Rize-Artvin Airport Bridge, Turkey

Allplan in practice

ACCELERATED BRIDGE DESIGN IN TURKEY: THE RIZE-ARTVIN AIRPORT BRIDGE

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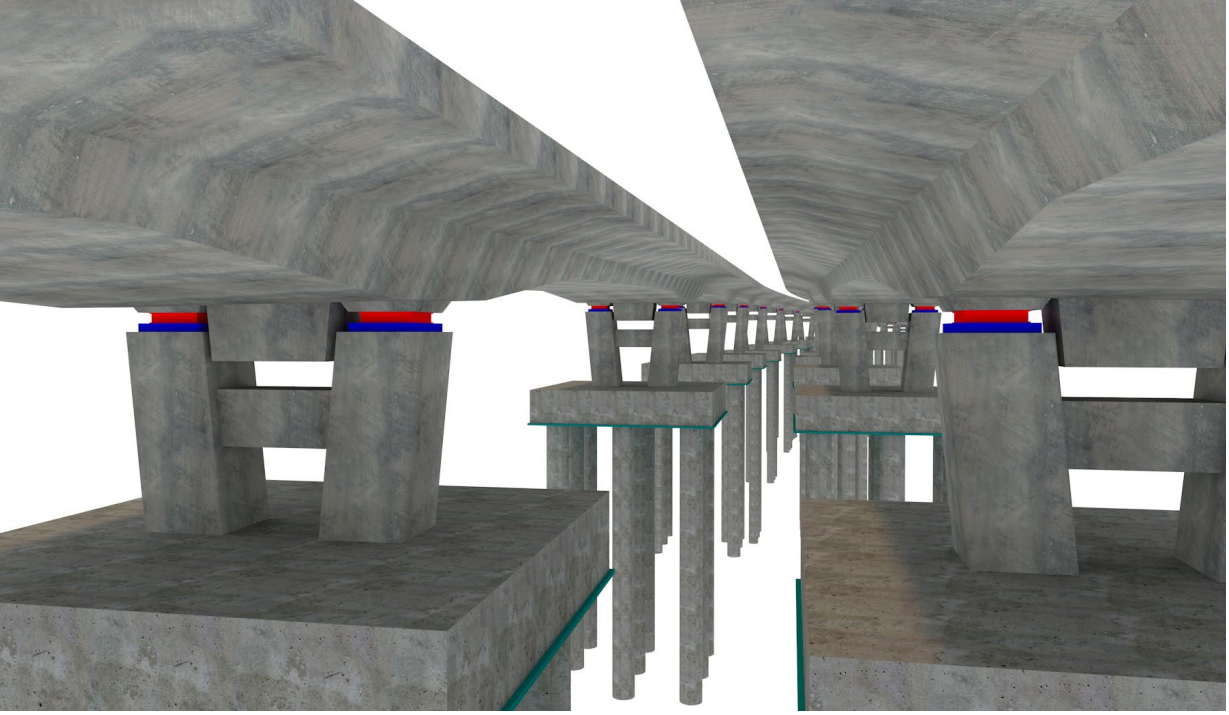
Located on reclaimed land off the northeastern coast of Turkey is the new Rize-Artvin Airport. The airport is a top priority for the Turkish government, with construction commencing in Spring 2020 and completion due at the end of 2021. As part of the works, the airport required a new cast in-situ, post-tensioned bridge to connect to the existing roads between the towns of Rize and Artvin. Spanning 444 meters, the bridge deck will reach a variable thickness of 120 to 180 cm and contain 13 spans along the length when construction is finished. However, the bridge needed to be completed prior to the opening of the airport, leaving just a two-month design period for the engineering consultants, Yüksel Proje.



3D model of the Rize–Artvin Airport Bridge

CHALLENGES

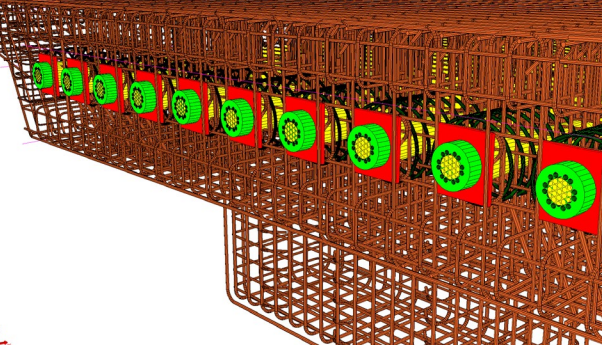
The biggest challenge on this project was the design and construction schedule. While designing a bridge in just two months would be a tall order for any consultant, this was further complicated by the fact that the bridge was being built on reclaimed land. As a result, there was additional geological surveys that needed to be carried out to help inform both the design and structural analysis. Although the poor soil conditions and potential for earthquakes are common issues for bridge foundation designs in Turkey, they nonetheless had to also be taken into account.

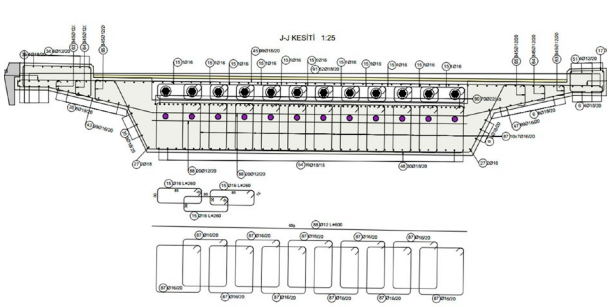
A further complication was the variable parameters of the bridge's geometry. For example, the deck height varied across the bridge's cross-section, and the tendon design was complicated as a result. Another challenge was the eccentricity of the bridge piers, which used V-shaped beams to support the bridge deck. As the deck rose, the distance between the piers increased, meaning that each pier was a unique shape and would have to be designed individually. The number of piles and their spacing – as well as the axis of the post-tensioning tendons – also had varying geometry. This made the design more complicated than a more straightforward bridge layout.

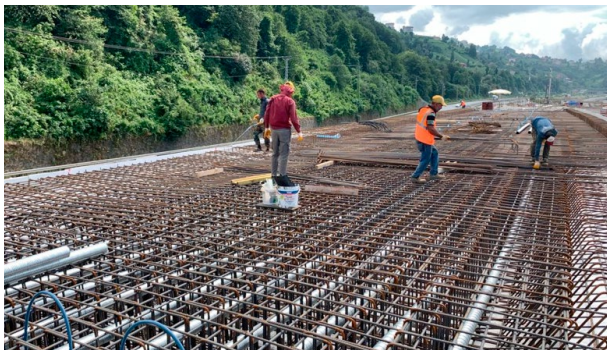
SOLUTIONS

As one of the largest engineering consultants in Turkey, Yüksel Proje is leading the way with regards to the use of Building Information Modeling (BIM) on their bridge design projects. While the client had not specified the use of BIM on this project, Yüksel Proje realized that the only way to efficiently design the bridge in the time allotted was to use advanced BIM-enabled 3D modeling software that would help remove or accelerate some of the manual design activities.

To achieve this, Yüksel Proje used Allplan and Allplan Bridge for a large proportion of their design work. "The main reason that we chose Allplan Bridge for this project was that the tendons and other geometry on this project was really complicated – so we needed a parametric bridge design program. Also we had to make revisions in a very short time due to fast construction." explains Zeki Harputoglu, Design Coordinator and Civil Engineer at Yüksel Proje. Allplan Bridge was used to prepare the BIM model of the bridge, as the teamwork it enabled with other disciplines would greatly assist the design stage. For example, the 3D terrain and road models were able to be imported into Allplan Bridge and then used as the basis for the bridge design, providing an accurate and coordinated base to work from. It allowed the bridge engineers to model different bridge alternatives and see the interaction between the geometry of the bridge with the existing site terrain, as well as any excavations and other site features quickly and easily. The ability to import and export to other software programs without losing data through the IFC data exchange formats saved valuable time, made the design options easier to create and evaluate, and increased the quality of the design output.







Clockwise from top left: 3D tendon and reinforcement detail, reinforcement plan, tendon detail, on site reinforcement detail

The plan and profile coordinates of the start and end of the bridge (where it would join the existing roads) were provided by the Transportation department of Yuksel, which the Bridge department imported into Allplan Bridge. From here, the bridge engineers used this information to inform the alignment of the bridge and designed the bridge to tie into these points. Where needed, they were also able to manually input and adjust the coordinates. Parametric modeling helped when designing the bridge deck, as the geometry of the bridge deck varied along the length. The bridge cross-section could be created parametrically and then extruded along the bridge alignment to quickly create the 3D bridge model.

Allplan Bridge was also particularly helpful for modeling the complicated tendon geometry in the bridge. Where the tendons crossed was particularly difficult to model accurately. Here, parametric modeling was required to ensure the tendon design was done precisely and efficiently, which Allplan Bridge provided. The ability to input the variations of the tendon profile and adjust the model easily by modifying these parameters made the design much easier than continually re-modeling the tendons with every design iteration.

Similarly, the parametric 3D modeling proved especially helpful for modeling the unique bridge piers. Without parametric input, each pier would have had to have been modeled individually, and manually adjusted should the bridge geometry change. This was able to be avoided and the piers designed much more quickly by using parametric modeling to specify how the piers should react to the elements around them. For example, if the bridge's vertical alignment raised or lowered, the piers could adjust automatically to the right height. "If we did not have Allplan Bridge, we would have had to draw each pier manually in the software. But with this, we generate all the piers with one click – it is very helpful and saves us time," explains Murat Erdogdu, Bridge Engineer at Yuksel Proje. With the 3D model, it was also much easier to visualize and check the seismic stoppers – which restrained the lateral movement of the bridge – and how they interacted with the piers to ensure the correct placement.

PROJECT INFORMATION AT A GLANCE

- **Focus:** Infrastructure, Bridge Engineering
- **Software used:** Allplan Bridge, Allplan
- **Client:** General Directorate of Highways Authority, Turkey
- **Contractor**: Cengiz İnşaat
- **Construction start date:** 01. April 2020
- **Completion:** 31. December 2021
- **Planning time:** 2 months
- **Building time:** 21 months
- **Cubature:** 13,000 m^3
- **Usable area:** 8,000 m^2
- **Total length:** 444 m
- **Spans:** 24 m / 11 x 36 m / 24 m
- **Width:** 2 x 11.25 m
- **Costs:** $ 6,000,000

Rize-Artvin
Airport Bridge

Once the bridge was modeled, it was imported into Allplan where the section details and reinforcement design and detailing was carried out. The ability to take a section from the 3D bridge model and use it to create the reinforcement details and general arrangement drawings plans also saved time while increasing the quality. "As the sections have originated from one 3D model, there is consistency between all these sections. As long as the bridge model is correct, the sections will also be correct," noted Burak Kurtman, Head of the Bridges Department. This not only saves additional drawing time, but also makes the checking process much faster.

Other benefits of having a 3D bridge model included the automatic clash detection tools and the accurate quantity calculations. Any collisions between different bridge elements was easier to identify with the automated clash detection feature, rather than relying solely on a visual check. Similarly, the quantities could be quickly generated from the model with the in-built reports. This not only improved the design quality, but also ensured that the design phase was as efficient as possible. With such a short design window, accelerating design activities was essential in order to deliver on time.

The bridge team is also supporting the contractor with the bridge construction process using BIM as needed. Occasionally, during construction the contractor has required different sections or data that were not submitted to the client with the final construction drawings. However, with Allplan, creating this extra information has not been an issue. "With Allplan, we can very simply and easily generate these cross-sections or information and deliver these to the construction site quickly. So, the program is very beneficial for us, but also for the contractors," says Burak.

OUTCOMES

While Yüksel Proje have been using Allplan since 2017, the Rize-Artvin Airport bridge was their first project using Allplan Bridge. The benefits of using a specialist, parametric 3D bridge solution were clear for Yüksel Proje – without it, they would not have been able to complete the bridge design in the allocated timeframe. The engineers estimated that without Allplan Bridge, they would have required at least four months to complete the design instead of just two – a significant increase. This leap in productivity is why Yüksel Proje are now using Allplan Bridge to model nearly all their new bridge projects.

The project team have also begun to lead the way in terms of BIM and 3D modeling, now using BIM on all their projects irrespective of whether it is a client requirement or not. They are also requiring other disciplines to supply 3D models of their sections, to help ensure a coordinated approach between disciplines. "It is very helpful to use the 3D model for alternatives during the conceptual phase to see the interaction with the geometry, the terrain, excavations, and so on," explains Burak. For Yüksel Proje, 3D bridge design using BIM is no longer an optional extra, it's an essential part of delivering a quality project on time and to budget.

THE CUSTOMER

Yüksel Proje, founded in 1978, is one of the largest engineering and consultancy firm in Turkey today. The engineers and consultants provide services mainly in the fields of feasibility, design, construction supervision and project management under the main sectors of transportation, infrastructure and environment, buildings, geological and geotechnical engineering. Yüksel Proje has carried out projects in 28 countries until today and has nearly 1,100 employees.

ABOUT ALLPLAN

ALLPLAN is a global provider of BIM design software for the AEC industry. True to our "Design to Build" claim, we cover the process from the first concept to final detailed design for the construction site and for prefabrication. Allplan users create deliverables of the highest quality and level of detail thanks to lean workflows. ALLPLAN offers powerful integrated cloud technology to support interdisciplinary collaboration on building and civil engineering projects. Around the world over 500 dedicated employees continue to write the ALLPLAN success story. Headquartered in Munich, Germany, ALLPLAN is part of the Nemetschek Group which is a pioneer for digital transformation in the construction sector.

ALLPLAN GmbH
Konrad-Zuse-Platz 1
81829 Munich
Germany
info@allplan.com
allplan.com

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