annotations to be used during the installation.

2) Prefabrication of electromechanical pipe

supports

The use of Revit software for electromechanical pipeline modeling, electromechanical integrated pipeline layout and anti-collision checking, deepening design and design optimization, solving the problem of pipeline collision in advance, effectively guaranteeing the integrated pipeline layout, rationally arranging the layout of the equipment, reducing the difficulty of the construction, and ensuring the accurate prefabrication and installation in the later stage [8].

Due to the complexity of equipment pipelines of various systems in the new Phnom Penh International Airport project, the application of BIM integrated pipeline optimization can realize the checking of design drawings, the optimization of net height, the optimization of spatial alignment layout, etc. (Fig 20), reduce on-site reworking, and improve the rate of one-time success and quality.4) BIM to assist in management and maintenance

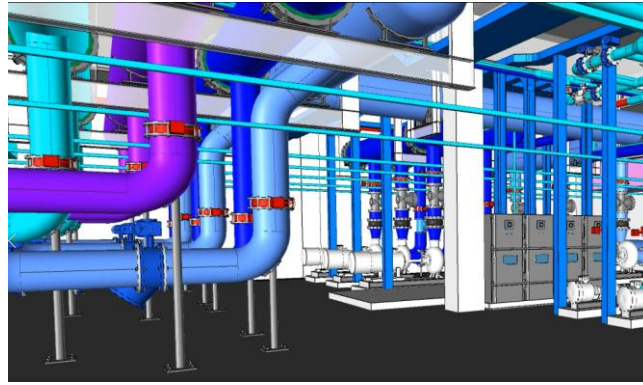


Fig 20 BIM model piping arrangement

### 3) BIM-assisted steel erection

The size of the terminal building roof is 360m\*216m, and the total steel consumption is about 7600t. The project adopts large-span super-heavy truss whole lifting and mesh shell optimized slice lifting technology, shows the steel

structure installation process in 3D through the BIM model (Fig 21), and calculates the stress condition of the components in the process of installation by using the Midas Finite Element Analysis Software, to ensure the smooth installation of the main steel structure (Fig 22, Fig 23).



Fig 21 Virtual construction drawing for truss lifting



Fig 22 Steel frame lifting on site

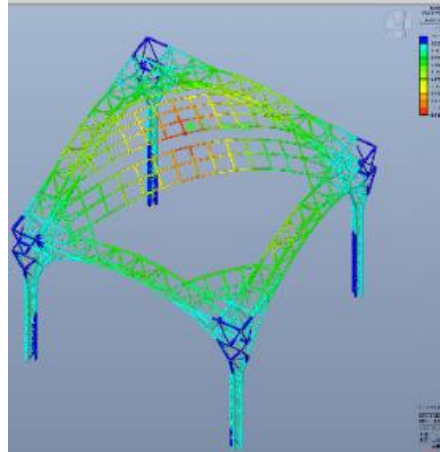


Fig 23 Finite element simulation of steel frame stress distribution

#### 4) BIM to assist in management and maintenance

At the as-built drawing stage, the design depth of the BIM model is to reach LOD500, and this design depth is identical to the actual situation on the site CSCEC conducts a 3D laser scan for each zone of the project to combine it with the virtual

BIM model and detect the differences, so subsequently if the pipelines and other components need to be managed and maintained, the repair location can be accurately found out through this BIM pipeline network refinement model (Fig 24).

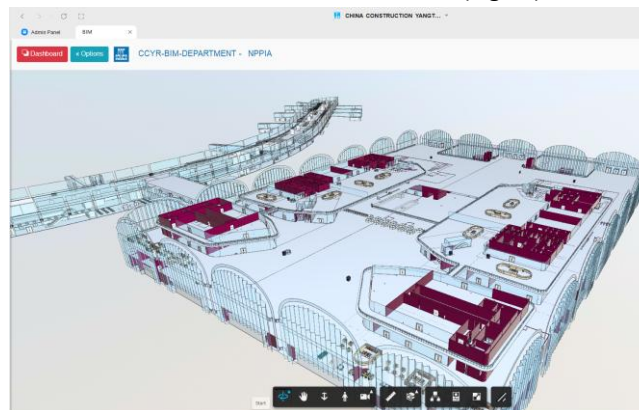


Fig 24 BIM model for management and maintenance

#### CONCLUSION

With the BIM technology is more and more attention by construction enterprises, the implementation and application in the actual project, for the enhancement of the enterprise technical force, and management level, making the enterprise and the project department management and implementation team in the direction of high standard, refinement construction and a step forward.

In large-scale airport projects, BIM technology can play its advantages to maximize the relief of large-scale airport construction, long cycles, many specialties and quality requirements, and other difficult problems.

Through the application of BIM technology in the construction process of the new Phnom Penh International Airport project in Cambodia, we have accumulated experience in the application of BIM technology in the planning, design, and construction phases of complex airports. The application value of BIM technology in this project can be mainly reflected in the following aspects:

(1) The application of BIM technology in high-standard airport projects, in addition to the current BIM main visualization, collision checking, and other applications, in-depth research and practical application in the construction simulation and optimization of complex key nodes as well as the scheme design of temporary facilities and

verification of the implementation effect have also been carried out.

(2) The BIM model of the airport project is established to realize the visualization of the project, and the research explores the valuable application points of BIM for complex airport projects, which has a certain degree of versatility and accumulates experience for the virtual construction and simulation operation of similar airport projects in the future during the planning, design, and construction stages of the project.

(3) By combining BIM technology and establishing a high-standard three-dimensional model for MEP systems, it can effectively improve the working efficiency in the process of technical management. In the process of technical briefing, the application of 3D modeling for the construction plan and drawing briefing can make it easier for the employees and workers who accept the briefing to understand the content of the technical implementation plan and technical drawings.

(4) Adopting BIM technology can provide better economic benefits. In the project design and construction phase, the application of BIM model coordination can reduce the number of drawings, program content, and business calculations, reducing unnecessary costs. In the project completion and operation stage, BIM is applied to make energy simulation and improve project facility management.

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