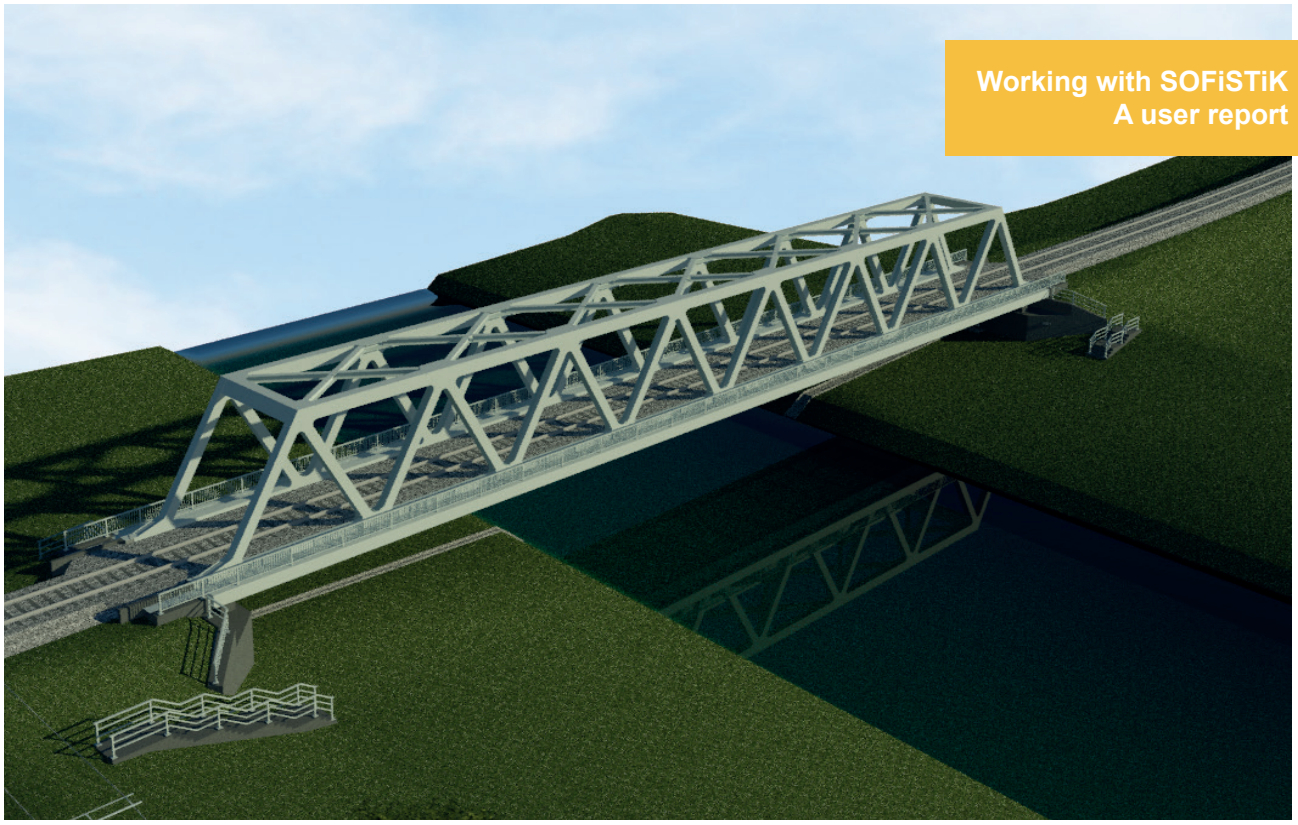
SOFiSTiK



Working with SOFiSTiK
A user report

# BIM In The Sixth Dimension

6D planning of the Unstrut Bridge using Autodesk® Revit® and SOFiSTiK

**Time and costs have long since added a fourth and fifth dimension to the classic 3D digital model. Using a railway bridge (steel framework) as an example, the engineers of Emch+Berger Weimar show how structural calculation and reinforcement design extend the digital model. Autodesk® Revit® as software for modelling and SOFiSTiK for calculations and design prove to be perfect partners for intelligent and efficient engineering.**

Germany's DB Regio AG (a regional passenger train company) wants to put the "Kyffhäuser-Bahn" line in Thuringia, which was closed in 2006, back into service. DB Regio has commissioned Emch+Berger Weimar with all the work phases and structural design of the object, including recalculation and structural testing for returning the line to service. The recalculations have shown that the long-term viability of the current bridge cannot be guaranteed. The preferred option is replacing the existing three-span railway bridge over the Unstrut River with a single-span steel framework in accordance with Ril 804.9010. As of 2023, trains will once again run between Betleben and Sondershausen.

## The Natural Choice For Emch+Berger: Applying BIM In Bridge Construction

Although Building Information Modelling (BIM) has been successfully applied in structural engineering for years, it is barely used in bridge construction. In contrast to buildings, for which the components are usually located on grids and levels and have simple cross-sections, bridges have longitudinal and transverse inclinations, superelevations, complex boundary conditions and construction stages, that are not easy to model. Added to this

is the lack of experience of some clients, planners and contractors in this field. BIM sceptics tend to overestimate the modelling effort and underestimate the quality of the results. However, the intensive effort in the first phases of planning is compensated for when you look at the entire planning process, since unavoidable planning changes can be implemented much more effectively in a BIM-model. Furthermore, a higher quality of planning is achieved, among other things by:

- detection of spatial conflicts
- more precise quantity determination
- representation of construction phases (4D)
- the link to construction costs (5D)
- calculation models for structural design (6D)

Due to the required accuracy in planning and the complexity of the existing boundary conditions as well as the planned construction technology, Emch+Berger decided to undertake the Unstrut Bridge construction as a BIM project using the Autodesk Revit and SOFiSTiK.

## Surveying

The existing ballast-free railway bridge consists of three jointed single span girders (girder grid + truss + girder grid). The massive abutments and piers have deep foundations on eight reinforced wells. The existing structure was modelled based on the as-built plans and the on-site survey (scans). This high level of detail was necessary for recalculation, construction technology (tonnage of the superstructures for dismantling or crane assessment) and planning of the new pile foundation, as four bore piles will be built in the core of the existing well foundation.

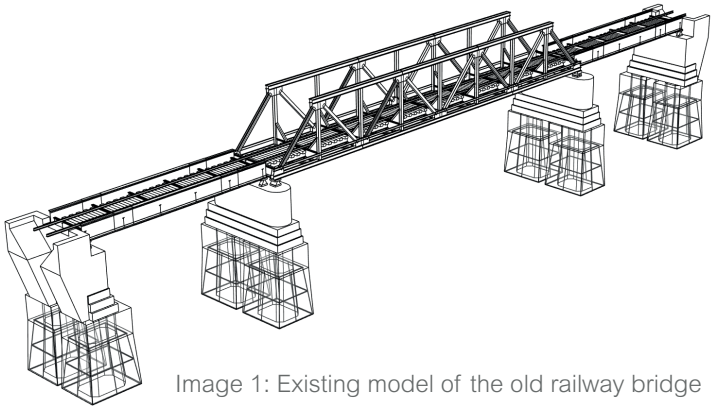


Image 1: Existing model of the old railway bridge

## Parametric Modelling Of The Steel Framework

While substructures, pile foundations and other facilities were planned conventionally with Revit, the engineers at Emch+Berger used Dynamo® – a graphical programming add-on for Revit for modelling the steel framework:

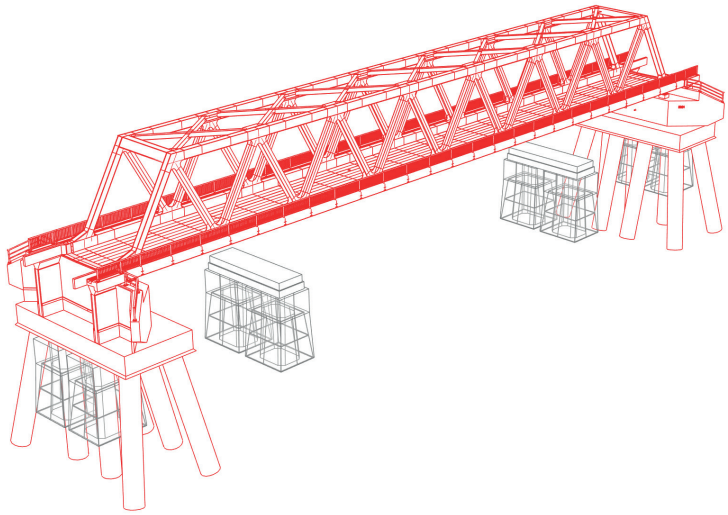


Image 2: Revit model of the new railway bridge

Using Dynamo offered several advantages:

- parameterized modelling of the structure based on coordinates
- rapid implementation of changes in the structure's geometry in the design phase
- rapid adaptation of the model, taking into account the longitudinal inclination and superelevation

Emch+Berger now also uses the new SOFiSTiK Bridge Modeler (SBM) for Revit as a complement/alternative to Dynamo: SBM allows you to parametrically model infrastructures and enables Revit users to create parametric models in their familiar Revit environment.

## Dimension Four: Time

BIM allows you to simulate the construction process. The main construction stages: existing construction, constructing and final state of the Unstrut River bridge, were modeled in Revit.

This alone made it easier for clients, project participants and the general public to understand the project and its process. Much more important, ho-

wever, was the opportunity to plan the construction technology precisely and to provide answers to numerous questions, e.g.: Under what conditions will the new steel framework be mounted on the substructures? What tonnages are considered for the superstructures during dismantling? What protective measures are needed when using cranes? What restrictions apply to the existing structures during the construction period?

### Dimension Five: Costs

The digital Revit model contains – depending on the requirements – much more information than just geometry. Information about material, quality, thickness, weight, price, etc. can be included and managed; the model updates the latest figures whenever changes are made. Depending on completeness and accuracy of the entered data, reliable information about expected costs is available at any time.

### Dimension Six: The Structural Model

In order for the structural analysis to play the role of another "dimension" in planning, it must be linked to the model, the same way as time and costs. The bridge over the Unstrut River shows how this works. At Emch+Berger we use SOFiSTiK FEA programs for analysis. The challenges were huge, due to the complexity of the steel framework: In addition to nodes, the roadway with longitudinal ribs and cross girders, as well as kinematic connections and bore profiles had to be taken into account; Also the number of load actions (LM71) had to be taken into account and the local verifications had to be determined during execution planning (buckling, welding, etc.). When modelling with Autodesk Revit, the analytical model for the calculation is created in the background and can be imported directly into the SOFiSTiK Structural Desktop (SSD) via the SOFiSTiK – Revit interface. There you can add bridge-specific information; the software then performs various calculations and verifications based on continuous and parametric SSD tasks.

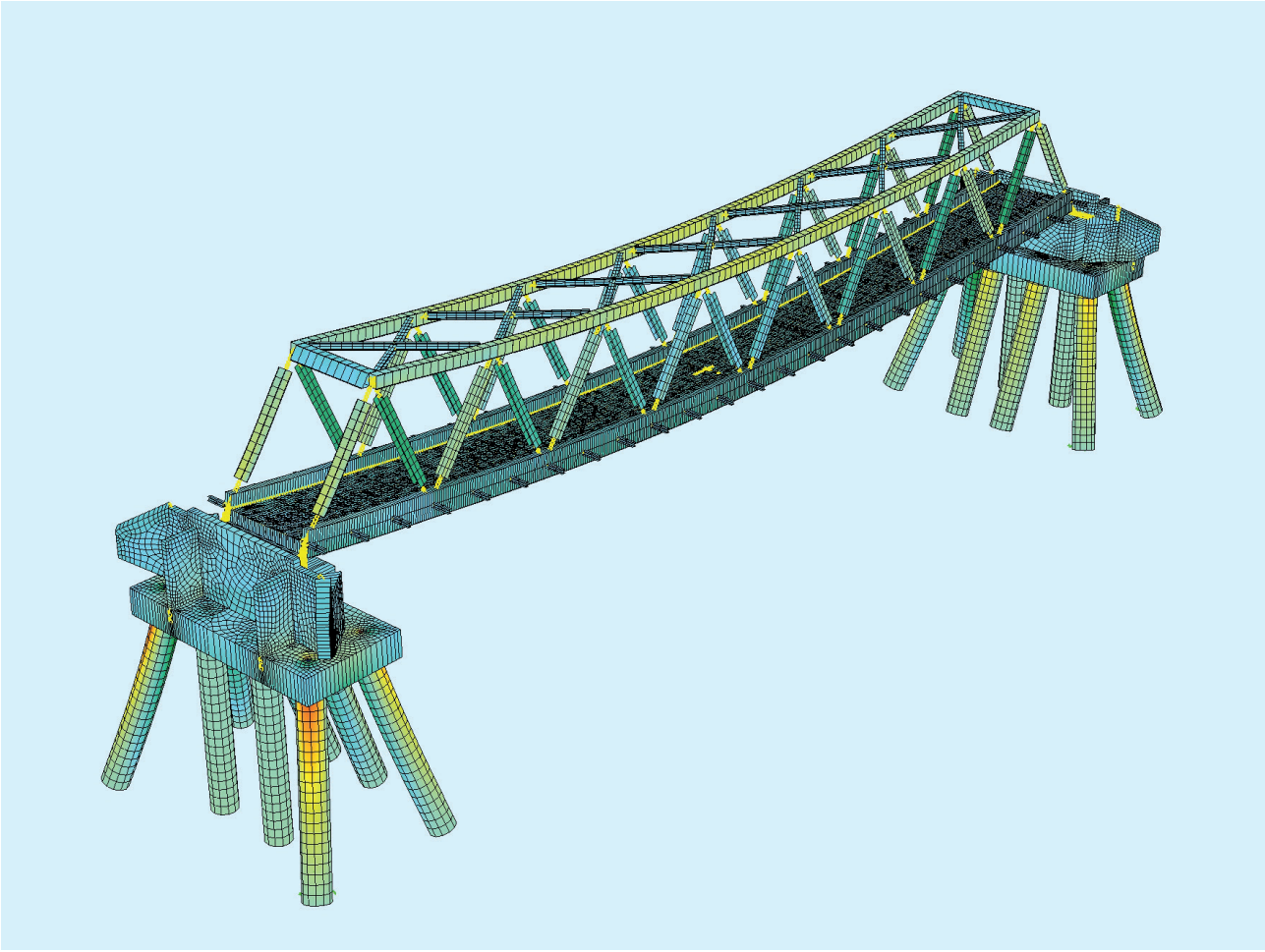


Image 3: SOFiSTiK FE model derived from Revit (excessive deformation)

**Off To The Construction Site!**

Whether 3D, 4D, 5D or 6D – at some point the information about what is to be built and how must be sent to the construction site. Execution plans are still in demand there. These are easily generated using BIM models. SOFiSTiK extends the capabilities of Autodesk Revit regarding reinforcement design. Emch+Berger uses SOFiSTiK Reinforcement Detailing to create reinforcement plans for the massive substructures.

For Gustavo Cosenza, Project Manager for Structural Engineering at Emch+Berger, SOFiSTiK is an indispensable partner and does much more than just delivering excellent software. BIM has not reached bridge construction yet, although it leads to better quality in all respects," he says.

Emch+Berger is a medium-sized and employee-led engineering group with about 280 employees in Germany and France. Emch+Berger Ingenieure und Planer Weimar GmbH has been offering planning services and construction supervision for structural engineering, traffic facilities, environmental and landscaping projects since 1990.

Gustavo Cosenza, Project Manager for Structural Engineering at Emch+Berger Weimar GmbH says:

„For us, SOFiSTiK is above all a reliable partner for BIM implementation."

Emch+ Berger

An eye for the full picture
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