[Building the Fanli Bridge with vertical and horizontal BIM]

by: Teresa Elliott | 03/23/2016

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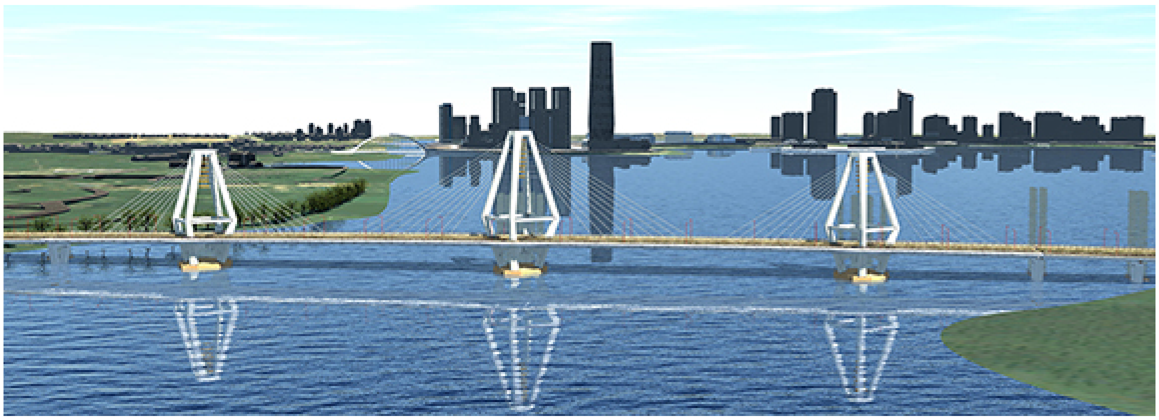


Project: Fanli Bridge Agency: Yixing City Department of Traffic and Transportation Location: Yixing, Jiangsu Province, China Software used on the project: Autodesk Revit, AutoCAD Civil 3D, Autodesk Navisworks Manage, Autodesk 3ds Max, and Autodesk InfraWorks 360.

Currently under construction, Yixing's Fanli Bridge in Jiangsu Province, China, is a cable-stayed bridge with three lantern-shaped towers that cross the Dongjiu River and Fanli Avenue.

The total length of the bridge is 500 meters with six dual vehicle lanes, and the project's total cost is approximately US$100 million. The Tongji Architectural Design and Research Institute designed the bridge and is involved in the construction planning. Due to the urban landscape requirements, the special lantern shape is adopted for the towers. The bridge's unusual lantern-shaped towers adds to the complexity of the structure's design and construction planning, but BIM processes and model-based design, analysis, and construction planning helped the team master the project's intricacies and supported a significant schedule and cost savings (compared to traditional 2D design processes).

Design for vertical and horizontal BIM

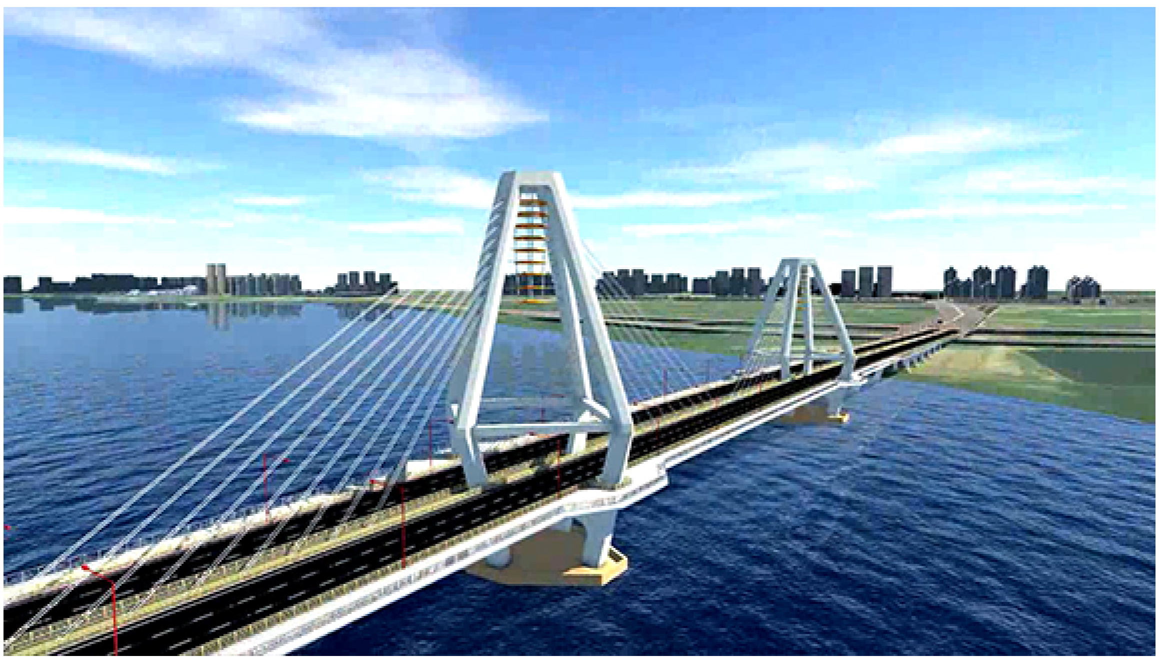
Unique design challenges

1. Design the stiffeners and diaphragms to ensure safety of the tower, especially the lower crossbeam nodes and the cable anchorages
2. Decisions on how to divide the steel box girder (longitudinally and laterally) and steel towers (vertically) so that these sections can meet the highway transportation size limit and the maximum hoisting weight of the floating crane; at the same time, when designing longitudinal division and transverse diaphragms, positions of the anchorages in the box girder and towers must be considered.

3. Collaborative design is needed for the towers and the box girder especially where the tower legs cross the girder; collaborative design is needed between the cables and the girder and between the cables and the towers.
4. Maintain operating space for both welding and later maintenance.

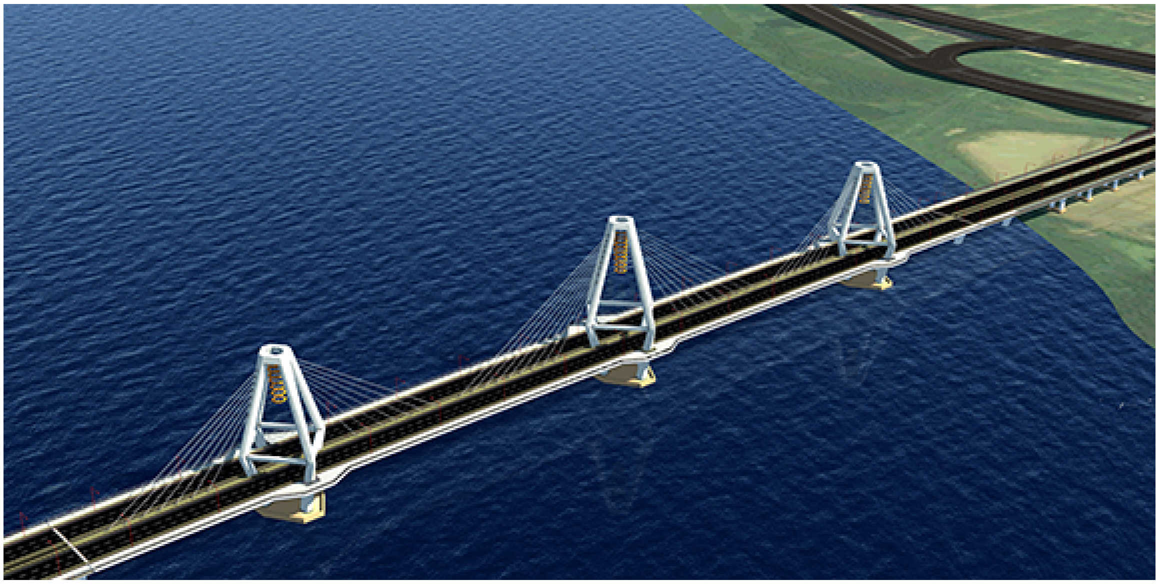
Model-based workflows

For its design effort, Tongji used an intelligent 3D Revit structural model as its main design platform. This model was central to the team's structural design and documentation workflows—and since the software automatically generates a corresponding analytical model, the Revit model was also used for structural analysis. The team used the model to create 3D images and videos of the project for better understanding and decision making throughout the extended team, even down to the colors of the bridge varnish. Model-based design workflows helped improve efficiency and reduce rework. With everything integrated into the model, information was more easily and accurately acquired. And it was easier to manage the overall design process.



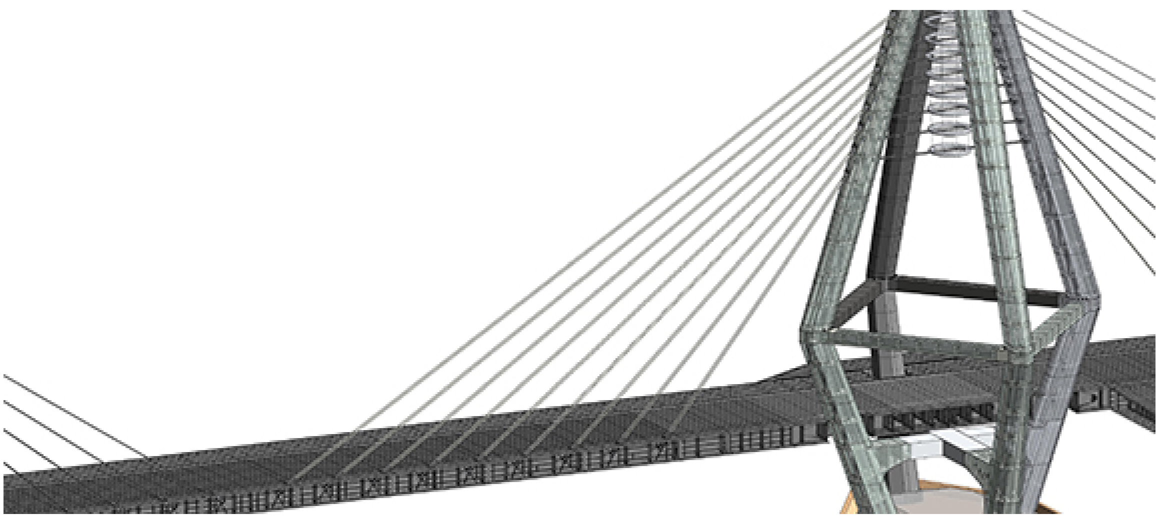
InfraWorks 360 helped a lot in conceptual designing, for its convenience in rapidly generating the terrain and land features. Roads and conventional beam bridges can also be generated using road and bridge design tools. Several schemes of the main bridge (with different span distributions and even different bridge types) can be imported from Revit to into InfraWorks 360 to create different scheme visualization, which helped the owner make decisions. With visualization the team could show that they met the requirement to have the bridge remain harmonious with the environment. And, the colors of the bridge varnish, details of the design and styles of the auxiliary facilities were easier to demonstrate.

Furthermore the cloud was helpful in providing the ability for the team to upload the models and view anywhere which helped save time in delivering files and provided space to store files.

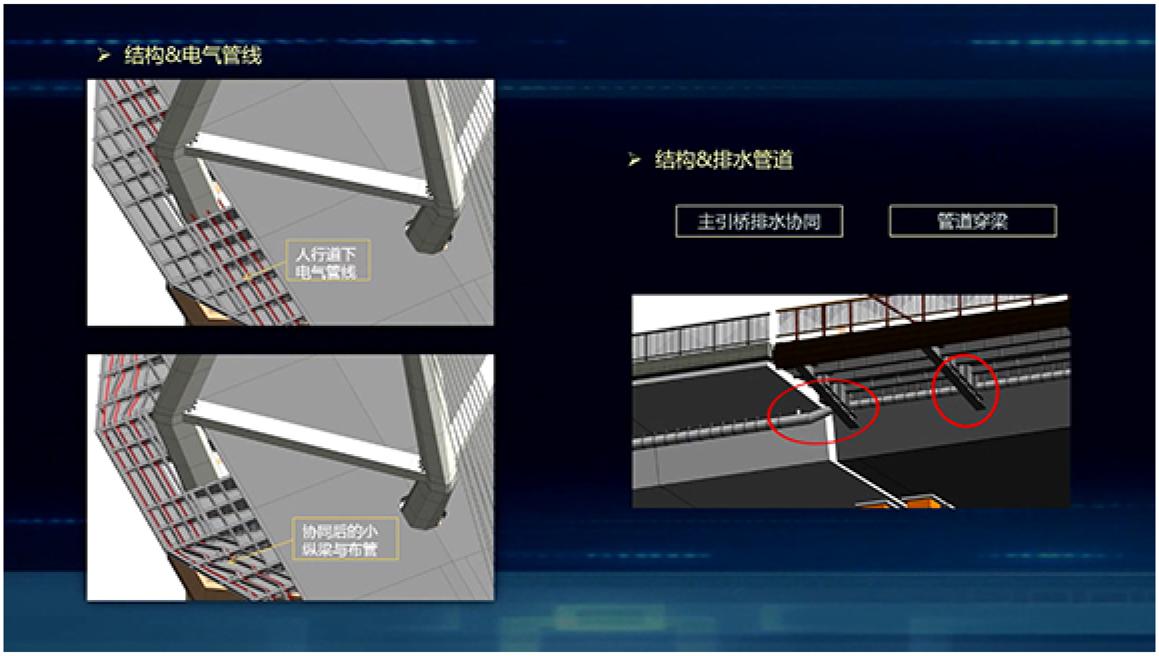


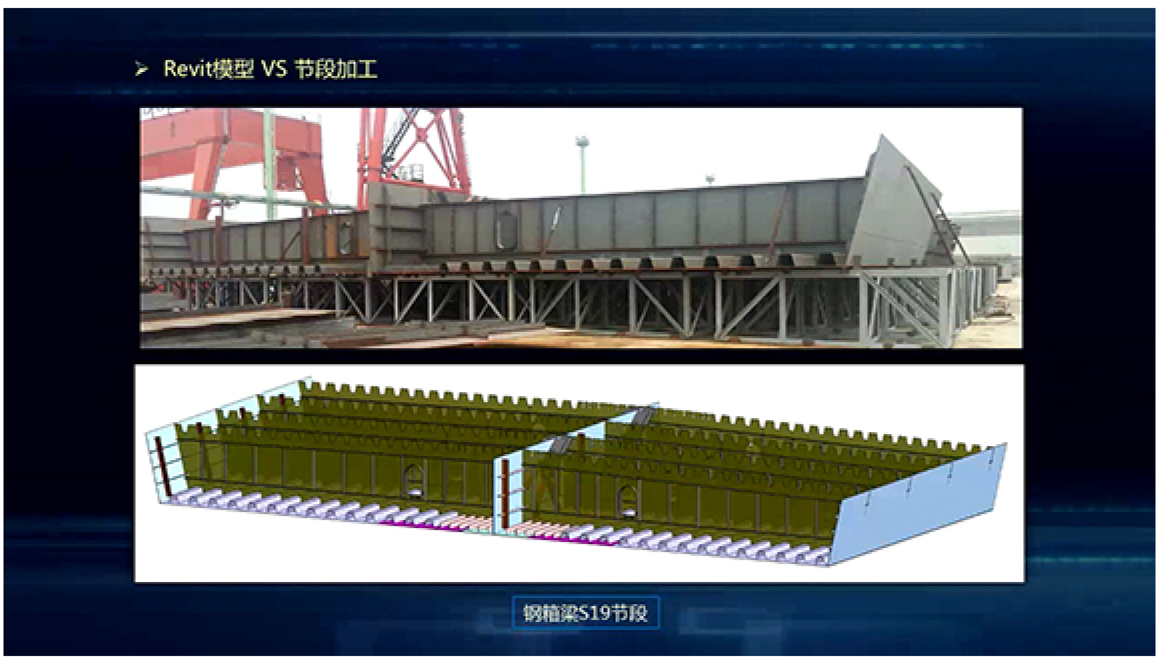
Bird's-eye view. This is a snapshot from Autodesk Infraworks 360.

Tongji designed the vertical structures with Revit and AutoCAD, the team built a 3d model, exported to FEM software for analyzing, revised the model and then generated detailed drawings. All of these were based on the same integrated central data, through which all the parameters can be saved, revised and updated.



Profile of the Bridge – The inner details of the mid-tower and the box girder shown in Revit





Construction for vertical and horizontal BIM

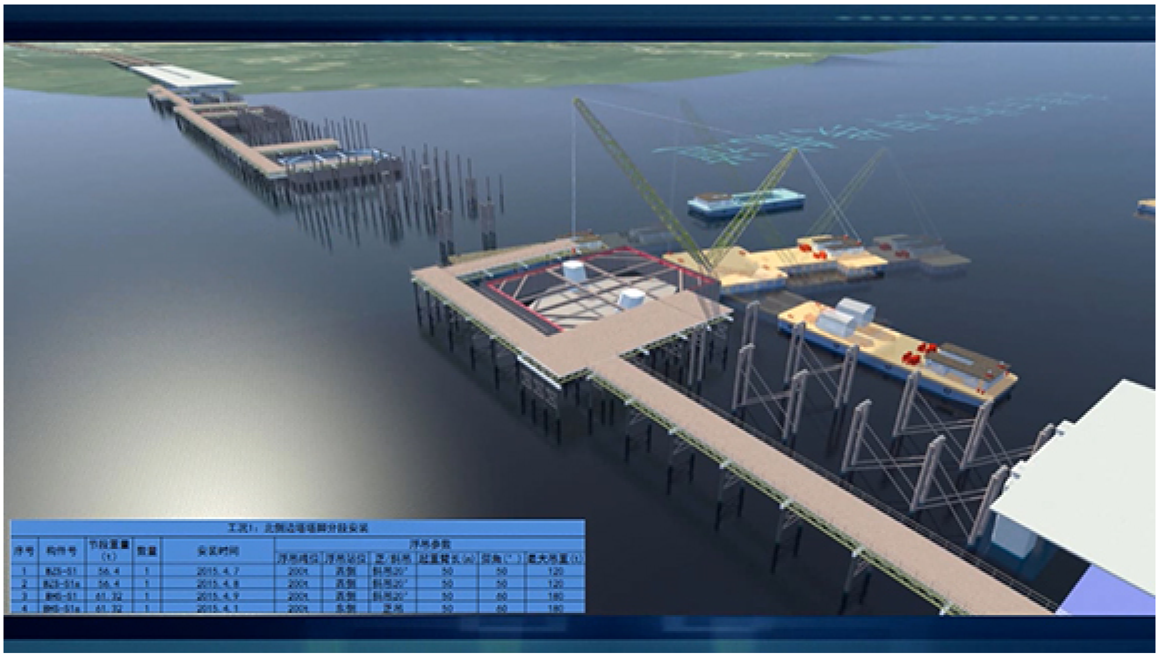
Unique construction challenges

1. How to manufacture the steel tower sections in the factory, find the reasonable plate assembly and welding order.
2. How to make schedule arrangements to make full use of people, machines and materials.

3. How to arrange the proper position, angle, route of the two floating cranes and avoid collision between the cranes and the installed sections, temporary supporting frames, the beam assembly platforms.

Construction planning and simulation

Tongji used Navisworks Manage to combine the structural model of the bridge with the Civil 3D civil engineering model of the road and surrounding terrain models for multidiscipline project coordination and clash detection.



This multidiscipline model was also used for construction planning and simulation, helping the team evaluate in advance factors such as the proper position, angle, and route of the floating cranes used during construction. Navisworks simulation helped to arrange construction schedule, to make best use of human, machines and materials.

- Operating space for both welding and maintenance can be checked.
- Plate assembly and welding orders for complex nodes was simulated to help factory manufacture.
- Collisions were eliminated in advance; proper position, angle and route of the floating cranes were given to avoid disaster caused by collision between structures and equipment.
- Influence on the navigation was minimized.

The results

Tongji reports that by avoiding manual design and documentation rework, it was able to reduce the design schedule by 40 percent. Reusing the design models for virtual construction planning and simulation helped Tongji shorten the field construction schedule by 30 percent. Additionally, the use of design models for digital fabrication helped lead to a 20 percent reduction in manufacturing time. View the overview of the project in the video.

Overall, Tongji estimates that these schedule reductions will result in a US$2 million cost savings during construction due to reduced labor, machine rental costs, and so on. Beyond the efficiency and cost savings during design and construction, Tongji has delivered an iconic bridge design that is safe to build, navigate, and maintain

Time and money

- **40% time saved** for the designing process compared to traditional design and avoid a lot of rework
- **30% time saved** for field construction duration by scheduling through simulation
- **20% time saved** for factory manufacturing
- **$ 2 million saved** by shortening the construction duration (cost on human labor, cost on machine rent and so on)

Project performance and delivery

- Time-saving and efficiency improved for both design and construction; safety ensuring; collision eliminated.
- Construction simulation videos are shared with construction teams.
- 3d BIM model, construction simulation videos, project navigation videos were all delivered to the owner for project management and future maintenance.

Learn more about the software used on the project: Autodesk Revit, AutoCAD Civil 3D, Autodesk Navisworks Manage, Autodesk 3ds Max, and Autodesk InfraWorks 360.

Learn more about Autodesk and bridge design.

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