

e-BrIM

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Front Cover: Rav-Hamecher Interchange Project

Credit: Via Bridges

Back Cover: Cable inspection using a robot

Credit: Yangzi LIN

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Dear Readers,

*In the first article, the authors present the design of the **Rav-Hamecher Interchange Project**. They focus on Bridges BR-01 and BR-02, which served as the basis for an integrated parametric–analytical workflow within a single, coordinated design environment.*

*The second article explores the possibilities offered by **specialised cable inspections**, which typically include surface inspections of polyethylene (PE) sheaths, non-destructive testing to detect broken wires and corrosion inside the sheaths, cable force testing, and detailed inspections of structural components such as anchor heads and cable conduits.*

*In my interview with **Professor Francisco Millanes Mato**, we discussed his career, the projects he finds most personally satisfying, and his views on the future of the bridge industry, including the use of BIM and emerging technologies such as AI.*

*The next article focuses on the **construction of an overpass** that, despite its relatively short length and standard width (two traffic lanes, pedestrian paths and a shared-use cycle path), plays an important role in connecting two residential areas separated by a high-speed railway.*

*The final article in this issue explores **current developments in BIM for design**, drawing on the authors' professional experience. Using examples from transport infrastructure, it shows how design data can support earthwork volume calculations using IFC models, machine guidance through foundation-joint surfaces provided in LandXML format, and the dynamic generation of cross-sections at any station without the need to produce numerous drawings manually.*

*Finally, we look back at the **SISMICA S&G 2026 — International Conference on Structural & Geotechnical Engineering**, an online international conference that brings together two disciplines often discussed separately, yet closely connected in real-world engineering practice: structural and geotechnical engineering. The conference also marks the beginning of a **new annual event** organised by the SISMICA Institute.*

The e-BrIM magazine is also published in Spanish as a separate edition at www.e-brim.com/es.

*I would like to **thank all the people and companies** that have been cooperating on this issue and helping me put it together; big thanks to the members of the **Editorial Board**, and to **Sandra Komar Frimpong, Borja Balbastre Camarena, Carla Ody Julian and David Herrero Mediavilla** for their assistance with the language revisions.*

*We also **thank our partners for their support**.*

*On behalf of the organisers, we invite you to the **2026 World Bridge Engineering Conference**, focusing on Innovative Bridge Technologies and Accelerated Bridge Construction, taking place on **1st and 2nd December 2026 in Miami, Florida, USA**.*

*The next e-BrIM, in English and Spanish, will be released on **20th February 2027**.*

*We welcome articles for the e-BrIM magazine, in both English and Spanish. If you would like to submit an article, please contact me at magda@e-mosty.cz. The **instructions for authors** are available on our websites: www.e-brim.com and www.e-brim.com/es.*

Magdaléna Sobotková, MSc.

Chief Editor



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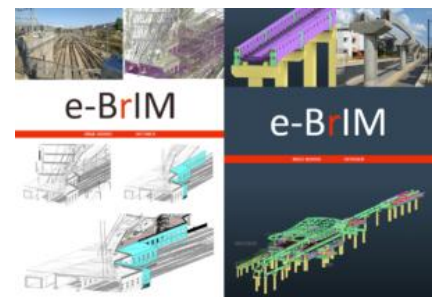
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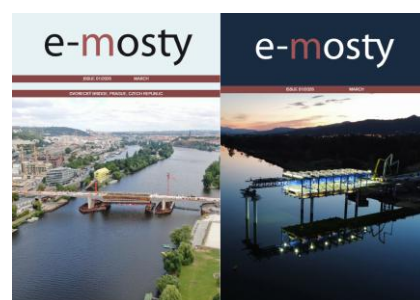
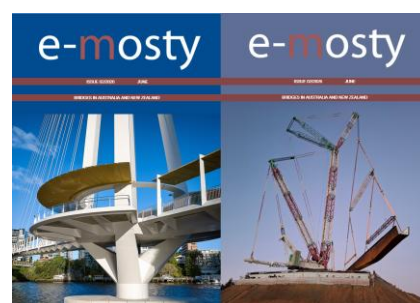
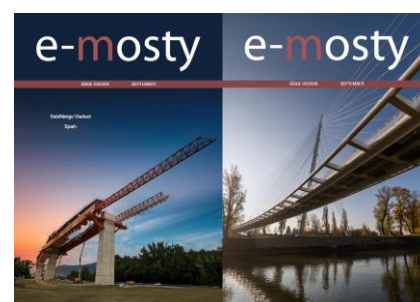
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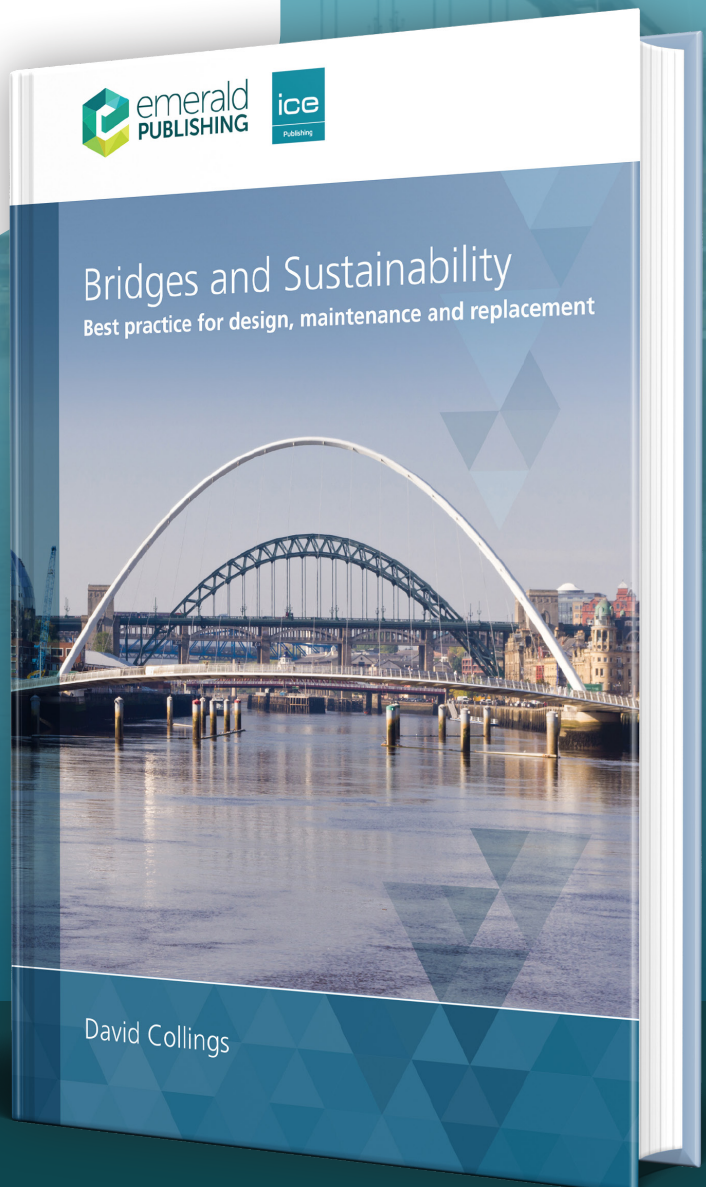
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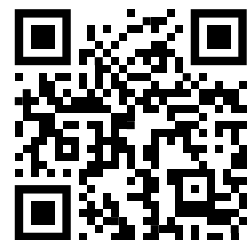
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LINKING PARAMETRIC DESIGN, BRIM, AND FEM ANALYSIS IN THE RAV- HAMECHER INTERCHANGE PROJECT

Yoni Pestes, Lead Bridge Design Engineer
Via Bridges



Figure 1: 3D rendering of the side view of the Bridge BR-01

PROJECT BACKGROUND

Modern infrastructure projects are becoming increasingly complex, requiring bridge engineers to adopt design approaches that go beyond conventional drafting and documentation methods.

This is particularly true in projects where complex geometry, multidisciplinary coordination, and construction staging must be addressed from the earliest design stages.

The Rav-Hamecher Interchange project is located at a major northern gateway to the Tel Aviv metropolitan area. Ongoing residential and commercial development in the surrounding area is expected to increase traffic demand significantly in the coming years. The new interchange is therefore being constructed to improve connectivity, increase capacity, and enhance traffic flow along one of the principal entrance corridors to Tel Aviv.

The project comprises a diverse family of bridges, each designed according to different structural requirements, construction constraints, and architectural considerations. These include three precast concrete girder bridges, two post-tensioned cast-in-situ concrete bridges, and the landmark Bridge BR-01, conceived not only as an essential transport link but also as a signature structure marking a major gateway to the city.

This article focuses on Bridges BR-01 and BR-02, which served as the basis for an integrated parametric-BrIM-analytical workflow within a single coordinated design environment.

Using Rhino Grasshopper, Tekla Structures, and SOFiSTiK, the project team established a workflow in which geometry, structural analysis, and production documentation were developed as interconnected parts of the same design process for two structurally distinct bridges: a steel network tied-arch bridge and a post-tensioned cast-in-situ concrete bridge.



Figure 2: Location of the Bridge
Click on the image to open Google Maps

PROJECT DATA / CREDITS

Item	Description
Project	Rav-Hamecher Interchange Project
Location	Tel Aviv metropolitan area, Israel
Client	Ayalon Highways Co. Ltd.
Project Management	Epstein Project Management
Geometric / Road Design	Levy & Shtark Zilberstein
Architecture	Yael Architects
Bridge Design and BrIM model	Via Bridges
BR-01	Steel network tied-arch bridge, 84.0 m span, 48.0 m width
BR-02	Three-span post-tensioned cast-in-situ concrete bridge, 27.5 + 50.0 + 27.5 m, total length 105.0 m, width 13.0 m
Digital workflow	Integrated parametric-BrIM-analytical workflow
Software environment	Rhino Grasshopper, Tekla Structures, SOFiSTiK
Rendering BR-01	IN3D

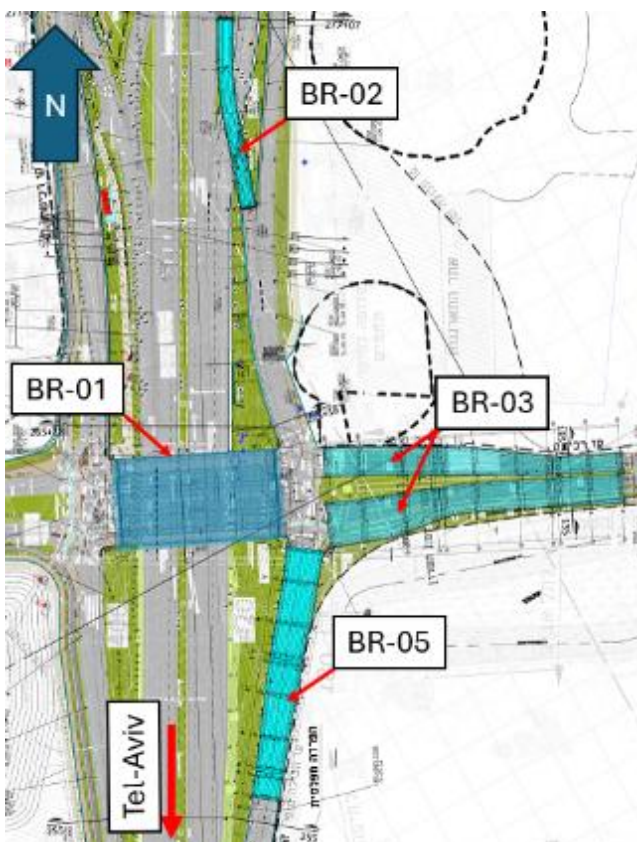


Figure 3: Rav-Hamecher Interchange project, Bridge layout

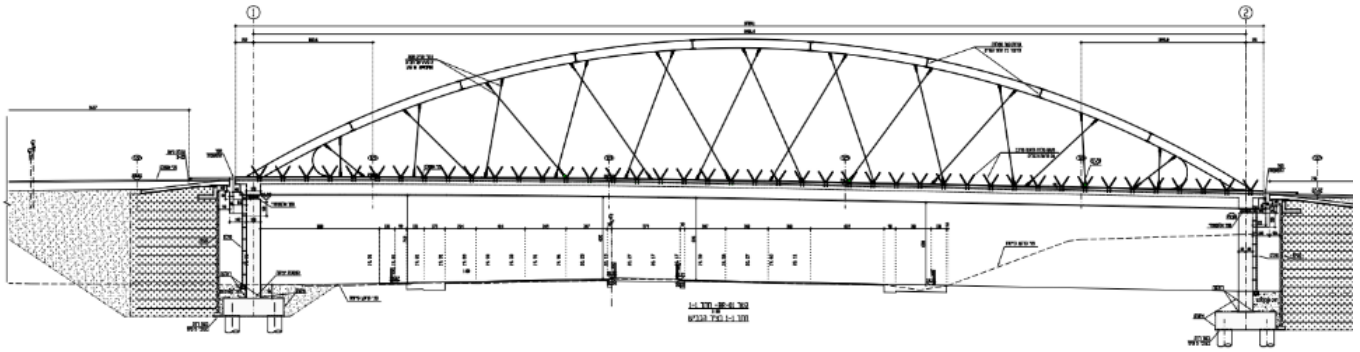


Figure 4: Longitudinal section of BR-01

BRIDGE BR-01: A LANDMARK NETWORK TIED-ARCH BRIDGE

Among the bridges included in the Rav-Hamecher Interchange project, Bridge BR-01 was designated as the signature structure. The bridge crosses Road No. 2 in an east–west direction and carries eight traffic lanes, four in each direction, together with two sidewalks that also incorporate bicycle paths.

Shading canopies are planned along both sidewalks, reinforcing the bridge's role not only as a transport link, but also as a visible urban and architectural element.

The selected structural solution for BR-01 is a steel network tied-arch bridge with a single span of 84.0 m and an overall width of 48.0 m.

The bridge consists of six inclined arches arranged symmetrically across the width of the deck. Four arches are located above the sidewalk zones, two on each side of the bridge, while two additional arches are positioned in the central part of the cross-section.

This arrangement gives the bridge a balanced architectural composition while maintaining a clear and efficient structural system.



Figure 5: 3D view of the bridge

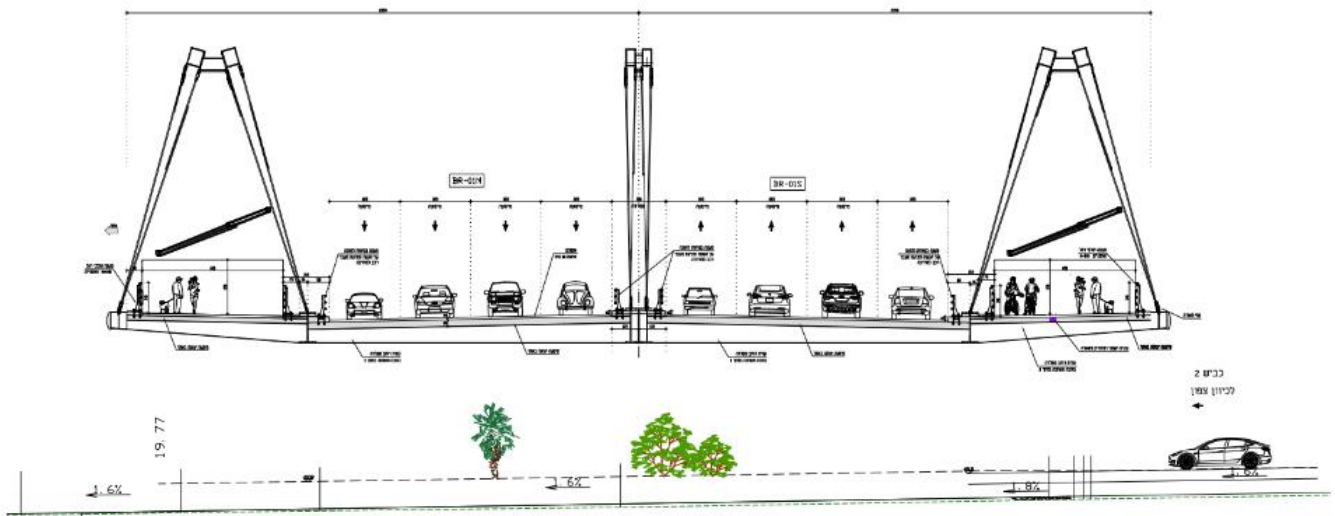


Figure 6: Section view of BR-01

In the adopted network tied-arch configuration, the horizontal thrust generated by the arches is resisted by longitudinal tie beams, while a system of transverse steel beams and a cast-in-situ concrete slab forms a composite deck.

Inclined hangers arranged in a network pattern connect the arch ribs to the tie beams, creating an

efficient structural system that improves force distribution along the span while also contributing to the bridge's distinctive architectural appearance.

The construction methodology was strongly influenced by the bridge geometry and by the need to maintain traffic on Road No. 2, one of Israel's main traffic arteries.

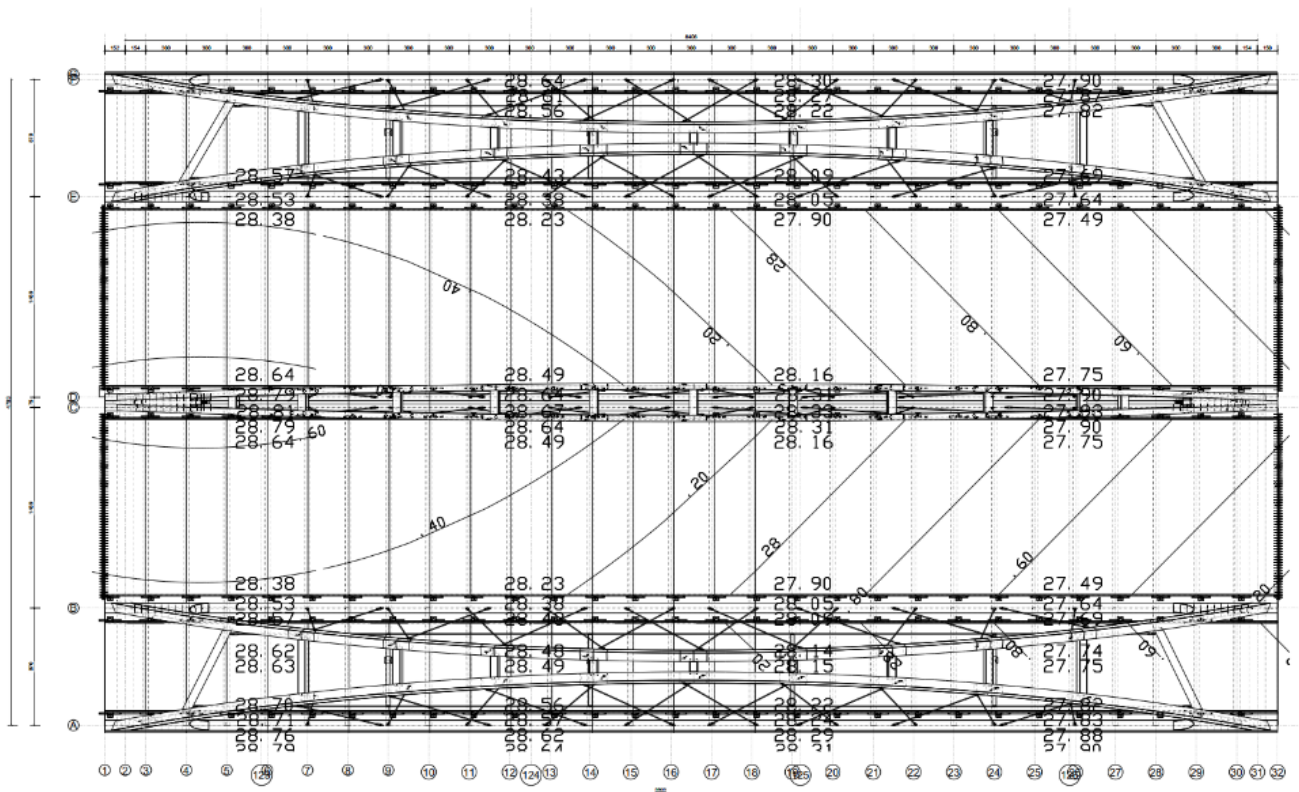


Figure 7: Plan view with road elevations of BR-01

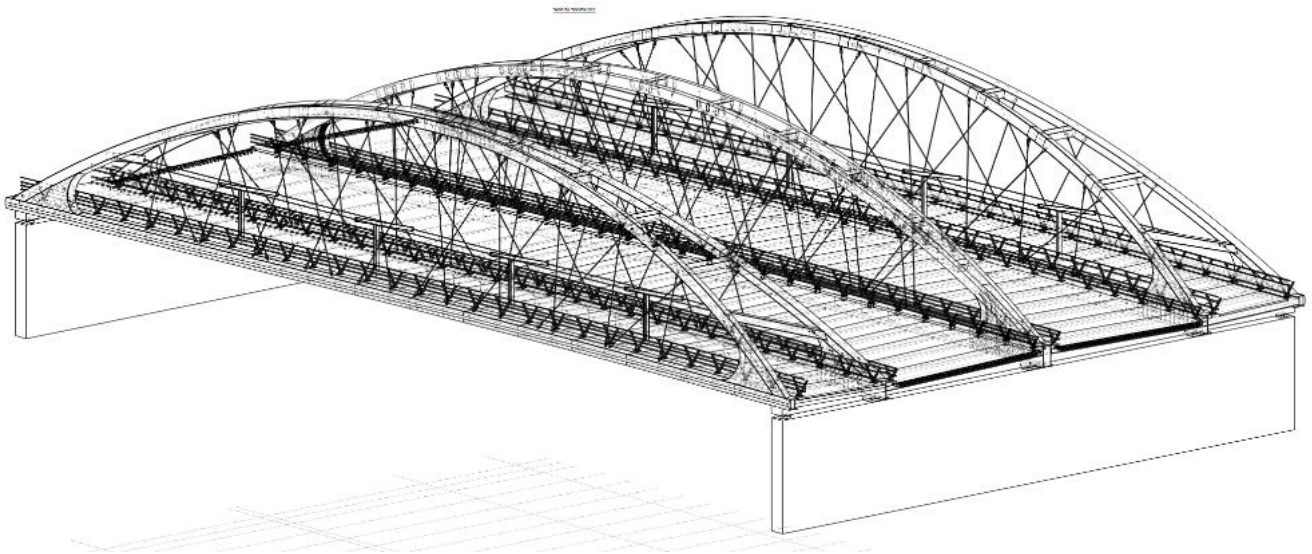


Figure 8: 3D wireframe model view of BR-01

Since temporary supports could not be placed within the active traffic corridor, the bridge was designed to be assembled in a dedicated area alongside the road and transported into its final position during night works using Self-Propelled Modular Transporters (SPMTs).

Owing to the exceptional width of the superstructure, the bridge was divided into two symmetrical half-width structures, which were transported separately and then connected in situ.

BRIDGE BR-02: POST-TENSIONED CAST-IN-SITU CONCRETE BRIDGE

Bridge BR-02 represents a different structural typology within the Rav-Hamecher Interchange project. Unlike the landmark steel tied-arch solution adopted for BR-01, BR-02 is a three-span post-tensioned cast-in-situ concrete bridge with span lengths of 27.5 m, 50.0 m, and 27.5 m, giving a total length of 105.0 m. The bridge has an overall width of 13.0 m and a superstructure depth of 2.0 m.



Construction Stages		Construction Stages	
0	Existing condition	10	Installation of the network hangers and removal of temporary supports
1	Traffic diversion and establishment of the contractor's work area	11	Positioning of SPMTs beneath the bridge for transport
2-8	Assembly of the bridge temporary supports	12-13	Transport of the bridge to its final position during night works
9	Installation of canopy supports and stressing of canopy cables	14	Completion of deck casting and opening of the bridge to traffic

Figure 9: Construction stages of BR-01

Bridge BR-02 crosses above an interchange exit ramp where the roads intersect at a prominent skew, while also following the horizontal curvature of the road alignment. For this reason, a cast-in-situ post-tensioned solution was selected. This structural system provides an efficient span-to-depth ratio and allows the superstructure geometry to be adapted to the curved alignment and crossing geometry.

Although a cast-in-situ solution requires temporary falsework and formwork, this construction method was suitable for BR-02 because the bridge is located alongside the main road, allowing the temporary works to be erected without interfering with active traffic.

The bridge was designed as a continuous concrete superstructure, rigidly connected to the intermediate piers and supported on elastomeric bearings at the abutments, allowing the required movements resulting from temperature variations, creep, shrinkage, and seismic actions. Its prestressing system was designed to satisfy serviceability requirements and provide the necessary longitudinal capacity of the superstructure.

For the purpose of this article, BR-02 is particularly important because it demonstrates that the integrated parametric–BrIM–analytical workflow was not limited to the landmark steel tied-arch bridge.

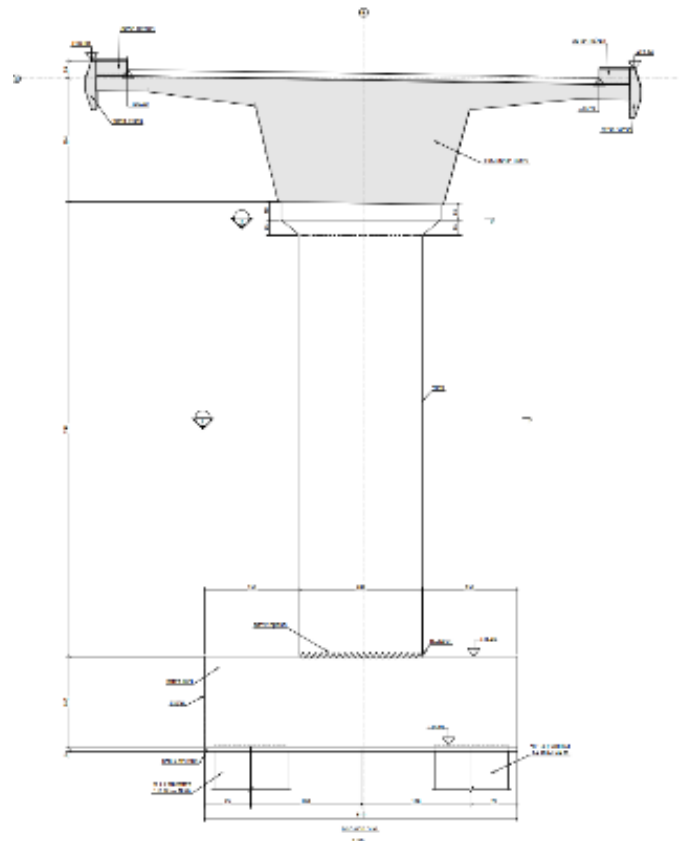


Figure 10: BR-02 Pier section

Together, BR-01 and BR-02 provided two different testing grounds for the same digital methodology: one involving complex steel geometry, architectural expression, and staged assembly, and the other involving a curved, skewed, post-tensioned cast-in-situ concrete bridge.

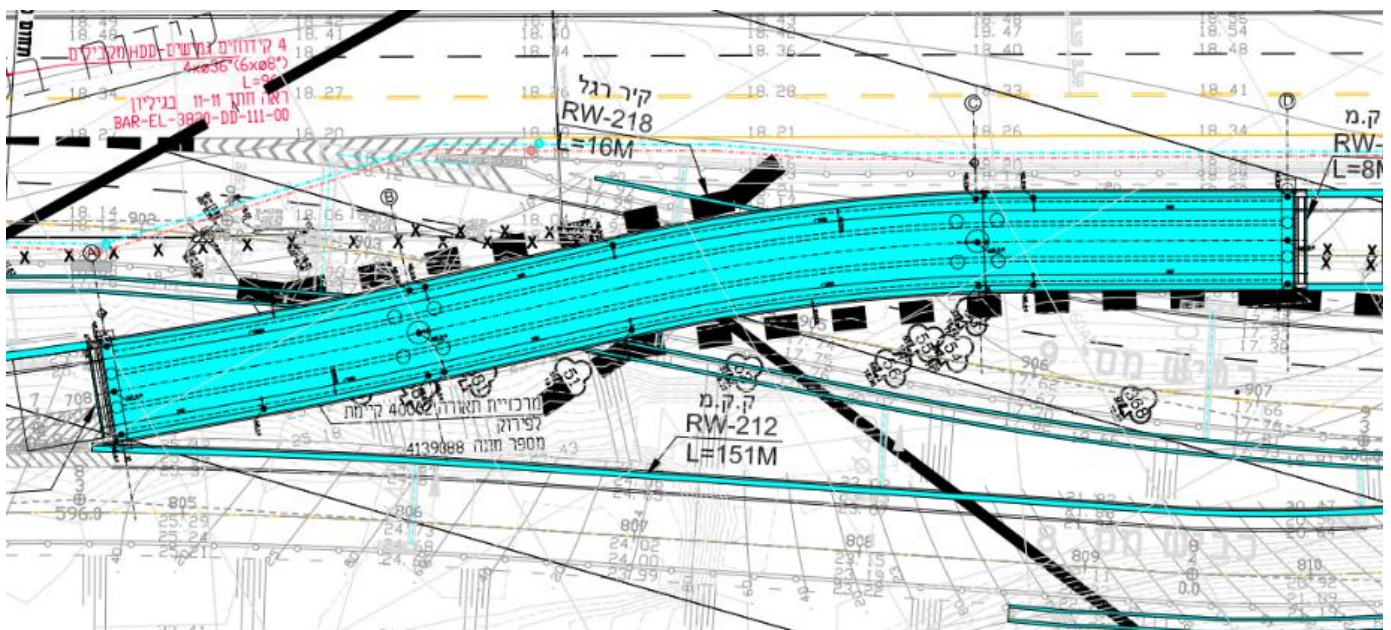


Figure 11: Plan view of BR-02 showing road curvature

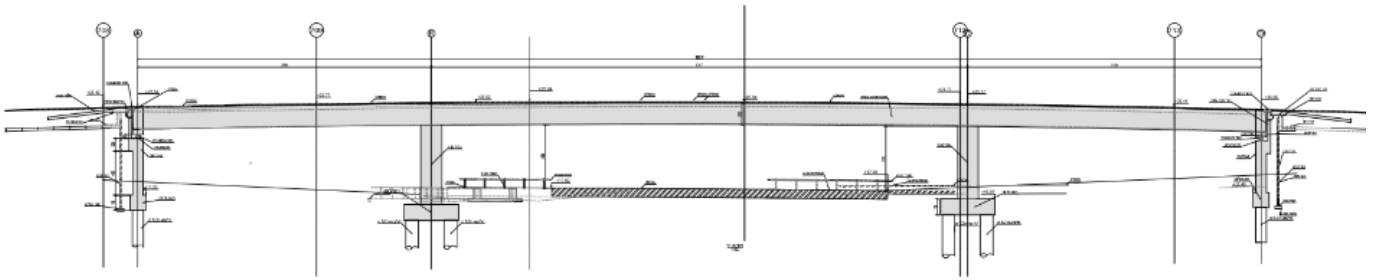


Figure 12: Longitudinal section of BR-02

This combination allowed the design team to examine how a single integrated workflow could support different bridge typologies within the same infrastructure project.

This was particularly evident in BR-02 in the connection between the analytical model and the Tekla production model for post-tensioning and reinforcement.

After the tendon geometry had been defined and verified in the analytical environment, it was recreated in Grasshopper and transferred into Tekla Structures, where it could be incorporated into the BrIM model together with the reinforcement arrangement. This enabled a closer relationship to be maintained between the analytical definition of the bridge and the production model used for detailing and drawing production.

It also allowed design updates, such as changes in tendon layout, to be implemented more quickly and consistently across the different modelling environments.

ENGINEERING COMPLEXITY AND THE NEED FOR AN INTEGRATED DIGITAL WORKFLOW

The two bridges presented above created different types of engineering complexity. In BR-01, the challenge was driven by the spatial geometry of the network tied-arch system, the interaction between the arches, tie beams, inclined hangers, and composite deck, and the need to model a complex steel structure together with its connections.

In BR-02, the main challenges were related to the curved alignment, the post-tensioning layout, the behaviour of a continuous cast-in-situ concrete superstructure, and the need to model concrete geometry together with reinforcement arrangement and prestressing components.

These conditions called for a design process in which geometry, structural analysis, and production documentation could be developed in a more coordinated manner. The integrated workflow was therefore adopted in order to improve coordination between the analytical model, the BrIM model, and the final drawings, particularly when design alternatives or geometric refinements were introduced.

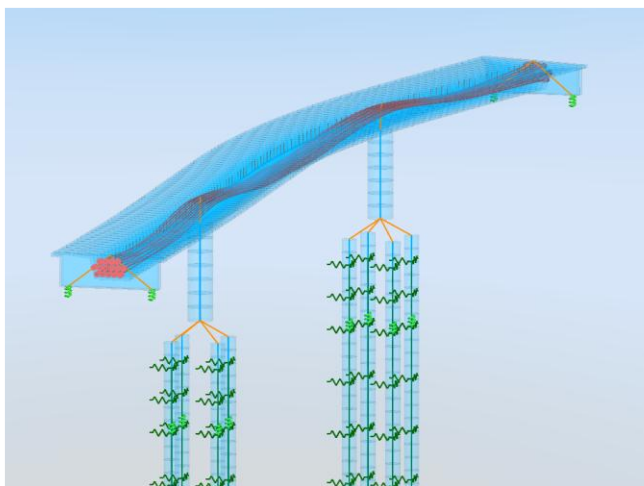


Figure 13: BR-02 – SOFiSTiK FEM model with tendon calculated geometry

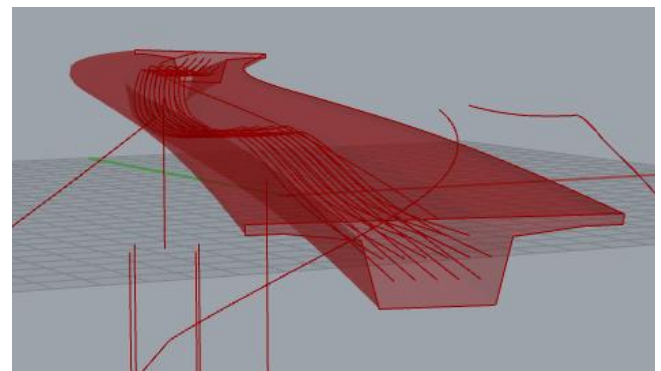


Figure 14: The imported tendon geometry in Grasshopper from SOFiSTiK

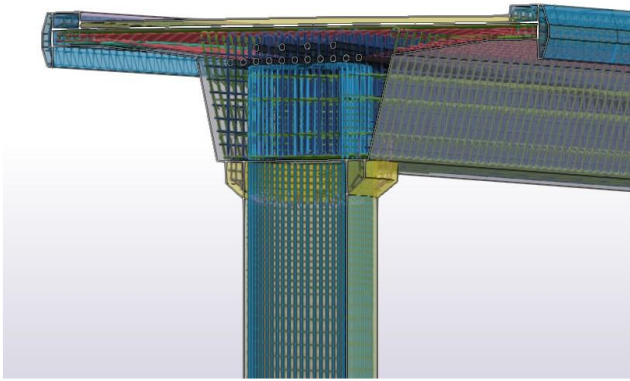


Figure 15: Tendon and reinforcement geometry incorporated into Tekla Structures

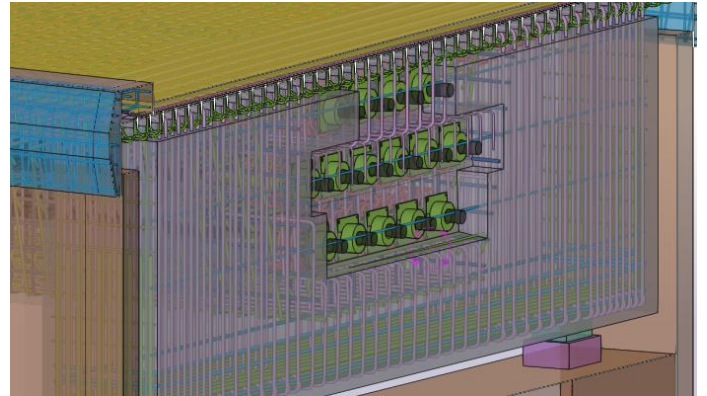


Figure 16: End diaphragm of BR-02 showing the post-tensioning anchorage

To address these challenges, the project team adopted an integrated parametric–BrIM–analytical workflow beginning with the creation of a parametric bridge skeleton model.

STARTING THE WORKFLOW: FROM ROAD DATA TO THE BRIDGE SKELETON MODEL

Bridge design is a multidisciplinary process. The bridge engineer does not work in isolation, but as part of a wider design team that typically includes road designers, drainage engineers, utility coordinators, architects, and other infrastructure specialists. Since BIM and BrIM workflows are still not fully implemented across all disciplines, an initial

stage of data preparation is often required before a reliable parametric bridge model can be created.

The first essential input for the bridge designer is the geometry of the road carried by the bridge.

For bridge modelling purposes, this geometry cannot always be understood only as a centreline, but rather as a set of controlling geometric features that define the three-dimensional form of the deck.

While simple bridges may be described using only a limited number of control lines, more complex bridges often require additional geometric information to define changes in width, crossfall, deck edges, and other features influencing the final bridge form.

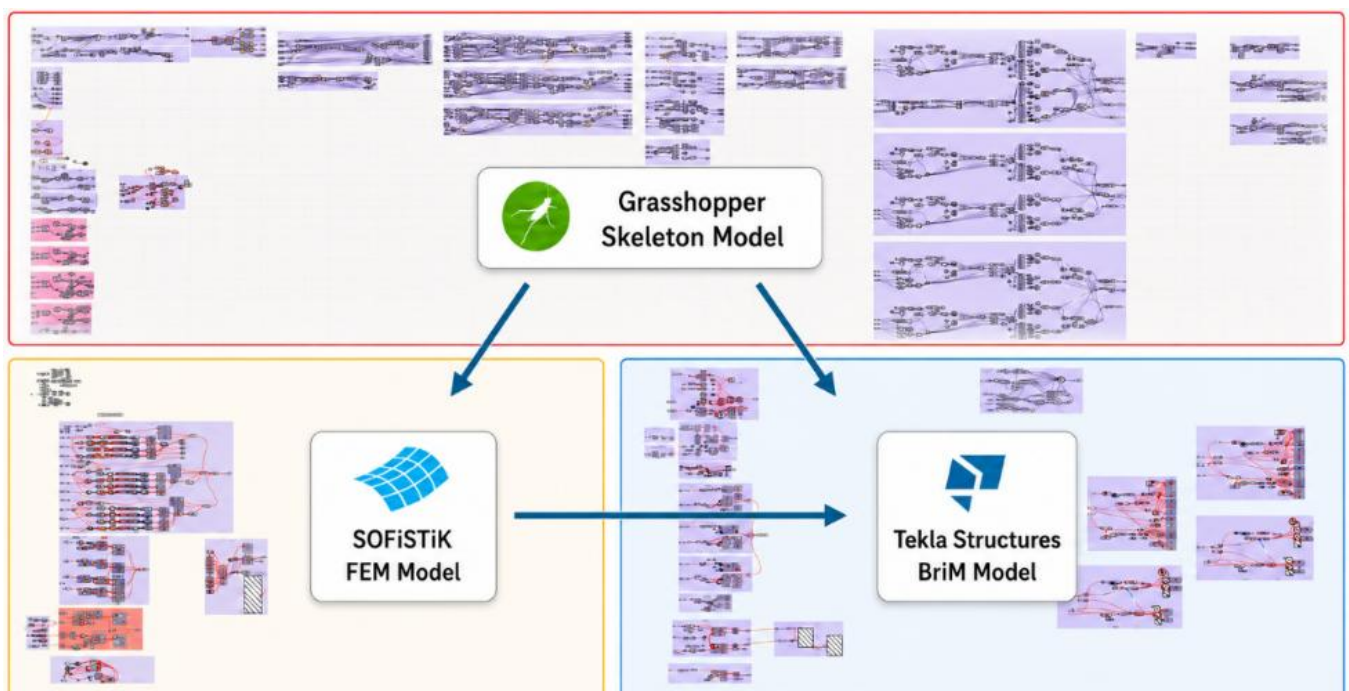


Figure 17: Integrated workflow linking the Grasshopper skeleton model with the SOFiStiK FEM model and the Tekla Structures BrIM model

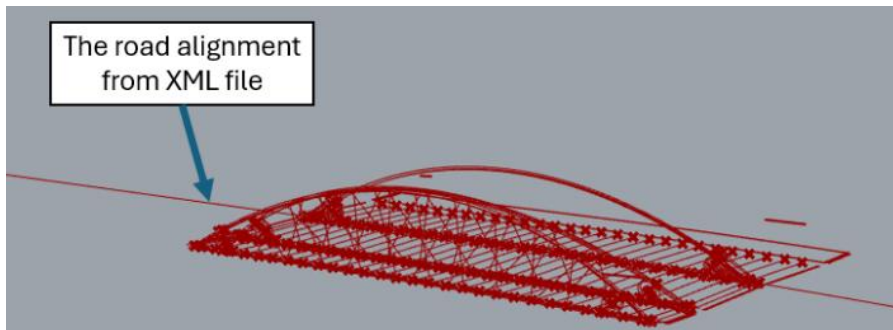


Figure 18: BR-01 Grasshopper skeleton model generated from XML road alignment data

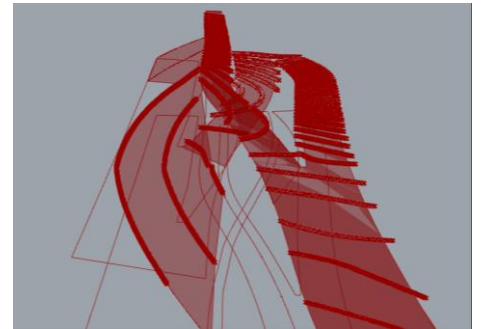


Figure 19: BR-02 Grasshopper Road surfaces generated from DWG elevation contours

In practice, this information may be received in several forms, ranging from complete three-dimensional feature lines to more limited centreline or elevation data.

In addition to the geometry of the carried road, the designer must also account for constraints below and around the bridge, including existing roads, ramps, clearances, utilities, drainage elements, and other obstacles that influence the location and elevation of piers, abutments, and foundations.

When this information is incomplete or indirect, additional processing is required before it can be used reliably for bridge modelling. In such cases, Grasshopper provides an effective environment for reconstructing the necessary three-dimensional control geometry and preparing it for incorporation into the skeleton model.

More recently, AI-based tools have also begun to be explored as a complementary means of supporting the processing and structuring of multidisciplinary input data before its incorporation into the parametric modelling workflow.

Once the road geometry and the relevant surrounding constraints have been processed, they are combined in the Grasshopper environment to form the bridge skeleton model.

This model becomes the central geometric definition of the bridge. It is not the final detailed BrIM model, but the controlling geometric framework from which the principal bridge elements are generated. From this point, the workflow is divided into two parallel streams, both driven by the same Grasshopper skeleton model.

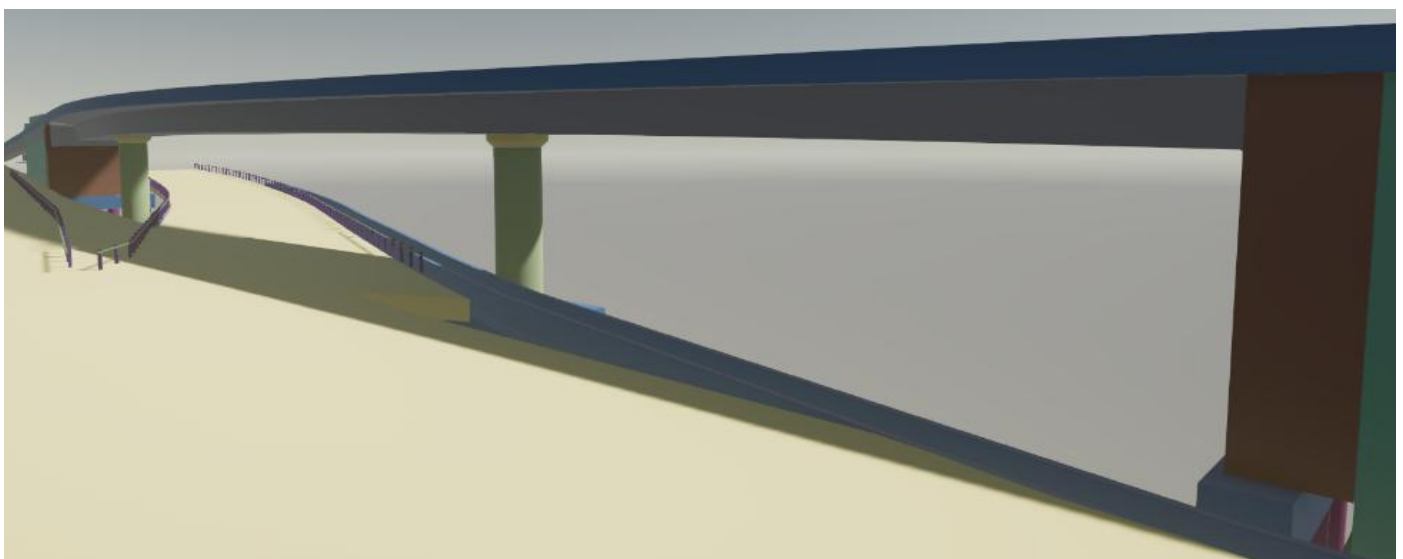


Figure 20: 3D model of BR-02 including roads and utilities under the bridge

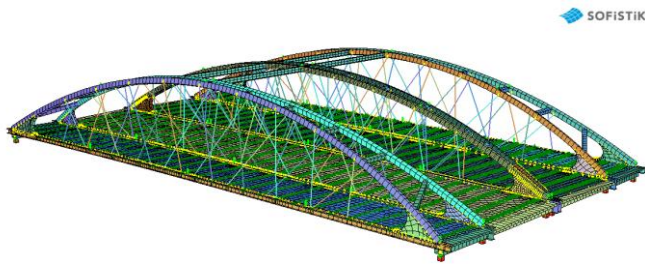


Figure 21: SOFiSTiK FEM model of BR-01

The geometric information is transferred to Tekla Structures through the Tekla Structures Grasshopper Live Link, where the three-dimensional BrIM elements are created for detailing and documentation. In parallel, the same skeleton model is transferred to SOFiSTiK through the SOFiSTiK Grasshopper interface, where the finite element model is generated for structural analysis.

As a result, modifications introduced in the Grasshopper skeleton model are reflected in both the Tekla Structures production model and the SOFiSTiK analytical model, maintaining a consistent relationship between the bridge geometry, the BrIM model, and the structural analysis model while reducing the need for repeated manual modelling across different software environments.

Despite this shared geometric basis, the requirements of a BrIM production model and a finite element analytical model are not identical. The skeleton model is primarily a line-based geometric model, and additional analytical idealisations may be required when generating the finite element model.

For example, rigid links, eccentric connections, or other analytical elements may be needed to ensure correct force transfer between members.

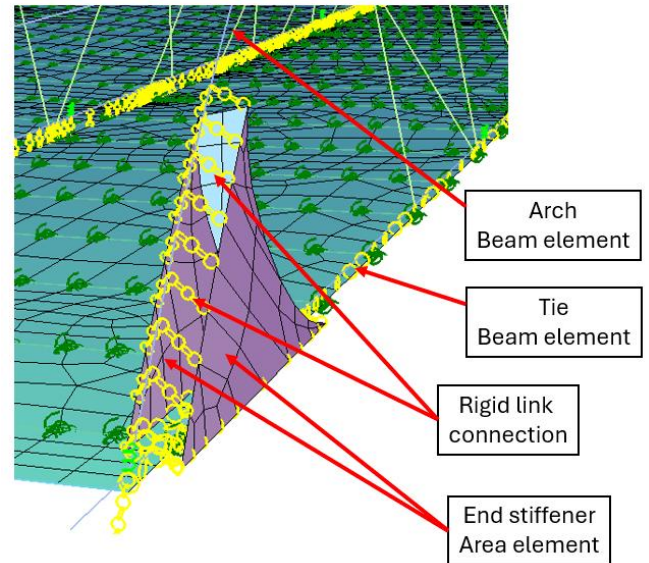


Figure 22: BR-01 arch-end stiffener and rigid-link connections in the SOFiSTiK FEM model

These elements are part of the analytical idealisation and are not necessarily physical bridge components.

The objective is therefore not to make the BrIM model and the FEM model identical, but to ensure that both are generated from the same controlled geometric source and remain consistent throughout the design process.

PRACTICAL CHALLENGES AND LESSONS LEARNED

Although the integrated BrIM workflow provided significant advantages in terms of geometric control, model consistency, and coordination between analysis and documentation, its implementation also highlighted several practical challenges.

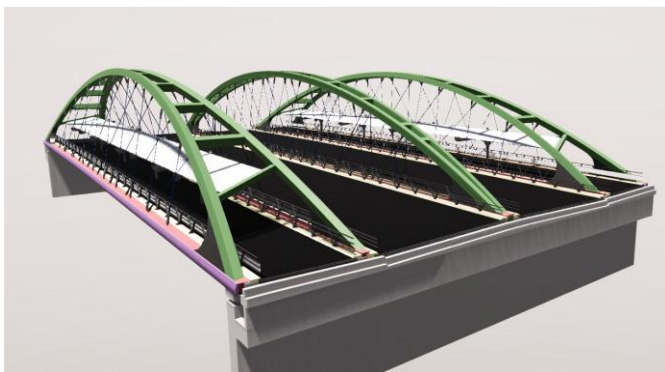


Figure 23: Render view of BR-01 using Tekla Structures

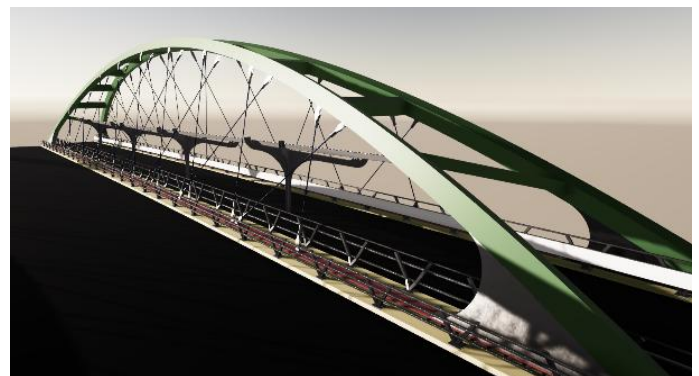


Figure 24: Render view of BR-01 edge arches and canopy using Tekla Structures

The main lessons learned can be summarised as follows:

- **Input data preparation:** Establishing a reliable skeleton model requires accurate information from other disciplines, particularly road design and architecture. In practice, this information is not always delivered in a format that can be used directly for parametric modelling, and additional processing, checking, and reconstruction may be required before it can serve as a dependable basis for the bridge model.
- **Current level of BIM/BrIM adoption:** Since not all consultants work within fully model-based workflows, the bridge engineer may need to translate two-dimensional drawings, partial three-dimensional information, or non-standard files into a structured parametric environment. This preparation stage can be time-consuming, especially at the beginning of the project.
- **Appropriate level of detail:** In conventional two-dimensional drawings, an early design concept can be presented without fully resolving every interface or local detail. In a three-dimensional BrIM model, by contrast, the geometry is much more explicit, and elements are expected to connect consistently. Producing a fully resolved model at the conceptual stage may therefore require significant effort that is not always necessary, especially when multiple alternatives are still being examined.
- **Value-based modelling decisions:** The parametric three-dimensional modelling approach is particularly effective for controlling global geometry, long structural elements, and repetitive components, where it can improve consistency and save time. However, not every individual detail must always be modelled in full. At the level of single bolts, local fittings, isolated connection details, or other one-off elements, full three-dimensional modelling may require effort that is not always justified.
- **Limits of digital modelling:** Even with an advanced BrIM workflow, not all construction challenges can be fully resolved in the digital environment. Certain issues related to site conditions, execution tolerances, temporary works, and contractor-specific construction methods may only become apparent during construction itself.

- **Economic considerations and lifecycle value:** In our experience, the cost of software and implementation is not a fundamental limitation to the adoption of BrIM-based workflows, but it is an important factor when comparing them with more conventional design methods. The investment extends beyond software licences and may include higher computing capacity, specialised software packages, training and certification, professional expertise, and the time required to develop, implement, and standardise new workflows within the design office.

At the same time, the value of a BrIM model may extend well beyond the design and construction stages. If properly maintained and transferred to the asset owner, it can support future inspections, maintenance, repairs, and retrofit works. In some projects, this lifecycle value may significantly exceed the additional cost of creating the model. Asset owners can therefore play an important role in promoting BrIM adoption by defining clear requirements for digital deliverables and recognising the additional design effort through appropriate compensation or financial incentives.

There is no clear minimum project or structure size above which such a workflow becomes economically justified. Similar BrIM-based workflows can also be applied effectively to relatively simple structures such as sign gantries, culverts and retaining walls. Even smaller structures may involve geometric complexity, coordination requirements, or repetitive design tasks that can benefit from a parametric BrIM approach. The economic justification therefore depends not only on project size, but also on complexity, repetition, coordination requirements, expected design iterations, and the potential for improving efficiency throughout the design process.

These challenges do not reduce the value of the integrated workflow, but they highlight the need for careful implementation.

Successful use of an integrated parametric–BrIM–analytical workflow requires reliable input data, clear modelling objectives, an appropriate level of detail for each design stage, and close coordination between all disciplines involved in the project.

CONCLUSION

The Rav-Hamecher Interchange project demonstrates that BrIM can be used not only as a three-dimensional modelling tool, but as part of an integrated engineering workflow connecting geometry, structural analysis, and production documentation.

The implementation on Bridges BR-01 and BR-02 showed that a single parametric source, developed in Rhino Grasshopper and linked in parallel to Tekla Structures and SOFiSTiK, can support two very different bridge typologies: a wide steel network tied-arch landmark bridge and a post-tensioned cast-in-situ concrete bridge with curved and skewed geometry.

This was particularly important in cases where changes in alignment, deck geometry, arch configuration, or tendon layout could influence several parts of the design process simultaneously. By maintaining a consistent relationship between the geometric definition of the bridges, the finite element analytical models, and the BrIM production models, the workflow supported a more coordinated development process across both bridge typologies.

The workflow can also support the evaluation and comparison of structural alternatives by providing additional geometric, structural, and quantitative information.

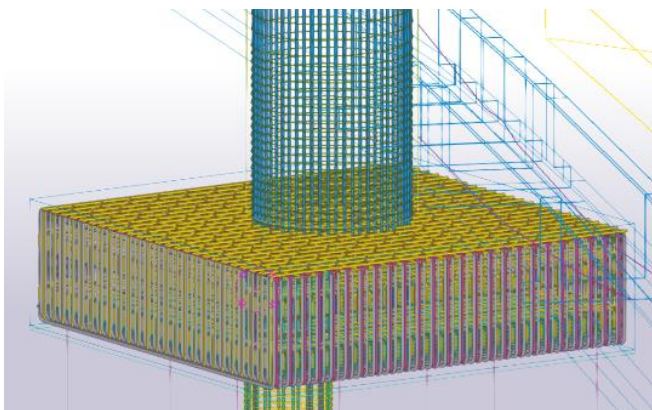


Figure 25: BR-02, pile cap and column reinforcement view

However, the selection of the bridge typology itself depends on a broader range of considerations, including site constraints, bridge geometry, cost, architectural requirements, construction methodology, and the equipment and capabilities available to the contractor.

At this early conceptual stage, engineering experience and judgement remain the primary basis for selecting the appropriate structural concept.

Parametric and BrIM tools can therefore strengthen and support this decision-making process, but should complement rather than replace engineering judgement.

The project also confirmed that the success of such a workflow depends strongly on the quality and structure of the input data. Road geometry, architectural requirements, clearances, obstacles, utilities, and other multidisciplinary constraints must be prepared and checked carefully before they can serve as a reliable basis for parametric modelling.

The workflow therefore requires not only advanced software tools, but also a clear methodology for information exchange between disciplines.

At the same time, technological development is making BrIM-based workflows more accessible than in previous years. In parallel, AI is beginning to support parts of the design process, helping to reduce some of the barriers that once made the adoption of such methodologies more demanding for design firms.

Overall, the project demonstrated that the real strength of an integrated parametric–BrIM–analytical workflow lies in its capacity to connect design intent, structural analysis, and production modelling within a single coordinated process.

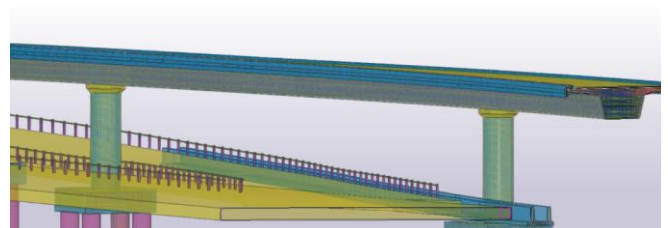


Figure 26: BR-02, bridge view with reinforcement rendering

DIAGNOSIS AND TREATMENT BASED ON SYNDROME DIFFERENTIATION TO SAFEGUARD THE HEALTH OF CABLE BRIDGES

Yangzi LIN, DEng, FHKIHT, RSE



*General Manager & Technical Director
Cable Bridge Technology*

INTRODUCTION

Cable systems have been widely used in long-span bridges, including the main cables and suspender cables of suspension bridges, the stay cables of cable-stayed bridges, and the suspender cables of arch bridges.

As primary components of the superstructure, cable systems play a critical role in ensuring structural safety and serviceability. Damage to the cable system can significantly reduce a bridge's durability and functional performance and, in severe cases, may lead to catastrophic failure, with serious social consequences and heavy economic losses.

To enhance the safety and long-term performance of cable-supported bridges, the research team has devoted more than a decade to developing comprehensive inspection, assessment, and maintenance technologies for bridge cable systems. This work has included detailed professional inspections and in-depth condition assessments, as well as targeted maintenance and rehabilitation using high-performance protective materials.

SPECIALISED INSPECTION OF CABLE SYSTEMS

Specialised inspection of bridge cables generally includes inspection of the surface of polyethylene (PE) sheaths, non-destructive inspection to detect internal broken wires and corrosion, cable force testing, and special inspection of structures such as anchor heads and cable conduits.

INSPECTION OF THE PE SHEATH SURFACE OF CABLES

Surface inspection of the cable PE sheath using a climbing robot can accurately locate defects, assess their condition, and determine their severity using the applicable assessment scale.

To ensure thorough inspection of the bridge cable, the climbing robot's core technology should meet the following requirements:

- It should be easy to install on cables of different diameters and able to pass over anti-rain spiral lines without causing damage.
- An appropriately sized power system with sufficient endurance should allow the robot to move forward and backwards and to hover freely, all under wireless control.
- It should transmit video in real time, wirelessly, to a ground receiving station, with the option of saving the recorded footage.
- The robot should be able to capture video with minimal distortion under varying environmental conditions, such as backlighting.
- The exact location of any damage on the cable should be accurately recorded.

The robot comprises of 5 systems: a mechanical structure system, a power system, a visual inspection and positioning system, a control and operating system, and a safety system.

To fully capture the condition of the PE sheath, the visual inspection system's hardware consists of four cameras, a main controller, and a data storage unit. As the robot climbs the cable, the controller transfers the camera footage to the data storage unit, creating a complete record of the cable's protective surface. A video synthesiser combines the four camera feeds for simultaneous monitoring.

At the same time, positioning data are integrated and transmitted to the ground monitoring system via the wireless transmission subsystem.

NON-DESTRUCTIVE DETECTION AND VERIFICATION OF INTERNAL WIRE FRACTURE AND CORROSION IN STRUCTURAL CABLES

The magnetostrictive guided-wave testing is based on the magnetostrictive and inverse magnetostrictive effects in ferromagnetic materials. The magnetostrictive effect causes a ferromagnetic material to change shape when subjected to a magnetic field and can therefore be used to generate guided waves. The inverse magnetostrictive effect causes the magnetic field of

a ferromagnetic material to change when the material is deformed, enabling guided waves to be received. Based on this principle, a magnetostrictive guided-wave testing system was developed. A computer generates a pulse and sends it through a USB connection to a power amplifier. The amplified pulse excites the transmitting coil, generating an elastic wave that propagates along the cable through the magnetostrictive effect. Defects such as broken wires or corrosion reflect part of this wave.

The receiving coil detects the reflected elastic wave via the inverse magnetostrictive effect and converts it into an electronic signal. This signal is amplified, filtered and digitised by the signal preprocessor before being input into the computer via the USB port. Analysis software then processes the signal and evaluates the cable's condition. A bias magnetic field is applied by the magnetiser to keep the magnetostrictive effect linear. This technique enables early identification and localisation of rust-induced deterioration and fractured wires in bridge cables.

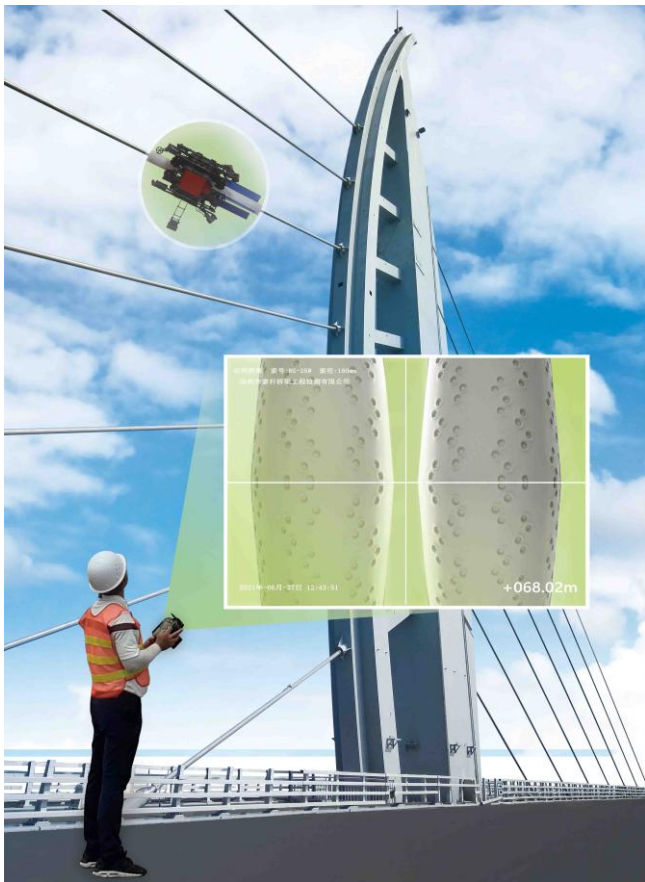


Figure 1: The surface inspection of the PE sheath using a cable climbing robot



Figure 2: Detection of internal corrosion and broken wires in cables

The advantages of this technique include the following:

- **Efficient and advanced:** sensors need only be installed on cable sections near the bridge deck to detect internal damage along the entire length of the cable, including within the anchorage.
- **Accurate and high-precision:** cross-sectional metal loss as low as 2%, relative to ideal conditions, can be detected.
- **Non-intrusive to traffic:** rust and broken wires inside bridge cables can be detected without disrupting traffic.

CABLE FORCE INSPECTION OF CABLES

Cable force testing is used to determine the current force state of the cables and thereby assess whether the internal forces in the structure deviate from the design condition.

The pull-out test can be used to measure the absolute cable force with greater accuracy.

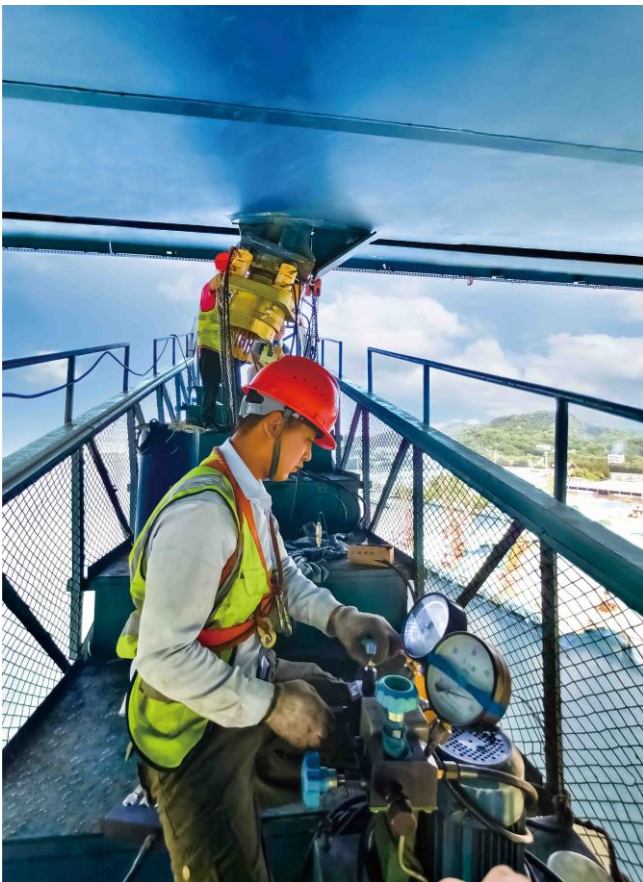


Figure 3: Absolute cable force detection system for bridge cables

Three methods are generally used in cable force testing technology for bridges in service:

- frequency method;
- tension method;
- pressure sensor method.

The vibration frequency method is the most commonly used method for measuring cable force in bridges in service because of its compact size and simple equipment requirements. However, calculating cable force using the frequency method presents several technical difficulties, including:

- The effective cable length is difficult to determine.
- The influence of stiffness on the calculated force cannot be ignored for short cables.
- Most of the cables are fitted with a damper, which introduces error into the cable force measured by the vibration method.
- Other influencing factors, such as the outer sheath and non-uniform stress distribution within the steel strands, also affect the result.

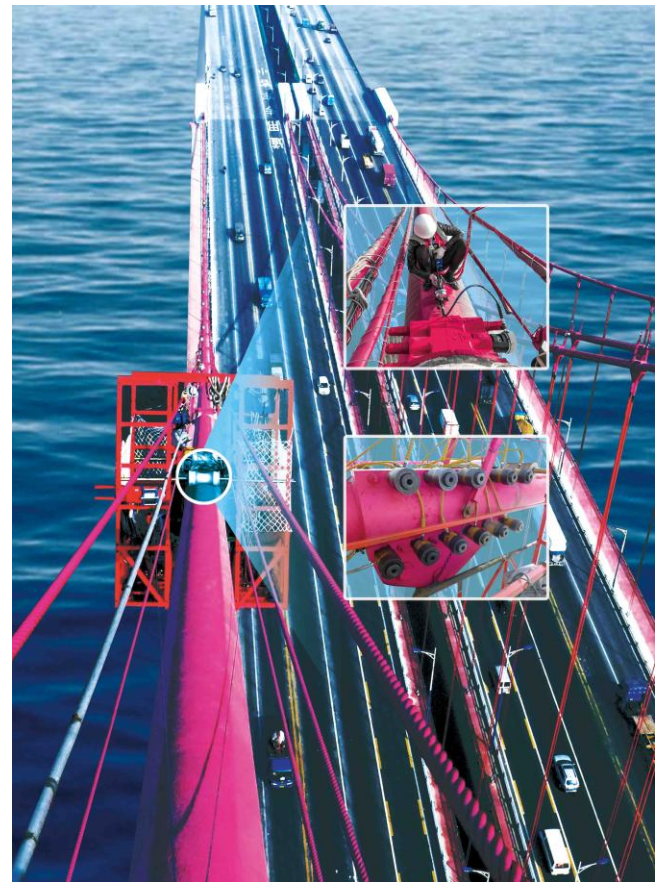


Figure 4: Inspection and synchronous retightening of cable clamps

To accurately and intuitively measure the cable force of an in-service bridge, especially for a cable replacement project, it is necessary to determine the cable force with precision. The tension method can be used for this purpose and is especially suitable for testing the steel strand cables and short cables on bridges in service.

SPECIAL INSPECTION OF ANCHOR HEADS, CABLE CONDUITS AND OTHER COMPONENTS

Anchor heads, cable conduits, and related components can be visually inspected and assessed for defects, including missing anchor covers and loose fixing bolts, so that any issues identified can be addressed promptly.

SPECIAL INSPECTION AND SYNCHRONOUS RETIGHTENING OF THE CABLE CLAMP

The clamping force in the bolts of the suspension bridge cable clamp gradually decreases over the service life of the bridge. To support inspection and maintenance operations, dedicated work platforms can generally be designed and fabricated to crawl along the bridge's main cables, tailored to their specific structural configuration.



Figure 5: Special maintenance of the cable system

In accordance with the applicable specifications, the tension force of cable clamp bolts should be measured periodically using calibrated equipment after bridge completion and throughout the bridge's service life.

If the measured tension deviates from the design value, the bolts shall be retightened synchronously to restore the required clamping force and ensure that the cable clamps maintain the prescribed anti-slip safety factor.

SCIENTIFIC DECISION-MAKING FOR MAINTENANCE AND REINFORCEMENT

The cable-system condition rating is determined from the inspection results and relevant historical operation and maintenance data.

Measured cable forces are incorporated into a finite element model, and the cable's load-carrying capacity is evaluated through iterative analysis in accordance with the applicable design, testing, and evaluation specifications. Each cable should be evaluated individually to support an accurate assessment of the bridge's overall load-carrying capacity.

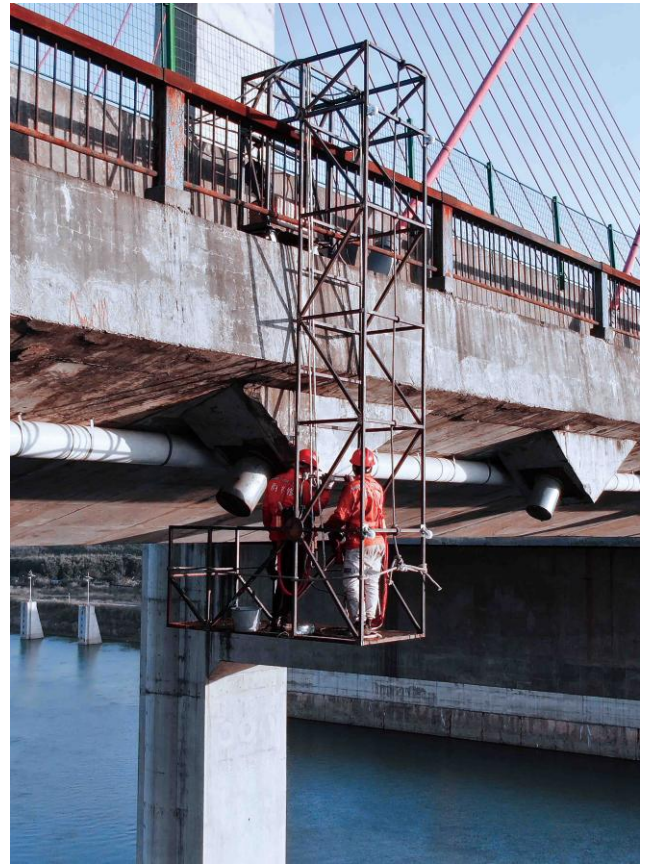


Figure 6: Professional maintenance of cable anchor heads

The cable load-carrying-capacity assessment provides bridge owners and maintenance personnel with an objective basis for decisions about repair, strengthening, or cable replacement. If replacement is required, a project-specific design must be prepared.

Maintenance and reinforcement mainly include repairing bridge cables, wrapping them with PVF tapes, repairing cable anchor heads, repairing and dehumidifying the main cables of suspension bridges, and replacing bridge cables when necessary.

Maintenance and anti-ageing of PE sheaths for cables

Because the PE sheath is exposed to air and ultraviolet radiation over long periods, it may be damaged by material ageing or inadequate protective measures during construction.

Before repairing a damaged area, it is necessary to clean the area thoroughly, prepare PE strips of matching colour, carry out a hot-melt repair using specialised tools, and then grind the repair down to restore the PE layer to its original thickness.

To slow the continuous ageing of the HDPE sheath, its surface should be covered as needed. Wrapping it in PVF anti-ageing tape prevents direct exposure to ultraviolet radiation and acid rain, thereby slowing the sheath's rate of ageing, extending its protective service life, and delaying the need for cable replacement.

Maintenance of anchor heads, sealing covers and cableway pipes

Rusting of the anchor heads and water accumulation in the cable conduits are also common problems.

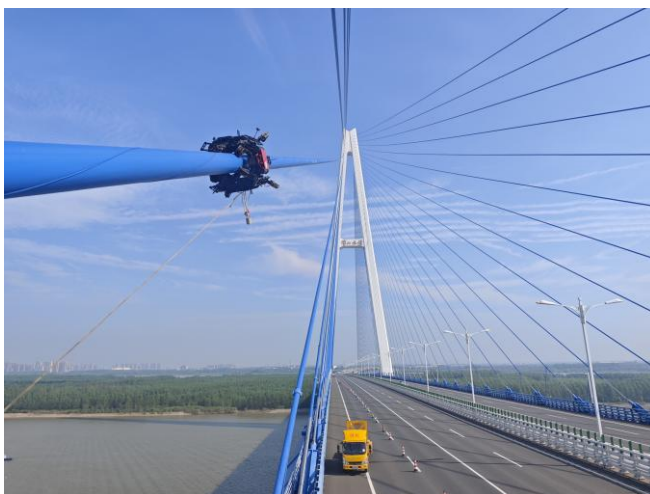
Anchor heads can be protected by removing corrosion, applying sealing wax, and installing protective membranes. Conduit defects can be addressed by removing accumulated water, injecting sealing wax, and replacing the sealing ring.

CONCLUSION

Following a bridge inspection, it is inappropriate to either presume structural safety without adequate evidence or to prematurely declare that the cable system is in critical condition. Instead, the cable system should undergo a comprehensive and systematic evaluation supported by detailed inspection findings, advanced diagnostic technologies, and quantitative structural analysis.

Any conclusion regarding a cable's condition should be grounded in objective evidence, and maintenance strategies should be established through a rational and balanced consideration of structural performance, deterioration mechanisms, and associated risks.

Based on this process, targeted and professionally designed intervention measures can be implemented to secure the long-term safety, reliability, and serviceability of cable-supported bridges.



Figures 7 and 8: Bridge cable inspection using a climbing robot

INTERVIEW

WITH FRANCISCO MILLANES MATO

PROFESSOR OF STEEL AND COMPOSITE BRIDGES, TECHNICAL UNIVERSITY OF MADRID, SPAIN

Magdaléna Sobotková

First of all, thank you for taking the time for this interview.

Both our magazines, e-mosty and e-BrIM, revolve around bridges. Could you tell us about your relationship with bridges and how it all started?

I studied Civil Engineering at the Polytechnic University of Madrid between 1968 and 1973.

Once I completed my studies, I immediately began working in the field of building and bridge structures, and later, between 1977 and 1979, I went to Paris to pursue doctoral studies, where I obtained the title of Docteur-Ingénieur from the École Nationale des Ponts et Chaussées, with a thesis on “the anchorages of the prestressed concrete cables in bridges built by successive cantilevers”.

Upon my return to Spain, I remained closely linked to the field of bridges:

In academia, I served as Professor of Bridges at the Polytechnic University of Valencia from 1979 to 1981, and later, from 1981 until my teaching retirement in 2021, as Professor of Structures and Metallic and Mixed Bridges at the Higher Technical School of Civil Engineers of the Polytechnic University of Madrid.

In the professional field, I was associated with two of the most illustrious and internationally recognized professors and design engineers of Spanish bridges of the second half of the 20th century: José Antonio Fernández Ordóñez and Julio Martínez Calzón, with whom I worked between 1981 and 1990 and later,

as President and CEO of the Engineering Consultancy IDEAM, specialising in all types of bridge and structure projects, both prestressed concrete, as well as metal and mixed, until my retirement in 2023, coinciding with the integration of said company into the renowned company TYLIN.

That is, for practically 50 years I have been closely linked to teaching, design and construction of all types of bridges of the most varied typologies.

I have always been paying the utmost attention to the aesthetic and formal aspects of their design, as well as to the development and application of the most advanced technologies, both in the field of steel and concrete and, especially, in their integration into the technology of the design and construction of composite structures and bridges.



Who has most influenced your career, mission, and way of thinking?

As I mentioned earlier, my entire professional career, my theoretical training, and my understanding of bridge design and construction can only be understood through the personal and professional influence of two of the most valuable Spanish engineers of the late 20th century: José Antonio Fernández Ordóñez and Julio Martínez Calzón, both also professors at the Polytechnic University of Madrid. Since the 1970s, they introduced and developed mixed concrete-steel construction at the highest level in our country and in an internationally recognised manner, when it was barely known or used worldwide except in Germany and Switzerland. I collaborated closely with them from the start of my professional career in 1973.

I owe them the immense fortune of training and specialising in bridges and structures from the comprehensive perspective offered by composite steel-concrete construction. This approach, with its combined use of both materials and the enormous synergies derived from the power and consistency of its theoretical and design concepts, allows for a fluid and coherent transition between reinforced concrete, prestressed concrete, and steel structure technologies, as well as a continuation of composite systems when one of its components is eliminated or significantly reduced.

My extensive experience in teaching, theory, and project design has allowed me to confirm the enormous richness and potential of this approach.

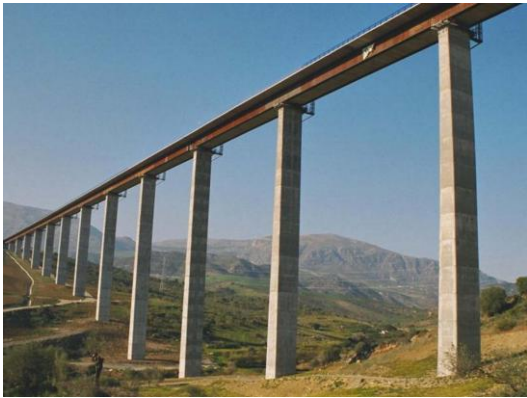
What is the most personally satisfying project you have worked on, and why?

It is not possible for me to choose just one, but, as I will detail later, there are perhaps six that I could select that, in some way, immediately come to mind when I reflect on my professional career:

- **The Arroyo de las Piedras Viaduct**, in Malaga, the first viaduct with a mixed structure on Spanish High-Speed lines, and the one with the longest span (63.5 m) that had been built up to that time in this type for high-speed rail;
- **The Archidona Viaduct**, a mixed structure viaduct also in Malaga, which, with its 3150m distance between abutments, constituted the

longest structure built up to that time with structural continuity and absence of intermediate joints between the only two track expansion devices located at both ends of the viaduct;

- **The Infante Don Enrique laminar arch bridge**, over the Douro River in Porto, with a span of 280m, which posed not only a risky technological challenge due to the enormous slenderness of the arch, only 1.5m deep, and a maximum reduction in the magnitude of the structure, but also due to the landscape and aesthetic challenge posed by its location in the historic centre of Porto, a World Heritage Site and among the impressive metal arches of Eiffel and Zeidig, unsurpassed references of our profession;
- **The Abandoibarra footbridge in Bilbao**, in a privileged urban setting between the University of Deusto and Frank Gehry's Guggenheim Museum, was designed and built by us. Our solution won an Ideas Competition that emphasised technological and aesthetic innovation in the proposals. The structure, with its innovative folded sheet-metal forms spanning 140m, was the first long-span bridge to use high-performance duplex stainless steel, contrasting with the titanium of the museum's façade. The interior of the structure, which accommodated pedestrian traffic, was clad in lapacho wood from the tropical forests of Brazil.
- **The viaduct over the Ulla River**, located in a unique landscape, on the Atlantic High-Speed Rail line of Galicia. It was a truss with a mixed structure that, with a span of 260m, exceeded by 40m the previous world record for this type, the Nantenbach Viaduct, by the renowned German engineer Leonhardt;
- **The Concordia Bridge**, the last one I designed and built before retiring, a mixed arch with a 150m span, located at the entrance to Madrid from Terminal 4 of the Barajas airport, with a powerful and innovative design, both from a technical point of view and, especially, formal and aesthetic, which was the winner of an Ideas Competition called for that purpose given the singularity and relevance that was intended to be given to the project.



The Arroyo de las Piedras Viaduct, Malaga, Spain



The Archidona Viaduct, Malaga, Spain



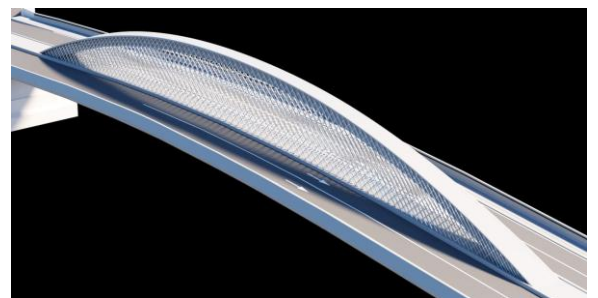
The Infante Don Enrique laminar arch bridge, Porto, Portugal



The Abandoibarra footbridge, Bilbao, Spain



The viaduct over the Ulla River, Spain



The Concordia Bridge, Madrid, Spain

Can you recall approximately how many bridge projects you have been involved in, and what roles you played?

During the approximately 40 years in which I developed my professional activity in the field of bridges, first as an associate of the engineers Fernández Ordóñez and Martínez Calzón and, from 1990, in the management of the IDEAM Consulting company, I designed more than 600 bridges of the most diverse types, both of prestressed concrete and metal structure as well as of mixed concrete - steel type, technology with which I undoubtedly feel more identified.

My professional activity has not been limited to the design and conception phases, but in most cases, especially the most unique ones. I was responsible for the support and technical assistance to the construction, as well as the control and monitoring of its execution, whether by the construction company or on the side of the owner or the administration.

In the last 20 years of my professional practice, I also developed and promoted a department at IDEAM specialising in the inspection, diagnosis, rehabilitation, and reinforcement of bridges with pathologies. This activity has been very attractive to me professionally and has provided me, as a result of the conclusions derived from the analysis of pathologies in existing bridges, with an invaluable wealth of lessons to apply to the details and concepts of the design of new bridges, with the consequent improvements that these innovations allowed to impact their durability.

I would also like to highlight my participation in several evaluations and reviews of other projects, as well as expert assessments of accidents and incidents on bridges in service or under construction.

Are there any projects that are especially meaningful to you or stand out as your favourites?

Undoubtedly, the six projects I mentioned and described earlier stand out, as in each I had to address—not gratuitously, but out of necessity—technological challenges that surpassed anything previously designed or built. What I found most stimulating and rewarding, both personally and professionally, was that these technical challenges came with stringent aesthetic and formal

requirements because of their unique urban or landscape locations and strict environmental integration needs.

As I mentioned earlier, in all of them my participation was not limited to the conceptual and design phases, but what I found most rewarding and what left an indelible mark on me both personally and professionally was my close involvement during the construction phase as technical support, as well as being responsible for the control and monitoring of the quality of execution.

Over the course of your career, what major changes have you observed in bridge technology? Which technical advance do you consider the most significant?

From a structural typology perspective, I understand there have been few significant changes and innovations, given that major achievements in steel bridges were already developed in the second half of the 19th century and the first decades of the 20th. Prestressed concrete experienced a significant boost with the development of public works after the Second World War, but most typological and technological advances occurred in the 1960s and 70s. After those years, perhaps the most notable development was the consolidation and expansion of cable-stayed bridge solutions, which are now practically standard for spans exceeding 200 m.

However, I would highlight two changes that I have observed and that I find very relevant, due to their novelty, relevance and potential in the immediate future, and in which I have been involved throughout my professional career:

- The emergence and development of the concept and implementation of "open prefabrication", an area in which Spain has been a pioneer and a global leader. This approach overcame the strict limitations of traditional isostatic precast solutions (such as double-T beams) and, through the use of second-stage post-tensioning and, above all, external post-tensioning, extended the scope of prefabrication to virtually all structural types previously exclusive to cast-in-place construction: medium-span bridges, including those with spans approaching or exceeding 100 m, featuring continuous decks of constant or variable depth, as well as curved or skewed alignments; and, for longer spans, extradosed

and cable-stayed precast solutions. Today, prefabrication can be considered a competitive option for virtually any structural solution that is viable for cast-in-place construction;

- The development, now practically universal, of mixed-type bridges, which until the 1970s were largely limited to a few projects in Germany and Switzerland. As I have already mentioned, I have been incredibly fortunate to witness and participate in their introduction to Spain in the early 1970s, just as I was beginning my professional career, and privileged to collaborate on their technological and conceptual development in a wide variety of road and rail bridge projects over the past 50 years. These projects have placed Spain at the forefront of this technology worldwide, boosting its development and competitiveness internationally, particularly in Latin America, the United States, and Canada. The development and approval of Eurocode 4, in which IDEAM had the opportunity to participate, has placed composite construction on the same level as concrete (Eurocode 2) and steel (Eurocode 3) technologies, not only from the point of view of projects but also in research, theoretical developments and teaching in Polytechnic Universities. When I finished my studies in the 70s, it was unthinkable that steel and concrete technologies could be integrated, as they constituted two parallel worlds, isolated and with hardly any interrelationships, neither in academia, project consultancies, nor construction companies.

How do you see the development of BIM utilisation in the bridge industry?

Inevitable and very beneficial, but necessarily gradual and progressive to ensure the viability and consistency of its implementation in project engineering, construction, and bridge rehabilitation.

Implementing BIM methodology in the engineering processes that were in place until recently in consulting and construction firms presents many challenges and issues to resolve in order to ensure that the undeniable potential of this new methodology is integrated without negatively affecting the quality and future developments of current engineering, which the incorporation of BIM should never negatively impact.

In what ways has the introduction of BIM changed your own work?

It hasn't directly affected me since, in recent years, I have not been very involved in direct production tasks; however, we were—and increasingly are—progressively implementing the BIM methodology across all IDEAM departments. We are bringing on board new BIM coordinators, BIM managers, and modellers, while also requiring BIM proficiency from new designers and supporting young engineers in mastering this technique, which is becoming increasingly essential for the future.

In Spain, and increasingly in Latin America, where we work more frequently, BIM is now a common requirement for all new projects, especially large projects or those involving multiple professionals in addition to structural engineers (highways, railway lines, public and private architecture, tunnels, stations, etc.). This is particularly true at LOD 300 (level of detail), which includes only geometric shapes and does not yet include the complete, precise details of the joints and connections between elements.

The requirement to incorporate reinforcement and detailing is also spreading more slowly and gradually, as it is still unmanageable in many cases, and implementing it would have an unacceptable impact on processes and, above all, on the costs and deadlines that have governed the engineering market until now.

In your opinion, what is the current level of acceptance of BIM within the construction industry, and what challenges remain for its full deployment?

There is now a widespread consensus within the sector that BIM is inevitable, increasingly demanding, and moving toward higher Levels of Development (LODs) across buildings, bridges, and structures. The viability of our engineering and construction companies is directly linked to fully implementing this methodology in their processes. There is also widespread agreement on its potential time and deadline savings, the elimination of unforeseen problems, and its positive impact on quality, sustainability, and the subsequent durability and monitoring of projects.

The remaining challenge is how to proceed with this implementation given companies' pre-BIM cost and productivity structures.

Therefore, its implementation must necessarily be gradual, consistent, and progressive if the process is to be viable. This must also be understood by public administrations and property owners, and properly reflected—without wishful thinking destined to fail—in contracts, their specifications, costs, and deadlines, so that its implementation and enforcement can subsequently be feasible.

In this regard, I understand that the implementation process, from initial planning to full implementation, can vary considerably depending on the type of contract. In my opinion, its advantages may be more evident, and its full implementation therefore faster, in some types of contracts, such as:

- Those processes, such as the prefabrication of concrete or the execution of metal structures, in which the execution is more industrialised;
- Contracts for large buildings, stadiums, hospitals, airports, etc., where it is increasingly necessary to integrate, coordinate and avoid interference and unforeseen events among professionals from the different disciplines involved: architecture, structure, installations (electrical, mechanical, climatic, etc.);
- Contracts for highways, subways, tunnels or high-speed lines in which, in addition to structural engineers, other types of engineers specialising in layout, installations, geotechnics, etc. are involved;
- Contracts for inspections, monitoring, reinforcement, maintenance and conservation of structures in which, in addition to the detailed "as built" information of the work carried out, and of the possible incidents or pathologies during construction, it is necessary to know and record all possible inspection actions, diagnoses, tests, pathologies, rehabilitation and reinforcements undertaken to ensure the management of durability throughout the useful life of the structure.

Today, we see many emerging technologies—AI, AR, autonomous vehicles, IoT—shaping construction. Which of these do you believe will most influence the future of BIM, and in what way?

Probably, as in many other areas, AI will drastically revolutionise the world as we know it and, associated with and combined with the BIM

methodology, will take the digitisation of engineering to extremes that we can hardly imagine today.

The intense momentum of current AI development has not yet allowed us to implement it more than minimally in our current practice, so we can only vaguely intuit the drastic changes that may be on the horizon for the near future of engineering, such as:

- In the design and project phases, AI algorithms interacting with finite element programs for the structural analysis of 3D information collected in BIM models will undoubtedly allow for the optimisation of thousands of variables to achieve more efficient and safer geometries, designs, and construction processes, better aligned with the environmental, geotechnical, topographic, hydraulic, and other constraints of the surroundings.

AI can also effectively detect errors, conflicts, interferences, deficiencies, or ambiguities in the documentation during the project phase, minimising risks and uncertainties before construction begins.

- In the execution phase, AI algorithms will undoubtedly be very efficient for the control and monitoring, in terms of behaviour, costs and deadlines, of the physical progress versus the digitised design, proposing corrections or preventing risks of failures before they occur;
- During the maintenance phase of a bridge's service life, AI can greatly enhance the usefulness of information gathered from historical BIM records of all pathologies, inspection data, and reinforcement or rehabilitation work carried out, allowing for the estimation of the remaining service life of each element.

Automatically integrating IoT sensor data from the bridge (fatigue levels, corrosion, crack width, vibration, etc.) into Digital Twins, along with high-definition drone imagery, will enable continuous, real-time monitoring of the bridge.

AI algorithms processing this information will revolutionise and significantly enhance the engineering management, conservation, and preventive maintenance of bridges and critical structures.

How can BIM be used in the operation, maintenance, and long-term preservation of bridges?

It is perhaps in the area of monitoring, maintenance and conservation of bridges that the incorporation of the BIM methodology will bring about a drastic improvement in the near future.

For over 20 years, IDEAM has been developing a dedicated Bridge and Structure Conservation department that has carried out hundreds of inspections, pathology diagnoses, and reinforcement and repair projects for road and railway bridges, both in Spain and Latin America.

Our experience in this field shows that the greatest difficulty in detecting the origin of pathologies, as well as assessing their impact on structural safety and the resulting need for reinforcement or repair, is the lack of reliable information, and especially its traceability, between the construction phases and any incidents that may occur, the moment of acceptance of the completed structure, and subsequent inspections, tests, trials, reinforcements, or repairs throughout the structure's lifespan. In most cases, this information has been collected by different companies and stored in isolation, disconnected from the rest of the documentation.

The use of BIM, especially in bridges that have already been contracted using this methodology, both in the project phase and in the execution phase (with detailed recording of possible incidents, assembly breakdowns and specifications of the materials used) and in the acceptance phase (with final recording of the geometry, movement in the supports, load tests, etc.), can represent a drastic change, in a positive way, in the maintenance and conservation operations.

BIM will not only ensure the traceability of all the information collected and stored, between the moment of the acceptance of the work and the subsequent and successive inspections and actions to repair pathologies and possible reinforcements, but it can also incorporate the continuous updated record of any possible monitoring sensor incorporated for the monitoring of the structure (corrosion meters, movements, vibrations, opening of cracks, deformations, etc.).

What tasks and challenges do you see ahead for the next generation of engineers and for the bridge industry as a whole?

I completed my engineering studies using only slide rules. My early years as an engineer coincided with the arrival of the first HP minicomputers, on which project offices personally implemented our first automated calculation applications and finite element models. For my doctoral thesis at ENPC in Paris, I had to develop nonlinear finite element models of concrete using a 20K computer (!!).

At that time, the still relatively precarious and limited methods of automated structural calculations, especially for bridges, compelled engineers to train in and deepen their understanding of structural concepts to design and construct the numerous and increasingly spectacular developments in bridge engineering after World War II. It is even more relevant to reflect on the incredible advances in metal bridge construction in the 19th century, from the 30.50m Coakbrookdale Bridge in 1779 to the 487m Brooklyn Bridge in 1883, based primarily on manual calculations using highly simplified structural models. This required designs and dimensions based on structural concepts of enormous consistency and solidity.

Over the past 50 years, software for analysing structural models based on the finite element method has developed remarkably. Equally remarkable has been the development of graphical models and modules for the 3D design and modelling of virtually any bridge or structure. To this, we must add the changes imminent with the development of BIM and AI applications in the design, construction, and monitoring of bridges. Today, we can calculate and design almost anything, and represent it in 3D, with forms and typologies that were previously unattainable and perhaps even unimaginable.

All of this can push, especially new engineers trained in this digital environment, towards a virtual engineering approach, increasingly based on models and, at the same time, far from the concepts that underpinned the spectacular developments of the last two centuries. In my view, this is the challenge engineering must face in the immediate future, a future that is increasingly becoming a present we are forced to confront.

What advice would you give to young engineers starting their careers today?

In Spain, they are unlikely to experience another golden age in bridge and civil engineering as intense as the 25 years they enjoyed between joining Europe in the 1980s and the major crisis of 2010. Nor is it foreseeable that Western Europe will again see large investments in highways and high-speed rail lines in infrastructure that is somewhat saturated for the moderate growth needs expected. The future of bridge engineering lies primarily in Latin America, with impressive development potential, and also in the United States, Canada, and Asia, although in these latter regions, the large American and Asian engineering and construction companies will not make it easy for European engineers and engineering firms to compete.

In any case, large projects and works will be located far from our environment, which, together with the enormous development of automated calculation and design systems, AI and the almost unstoppable promotion of remote working, will inevitably tend to distance young engineers, and engineering companies in general, from the reality of the terrain and direct presence in the construction processes of the great works, which in my opinion is inextricably linked to what is, and until today has been, the foundation of engineering and training in this discipline.

Young engineers face the risk of "virtual engineering" in their professional training, which can turn them into "operators" of systems and calculation and design algorithms, far removed from what engineering really is. It can leave them in a precarious position as they face professional development and progression amid increasingly powerful computer applications and competition from new generations of young engineers who are better adapted to new environments.

In this context, certainly difficult and different from that experienced by those of us who have had the opportunity to develop our professional activity in recent decades, I believe it is advisable for the training of new engineers to take advantage of any opportunity to leave their "comfort zone" in front of a computer screen hundreds of kilometres away from where future engineering projects or works will be carried out, and to support their training by making direct contact with engineering where it will be developed.

Finally, what are your own plans for the future?

It has been three years since I retired from both the academic and professional fields, so I no longer have an active future in engineering like I did for almost 50 years.

In return, I have gained control over my time and schedule, which allows me to reflect on the many projects I have worked on, the bridges I have seen built, and the teams of magnificent engineers I have led. I am grateful for the unique era of bridge engineering I have lived through and for how much it has allowed me to develop professionally and contribute personally.

SHORT BIO

Teaching Career

- 1968–1973: ICCyP, Madrid School of Civil Engineering, Polytechnic University of Madrid (UPM).
- 1976–1979: Trainee at CEBTP, Saint-Rémy-lès-Chevreuse, Paris.
- 1979: Doctor of Engineering, École Nationale des Ponts et Chaussées, Paris.
- 1979–1982: Interim Associate Professor of Bridges, School of Civil Engineering, Valencia.
- 1982–1993: Assistant Professor of Steel Structures, School of Civil Engineering, Madrid.
- 1993–2021: Professor of Steel and Composite Structures and Bridges, ETSICCP, UPM.

Professional Career

- 1973–1976: MC2 (Bridge and Structural Engineering Consultancy founded by Julio Martínez Calzón).
- 1981–1990: Mart-2 (Bridge and Structural Engineering Consultancy, in association with J. M. Calzón).
- 1990–2008: IDEAM. Managing Director.
- 2008–2021: IDEAM. President and CEO.
- 2022: IDEAM. Honorary President.

Awards and Other Achievements

- 2006: FIB Awards for Outstanding Structures (Infante Dom Henrique Arch, Porto).
- 2008: ECCS Awards for Outstanding Steel & Composite Bridges (Arroyo Piedras Viaduct, Málaga AVE high-speed railway).
- 2015: CONSTRUMAT Award (Ulla River Viaduct, Atlantic Axis AVE high-speed railway).
- 2015: Madrid Regional Civil Engineering Award, College of Civil Engineers (ICCP).
- 2016: IABSE Awards for Outstanding Structures (Ulla River Viaduct, Atlantic Axis AVE high-speed railway).
- 2016: Professional Merit Medal, College of Civil Engineers (ICCP).
- 2017: Santo Domingo de la Calzada Award, College of Civil Engineers (ICCP).
- 2014 and 2017: ACHE Structural Engineering Awards (Archidona and Ulla viaducts).

Approximately 100 technical publications and 600 bridge and structural engineering projects.

INFORMATION MODELLING OF CURVED CITY STEEL-CONCRETE OVERPASS OVER HIGH-SPEED RAILWAY

*Nikolai Kozak, PhD, BIM Manager of the Project;
Dmitry Yaroshutin, CEO of the Company; Oleg Utenkov, Project Director
Centre of Competence Bridges
Nikolai Daliaev, Chief Engineer, Construction Company Baltiysky Bereg*

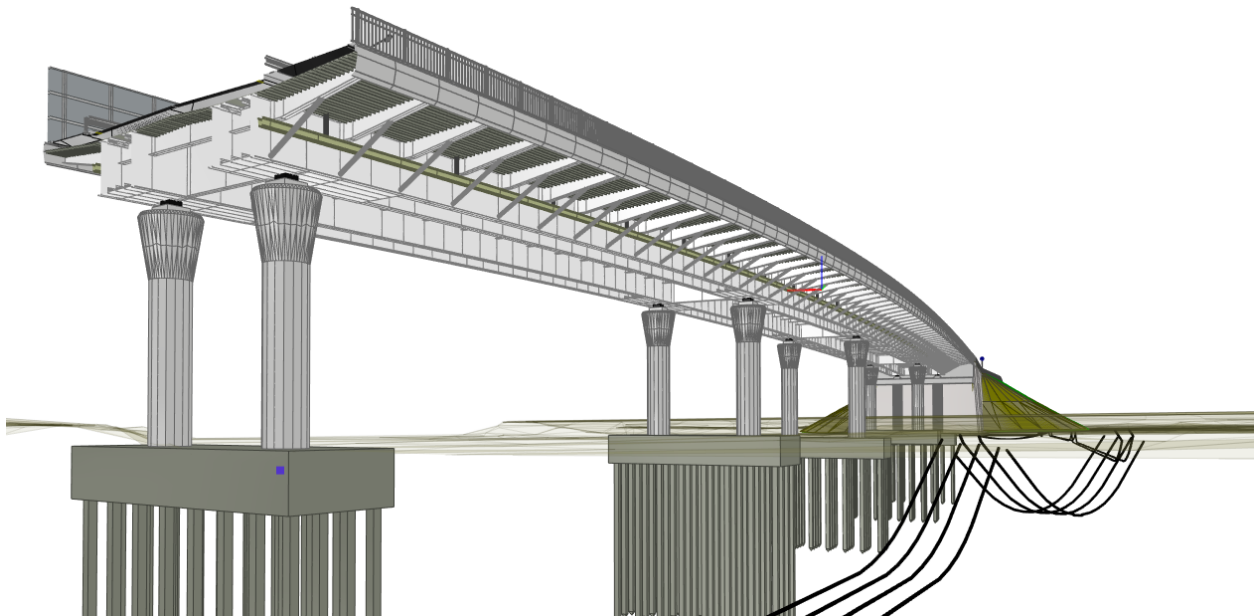


Figure 1: General view of the overpass model

PROJECT DETAILS

This article is dedicated to the construction project of an overpass that, despite its relatively short total length and standard width (only two traffic lanes, pedestrian paths, and a combined bicycle lane), holds significant value as it connects two parts of residential districts separated by a high-speed railway.

The work process on this complex project, which includes two new sections of the street and the overpass itself, began in 2022.

The key requirements that determined the design features of the project were as follows:

- Design plan for the proposed street with a curve over the railway intersection area;
- Limitations on the construction technologies for the main span structures of the overpass are due to restrictions aimed at minimising the impact on train traffic (high-speed trains run along the line at intervals of 2 hours during rush hours);
- Narrow area of the construction site;



Figure 2: Project visualisation for public discussion

- A large number of ground and underground utilities (110 kV high-voltage electric power lines, high-pressure gas lines) are located below and near the construction area;
- Considering the established walking routes of the area for the residents, as well as to guarantee their comfort during and after the completion of construction.

The visualisation of the project for public discussion, which was held with neighbouring residents at the beginning of the project implementation, is shown in Figure 2. For this, a simplified geometric model was developed in SketchUp in a short time of two days.

A significant aspect of the project was the extremely tight deadlines for both design and construction. The first version of the overpass design documentation was ready in the spring of 2023, and work on the construction site began in the fall of 2023. The installation of the span structure in the designed position was completed in April 2024. The pre-operation inspection and load testing of the overpass took place in June 2024, and full operation of the structure began a month later.

REASONS FOR BIM

Design documentation in the form of information models has been mandatory for all buildings and structures developed with state budget. Before that, the use of information modelling tools was not regulated, and they were mainly used by large design companies that recognised their benefits for optimising project management for their size.

Currently, developing an information model during design is mandatory for all projects and companies, regardless of size.

Unfortunately, for infrastructure objects (bridges, tunnels, roads to a lesser extent), the transition to BIM-required design was quite abrupt, which does not allow the design process itself to fully shift to a BIM philosophy. Most bridge designers still develop design documentation using “classical” methods with drawings and tables, while colleagues in BIM departments simultaneously develop an information model based on completed parts of the “classical” documentation.

THE MAIN PARAMETERS OF THE DESIGNED OVERPASS

Total overpass length	246.11 m
Width of span structure	17.5 m
Curvature in plan	up to 410 m
Elements of the street	2 lanes Sidewalk and combined bicycle-pedestrian path
Type of span structure	Composite steel-concrete span structure; 2 continuous beams in transverse section (boxed over the piers and in the main span, open in the lateral) connected with transverse beams and slab
Span structure	33,00+42,00x2+36,00+54,00+33,00 m

Thus, it is possible to identify the two main goals that were solved in the current project by developing an information model:

- Fulfilment of the customer's formal requirements for providing the information model of the designed object in a set of *.ifc format files (external goal);
- Internal control of developed design solutions for collisions, verification of elevation marks, and monitoring of design material volumes (internal goal).

STRUCTURE OF AN INFORMATION MODEL

At the time of the project's implementation, local regulations and the customer's technical tasks did not specify the requirements for the composition and level of attribute content in the information model. In this regard, the design company independently developed a preliminary internal standard for bridge information modelling. Then, based on it, a BEP (BIM Execution Plan) was developed for the current project, on the basis of which the further modelling process was carried out.

In alignment with the "classical" framework of the design documentation, the following structure of the information model has been established in the BEP, highlighting the primary software tool for its development.

- DTM – Digital Terrain Model (Topomatic Robur);
- TKR-1 – Road model, including pavement and equipment (Topomatic Robur);
- TKR-2 – Overpass model (along the boundaries of bridge transition slabs (Autodesk Revit);
- TKR-16 – Structures on the approaches, including retaining walls and pedestrian tunnel (Autodesk Revit);
- TKR-5 – Underground gas line reconstruction (Autodesk Civil 3D);
- TKR-6 – Underground high-voltage electric power lines after reconstruction (Autodesk Civil 3D);
- TKR-7 – Street lighting system (Autodesk Revit).

In the list of the parts mentioned above, "TKR" refers to the parts of the documentation that contain technological and structural design solutions. In accordance with BEP requirements, each part of the model should be developed as a separate *.ifc format file.

The requirements for the level of attributes within the modellers' own initiative were set notably high (close to the LOD/LOI 300).

The purpose of such a level of attributes was to create a database that would enable automated preparation of the overpass technical passport at the operational stage.

MODELLING PROCESS AND ITS DISCUSSION

At the beginning of the project, the company had already successfully applied information modelling technologies in other projects at the stages of processing engineering survey data and designing road geometry and structures.

For both of these tasks, we used Topomatic Robur software. The information modelling of the overpass seemed more complicated.

Based on our team's existing experience in civil engineering tasks, Autodesk Revit was selected as the primary environment for developing the information model of the overpass.

From the start of the modelling, it was clear that additional external tools (third-party software and scripts) would be advantageous for bridge-specific tasks.

Table 1 presents the main tasks and associated issues identified during modelling, along with our proposed solutions.

It should be noted that in the context of modelling bridge structures in the Revit environment, it was necessary to redefine the concept of "Level" to a more appropriate concept of "Group of Structures."

Since the output format for the model was intended to be IFC 2x3, the redefinition of standard IFC element classes to bridge-type ones (which were introduced in IFC 4) was not carried out within the scope of this project.

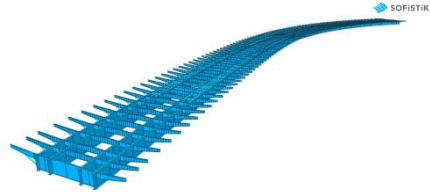
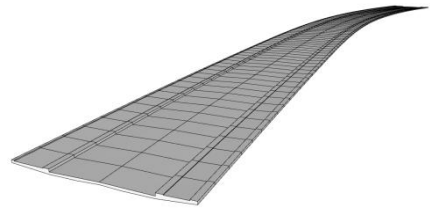
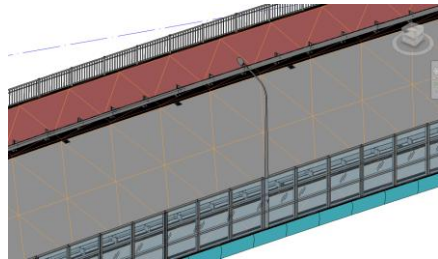
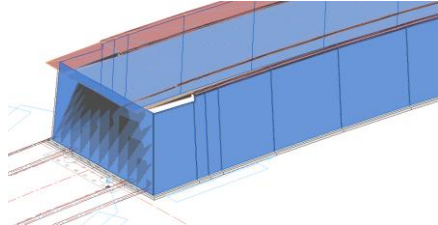
Issue (Task)	Solution method	Illustration
Geometry modelling of a steel span structure located on a complex curve (with variable curvature in the plan and longitudinal profile)	Using SOFiSTiK's Computer-Aided Bridge Design tools to develop a simplified axial model with the target curvature and then exporting it to Revit for detailing	
Geometry modelling of a superstructure reinforced concrete slab on a complex curve (with variable curvature in the plan and longitudinal profile, as well as variable cross-sections)	Direct polygonal geometry modelling in SketchUp is based on a steel structure model imported via *.ifc. Then, it is exported to Revit as a "Model in context"	
Placement of single (point) elements of the bridge deck (guardrails and barrier posts, light masts, drainage pipes and others)	Developing and then applying custom Dynamo scripts to create element arrays along complex curves selected from the model	
Geometry modelling of the retaining walls at the approaches to the overpass based on the data from the road model (TKR-1)	Exporting the full-elements model from Topomatic Robur to SketchUp; modelling a simple external outline solid model, followed by exporting it to a *.dxf file, using it in Revit as a form-generating element for wall-type elements.	

Table 1: List of main issues and their solutions

The decomposition of the overpass information model (model part TKR-2) was adopted as follows:

- Bridge deck (pavements, guardrails and barriers, noise protection screens, drainage system, expansion joints);
- Superstructure (reinforced concrete slab and steel structures);
- Piers No. 1 to No. 7 (including foundation and bearings).

The approach structure model (TKR-16) consists of two groups of structures for Approach No. 1 and Approach No. 2, respectively.

For all other models (DTM and TKRs 5, 6, 7), the decomposition system was taken unchanged from the software used.

RESULTS OF MODELLING

Figure 1 illustrates a typical section of the developed information model. In contrast, Figure 3 displays the final assembly of the project model with a vertical offset by groups of structures (flattened division by the model parts and by local decompositions by "Groups of Structures" or "Levels"). Figure 4 presents an example of the model's attribute content of intermediate pier No. 6 (numerical parameters of its geometry).

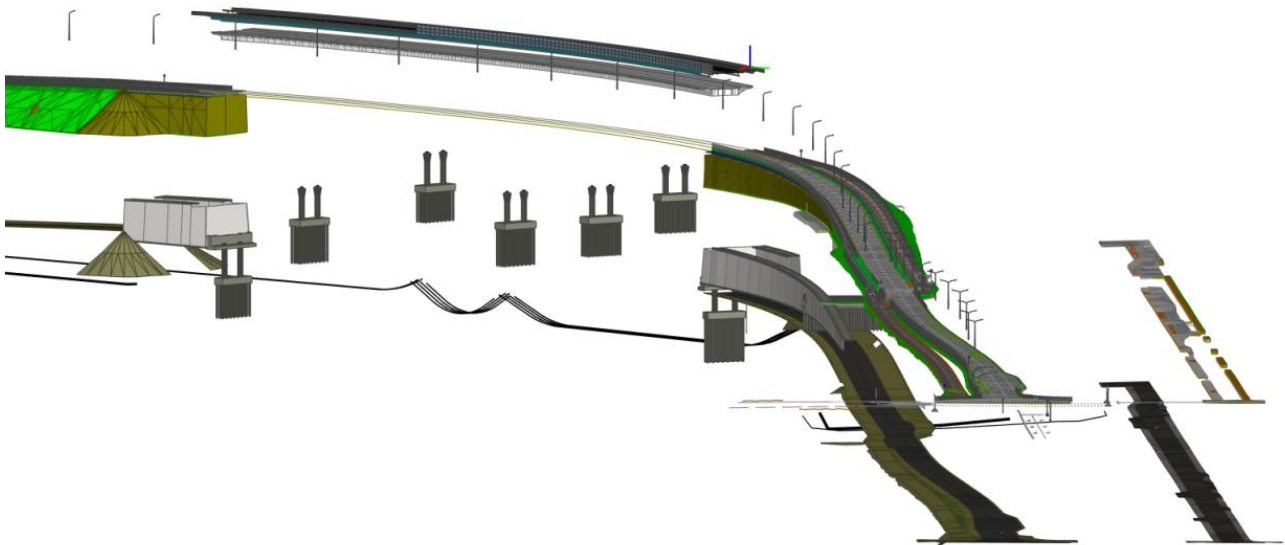


Figure 3: Decomposition of a project model by groups of structures (created with a level shift in the IFC viewer)

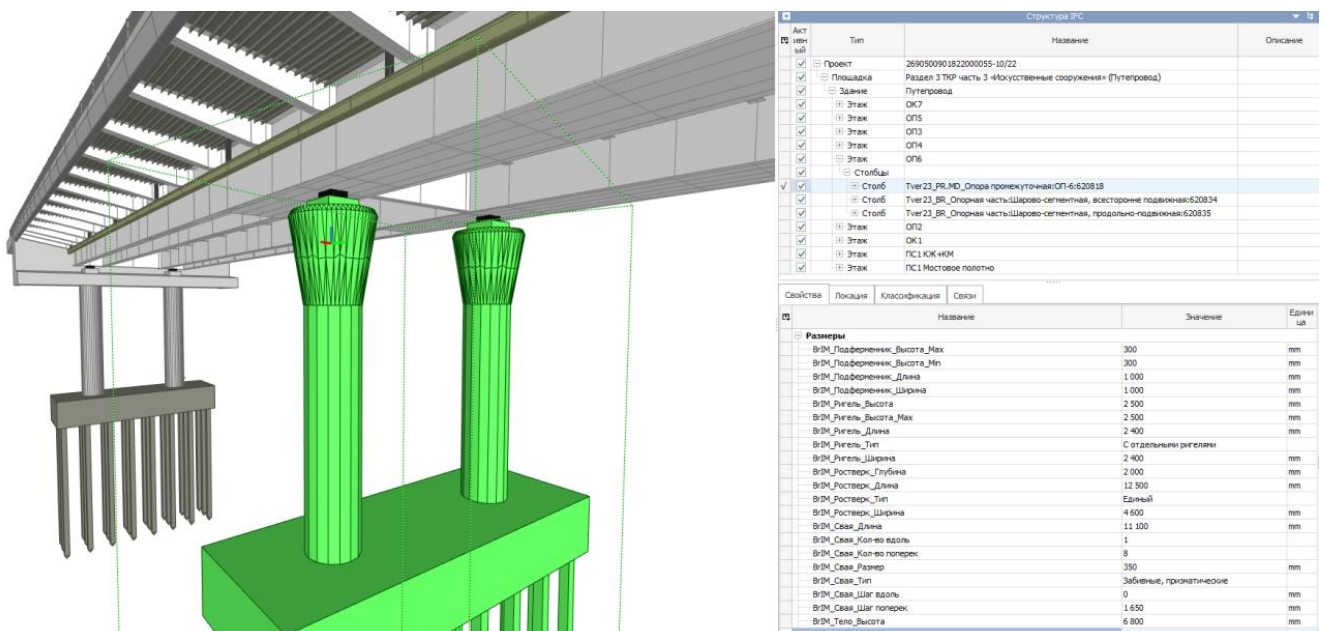


Figure 4: Attributive content of the information model (example of the pier No.6)

CASE STUDY OF THE APPLICATION OF THE INFORMATION MODEL TO PRE-OPERATION INSPECTION TASKS

The construction works of the overpass were completed in the spring of 2024, see Figure 5.

As part of the pre-operation inspection, 3D laser scanning of the main structures was carried out from more than 40 scanning stations, see Figure 6.

Subsequently, to ensure that the constructed structure adheres to the designed one, the assembled point cloud has been compared with the developed information model, Figures 7 and 8.

The point cloud and IFC model were matched in semi-automatic mode through iterative visual comparison of control sections (beginning, middle, and end of the overpass), followed by automated adjustment using software tools.



Figure 5: The overpass after the construction work was completed

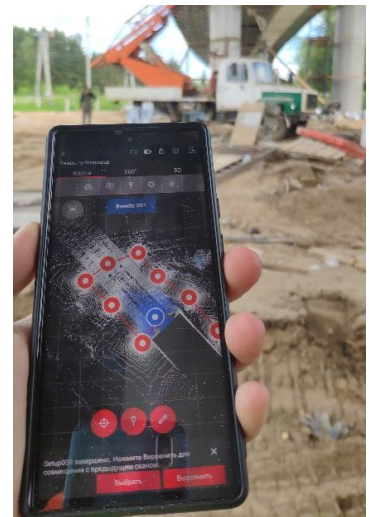


Figure 6: The process of 3D laser scanning of the overpass



Figure 7: Visual comparison of the point cloud with the information model. Bottom view



Figure 8: Visual comparison of the point cloud with the information model. Top view

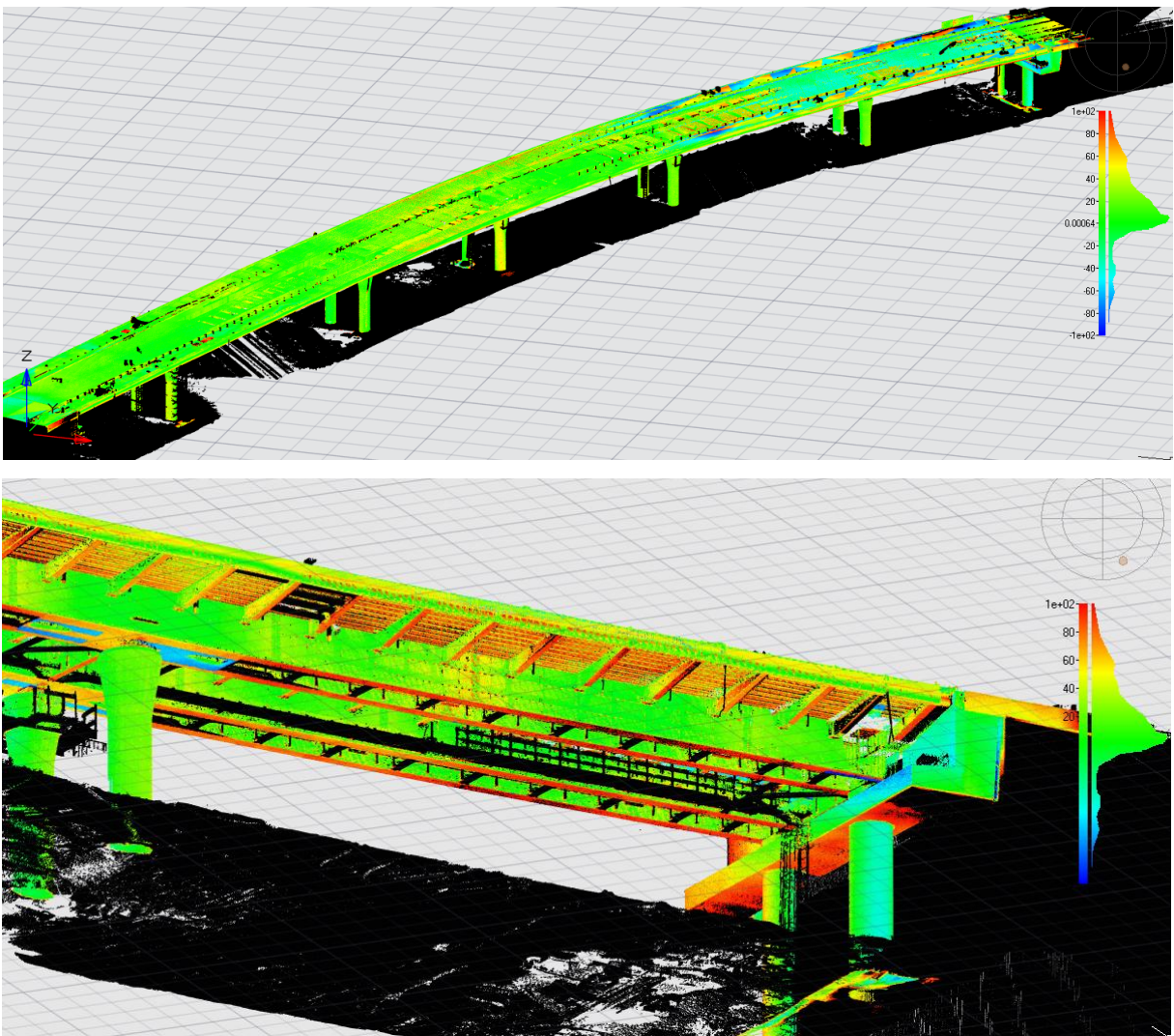


Figure 9: Digital comparison of the point cloud with the information model with the activated layer of the distance difference map

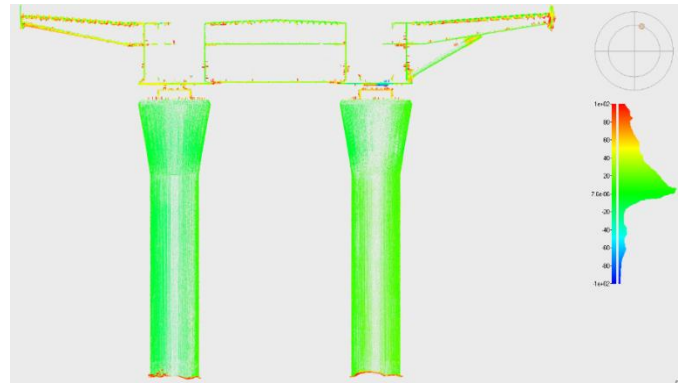


Figure 10: Control of geometric parameters of the span structure and pier in the section of intermediate pier No. 6. Green values represent low deviations (low distances) between the cloud and the model, while red or blue indicates large differences

The point cloud was analysed to determine the values and directions of deviations of the actual points obtained from the design geometry of the information model.

Figure 9 shows a graphical interpretation of the obtained values.

Significant deviations were noted at the bottom of the span structure slab, which can be explained by the different shapes of the formwork elements actually used (Figure 10). It was also noted that the abutment pier located on a complex curve has a slight turn relative to the design model, which was also explained by adjustments made to the project during its construction.

Actual geometric parameters were also checked for the pedestrian tunnel constructed under the road at approach No. 1 (Figure 11). Based on the comparison of the information model and the point cloud, deformations of the tunnel vault due to soil load were observed (within the design tolerances).

CONCLUSION

Experience from complex project implementation shows that, beyond meeting the customer's formal requirements, developing a bridge information model also enables engineers to conduct additional quality checks and ensure the accuracy of design solutions.

The information model is also useful during pre-operation inspection, allowing experts to fully compare the design with the structure's actual geometric parameters. The next step is to save information on identified geometric deviations in a multi-stage information model for further use during operation.

ACKNOWLEDGMENTS TO OUR TEAM

Oleg Kozlov, Engineer – 3D laser scanning

Maria Zobova, Technician (Assistant Engineer) – information modelling

Ilya Gumaniuk, Technician (Assistant Engineer) – information modelling

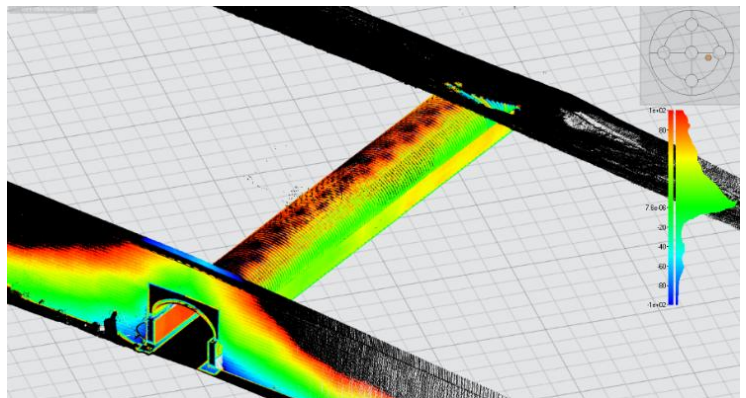


Figure 11: Control of geometric parameters of the pedestrian tunnel on approach No. 1

FROM 2D DRAWINGS TO A DIGITAL CONSTRUCTION SITE: WHAT DATA CAN A DESIGNER PREPARE FOR THE IMPLEMENTATION OF BRIDGE AND LINE STRUCTURES

Ing. Pavel Vlasák, Hyperon Advisory

Ing. David Novák, Ing. Magdalena Křečková
AFRY CZ

INTRODUCTION

Traditionally, the designer's role has largely been understood as preparing and submitting implementation documentation, predominantly as sets of 2D drawings.

Modern engineering practice shows that the designer can be an active technological partner to the contractor, preparing data that can be used directly for machine control, volume determination, layout, and spatial coordination.

The key to this transformation is the open philosophy of openBIM, integration with geographic information systems (GIS) and the transition to drawingless implementation.

Using specific examples from transport infrastructure, the authors show what data a designer can offer, from earthworks in IFC format for determining cubic volumes and foundation joint surfaces in LandXML format for machine guidance to the dynamic generation of cross sections at any station without manually generating dozens of drawings.

Attention is paid to bridge transition areas, where bridge regulations coexist with the requirements of the substructure of railways or roads. It is precisely in these areas where a unified view is provided using modern web platforms that integrate 2D drawings, 3D BIM models, geospatial data, photogrammetry, and point clouds to create a single display for clear

control of construction in context, be it quantities, eliminating collisions, or, of course, mutual understanding among all professions.

However, on site, this practice meets a harsh reality: the project is created in a 3D/BIM environment but implemented from simplified 2D drawings, which may reduce clarity. Last but not least, the journey from designing in 3D to producing 2D drawings significantly extends the time needed to incorporate on-site changes.

This article examines selected aspects of ongoing developments in BIM for design, drawing on the authors' professional experience and expertise.

MODEL-BASED CONSTRUCTION

This approach to designing, approving, and implementing a construction project uses the 3D BIM model(s) as the primary carrier of all geometric and non-graphic data (properties, parameters, materials, etc.).

Unlike the traditional approach, where the model is merely a tool for generating 2D documentation, in the model-based concept the model is the only authoritative and central source of truth (Single Source of Truth).

Information is not transferred to the construction site indirectly via drawings, but directly in digital form via open formats (e.g. IFC for structures and LandXML for routes and terrain) and the Common Data Environment (CDE).

In practice, the concept goes beyond simply replacing paper drawings with PDF files on a tablet. It is a fundamental paradigm shift; the 3D model becomes the only contractually binding basis for production and assembly.

Manual derivation of 2D drawings, which has traditionally served as an intermediate step and may introduce inaccuracies or transcription errors, can be reduced or avoided where the 3D model is used directly.

Data from IFC and LandXML flows directly to machines, warehouses and the mobile devices of field workers, who always draw up-to-date information from the model in real time and in the context of the entire project.

This should not be understood as a call to eliminate 2D drawings, but rather as an encouragement to consider alternative forms of representation where they may offer greater relevance or effectiveness.

2D models may, of course, remain appropriate where their use is justified by the specific context and purpose.

WHAT DATA CAN A DESIGNER PROVIDE?

Czech and foreign practice confirms that a designer with modern tools can prepare digital packages for construction with immediate added value, such as:

- **Surfaces and solids for machine guidance (LandXML).** Instead of dozens of situations with elevation and slope data, the designer now exports triangulation networks of plains and foundation joints directly to the levelling systems of dozers and excavators.
- **Structural element models (IFC).** Accurate solids/volumes, bridge deck, precast elements and reinforced concrete cages with assigned properties for automated bills of quantities and reinforcement orders.
- **Dynamic cutting at any station.** Thanks to the underlying route in LandXML and models in IFC, as well as other formats, the designer no longer has to generate static sections every 2 metres at the contractor's request. Anyone on the team can create a section of the model at the desired location directly in the browser and even export it as a DXF file.

BRIDGES AND TRANSITION AREAS

A particular field of consideration is the transition area between the bridge abutment and the adjacent railway or road structure. In this zone, different standards for bridge structures and railway or road (transition wedges, sleeper subgrade structures, drainage) coexist.

In 2D documentation, this interface is usually described only schematically or captured in one section every 25 metres, which can lead to different interpretations on the construction site and to discussions regarding cubic capacity.

Where the bridge and line design models are coordinated within a neutral CDE environment, this provides a clearer definition of the intended design state. With this design state, it is then possible to compare changes that occur on site, such as determining cubic capacity in case of overloading or changing the foundation method under different geotechnical conditions.

BIM AND GIS INTEGRATION FOR FIELD INSPECTION

Prepared data gains maximum effect in conjunction with lightweight web platforms, such as the Nordic system Vektor.io. It reduces the reliance on specialised CAD software and combines BIM (IFC), GIS map services (WMS/WMTS), terrain models and point clouds from scanning and photogrammetry into a single browser window.

This provides additional means of supporting immediate on-site control:

- **Deviation Analysis.** Automatic comparison of the scanned point cloud (actual execution) with the project IFC model, e.g. using a colour deviation map, immediately reveals, e.g., formwork or pile displacements.
- **Cut & Fill.** Direct calculation of earth volume from geodetic surveys for quick invoicing and work progress monitoring without waiting for office processing.

The key principles of this approach can be summarised as follows:

- Contractual and legally binding nature of the model (Model as a legal document).

The contract for work specifies the digital model (IFC, LandXML) as the legally binding basis for implementation, not the drawings. If any discrepancies arise, the model prevails.

- The model must be designed in such detail that it is possible to manufacture and install each element without the need for guesswork on site.
- Direct access to data in the field without the need for software such as CAD/BIM/GIS (on-site digital access). The model can be accessed directly on site via durable tablets, mobile applications, or field "BIM kiosks". Dimensions can be measured directly from the model, while sections can be displayed and the view filtered to focus on the areas currently being installed.
- Machine guidance and direct connection to production. Geometric data from the model can be transferred directly to, for example, rebar benders in reinforcement shops or to 3D levelling systems on construction machines, reducing the need for manual redrawing and coordinate transcription.

- Continuous validation by scanning against the model. As-built inspection is carried out through regular laser scanning or photogrammetry, with the resulting point cloud compared directly with the design model to evaluate deviations.

Examples from engineering practice show how using a 3D model can streamline processes, save time, and reduce errors. The following case studies illustrate some of these benefits in practical applications.

CASE STUDY 1: Geometrically complex loading area: the benefits of 3D data compared with 2D drawings

A commonly cited reason for moving to a drawing-less project and directly using 3D data is the implementation of geometrically variable surfaces.

A model example from our practice is the design of a roughly 140m-long loading area located between the tracks. The two adjacent tracks had a spatially complex alignment; the design had to account for two altitude gradients and two directional curves.

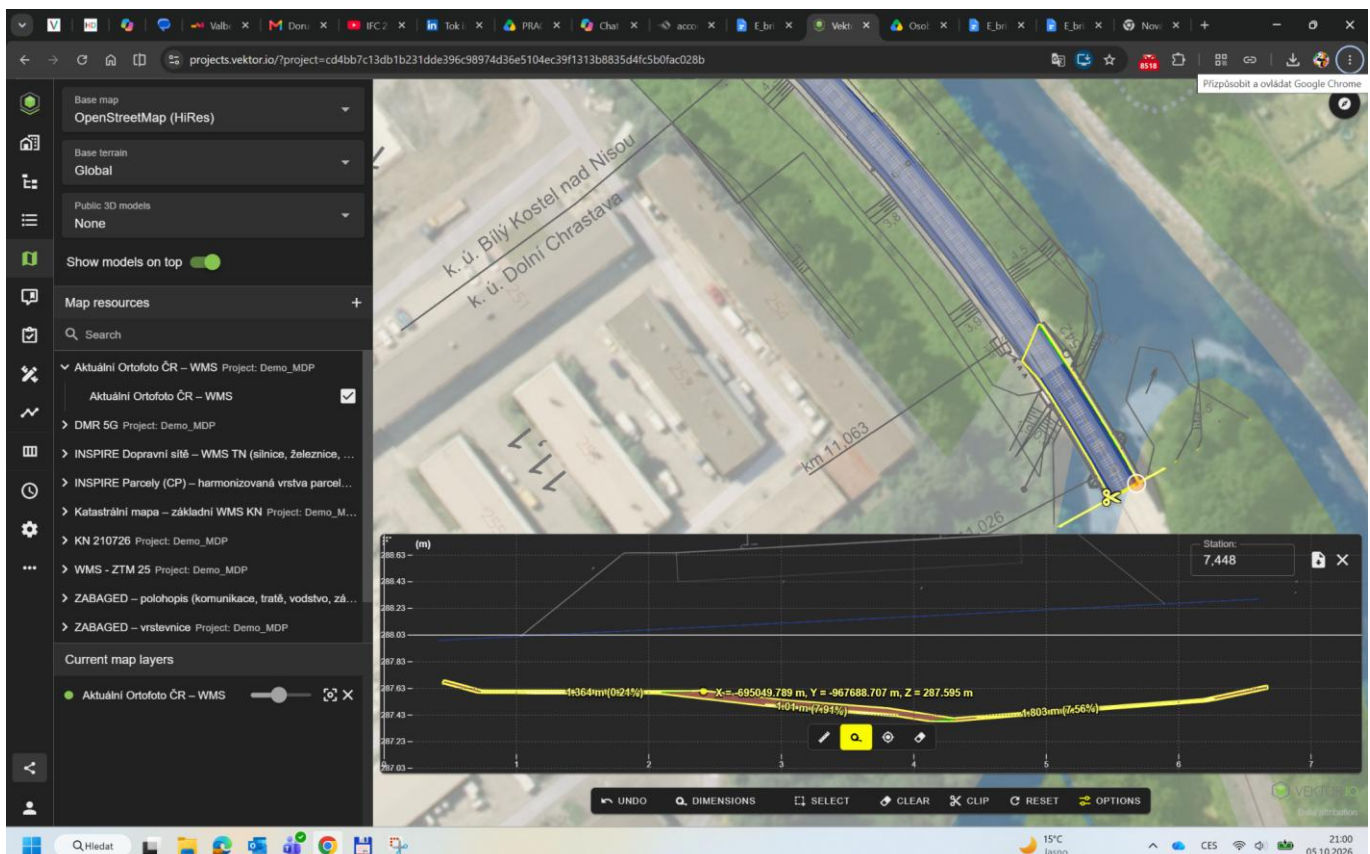


Figure 1: BIM and GIS integration in the browser

This spatial configuration required a variable transverse slope in the loading area, resulting in a continuous transverse shift of the drainage trough along the entire length of the body. Once the design was finalised, a key consideration was how to transfer the resulting information to the contractor efficiently and accurately for construction.

- **2D approach:** Handing over in 2D would require creating a detailed situation with sections and breakpoints, generating and dimensioning dozens of cross-sections, and compiling an extensive list of coordinates for surveyors. In design, this creates a huge amount of additional routine work. The key issue arises on site: 2D documentation only provides local, discrete information at the points of the sections. The contractor and surveyors have to interpolate the intermediate space in the field in a complex way, which increases the risk of errors, or they turn back to the designer to request additional sections after a few metres.
- **3D / Model-based approach:** For 3D control of construction machinery and field inspection, a single file export from the software was sufficient: a triangulation of the foundation joint surface in the open LandXML standard.

- **Benefit for the construction.** While preparing 2D documentation meant hours of manual drawing and dimensioning, exporting the open LandXML format took minutes. The machine's levelling system thus obtained a continuous digital model with millimetre accuracy without the need for any human interpolation on the construction site. The risk of misinterpreting the paper drawing was eliminated, and the construction gained an accurate basis for implementation and immediate control of cubic volumes.

CASE STUDY 2: Transition area of a railway bridge, spatial coordination without specialised software

The transition areas between a railway bridge and the adjacent track with a classic sleeper subgrade construction (aggregate fr. 0/63, asphalt concrete, aggregate fr. 0/32) are among the most sensitive points of infrastructure projects from a coordination perspective. This is where the standard requirements and regulations for bridge structures clash with the requirements for the railway subgrade.

In 2D documentation, the transition area is commonly drawn in more detail in the bridge section, while in the railway underpass documentation it is usually described only in text, or captured by a single cross-section every 25 m.

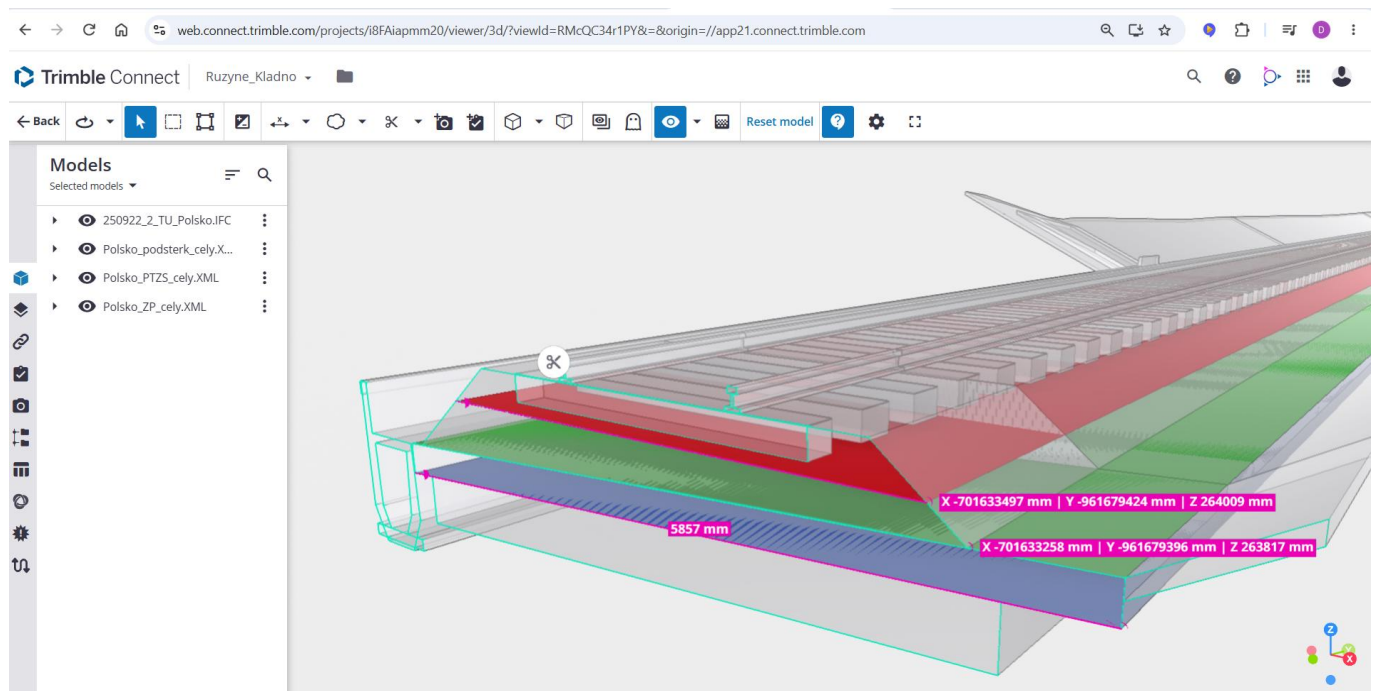


Figure 2: Coloured materials for machine guidance. Red: the level of the gravel layer; green: the surface of the crushed gravel; blue: the ground plane

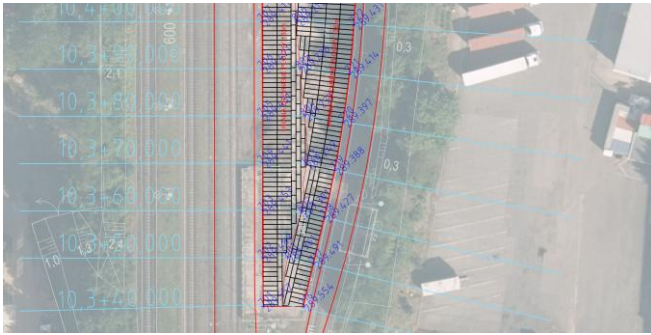


Figure 3: Loading area layout with section lines and local elevation values

2D drawings may provide limited scope to verify whether the intended structural solution is represented consistently across different design disciplines. This may lead to disagreements on site and protracted disputes about the actual volumes of excavations and embankments.

We verified the practical benefits of the openBIM philosophy on a specific project, where the substructure and superstructure of the bridge and the railway track were designed by two different designers.

Each profession worked in their own specialised software - the bridge was created in the Rhino 3D environment, while the track section was created in the ProVI program.

The export to open formats (IFC for bridge bodies and LandXML for route and substructure) and their upload to the Common Data Environment (CDE) enabled:

- Independence from specialised CAD licenses. Designers, investors, contractors and technical supervisors could view the complete model directly in a web browser;
- Transparent inspection of volumes and geometry. In the CDE, the spatial concurrence of the sleeper subgrade layers, transition wedges, and the back of the bridge abutment is immediately readable along the entire length, including the direct impact on the volumes of both structures.

The digital model provided a clear spatial context for coordination and decision-making, supporting an efficient preparation process and enabling potential issues to be addressed before excavation work began.

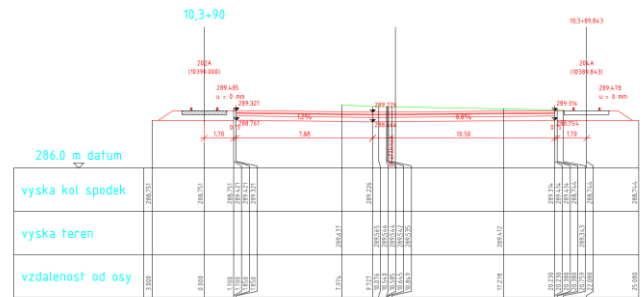


Figure 4: One of many loading area cross-sections with local elevation and distance values

CASE STUDY 3: The difference between the predicted and actual exposed surface of an arch bridge

OpenBIM allows the designer, builder, and investor to assess whether the design needs to be modified based on newly discovered facts.

The arch surface of the existing bridge was exposed during construction. It was necessary to verify that it corresponded to the assumptions in the design documentation. A geodetic survey of the edges was performed, from which a surface was subsequently created in the open LandXML format (in red in the image). In our experience, a scan would be an even faster solution. This surface was then compared with the design of the new bridge deck and with the lower edge of the track bed. The examination revealed the need to raise the track level. The modified lower edge of the track bed (blue in the figure) no longer collides with the arch surface and allows the deck to be installed.

Thanks to the IFC model and LandXML surfaces, it was possible to clearly determine the volume differences caused by this change. In the future, it would be appropriate to scan the current surface of the earthworks when the track alignment changes.

CONCLUSION

The transition to drawing-free construction and digital support of implementation is not a matter of the distant future or expensive IT equipment. As the worldwide implementations and perhaps even small examples of the authors show, the basis for success is active communication and work with open standards (IFC, LandXML). If the designer transfers machine-ready data and direct control, he becomes an indispensable partner in successful and economical construction.

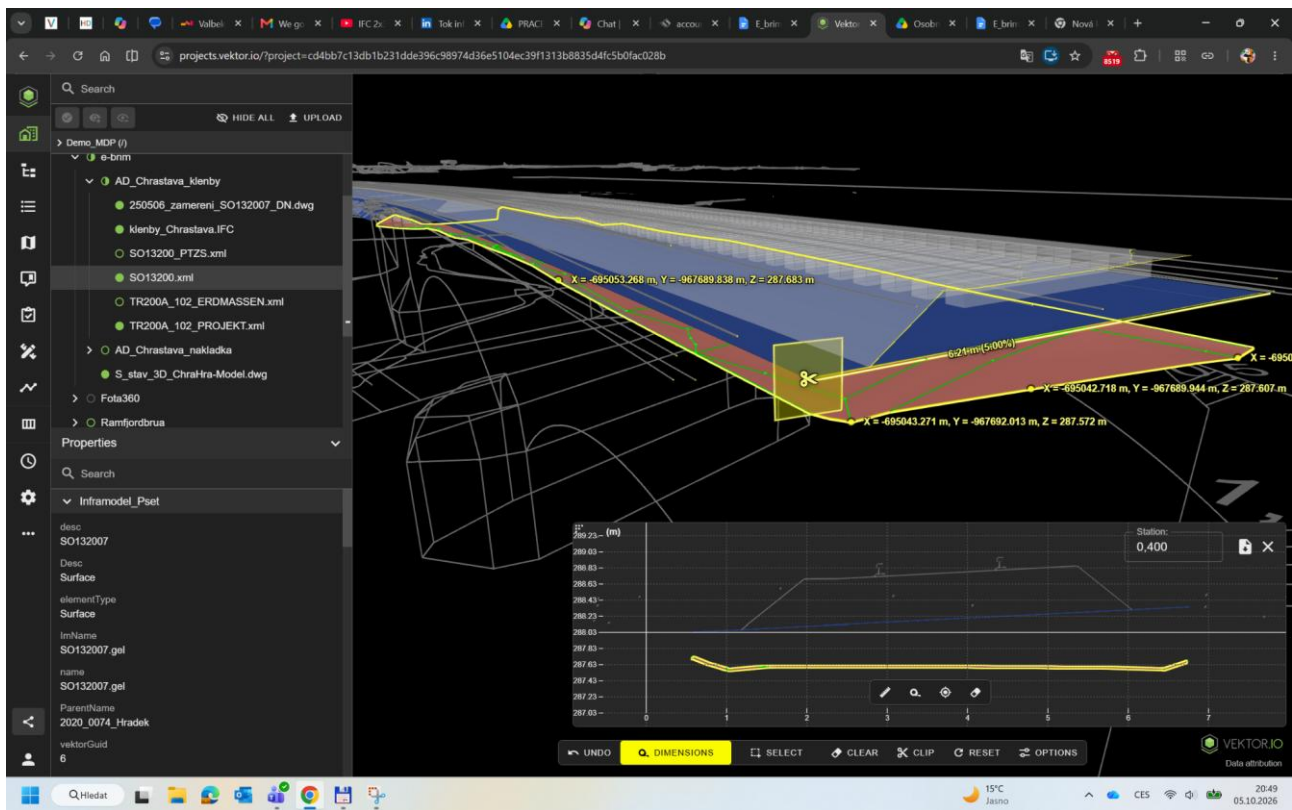
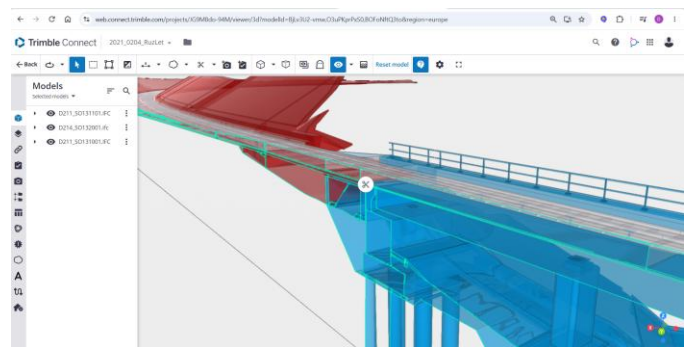
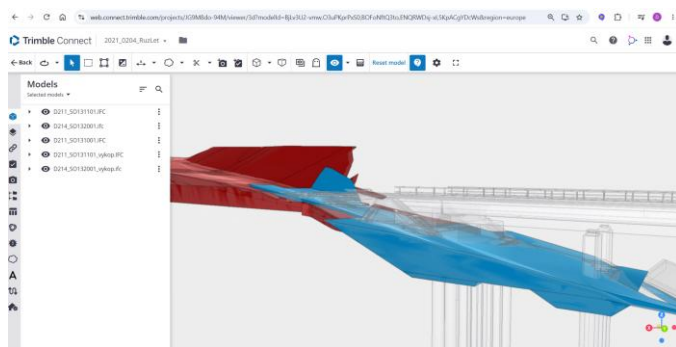
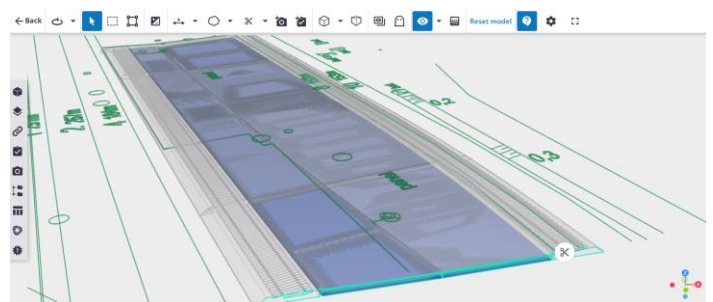
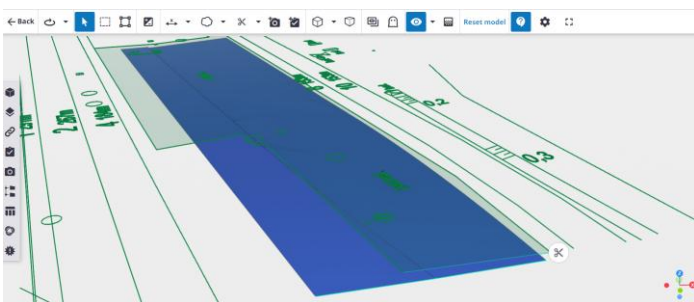


Figure 5: Bridge arch surface inspection for possible interference with the place of the railway structure



Figures 6 and 7: Coordination of new embankments in the transition area



Figures 8 and 9: 3D model as a common spatial reference compared with 2D drawings

SISMICA S&G 2026: BRINGING STRUCTURAL AND GEOTECHNICAL ENGINEERING TOGETHER IN REAL-WORLD

Edinson Guanchez, CEO, Sismica Institute



From 18th to 20th June 2026, SISMICA Institute hosted the first edition of SISMICA S&G 2026 — International Conference on Structural & Geotechnical Engineering, an online international conference created to bring together two disciplines that are often discussed separately, but are deeply connected in real engineering practice: structural engineering and geotechnical engineering.

Over three days, the event gathered **1,213 registered participants** from 62 countries and territories across **5 continents**, creating an international space for technical exchange, professional reflection, and knowledge sharing around some of the most relevant challenges in civil engineering today.

The conference was held online through Zoom Events and featured a bilingual program in English and Spanish, with the participation of 20 speakers from different countries and professional backgrounds.

A CONFERENCE DESIGNED TO CONNECT SOIL AND STRUCTURE

One of the main purposes of **SISMICA S&G 2026** was to create a technical meeting point where structural and geotechnical perspectives could be addressed within the same conference program.

In professional practice, structures and soil cannot be understood as isolated systems. The behaviour of a building, bridge, industrial facility, retaining system, tunnel, or foundation is directly influenced by the interaction between structural demands, ground conditions, seismic actions, foundation response, construction constraints, and long-term performance requirements.

For this reason, SISMICA S&G 2026 was organised around a 3-day program designed to reflect the way engineering problems are solved in real projects: from structural performance and seismic behaviour to foundation design, geotechnical response, industrial facilities, special structures, and complex infrastructure systems.

Day 1: Structural Engineering & Bridges

The first day of the conference focused on Structural Engineering & Bridges, addressing topics related to structural performance, seismic behaviour, infrastructure, and service life.

This day included keynote lectures and technical sessions on concrete infrastructure, gravity dams, seismic behaviour of buildings, structural reliability, tunnels, underground works, and buildings with base isolation systems.

Speakers discussed topics such as service life extension of concrete infrastructure, seismic analysis and instrumentation of concrete gravity dams, lessons learned from recent earthquakes, uncertainty propagation in structural engineering, seismic considerations for underground works, and the structural performance of base-isolated buildings.

Day 2: Foundations & Geotechnical Engineering

The second day was dedicated to Foundations & Geotechnical Engineering, with a strong focus on soil behaviour, foundation systems, seismic response, and geotechnical applications.

The sessions addressed advanced methods for determining pile length in infrastructure projects, the estimation of soil deformation parameters and their influence on foundation design, the undrained shear response of clays, helical piles as an alternative deep foundation system, uplift mechanisms in shallow foundations, and the state of the art in drilled shafts.

Day 3: Industrial Structures & Special Projects

The final day of SISMICA S&G 2026 focused on Industrial Structures & Special Projects, bringing the conference into the context of complex engineering systems and highly applied case studies.

The program included presentations on structural stability in steel buildings, seismic design and stability of industrial structures, structural assessment of reinforced concrete silos, seismic retrofitting of concrete tower systems, embodied carbon in bridge structures, and foundation design for industrial facilities such as steel tanks and silos.

The final day also reflected one of the central messages of the conference: real-world engineering requires coordination between disciplines, practical judgment, technical rigor, and a clear understanding of how different systems interact.



ACKNOWLEDGEMENTS

SISMICA Institute would like to express its sincere gratitude to all speakers who participated in this first edition of the conference. Their generosity, preparation, and technical quality made the event possible and gave meaning to the purpose behind SISMICA S&G 2026.

We also extend our appreciation to the technical moderators, participants, and the entire team behind the scenes, whose work, commitment, and attention to detail contributed to the successful development of the event.

THE BEGINNING OF AN ANNUAL CONFERENCE

SISMICA S&G 2026 marks the **beginning of a new annual conference** organised by the SISMICA Institute.

The objective is to continue creating a meeting point where structural and geotechnical engineering come together in real-world practice, allowing professionals from different countries to share technical knowledge, project experience, research findings, and applied methodologies.

SISMICA Institute will announce the dates and details of the next edition of SISMICA S&G soon.

THANK YOU

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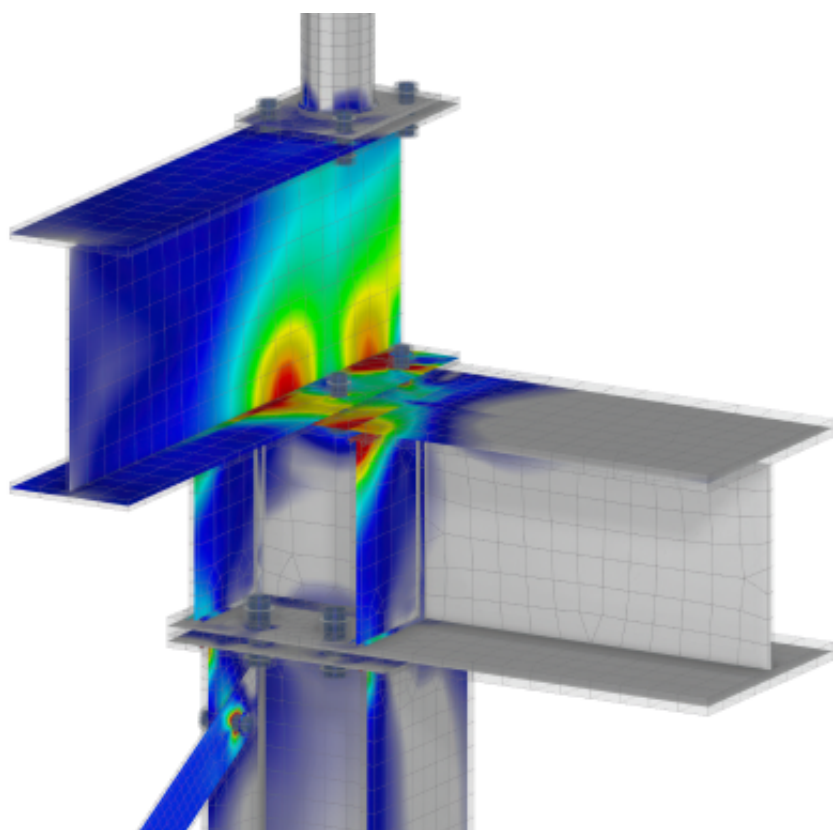
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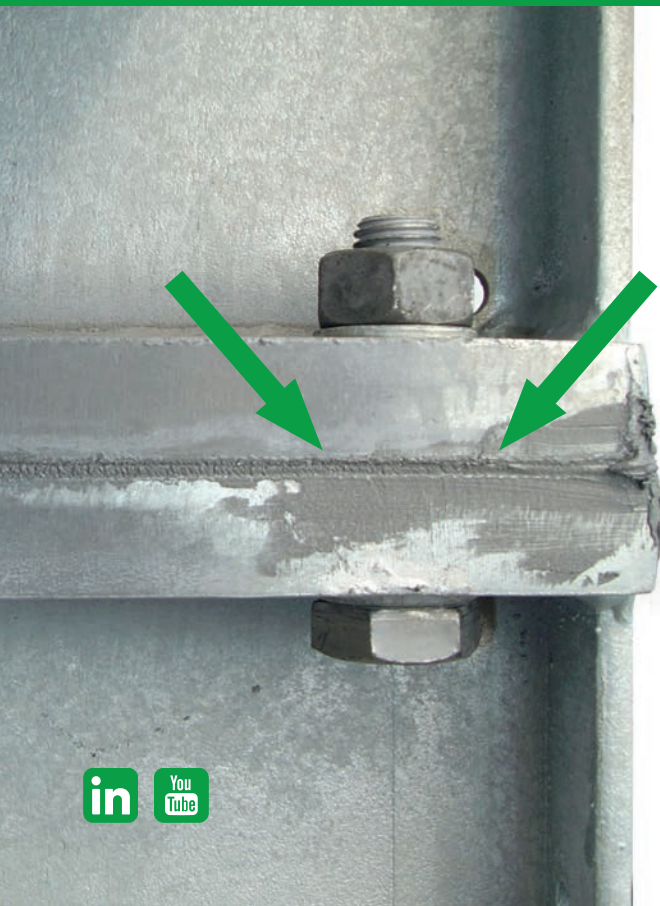
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References:

- Bahia de Cadiz, Spain
- Hochmoselübergang, Germany
- Osman Gazi Bridge, Izmit, Turkey
- Mainbrücke Randersacker, Germany
- Millau Viaduct, France
- Rheinbrücke Schierstein, Germany
- Rion Antirion, Greece
- Russky Island Bridge, Vladivostok, Russia
- Tsing Ma, China

A low-angle, perspective view of the San Francisco-Oakland Bay Bridge East Span, showing the bridge deck and a tall, white, A-frame pylon with numerous stay cables. The bridge is set against a sunset sky with warm orange and yellow hues, and the water below reflects the bridge and the sky. The sun is visible on the horizon to the left.

American Icon

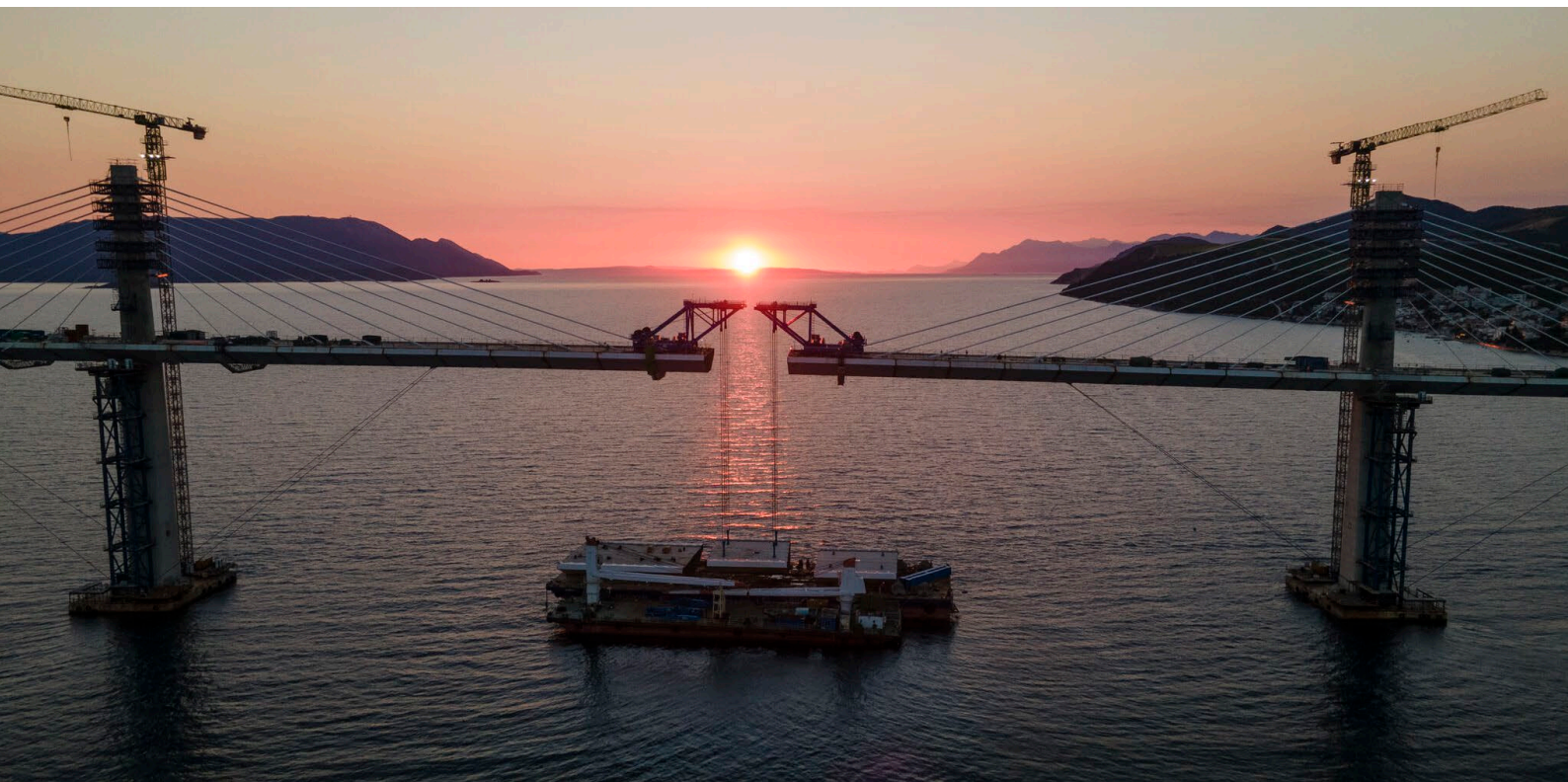
San Francisco-Oakland Bay Bridge East Span

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Photo Credit: Thomas Heinser

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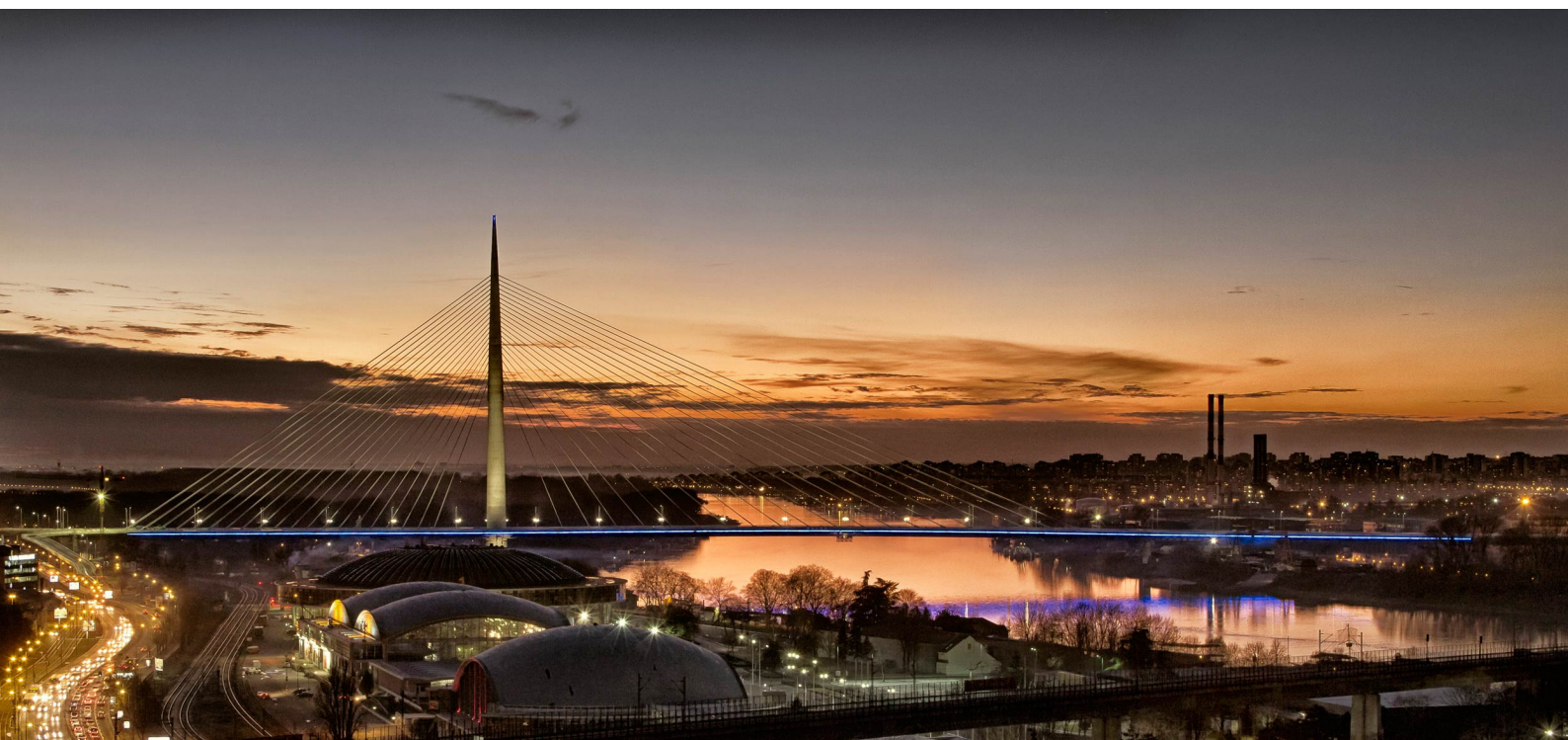
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Pelješac Bridge, Croatia

Conceptual/Preliminary/Final design

Joint Venture Faculty of Civil Engineering, University of Zagreb; Ponting; Pipenbaher Consulting Engineers



Ada Bridge over Sava in Belgrade, Serbia

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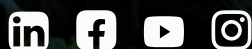
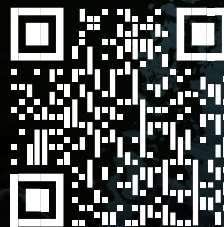


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