Hydropower Engineering Construction in Cloud Technology Age  

— Use of BIM Technology in Construction of Guanyinyan Hydropower Station on Jinsha River — Use of BIM Technology in Construction of Guanyinyan Hydropower Station on Jinsha River

The 3D BIM Construction System equipped with Autodesk BIM software fundamentally improves the effectiveness of quality control and is an innovation in the traditional product delivery method. It provides customers with high-quality design products through instant and fast data sharing.

— Cao Yinan  
Director of Science and Information Department, Director of 3D Design Supervision Department  
PowerChina Kunming Engineering Corporation Limited

PowerChina Kunming Engineering Corporation Limited (hereinafter referred to as KHIDI) is a large-scale, comprehensive state-owned class A unit for investigation, design and scientific research. KHIDI is mainly involved in the planning, research, consultation and assessment of domestic and foreign hydropower, water conservation and wind power projects, as well as investigation, design, scientific research tests, general contracting, management and supervision of engineering projects; investment and operation of hydropower and wind power projects; design of environment protection, design of water and soil conservation, design of roads and bridges, design of industrial and civil buildings, design and construction of geotechnical engineering, budget estimates and budgeting of project, water resource evaluation, security evaluation, geological disaster evaluation, investigation delimitation, and engineering monitoring, etc.

Since 1992, KHIDI has been among China’s Top 100 Designers and holds a leading position among hydropower designers. It also ranks first out of the Top 50 Designers in Yunnan Province. In the last 57 years, KHIDI has surveyed and designed more
than 460 hydropower stations and gained valuable experience in engineering practices; KHIDI now has a total staff of 1,600 and a strong technical workforce.

**Project Overview**

The Guanyinyan Hydropower Station on the Jinsha River, designed by PowerChina Kunming Engineering Corporation Limited, is located in the middle reaches of the Jinsha River - where Huaping County, Lijiang City (left bank), Yunnan Province and Panzhihua City, Sichuan Province (right bank) meet -- and is the last of eight cascade hydropower stations planned in the middle reaches of the Jinsha River. The hydropower station is at a straight-line distance of about 220 km from Kunming, the capital city of Yunnan Province. 5 units are installed in the hydropower station, with a unit capacity of 600MW and a total installed capacity of 3000MW. The engineering development function of the hydropower station prioritizes power generation and also considers water supply and flood prevention. After completing the construction of the hydropower station, tourism and reservoir region shipping can be developed, so as to promote the coordinated development of the local economy, society and environment.

**Project Background**

Construction of a hydropower project is complex system engineering. It features include: large numbers of participants, deployment of an entire complex project hub, extensive space and a tight construction schedule. In particular, construction of the main power house involves a large amount of concrete casting, coordination among different disciplines and complex working procedures... all is one of the keys to controlling the construction quality and progress of the entire hydropower station.

In the hydropower industry, 3D design technology has been comprehensively applied to the design of construction documentation by KHIDI. The power of 3D design has improved documentation productivity and shortened the design cycle, and its visualized method of creating drawings has been accepted by owners and construction companies. The 3D BIM design method constitutes a revolution in hydropower design. However, construction performed by construction companies is still based on paper construction blueprints generated by BIM models. This has some limitations, and does not embody the advantages of 3D design in a comprehensive and in-depth way. Moreover, there is a certain delay in exchange of data between different parties in the engineering construction (owners, designers, construction companies, supervisors, as well as operation and maintenance parties).

Improving the quality and efficiency of design disclosure to fully and promptly present the design results and intents is one of the important topics design companies face. On this basis, we have applied BIM technology heavily, exploiting its value to the fullest in order to provide better service in construction. We established a comprehensive data platform where users can have full and in-depth sharing of their designs -- the Guanyinyan 3D BIM Construction system.

**Solution**

Data exchange - Autodesk BIM 360

Autodesk BIM 360 provides a proprietary engineering data transmission channel, by which the design intents can be transmitted promptly, effectively and accurately. Traditional design changes are performed by sending notices of design change to the construction sites via fax or Internet, and then notifying the other party through phone calls or emails, or sometimes by providing newly modified drawings. This type of process leads to a certain delay of information transmission. The construction drawings sent to the construction sites are for specific regions, i.e., there is a lack of connection between different regions or professional drawings), and construction operators need to look up and check different drawings before construction, thereby increasing the difficulty of construction. Moreover, human error is not uncommon among field construction operators who have to deal with large numbers of drawings and notices of change. It is difficult to update engineering information promptly and wrong versions of drawings are sometimes used. All this severely affects the progress and quality of construction.

The Guanyinyan 3D BIM Construction System, with based extensively on its foundation in comprehensive 3D design, uses state-of-the-art cloud service technology to bring design results (including 3D BIM models, construction blueprints, notices of design change, contract documents, etc.) to mobile devices (iPad, iPhone, Surface, etc.), and is used in the engineering design, construction and management of Guanyinyan Hydropower Station.

The 3D BIM Construction System equipped with Autodesk BIM 360 is a dynamically updating system. The designers update and maintain the BIM, drawings and relevant documents in the cloud account promptly according to the latest design results and onsite change notice. The clients can obtain the latest real-time design results from the cloud server and update the field construction information promptly through a network connection.

![Fig. 4 Cloud Service Technology](Image)

**3D Browsing Solution for Windows System - Autodesk Navisworks**

The Windows client-side provides a 3D construction simulation scheme simulation solution for 3D construction. Through photorealistic real-time 3D simulation effect, designers and construction operators can fully understand the structure and arrangement of the hydropower station in advance, and grasp the overall layout before the construction of each system. This allows them to better coordinate the construction progress and processes so as to ensure high quality and efficiency in the construction of the hydropower station. Users on the Client side can rotate, look around, zoom in/out, section, measure and query the attributes of the BIM models. These functions can compensate for paper drawings, which lack the ability of full display, and can also be used to rapidly search for the required engineering information where the drawings are not clear.

![Fig. 5 Picture of the Latest Field Construction](Image)
THE 3D BIM CONSTRUCTION SYSTEM EQUIPPED WITH AUTODESK BIM SOFTWARE INSTANTLY UPDATES DESIGN DRAWINGS AND DOCUMENTS AND ENHANCES THE COMMUNICATION BETWEEN EACH ENGINEERING CONSTRUCTION PARTY, ALL ON A SINGLE DATA PLATFORM.

—Zhu Zhigang
Assistant Chief Design Engineer of Guanyinyan Hydropower Station
PowerChina Kunming Engineering Corporation Limited

The 3D BIM Construction System equipped with Autodesk BIM software instantly updates design drawings and documents and enhances the communication between each engineering construction party, all on a single data platform.

Service Platform for Engineering Information Presentation - Secondary Development of Navisworks, Supporting IPAD
Autodesk Navisworks provides the owners of construction projects with comprehensive visualized browsing services for engineering information. With an orientation towards project management by the owner, it provides a 3D simulation of BIM engineering models, simulation of construction plans of electromechanical equipment, simulation of actual installation progress of equipment, as well as comparison and analysis between plans and actual progress, in order for the owners of the projects to completely view the results, plans and implementation of engineering construction, as well as help them monitor engineering construction and make decisions in the future.

It provides technical support to carry out overall monitoring during engineering construction, solves the drawbacks of traditional engineering construction where the construction effect can only be imagined according to the drawings and the real effect can only be seen after completion of engineering construction, and greatly improves the level of comprehensive visualized management of engineering construction. The service modules in this platform mainly include a module for 3D model simulation and query, a module for installation planning of electromechanical equipment, and a module for 3D simulation and data analysis and comparison of actual installation progress.

3D Browsing Solution for iPad - Autodesk BIM 360 Glue
iPad clients are provided with a simulation solution for 3D construction. 3D BIM models can be browsed through the Glue clients on iPad. The browsing interface is simple, and has a game-like interface which is easy to operate. iPad’s excellent operating environment provides a smooth roaming experience for BIM models.

Through system terminal devices (iPad, iPhone, surface, etc.), the system users can: (1) view, rotate and section 3D models; (2) view and mark construction plans and system schematics; (3) roam the power houses to view surrounding buildings and equipment pipelines; (4) examine the components of buildings and attributes of electromechanical equipment; (5) examine design notices and contract documents, etc.; (6) view site pictures to understand the latest construction progress of the hydropower station.
3D BIM Construction System equipped with Autodesk BIM software plays an active role for all parties involved in engineering construction. Using this system, designers can express their design intent accurately, promptly and effectively, allowing them to provide high-quality design results to the owners and construction and supervisory parties.

As for construction and supervision parties, past engineering experience shows that during the construction of a power station, ambiguous design information and untimely transmission of design modifications result in construction operators misunderstanding the design information. Frequent errors, omissions and risk at the construction site likewise surface. All this has a major impact on construction progress and quality. 3D BIM Construction System equipped with Autodesk BIM software, allows construction operators to view the 3D models on their mobile devices and clearly understand the layout of equipment, pipelines, etc., as well as view the design change notices, and the parameters and attributes of each equipment component. This greatly reduces errors, omissions and risk, while decreasing rework and waste. In all, the following objectives are met: investment savings, on-time completion and quality engineering.

Owners using the 3D BIM Construction System equipped with Autodesk BIM software can effectively control key procedures in construction, get a prompt understanding of the engineering construction progress and improve the level of construction management.

Summary

By adopting a series of Autodesk software products (including the Revit series, Autodesk Navisworks series, Autodesk 360 series, etc.) and using state-of-the-art cloud service technology, the Guanyinyan 3D BIM Construction System carries out standardization, integration, networking and virtualization of engineering construction management.

Based on the successful implementation in the Guanyinyan Hydropower Station, this system can be promoted and used in other hydropower construction projects. Moreover, through further research and development, the system can also be applied in the operation and maintenance phases of hydropower stations, in order to realize the total lifecycle management of hydropower projects and build modern digital hydropower stations.