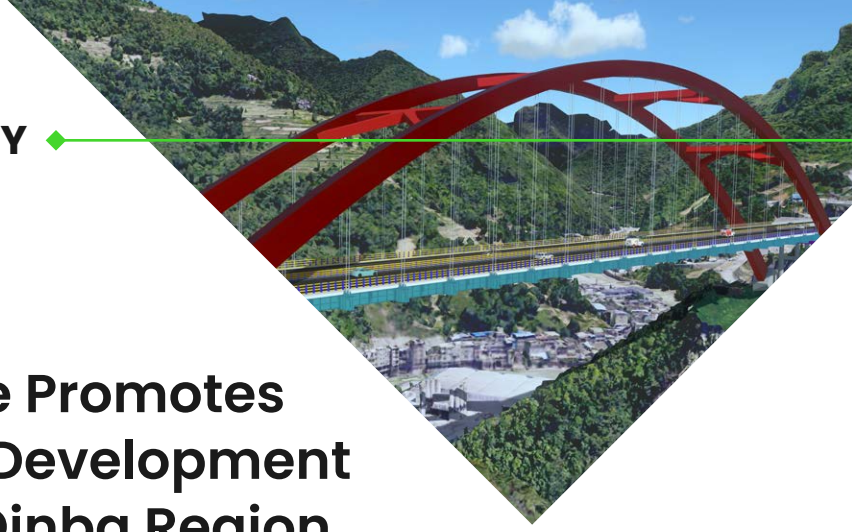
Bentley
Advancing Infrastructure

CASE STUDY



Iconic Liaozi Grand Bridge Promotes Industrial and Economic Development in China's Mountainous Qinba Region

Bentley Technology Facilitates Digital Workflows and Construction Simulation, Saving Time and Money

BRIDGE CONNECTIVITY SUPPORTS RURAL REVITALIZATION

An iconic project located along the Chengkai Expressway, the Liaozi Grand Bridge spans just over 330 meters across China's Qianhe Gorge and will improve transportation in the Qinba mountainous region. The main bridge is a medium-bearing, 252-meter steel box arch bridge with arch piers situated on both sides along the steep mountain ridge. It is the country's first non-coating, high-performance, weather-resistant steel box arch bridge. China Railway Changjiang Transport Design Group (China Railway) is delivering the bridge as a pilot project to support their research on the comprehensive application of BIM-based digital design and construction of large-span arch bridges. "The goal is to achieve a high degree of parameterization, refinement, and intelligence in the 3D fast forward design of large arch bridges based on precise GIS," said Fengmin Chen, head of the BIM technology department at China Railway.

As the final link in providing modern highway transport access to every county in Chongqing, the Liaozi Grand Bridge completes the operation of the Chengkai Expressway, opening the doors to convenient transportation for the long-isolated county of Chengkou. It eliminates hours of travel over mountainous roads, reduces travel time and distance by one-third, and connects the once inaccessible Qinba mountain area to the rest of the county. "This achievement is of great significance for driving economic development in the surrounding areas, promoting industrial and economic upgrading, and helping to revitalize rural areas in the Qinba Mountains region," said Chen.

MULTIPLE BRIDGE COMPONENTS AMID STEEP TERRAIN

Given its location, the project presented steep terrain and poor traffic conditions, making it difficult to build temporary construction roads and bring materials and machinery to the site. With both sides of the bridge arch abutment situated on the ridge where the slope angle is as high as 70 to 80 degrees, and the bridge deck ranges from 127 meters from the river surface to 186 meters at the highest point of the arch rib, China Railway faced significant construction challenges. "The highest point of the arch rib is 186 meters above the river surface, equivalent to a 60-story building, making construction difficult," said Chen.

As with most bridge construction projects, the Liaozi Grand Bridge also involved the planning and execution of multiple components in a dynamic environment, where once a problem occurs, it is often irreversible, resulting in safety issues and wasted time, resources, and costs. "Therefore, it is a problem determining how to use engineering information in depth and integrate management of engineering performance, quality, safety, progress, and cost in the lifecycle of large bridge construction projects," said Chen. China Railway realized that they needed an integrated 3D digital solution to model the bridge and simulate the construction process to ensure optimal planning, safety, and quality of the bridge. They wanted to promote comprehensive BIM application for highway and bridge design and construction, as well as propose new methods of bridge construction monitoring based on BIM technology to achieve intelligent construction management for the Liaozi Grand Bridge.

PROJECT SUMMARY

ORGANIZATION

China Railway Changjiang Transportation Design Group Co., Ltd.

SOLUTION

Bridges and Tunnels

LOCATION

Chongqing, Chongqing, China

PROJECT OBJECTIVES

- To reduce travel times and support rural revitalization within the Qinba region with the Liaozi Grand Bridge.
- To promote intelligent management of highway and bridge construction in China.

PROJECT PLAYBOOK

Bentley LumenRT™, iTwin® Capture, OpenBridge®, OpenRoads™, ProStructures™

FAST FACTS

- The Liaozi Grand Bridge provides the final link along the Chengkou Expressway, connecting every county in Chongqing to modern convenient transportation.
- China Railway applied comprehensive BIM workflows and virtual simulation to address bridge design and construction challenges amid the mountainous topography.
- They established a 3D digital design and construction management platform using Bentley's Open applications.

ROI

- Through parametric 3D modeling, China Railway reduced bridge design time by 300 hours.
- The BIM-based construction management platform improved on-site management efficiencies, saving nearly CNY 2.2 million in management costs.

"We applied Bentley's digital information technology and management concept to the design, construction, manufacturing, installation, and construction management cycle of the Liaozi Grand Bridge to provide a technological route and implementation plan for digital bridge construction."

– Fengmin Chen, Head of the BIM Technology Department, China Railway Changjiang Transport Design Group

LEVERAGING BENTLEY'S BIM AND REALITY MODELING APPLICATIONS

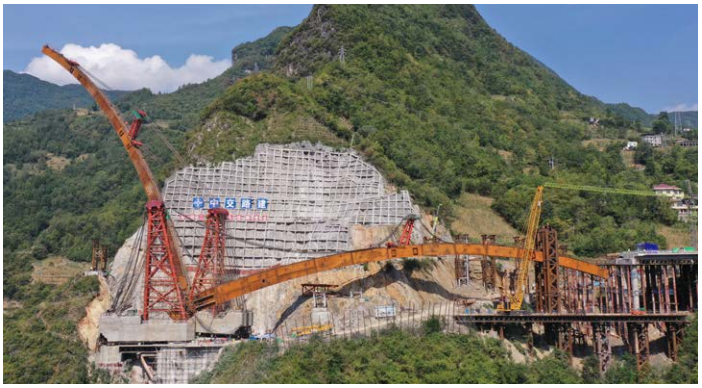
China Railway leveraged Bentley's digital reality modeling and BIM applications throughout design and construction to model the existing site and new bridge, as well as provide a virtual simulation of the construction process to guide, monitor, and manage the bridge construction process. Using iTwin Capture, they processed drone-captured images, orthophotos, and point clouds of the complicated terrain to generate a 3D digital terrain model to accurate present the different surfaces. The model also helped with analysis of the site's slope and elevation at various periods during the construction process. With MicroStation, they integrated the 3D bridge model with the reality mesh, modifying the terrain model to reflect the excavation works and determine the optimal bridge layout and construction scheme. "The integrated model can be used for the layout of the bridge location, fly-through display of the bridge, and construction simulation," said Chen.

With Bentley's interoperable 3D modeling applications, China Railway created a collaborative design and construction management platform. "The BIM-based construction management platform can perform full-bridge measurement payment, accurate simulation of construction progress, and accurate calculation of square volume," said Chen. It provided a virtual, visual representation to help China Railway determine that a combined vertical and horizontal rotation construction process for the main arch would be the most effective to address the limited site accessibility and topography conditions. Using Bentley technology, China Railway developed over 40 workflows. They were able to seamlessly work with over 20,000 digital bridge components and accumulate more than 120 gigabytes of digital assets, transforming traditional 2D manual management into 3D digital bridge construction management.

3D DIGITIZATION DRIVES SAVINGS, SUSTAINABILITY, AND INTELLIGENT BRIDGE MANAGEMENT

Implementing 3D BIM workflows and digital modeling enabled China Railway to accurately visualize the project site, improving design optimization and reducing onsite visits by approximately 25 days. The parametric modeling capabilities of Bentley's applications reduced bridge design time by 300 hours to save CNY 500,000 in design costs. "The use of a new [digital] workflow based on Bentley technology helped us complete the design project 35 days ahead of schedule," said Chen. Through virtual simulation, China Railway was able to express the design plan more accurately, as well as streamline communication with the owner and all project participants. Bentley's open, interoperable technology eliminated software compatibility issues with data integration, providing a single source of truth throughout the project lifecycle.

Working in the Bentley-based digital modeling and visual construction management platform, China Railway identified potential collisions during the rotation construction process prior to the actual on-site works, allowing them to increase the vertical rotation angle to avoid any issues. The construction solution saved CNY 20 million in management costs and risk-based losses, shortened the construction period by 55 days, as well as reduced the environmental footprint of the project. By applying comprehensive BIM strategies and construction simulation, China Railway achieved 3D visualization of the management process, workflow automation, and standard digitization. They formed an intelligent analysis system that provides the basis for developing a digital twin for digital bridge maintenance and operations and promotes industry digital industrialization. "This successful practice lays a solid foundation for the upcoming era of digital maintenance and operation and takes a solid step towards the goal of integrating physical engineering with information data in the digital twin," said Chen.



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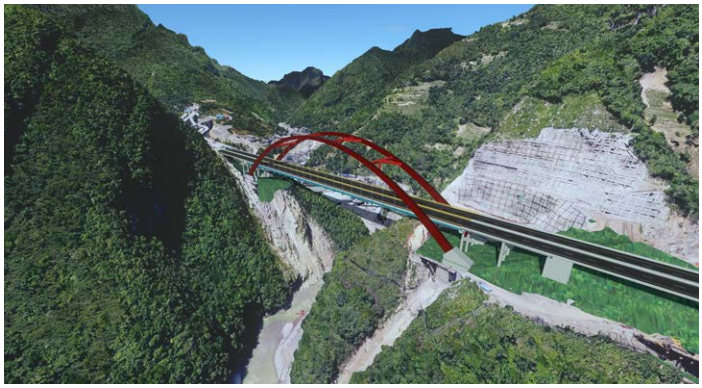

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