



Project Summary

Organization:

China Construction Sixth Engineering Corp., Ltd.

Solution:

BIM Advancements in Construction

Location:

Sanya, Hainan, China

Project Objective:

- Develop a large-scale information model for a marine infrastructure project to ensure structural integrity and safety in an underwater environment
- Implement 3D collaborative information management to establish data consistency and standardization among multiple disciplines

Products used:

AssetWise, AXSYS®, ContextCapture, Descartes, MicroStation, MOSES, OpenBridge, OpenRoads, ProjectWise®, SACS

Fast Facts

- The project covers 28 square kilometers in Hongtang Bay and includes various zones.
- Bentley's BIM applications to integrate 3D data and deliver a real-time, high-resolution reality mesh for the unique marine environment.
- ProjectWise connected platform enabled collaborative management of 3D information models.

ROI

- The 3D model and centralized data storage expedited the site allocation process, maintained construction quality, and improved collaboration.
- 3D BIM advancements and reality modeling facilitated real-time calculation and recording, improving accuracy by up to 32.5 percent.
- Bentley's integrated applications designed the largest domestic plug-in steel cylinder, serving as a reference for future national projects.

China Construction Sixth Engineering Division Implements BIM Approach for First Offshore Airport in Hongtang Bay

Bentley's 3D Digital Capabilities Optimized the Large-Scale Reclamation Project

An Offshore Gateway Airport

As part of China's belt and road initiative to promote trade strategies and increase China's role in global affairs, the State Council and Central Military Commission approved a new airport reclamation project. In Sanya, Hainan, China's first offshore airport in the South China Sea is being constructed on an artificial island created by reclaiming land from the Hongtang Bay. The airport will serve as a gateway for Southeast Asia, consistent with China's focus on connectivity and cooperation among Eurasian countries. Developed by an HNA Group subsidiary, the USD 5 billion project includes multiple construction contracts, several being secured by China Construction Sixth Engineering Division Corp., Ltd. (CCSE).

The massive reclamation project spans 28 kilometers and includes an airport operation zone, international trade zone, and auxiliary services zone. Numerous professional disciplines working in a complex underwater environment needed to effectively communicate and collaborate to create the artificial island and deliver the airport facility. CCSE was retained to implement a collaborative BIM approach and develop a large-scale dynamic information model of the extensive infrastructure to guide construction and improve engineering quality.

Integrated Technology Addresses Maritime Site Challenges

Given the unique maritime conditions associated with the island's structures, CCSE required innovative solutions to ensure transport stability and structural integrity. The project adopted a thin-walled steel cylinder cofferdam that was 30 meters in diameter. It needed to be transported and accurately positioned to support construction below the waterline. CCSE modeled the largest domestic plug-in steel cylinder using MicroStation® and, with Bentley's integrated simulation and design applications, analyzed and adjusted the design to optimize safety and prolong the life of the offshore engineering structure. Based on the model, the team used MOSES to simulate various vibration, wave, and tidal conditions, both on the cylinder and the semi-submerged transport ship. With SACS, the team performed fatigue damage assessments

to ensure initial, integrity, and damage stabilities of the steel cylinder, which was vulnerable to ocean impact during transport and positioning. The applications enabled finite element analysis, improving engineering efficiencies associated with the cylinder between 25 and 30 percent. Using Bentley's interoperable software reduced risk and optimized design to withstand the stresses of the ocean environment.

In addition, the offshore causeway, which serves as the main wave retaining structure of the artificial island, is extremely long, given the large area of the island. Therefore, the display of the accropode blocks for the wave resistance protection face presented technical difficulties. The team designed and analyzed the structure using Bentley BIM applications for optimal placement of the protection face elements, achieving a better wave-absorbing effect. With the modeling functions in MicroStation, CCSE staggered the accropode blocks in an arrangement on the causeway for a cost-effective solution.

Reality Modeling Optimizes Construction Planning

Faced with a complex construction environment and limited space resources, CCSE needed a complete understanding of the reclamation area to accurately model the island project and minimize costly and potentially risky changes onsite during construction. The team ultimately decided to deliver a real-time, high-resolution reality model to facilitate planning, improve engineering, and guide ongoing construction. Using unmanned aerial vehicles, the team acquired point cloud data and captured real-time site and detailed terrain information to assess the construction area and closely monitor and control the construction process. With Bentley applications, CCSE modeled terrain, water, and vibration conditions and integrated those 3D models into the reality modeling application of ContextCapture, generating an engineering-ready reality mesh to expedite the site allocation process and monitor construction progress of the artificial island. LumenRT enabled the team to create a live rendering of the Sanya airport site. Reality modeling and simulation of the construction plan provided an overall perspective of the works for continuous surveying and onsite progress, enabling digital control of the construction process, improving efficiency and

“Bentley products cover the entire project and connect data seamlessly, providing a one-stop intelligent solution. Bentley’s collaborative management platform provides a timely and accurate information environment, centralized data storage, and access for all participants, shortening the project period.”

*– Weiguo Tian, Chief Engineer,
Southern China Branch of China
Construction Sixth Engineering
Division Corp., Ltd.*

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construction quality, and resulting in time and cost savings.

In addition to checking the construction progress, 3D BIM methodology and reality modeling facilitated real-time calculation and recording of engineering quantities, optimizing construction planning from a material quantities and cost perspective. CCSE generated a digital terrain model (DTM) as part of its 3D visualization and extracted earthworks quantities and other material to calculate the construction quantities for the complex island structures, improving calculation accuracy of engineering quantities by up to 32.5 percent. Using the models to simulate the transportation path of the construction site also enhanced scheduling efficiency on site and ensured smooth traffic flow, integral to efficient construction planning.

ProjectWise Facilitates Digital Management

The foundation of CCSE’s integrated reality modeling and collaborative 3D BIM methodology is the ProjectWise information management platform. With numerous professional disciplines working with large amounts of data in different environments, CCSE required a shared workspace to ensure consistency and standardization of data throughout the project lifecycle. Using ProjectWise, the team developed a private cloud for the project to coordinate enterprises and professionals, achieving dynamic data retrieval and data processing. The Bentley-based platform provided an accurate, timely, and comprehensive information collection system, accessible in real-time to all project participants.

Working in a connected data environment with ProjectWise ensured all data was well correlated, highly consistent, and extensively shared for full use of information, collaborative

management of 3D models, and overall better decision making. The ProjectWise-based BIM application of Sanya airport enabled centralized data storage, streamlined workflows, and facilitated management of models and documents with digital workflows. With seamless access to accurate data and files, CCSE realized full digital control and visual management of the project, reducing project time and delivery costs.

Success Drives 3D BIM for Marine Engineering

The successful application of BIM advancements to the construction of Sanya’s new airport artificial island reclamation project demonstrates the effectiveness of this methodology to optimize engineering and construction management on a large-scale marine infrastructure project. Using Bentley’s integrated solution to deliver a real-time reality mesh of the airport site, CCSE introduced full digital intelligent management for the first time on a marine reclamation construction project. It exemplified the technology’s incomparable advantages over traditional methods.

With Bentley application’s design, analysis, and simulation capabilities, CCSE created a 3D real-time information management model, making the complex marine engineering construction digitally informative and integrated. As a key state project supporting China’s belt and road strategy, the land reclamation of Sanya’s airport is a testament to using 3D collaborative BIM methodology for intelligent construction and serves during future national key projects.



Bentley’s integrated simulation and design applications were used to analyze and adjust the design to optimize safety and prolong the life of the offshore engineering structure.