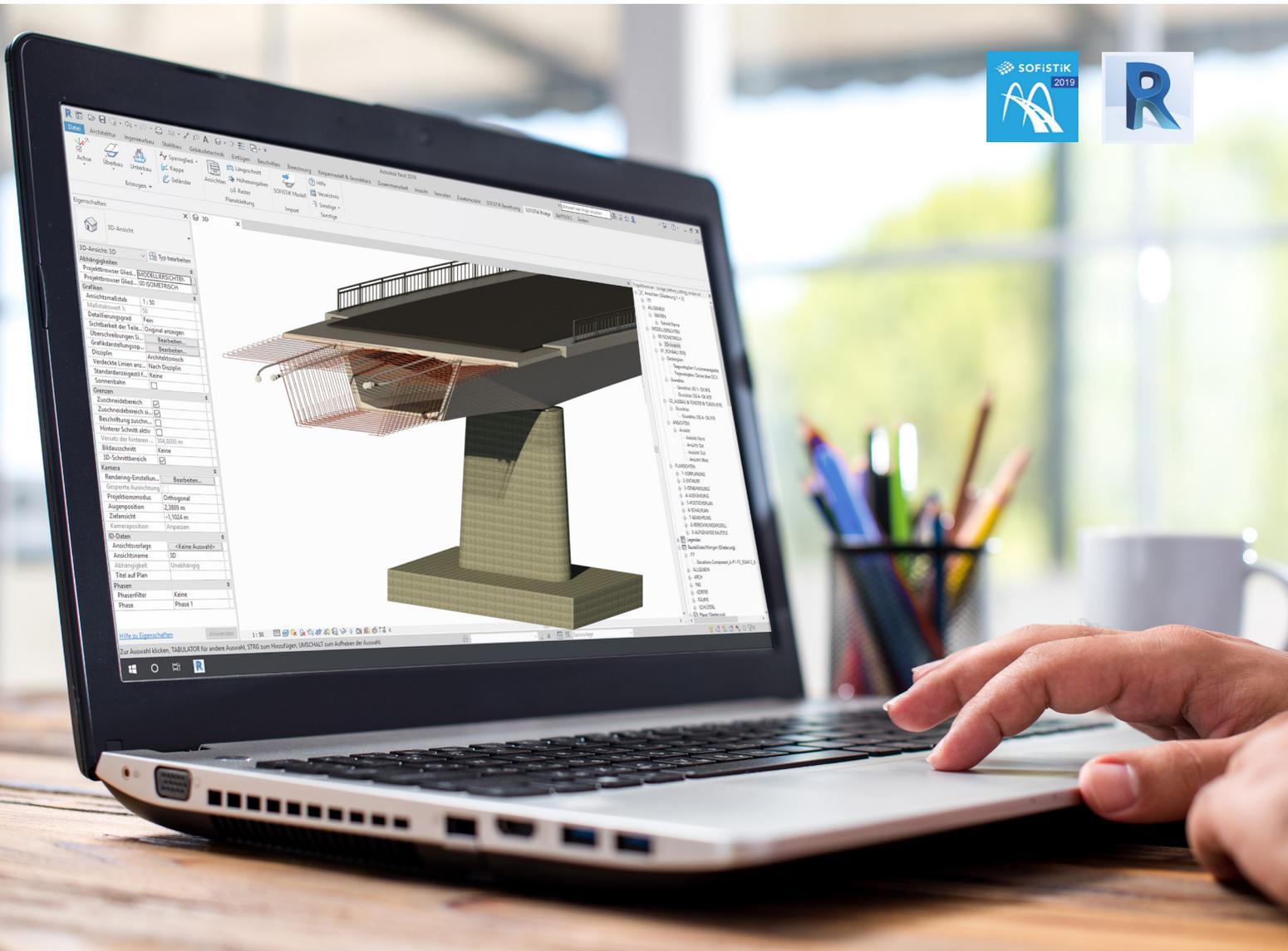BIM / Special November 2018 - Translated from the german publication

SOFiSTiK Bridge Modeler

Parametric Modeling of Bridges in Autodesk® Revit® 2019

BIM Workflow for Bridge Design

The SOFiSTiK Bridge Modeler is the first application on the market to integrate with Autodesk® Revit®. It provides axis-based parametric modeling of bridge projects.

Now, bridge planners have access to the easy-to-understand, BIM-ready tool that many government agencies around the world as well as the construction industry have been pushing for. The software offers fully parametric input and semi-automated and compliant plan generation, making it easy to analyze multiple variants.

Planning changes can be implemented at any time. The bridge model remains consistent and all derived information such as schedules, plans, and section-views are automatically updated. The experts at

SOFiSTiK AG have drawn on 30 years of development expertise in bridge construction to design the new software. SOFiSTiK Bridge Modeler has been specially tailored to the needs of bridge planners and is easy to integrate into existing workflows.

Many bridge projects are still planned in 2D. This approach is error-prone, time-consuming, and thus costly for bridge planners, especially when planning changes become necessary. The guidelines in the "Road Map for Digital Design and Construction" from Germany's Federal Ministry of Transport and Digital Infrastructure make Building Information Modeling (BIM) mandatory for infrastructure projects from 2020 on. Many planning offices in the infrastructure sector are currently in the process of establishing efficient, BIM-compliant workflows.

BIM as an information source and data hub

BIM is a relatively new technology that relies on 3D modelling and facilitating the exchange of data between the software platforms that project stakeholders use. This concept, which was primarily intended for the construction industry, is taking the world by storm. It is extremely effective at optimizing processes, as numerous construction projects have already proven.

The strength of BIM lies in its ability to capture the entire construction process holistically. This is not just another 3D planning tool — BIM offers an integrated means of planning, building, and operating a structure by following a holistic approach. BIM stands for the digital mapping of a building's physical and functional properties — from establishing basic parameters through to dismantling. In this way, BIM serves as source of information and data hub for the entire life cycle of the structure.

For construction projects in Europe, digital planning with the BIM method is already standard and is having a positive impact on all project participants. We are still, however, in the early days of consistently using digital building models as the basis for bridge projects.With the Bridge Modeler, SOFiSTiK has delivered a meaningful advance in the use of BIM for bridge planning and construction. For the first time, it's easy to use axis-based parametric modeling for bridge projects in Revit without Autodesk Dynamo®. Now, users can fully benefit from the options that Revit

offers for generating views, sections, schedules, and plans with BIM for bridge projects.

Frank Deinzer, head of sales at SOFiSTiK AG, said: "Our SOFiSTiK Bridge Modeler is a new, innovative solution for axis-based parametric bridge modeling in Revit." This software release re-affirms SOFiSTiK AG's position at the forefront of Building Information Modeling in Germany. With its 75 employees, the company is one of the world's leading suppliers of analysis, design, and engineering software for construction projects. It has been supplying the construction industry with advances in finite element software for years by providing design software based on AutoCAD and Revit. Together with its subsidiary BiMOTiON GmbH, which specializes in Revit training & consulting services, SOFiSTiK is taking on the biggest challenges that 3D planning and BIM for the construction industry will face in the coming years.

## Workflow – general concept

The graphical workflow of the SOFiSTiK Bridge Modeler is based on many years of experience with Computer Aided Bridge Design (CABD), which was implemented in SOFiSTiK's structural engineering software over 10 years ago. Parametric structural modeling is a tool that has been in use since the early 1990s. The Bridge Modeler now enables axis-based, parametric bridge projects in Revit while retaining all the benefits Revit has to offer.

Users can easily model a bridge in just four steps:

1. **Create the bridge axis**
2. **Create the bridge superstructure**
3. **Create the bridge substructures**
4. **Create the bridge equipment including parapets and railings**

After finishing the 3D bridge model, all necessary plans are derived from it including views, longitudinal sections, plan views, master cross sections, and more.
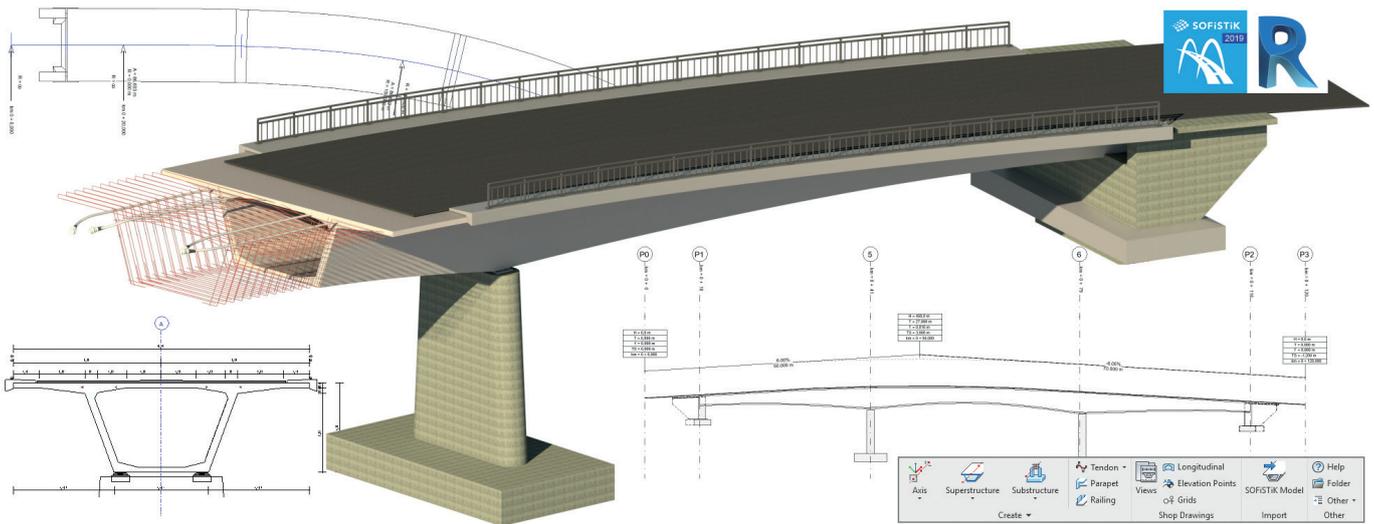
Defining the axis

In the first step, the user creates the axis in the plan view using various curve types (lines, spirals, circular arcs). Special transition curves for railway lines such as Bloss curves have also been implemented. The vertical alignment of the axis is defined using Z coordinates at station points in combination with bending radii. This results in a 3D axis with stationing in the plan view. This standard approach that is also used in SOFiSTiK's structural engineering software enables exact control of axis geometry and axis precision. In a single project, several independent axes as well as secondary axes offset from these main axes can be used.

Points of interest, also known as placements, can be defined in relation to the stations along an axis, a key step for the subsequent modeling of superstructure and substructure components. By default, the placements are perpendicular to the axis at the respective station. Local or global rotations can be defined, for instance for projects that involve oblique bridge bearings.

Bridge superstructure

In the next step, the user selects the appropriate superstructure cross-section and positions it along the selected axis between two or more stations. SOFiSTiK Bridge Modeler includes several predefined bridge cross-sections including box girders, single-T, and multiple-T beams as adaptive Revit families. Users can add or modify these families at any time or create and use their own cross-section families. It's easy

to generate as many station-dependent variables as required to account for variation in the cross-section along the axis. The raised superstructure adapts to the rotation of placements, allowing users to for instance model oblique bridge supports.

Bridge substructure and additional components

After completion of the superstructure, the substructure components are inserted at selected placements. These elements are also provided along with the software as adaptive Revit families. Users can modify them or add additional elements.
Railings, parapets, and prestressed beams can also be placed along the geometry of the axis or in relation to component surfaces.

The 3D model

The resulting 3D model can be integrated into a Revit topography to depict the structure in its surroundings. The topography can be easily imported from external data sources such as Civil 3D and Land XML, then adapted using tools included with Revit. This makes it easy to generate renderings of the structure in its surroundings.

A key advantage of the 3D model is that model data such as dimensions, costs, and time-specific information can be used for additional purposes. With additional attributions, components can be evaluated, grouped, and subsequently imported into AVA programs. Construction stage analyses can also be carried out.

The benefits of a fully parameterized model

A further advantage of parameterization is apparent when changes are made to the bridge model or multiple variants are evaluated. Until now, entering these model changes in the system was time-consuming and error-prone. A 2D workflow was used, the planning documents were not consistent with each other. With a parametric bridge model, as customary in Revit, changes are only made once. These changes automatically update across the entire 3D model as well as all derived sections, views, and lists. Users can thus ensure that consistent planning documents are always available, even after model changes have been made. The evaluation of multiple variants during the preliminary design phase is quick and easy to implement using parametric modelling.

Generating plans

The advantages of Revit make themselves apparent when documenting a bridge project. Creating views, sections, 3D views, renderings, plans, and schedules is an intuitive process for users. The SOFiSTiK Bridge Modeler supplements these documentation options with important elements for bridge construction. The Bridge Modeler is, for instance, able to generate flattened longitudinal sections with user-defined section depths. Labeling and dimensioning elements can be added to the longitudinal sections. Information on axis grids, bearing axes, stationing, and vertical alignment parameters are also displayed. Dimensioned cross-section views are generated fully automatically at any station along the axis. A RAB-ING-compliant plan view is thus fully supported.

The outlook

By using suitable data models and supporting open data interfaces, it will be possible in the future to support the entire process chain including construction, operation, and maintenance in addition to planning and documentation.

3D views or exploded views can be quickly generated from the BIM model and placed on plans to make things easier to understand at the construction site. Even completely digital workflows and support for machine-based processes such as automated cutting or 3D printing are conceivable in the future. It will however take a few years before these new methods receive government approval.

Conclusion

Many software vendors are currently considering the implementation of a BIM planning workflow that satisfies government regulations and the demands of the construction industry. In response to these challenges, SOFiSTiK AG has developed a new tool for use in Autodesk Revit 2019, SOFiSTiK Bridge Modeler.

A CABD concept that has been successful and widely used for many years for modelling FE systems has been integrated into this new tool. SOFiSTiK has delivered a tool to bridge planners that makes it simple to model and render bridge projects using a BIM workflow. That's how SOFiSTiK Bridge Modeler has already met the challenging requirements of the market.

This simple, four-step workflow for axis-based parametric modeling of bridge projects is seamlessly integrated into Revit, and it's easy to use. SOFiSTiK Bridge Modeler can be used to implement mandatory BIM workflows when planning bridges. Missing features in Revit such as flattened longitudinal sections are provided by SOFiSTiK Bridge Modeler. It's a tool that ensures high planning quality and reduced effort for planning changes. Thanks to the seamless integration in Revit and excellent usability, it's easy to get up to speed with the software, and the time-consuming customization other systems require is not necessary.

Everyone from experts to recent graduates benefits from the user-friendly, intuitive interface of SOFiSTiK Bridge Modeler.

SOFiSTiK