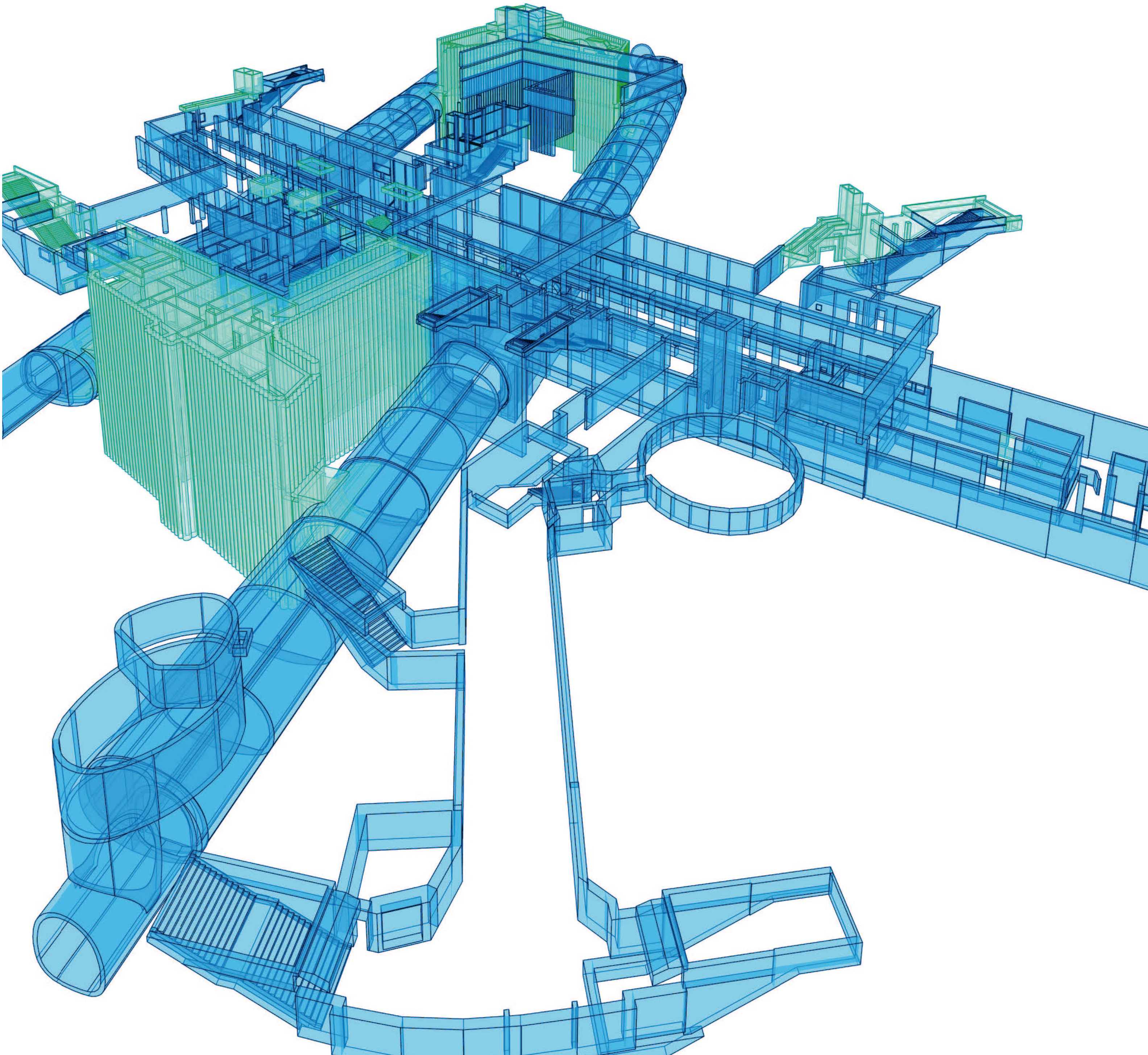
BIM

AND THE DIGITALISATION OF PLANNING AND CONSTRUCTION **AT SSF INGENIEURE AG**



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SSF Ingenieure and the digitalisation of planning and construction

As engineers, architects, draughtsmen, geologists, environmental planners and specialists in many fields we are dedicated to the technical realisation of multiple complex requirements taking into account numerous factors that influence design, construction execution, utilisation and operation.
Transparent and light structures, clear and modest constructions, best quality as well as a maximum economic efficiency correspond to our efforts to achieve functionality and aesthetic in harmony with technical feasibility, sustainability and robustness. Building Information Modelling (BIM) helps us with this process; and this new planning method is more and more applied recently. But what does this abbreviation mean? The most common interpretation is Building Information Modelling, more rarely Building Information Management. The term modelling leaves the impression that BIM is just another 3D tool. In fact, with this method even more attributes can be added to a 3D model, such as a time line or costs of the structure. An integrated digital management of the entire planning, a digitalisation of the planning, from construction to completion and operation of the structure, are now possible continuously throughout the whole process.

For more than 10 years, SSF Ingenieure has been embodying this design process. Digital design followed by construction is nowadays most clients' priority – minimising risks and increasing quality. Overall, the design, approval and construction processes are reduced by involving the public at an early stage. The digital models provide the citizen with an early overview of each planned construction project. Based on the BIM model, the time and financial need of the construction project can be better coordinated and controlled.

Until now, BIM has been most popular in building construction. During the design and planning of buildings and industrial projects SSF Ingenieure has been using BIM successfully for several years, though the method was used – at least at the beginning – mostly as isolated solution, called internally Little BIM or Closed BIM. However, the method shows its strengths mainly in the exchange of information with other planning partners with the so-called Big BIM – which is perfected when applied starting with the project concept until execution and construction supervision.

Projects from the field of infrastructure are more and more in the public's focus. Roads and bridges, airports and railway stations, special civil engineering and tunnel construction as well as underground railways in metropolitan regions are the main challenge in view of integrating all planning participants and their interfaces – in this area BIM offers first-class solutions. Moreover, the planning method is more and more demanded by clients of international projects such as underground railway construction. All over the world, the digitalisation of planning is a step towards improved integral planning and accelerates the transformation process in the construction industry. The digitalisation of planning corresponds to an optimised value chain in construction – it improves planning results, creates security in view of compliance with schedules and costs, determines progress, defines new standards and creates new fields of activity and tasks during the planning process.

In the SSF Group, different planning teams work on selected BIM projects– in disciplines such as structural engineering, architecture, building services engineering, geotechnics, GIS and surveying – at one common model. The design management names a BIM manager in charge who is responsible for BIM coordination of the different disciplines. More and more frequently, the client also provides a BIM manager who is in direct contact with SSF Ingenieure's BIM team.

The advantages of BIM are evident: optimised planning process, greater transparency through better communication, increased efficiency and economic efficiency are incontestable arguments in favour of a new planning method. But BIM only works when handled in a consistent and structured manner – SSF Ingenieure is committed to this process. It has created the relevant positions, trained its employees and pursues thoroughly the aim to apply BIM in all areas of planning and construction.

Advantages of the digitalisation of planning and construction

To demonstrate the advantages of BIM, we look at the structure's life cycle: its creation, operation, removal. The longest period of a structure is its time of use – the advantages provided by the BIM model for everybody involved in the project are evident.

Ideally, we, as planners, are included into the development and creation of the model. Even if the client does not explicitly ask for BIM, we obtain valuable advantages with the integral BIM planning. By planning with a 3D tool, we can, for example, avoid design and coordination errors at an early stage. 3D modelling allows us to look at the virtual structure from all angles; especially on complicated structures with a difficult geometry or complex integration into the topography, planning errors are detected early on.
BIM allows us to present our client a realistic model. A project to be planned becomes clearer, the comprehension of the structure increases on both sides: an ideal discussion basis for the client and the contractor. In particular, construction projects of public interest can be better demonstrated by realistic visualisations.

Quantity calculations with indication of materials can be precisely derived from a BIM volume model, also in case of difficult topography, alignment and geotechnics. We are thus able to exactly calculate costs and design even more efficient and economic structures.

We react more flexibly to changes. All information is saved in the model and can be easily modified. All sections, details, plan derivations are linked to the model and do not have to be newly created. Every modification is transferred, only the 2D plans have to be plotted again.

An overview of the advantages:

- 3-dimensional modelling; structure/component can be examined from all sides
- better understanding of the structure/component for the contractor and the client/ optimum discussion basis
- faster detection of errors especially in case of complex geometries and required high detailing or difficult topography
- exact representation of sections and views at any point
- simple and exact collision analysis
- increasing design depth by effective design of the construction site, virtual simulation of construction phases and the construction process
- avoiding errors, minimising risks, complying with schedules through precise preliminary planning with object-oriented design methods
- digital image of a project that forces decisions
- fast examination of variants, early chance to optimise
- exact calculations of quantities/heights/areas due to volume models
- use of the model for plan generation/workshop design/structural analysis/machine control/visualisation/simulation etc.
- exact calculation of accumulations and cuts for earthworks using DGM
- exact recording of the as-built situation and integration in the model by laser scan data
- cost security at an early phase and increased cost reliability
- demonstration of capacity limits
- increased efficiency
- quality increase during construction execution
- transparent and complete (digital) information management during the design and construction processes
- optimisation of ecological coefficients, CO_2 reduction (through early data harmonisation during design and transparent data during construction execution)
- comprehensive possibilities to process data from the construction company/client

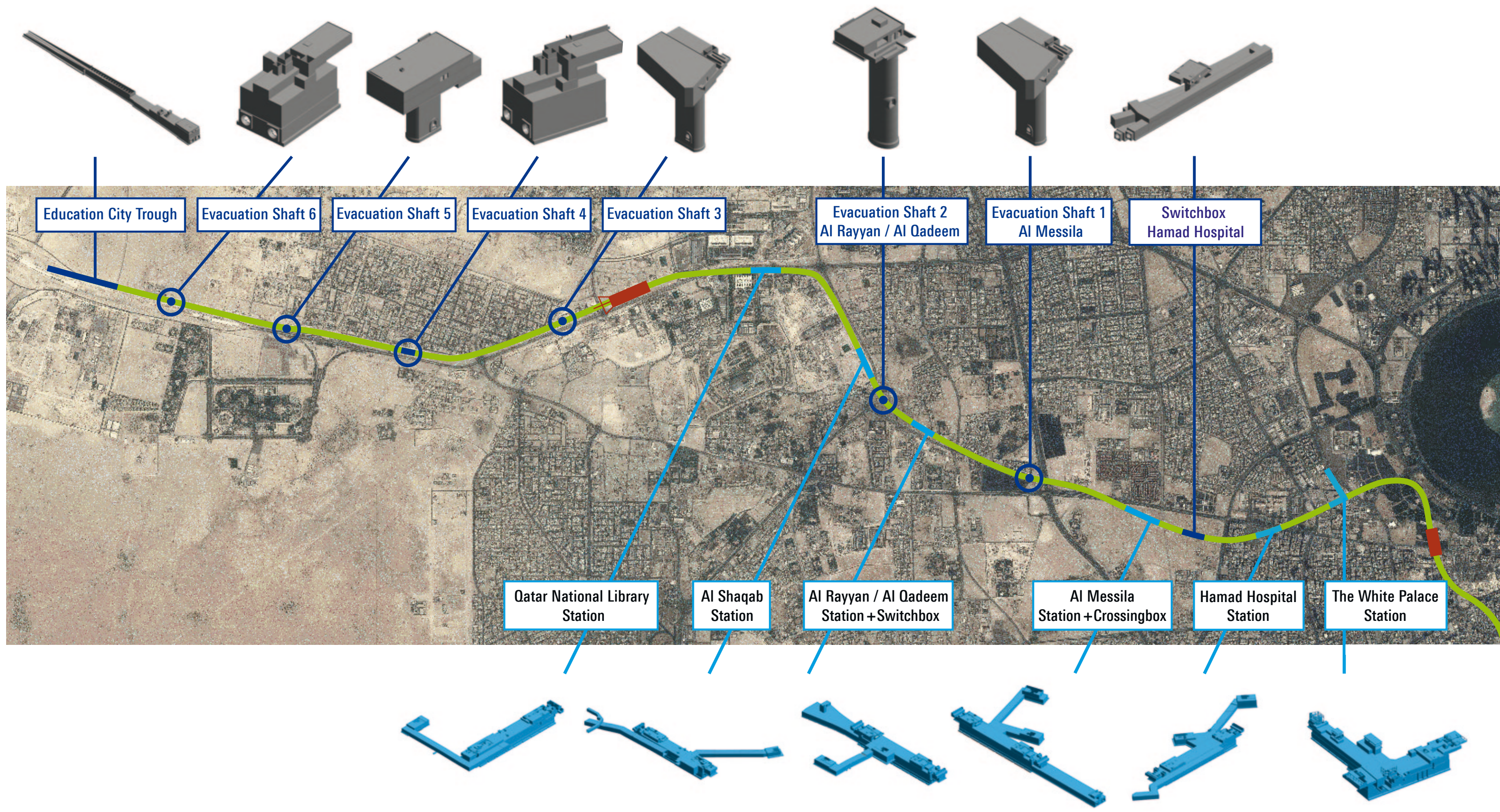
BIM PROJECT EXAMPLES

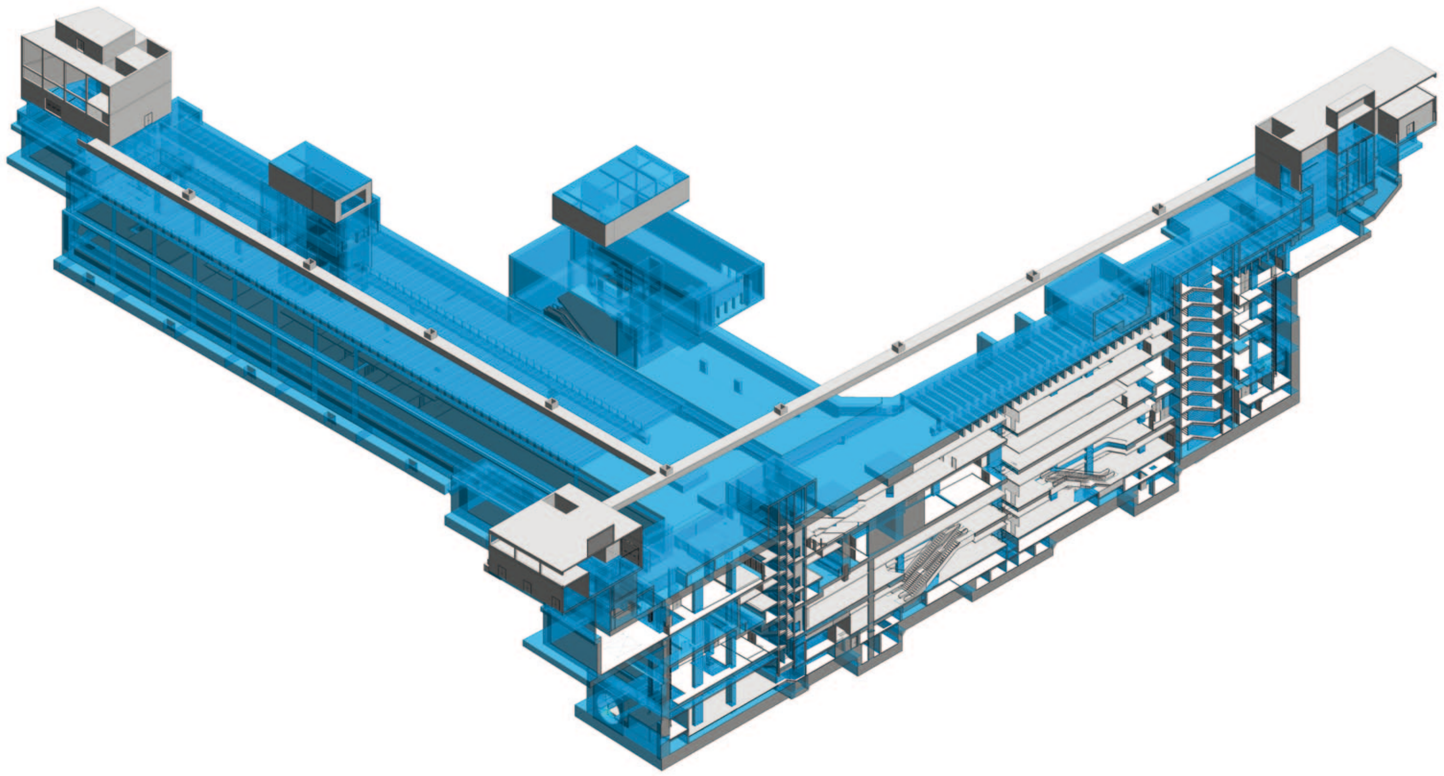
Metro Doha, Qatar – planning and implementation of the metro Education Line / Green Line

Client	Qatar Railways Company
Total length	18.5 km
Planning period	2013 – 2018
Construction period	2014 – 2018
Services	project planning § 43 HOAI* work phases 1 – 8
	structural engineering § 51 HOAI work phases 1 – 6

* refers to issue HOAI 2013, work phases: 1-basic evaluation, 2-preliminary design, 3-draft design, 4-approval design, 5-final design, 6-preparation of tenders, 7-evaluation of tenders, 8-construction management, 9-construction monitoring – applies to all following projects

In Doha, Qatar's capital, currently a modern underground network is being built. The project, launched in 2011 and worth millions, is an integral component of the Qatar Rail Development Programme. The four main lines of the underground network, around 90 % line (50 % tunnel) and around 30 stations 24 of them underground, run underground in the centre of Doha and mostly overground in the outskirts.



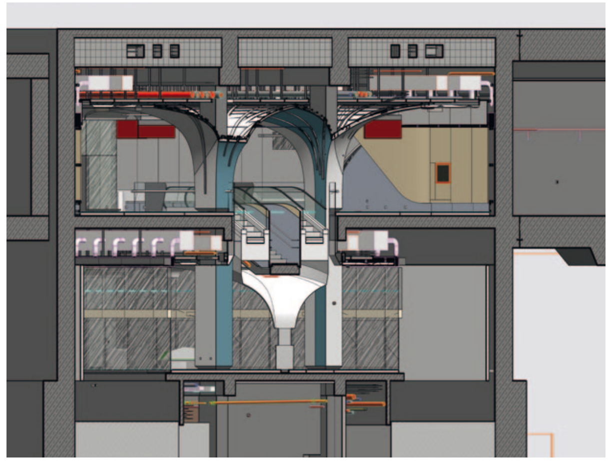


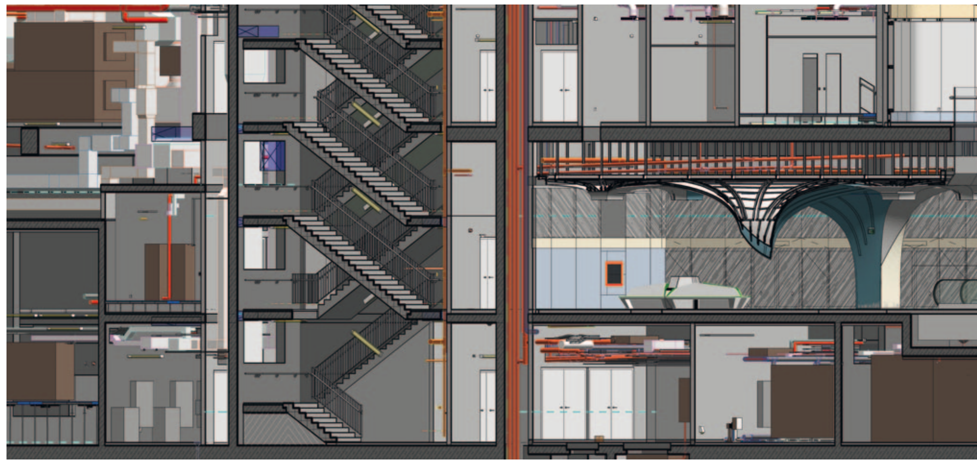
The Green Line, also called Education Line, is the underground part of one of the four main lines of the Metro Doha Project. The total length of this underground section is around 16.50 km. The cross section is a double-tube tunnel. In addition to six underground station buildings, ten emergency exit shafts and a switch box are built along the line. The project is a design-and-build contract implemented by the joint venture comprising the companies Porr AG Austria, Saudi Binladen Group Saudi Arabia and the local construction company Hamad Bin Khalid Contracting Company (PSH).

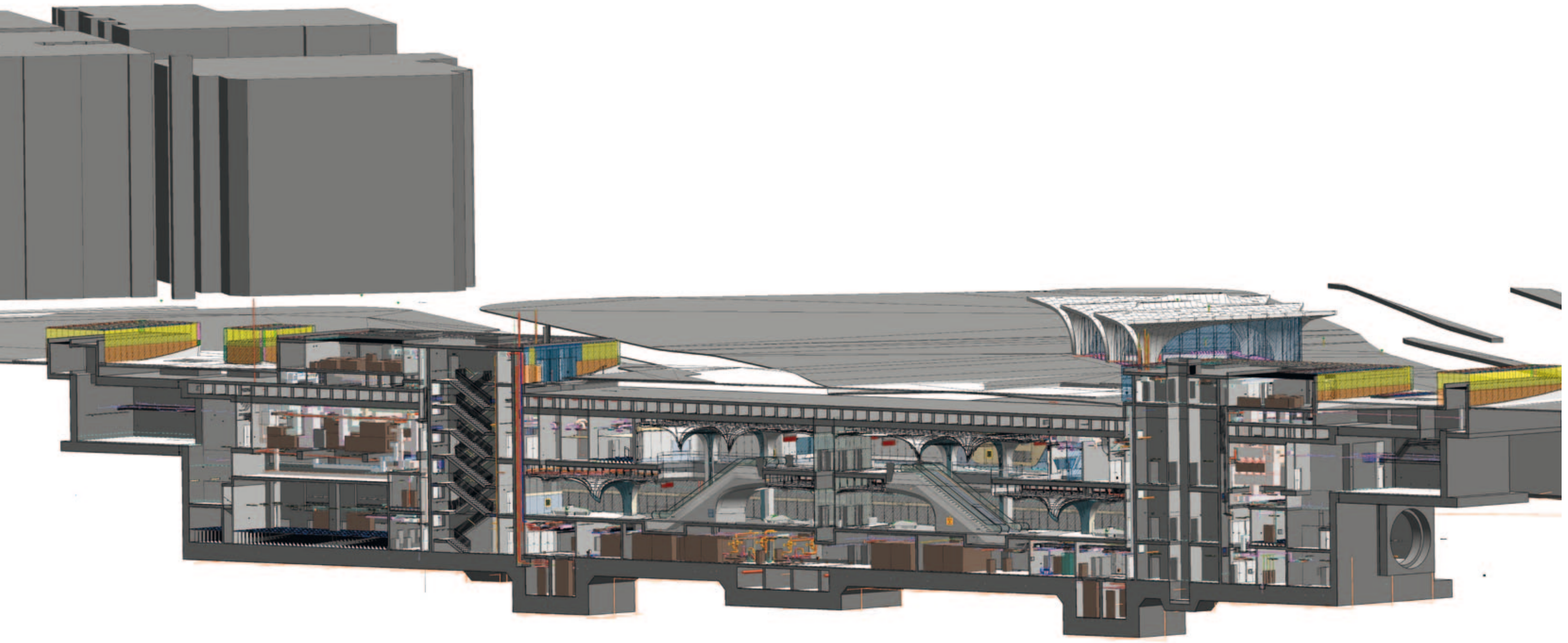
The structures' concept design was handed over by the client Qatar Rail with 2D design documents. The contract comprises the overall planning, from the preliminary design (basis of the building concept with room arrangement and final definition of use in coordination with all participants) to the detailed design of the individual trades. The client Qatar Rail required the application of BIM for the project as definite component of the call for tenders.

The tender documents were only produced in conventional 2D design and the following preliminary and detailed design phases are to be implemented consistently with the BIM method in order to support the future operation and maintenance of the metro system.

SSF Ingenieure was mandated with the overall planning as well as the disciplines geotechnics, structural engineering (excavation pits, stations) and architecture for the design of stations and non-public areas. Other disciplines such as landscape planning, building technology and tunnel design are implemented by other designers (from London, Paris and Vienna). In the framework of this demanding project, the designers and the design management each provide a BIM manager, responsible for BIM coordination with each other and the implementation in each company. As architecture and structural engineering are both delivered by SSF Ingenieure, those two BIM disciplines are harmonised by a coordinated BIM manager.





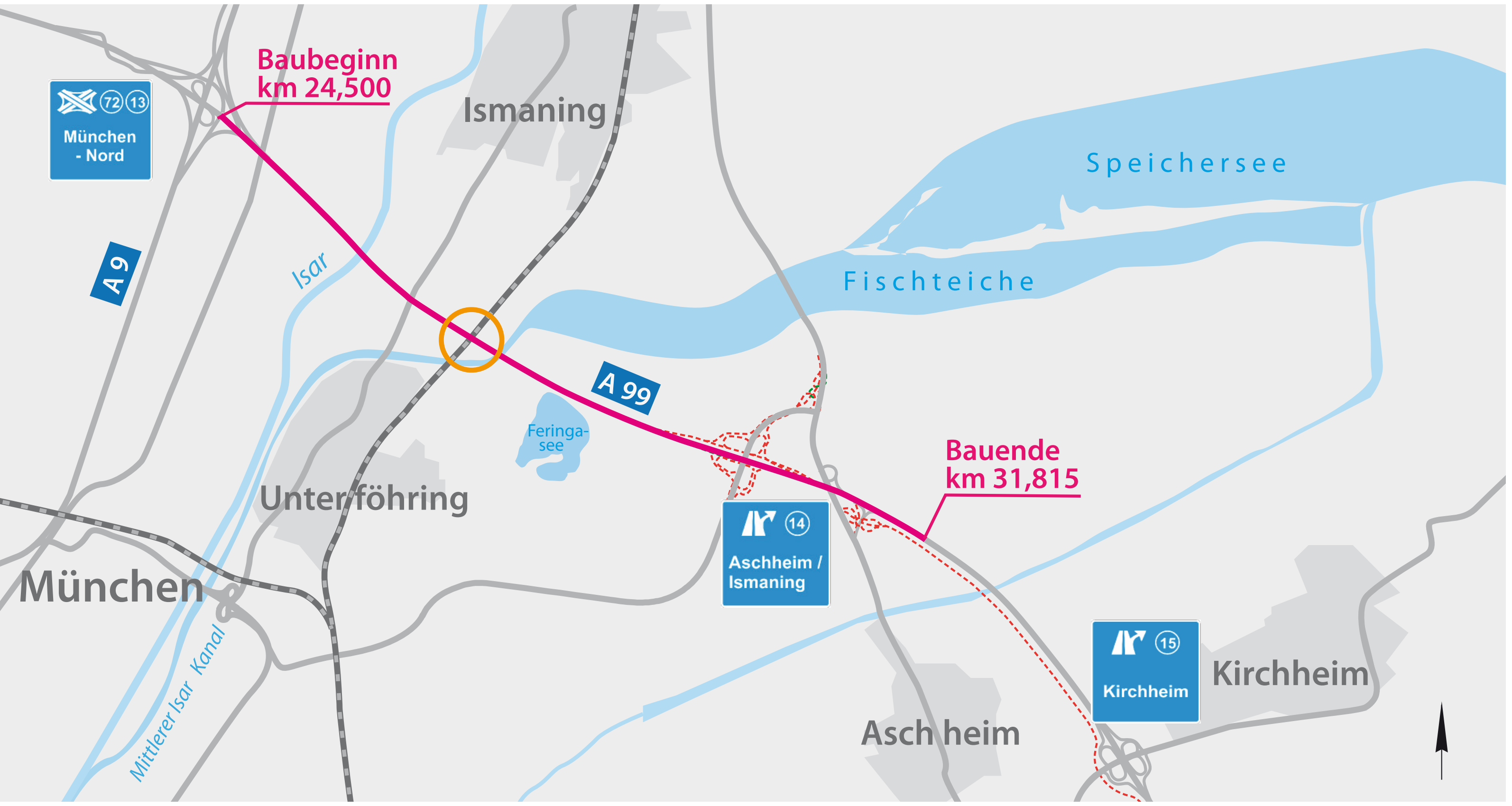


Particularities

- designs are based on conventional tender documents, digital design documents in 2D
- 3D postprocessing of tender design
- transfer to the preliminary design in accordance with BIM standards
- partial visualisation during the PD phase to find architectural decisions
- model serves as discussion and decision finding basis for the planned fittings
- continuous and integral BIM planning of architecture and structural engineering
- production of a compilation file in Revit (management of model standards) – a file which comprises all component catalogues to generate models as templates
- in analogy to the BIM guidelines, the parameters of these individual component catalogues, so called Revit Families, are produced
- in addition to the Revit Families the compilation file comprises templates for different views, pin assignments or tables; all models, generated for the project, are fed from this file

Motorway A99, 8-lane expansion at interchange Munich North until Haar, replacement of structure 27/1 over the railway line

Client	Authority of Motorways South Bavaria
Planning period	2016 – 2017
Construction	2018 / 2019
Services	project planning § 43 HOAI work phases 1 – 3, 6 structural engineering § 51 work phases 1 – 3, 6 additional BIM services

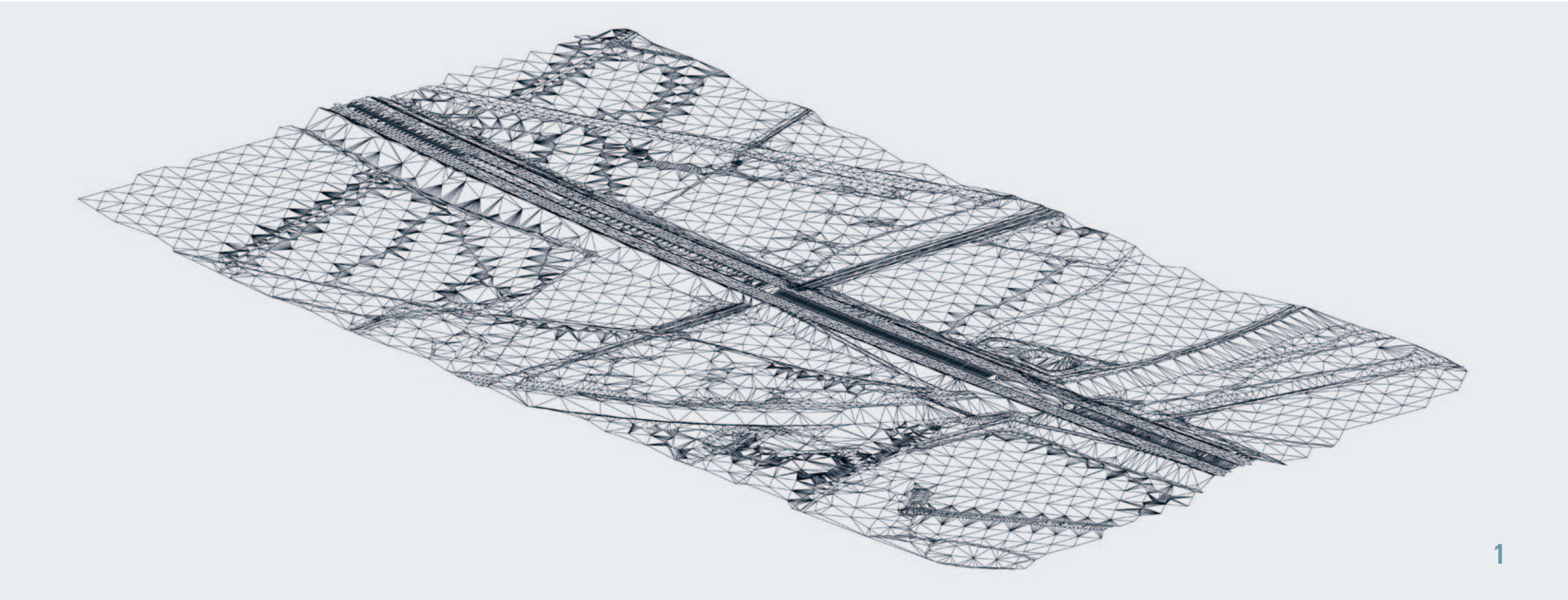


Motorway A99 is the motorway bypass of Munich. The traffic flows of five motorways lead onto it and are directed around the city of Munich. The current traffic load is at 150,00 vehicles/24 h. At the moment, A99 is a six-lane motorway and has a temporary hard shoulder release since 2005. Despite this improvement, the existing carriageway cross section cannot answer the average increase of traffic volume. Therefore, the Authority of Motorways South Bavaria plans the eight-lane expansion of A99 on a length of 18.6 km between interchange Munich North and junction Haar. In addition to renewing bridges and the superstructure, projects in view of noise protection – lownoise surface and higher noise barriers – are planned.
In collaboration with Prof. Schaller UmweltConsult GmbH (PSU), a partner company of the SSF Group, the integration of BIM and GIS engineering planning and environmental data is tested in practice.
Future requirements of flawless mutual data exchange between engineers and environmental designers are in focus in order to optimize and monitor all necessary environmental aspects from the beginning of the planning to project implementation and completion.

Particularities

Autodesk Revit as interactive BIM – CAD system for a completely continuous 3D planning

- 3D data collection of existing structure for demolition planning and construction within existing structures and with continued traffic
- cost estimate and cost calculation on the basis of models (volume, surface, attributes)
- better coordination with geotechnical experts by using of the 3D model
- essential structure plans are derived from the consistent 3D model
- the 4D model is created through linking the 3D model to the construction process
- individual construction phases with the required traffic management are clearly demonstrated at the 3D model in view of coordination
- simple transfer of quantities and areas of individual components
- simulation of the cost progression over time: 5D model, link of 4D model to components fabrication costs
- use of 3D model as basis for structural analysis
- outlook to the future: use for maintenance/operation/renovation – use of data in the programme SIB-Bauwerke, provision of models, integration into the GIS system used by the client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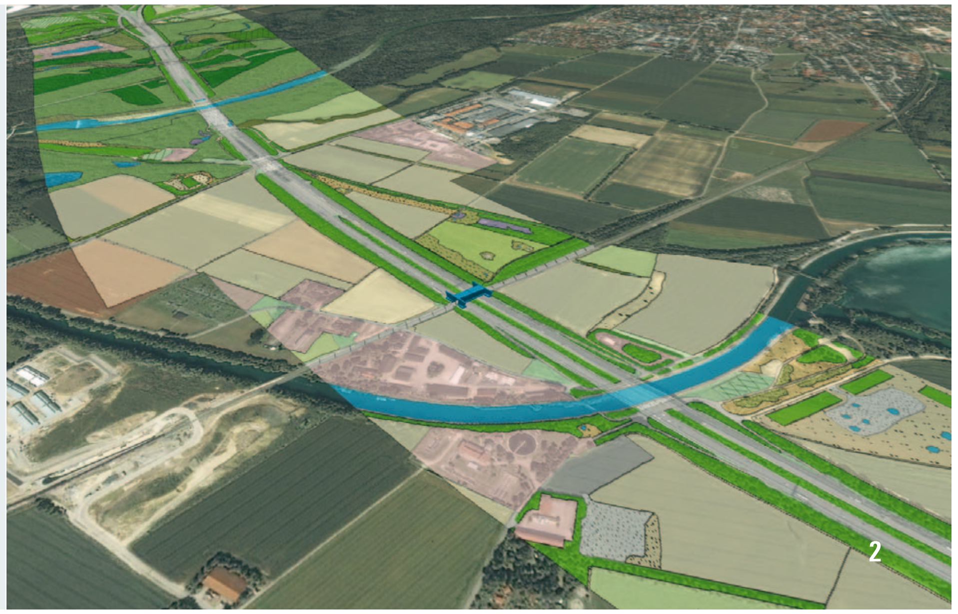
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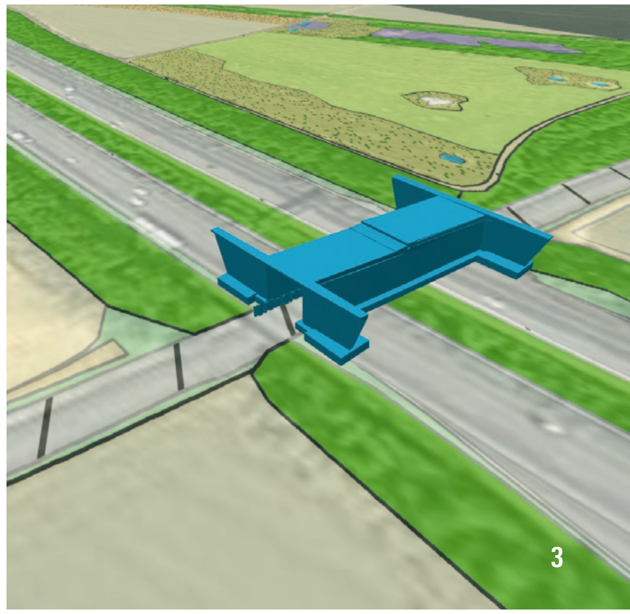
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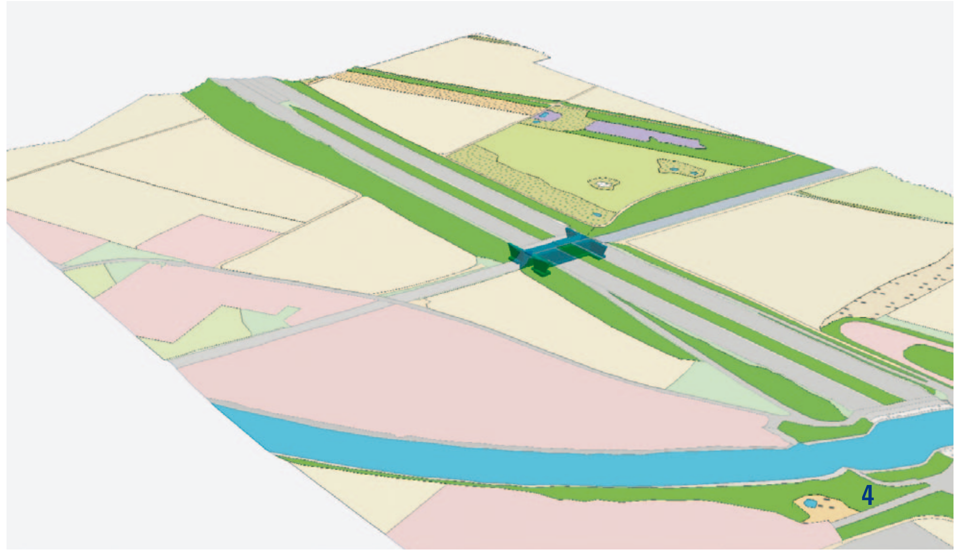
BIM and GIS data integration and evaluation

- simple integration of BIM data in the GIS environmental data base with ArcGIS
- FME/ETL process, georeferencing
- data exchange between BIM and GIS data
- creation of a jointly usable 2D and 3D geodata structure for engineers and environmental designers
- integration of elevation models and surveying data
- integrated analysis and visualisation of the structure in the landscape

this could include in the future
- consequences analysis, impact balancing, environmental impact assessment
- nature and species protection requirements
- landscape planning and final design
- landscape compensation and replacement measures
- ecologic construction supervision and ecologic monitoring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Pic. 1 TIN elevation model generated from surveying data

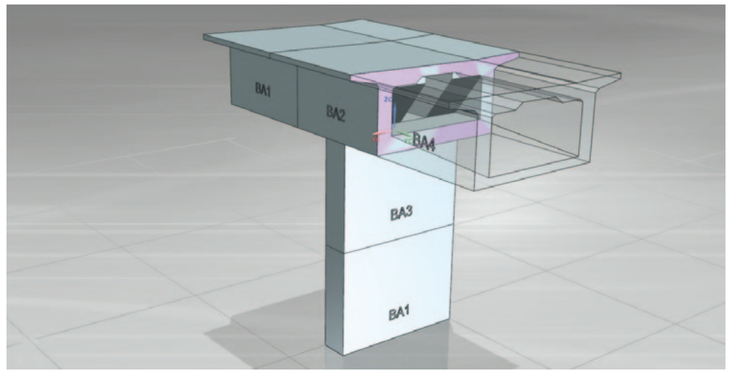
Pic. 2 Bridge design model imported into the 2D GIS database

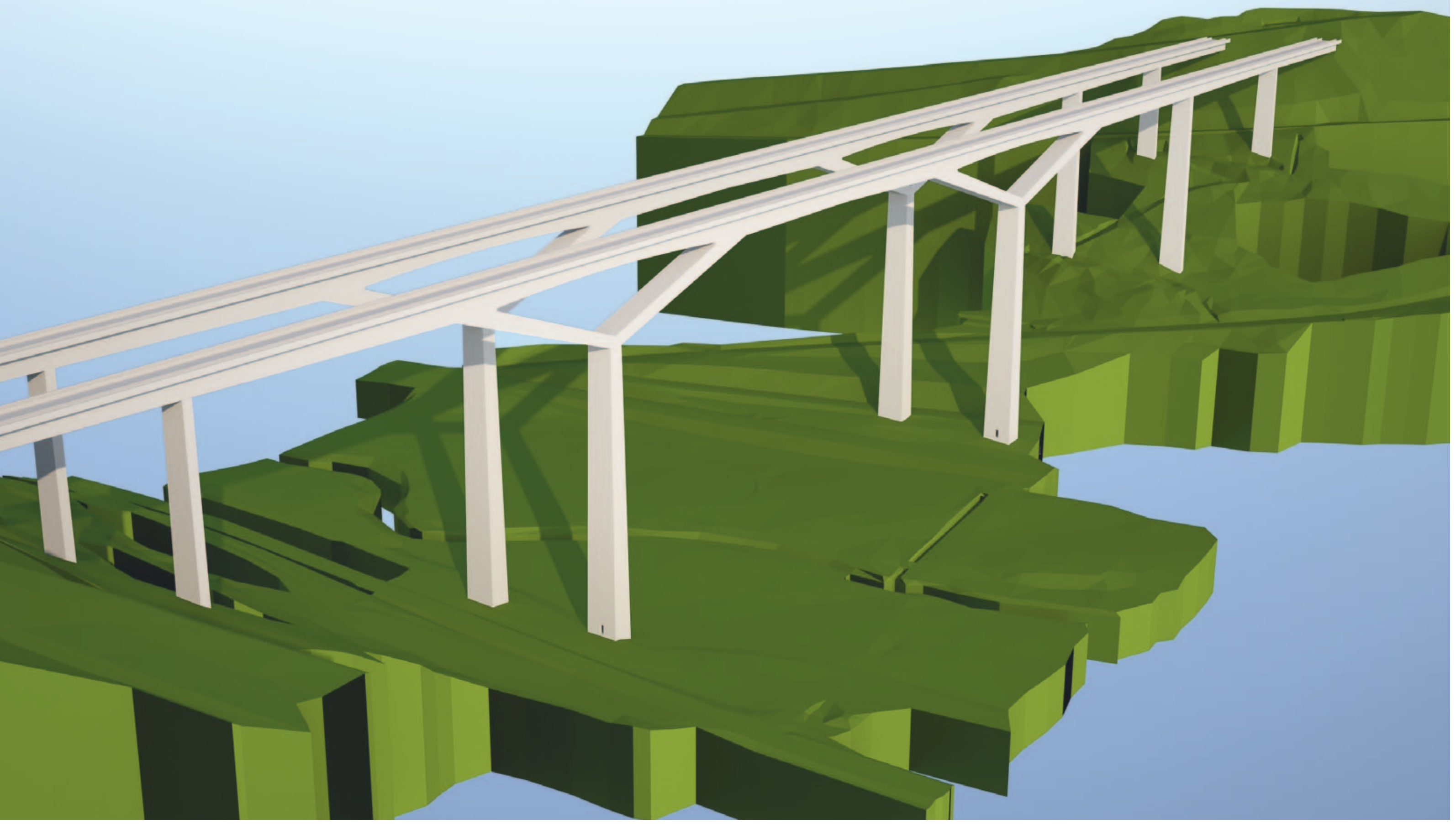
Pic. 3 Integration of the structure into the scope of landscape planning

Pic. 4 Integration of the structure and the TIN data into the 3D GIS geo and design data model

Newly built railway line Stuttgart – Ulm, new construction of Filstal Viaduct

Client	DB Projekt Stuttgart – Ulm GmbH
Span widths	44.00 m + 95.00 m + 150.00 m + 93.00 m + 58.00 m + 45.00 m = 485.00 m
Planning period	2013 – 2017
Completion	2018
Services	projekt planning § 43 HOAI Lph 3 structural engineering HOAI § 51 work phases 3 – 5 for the integral structure





The around 485 m long, double-tracked and semi-integrally designed structure crosses on two separate superstructures and up to 80 m high Y-columns the Filstal valley. It has a main span width of around 150 m and is on both sides connected to tunnels.
The structure is built as single-web hollow box cross section on a launching track and on up to 80 m high temporary supports. The raking supports of the Y-columns are concreted afterwards and connected monolithically to the superstructures. The high axle and breaking loads typical on railway lines, the future speed of 250 km/h on the ballastless track superstructure combined with the concept of a semi-integral bridge, the Y-columns with very flat diagonal struts and the difficult topographical and geometrical boundary conditions entail exceptionally high requirements regarding the design, work preparation and construction and the fabrication processes.

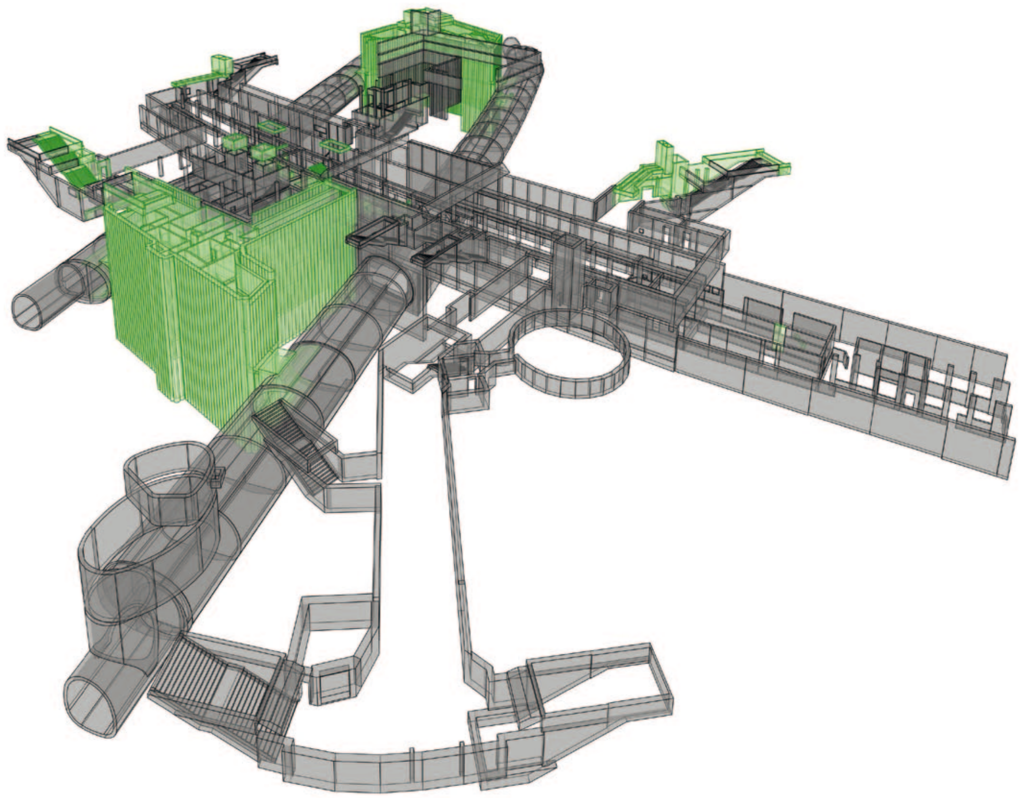
Particularities
This project is one of the four BIM pilot projects implemented by the German Ministry of Transport and Digital Infrastructure BMVI:

- 4D construction process and status report; representation of individual objects of the fabrication process such as structure, temporary scaffolding, construction pits and site roads; linking of individual objects to the construction schedule
- transparent and complete bill calculation of lump sum construction lots with BIM; parallel bill calculation of unit price construction lots, traditionally as well as with BIM comparison of both bill calculation methods
- mobile cloud-based BIM application with access via iPad app or web portal; provision of digital information with BIM 360 field software; documentation of the construction execution in situ on the construction site
- link of the plan management platform (EPLASS) to the BIM application (optional); link between the 3D model and the belonging plans on the construction component level
- integration and follow-up of the plans status in the 3D model

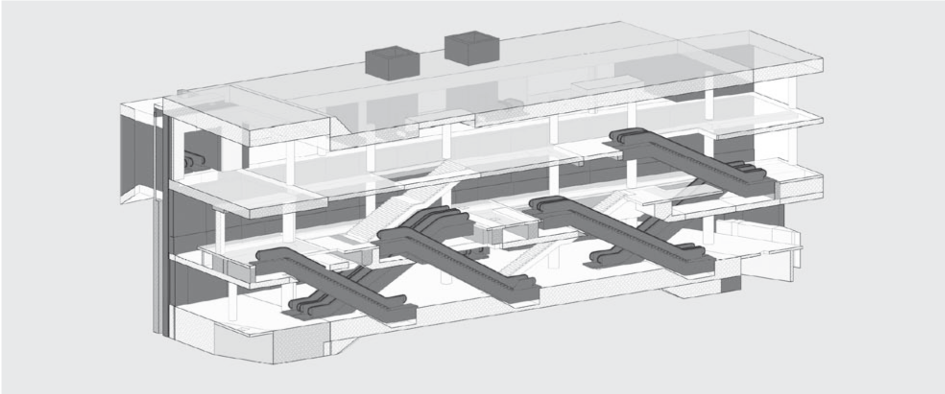
Expansion, conversion and modernisation of underground station Sendlinger Tor, Munich

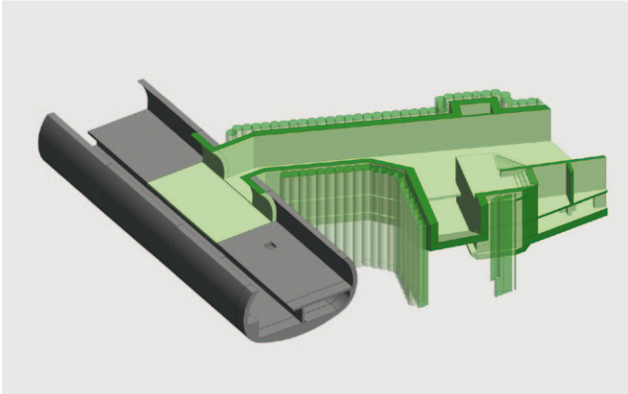
Client	Stadtwerke München GmbH
Architect	design joint venture Raupach + Bohn
Planning period	2012 – 2017
Construction period	until 2022
Services	project planning § 43 HOAI work phases 2–8 structural engineering § 51 HOAI work phases 3–6 BIM management

In order to rectify deficits of the 40-year-old underground station and to increase the subjective safety, complex conversion and modernisation measures are implemented. These measures comprise the fire protection upgrade of the station buildings and the improvement of the changing situations whilst operation is continued (underground railway, tramway and road traffic on the surface).



The project also comprises the demolition of technical and operational rooms to create more space, the rearrangement of existing escalators and stairs and the installation of additional escalators, the conversion of different access situations as well as the construction of two new cross-cuts at both platform ends of level U1/U2.





Particularities

In the context of a feasibility study elaborated by SSF in 2011 (by order of Stadtwerke München), the solutions to be designed were established, prepared and recommended for further development.

- The design is based on documents from the 1960s; few digital design documents
- 3-dimensional reproductions of the existing structure based on hand-drawn plans
- representation of the existing structure/demolition projects/new constructions/final state
- partial visualisation
- model serves as basis for discussions and decisions about the planned conversion project
- BIM planning of architecture and structural engineering

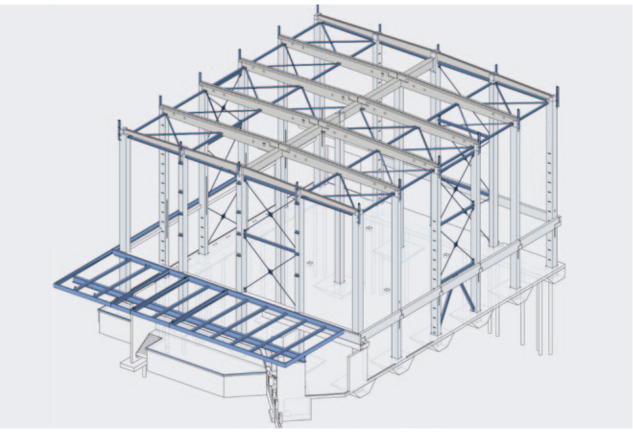
One essential aspect of the overall project is the visual upgrade of the underground station.

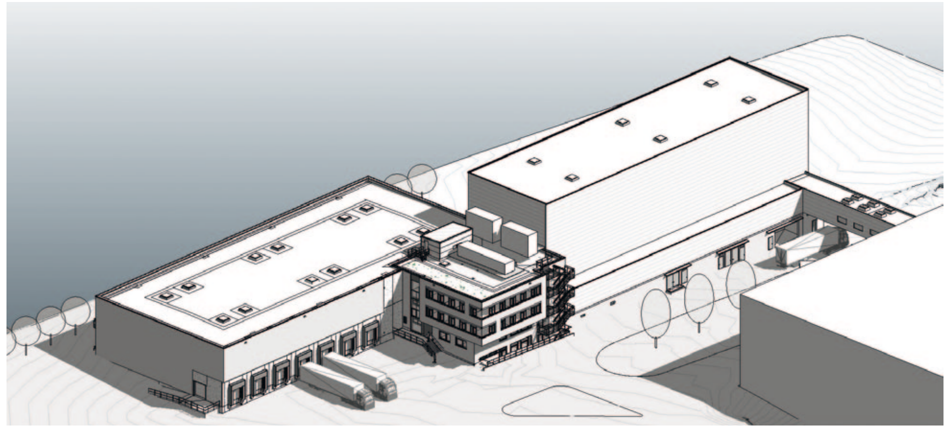
- complete 3D planning of planned conversion and modernisation works with Autodesk Revit
- linking of 3D design data to 3D construction logistics tool to demonstrate the structure status (4D planning)
- planning and construction of conversion/modernisation projects with sustainably low effort for maintenance and renovation as well as durable functionality, robustness and longevity

New construction and expansion of logistics centre of dairy Gropper GmbH & Co.KG

Client	Dairy Gropper GmbH & Co. KG
Planning period	2011 – 2012
Completion	2013
Services	project planning § 33 HOAI work phases 1 – 8 structural engineering § 51 HOAI work phases 1 – 6

The success of Dairy Gropper in Bissing goes hand in hand with the increasing need of space and the resulting necessary new construction of a logistics centre for storage and dispatch of dairy products, as well as the related administration. The newly build complex is connected to the existing production and storage facilities by a bridge.
The logistics centre comprises a two-storey, cooled dispatch hall with order picking facility, a lorry loading bridge implemented as reinforced concrete skeleton structure and a four-storey cooled high-bay storage as self-supporting steel system.
An around 31 metre cantilever cooled steel truss bridge with ISO panel façade and conveyor technology connects the new logistics centre to the old buildings.



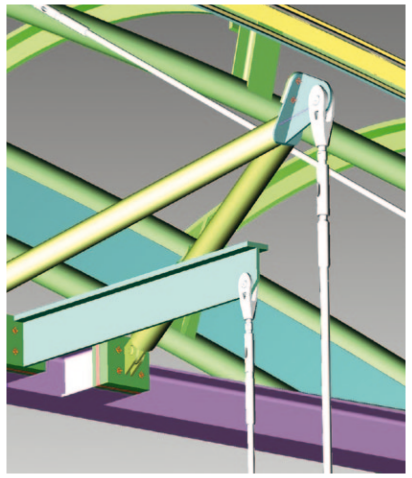


Particularities

- object and formwork plans of the building complex continuously derived from the 3D model with AutoCAD Revit
- use of 3D functionality to control the design, demonstrate complex geometries and visualisation
- use of BIM functionality to calculate quantities, room book and door schedule
- integration of external final design of high-bay storage and conveyor technology; operational planning/construction logistics – construction under ongoing operation
- harmonisation of foundations and load-bearing structure with the existing pipe lines
- energy certificate/verification as per ENEV

ZAE new construction – Energy Efficiency Centre

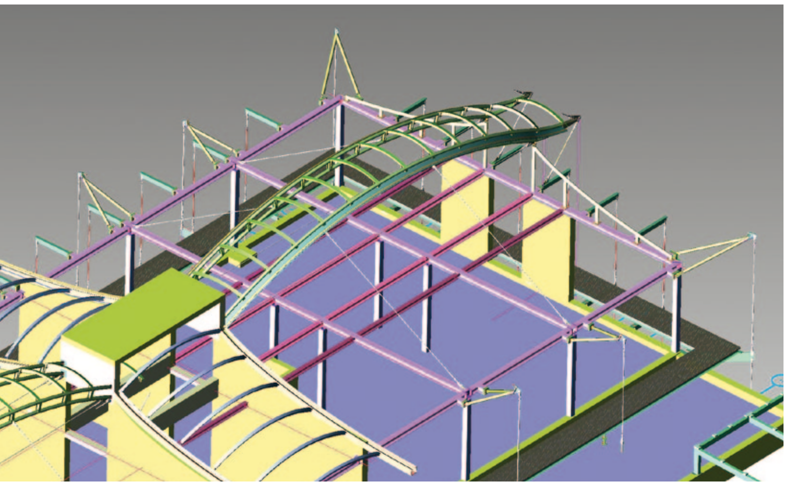
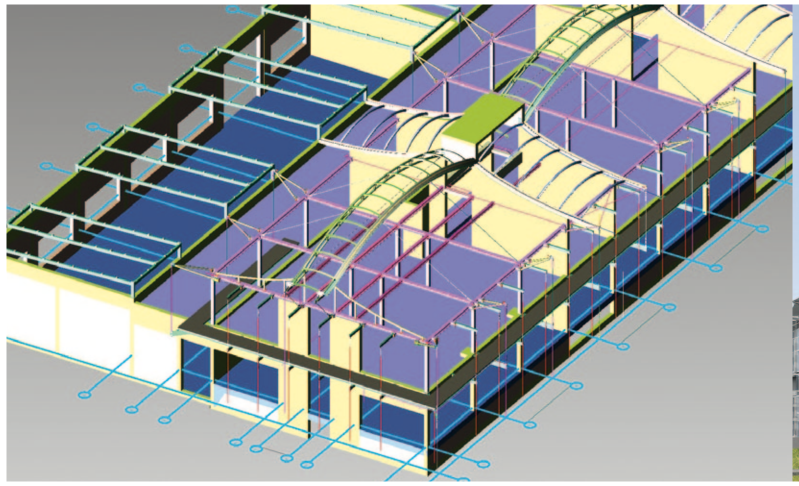
Client	Bayerisches Zentrum für Angewandte Energieforschung e. V.
Architect	Lang Hugger Rampp GmbH Architekten
Planning period	2010 – 2013
Services	project planningsteel structure § 43 HOAI work phases 1 – 6, structural engineering § 51 HOAI work phases 1 – 6, engineering control of execution together with Lang Hugger Rampp GmbH Architekten



The Energy Efficiency Centre was promoted by the Federal Ministry of Economy and Technology in the framework of the research focus EnOB (Research on optimised construction) as well as by the Free State of Bavaria.
Main goal of this building is to use new, innovative and efficient materials, systems and technologies and to verify by means of example their application within the building stock as well as on new buildings, to demonstrate them and to subject them to monitoring.
The load-bearing structure (concrete and steel) was designed by SSF Ingenieure as BIM isolated application. New energy storage solutions to provide heating and cooling required an interactive and integral collaboration between the architects, building services specialists and structural designers.

Particularities

- 3-dimensional development of the steel roof structure in consideration of different roof membrane geometries
- construction of transitions between roof structure as well as connecting details to the concrete structure as basis of the final design
- utilisation of the 3D model for coordination with the client and visualisation

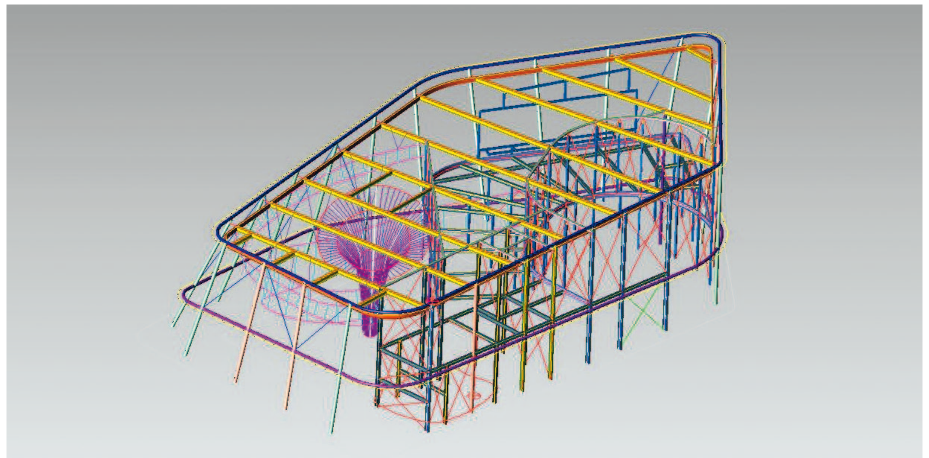
EDF pavilion Olympic park London

Client	iLuka Ltd, London for EDF
Architect	SCHMIDHUBER, Munich
Communication	MET Studio Design, London
Planning period	2012
Completion	2012
Services	structural engineering § 51 HOAI work phases 4, 5

Together with the architectural office Schmidhuber, SSF Ingenieure erected a pavilion at the Olympic Park for EDF the official partner and energy supplier of the London Olympic Games 2012. The pavilion made the subject »Energy« experienceable, and the visitor was invited to create energy through his own movements.
The Olympic Games in London explicitly opted for sustainable design and organization. For this reason, SSF Ingenieure AG and the architectural firm Schmidhuber developed a light structure, which can be entirely dismantled. The dynamic building represents three-dimensionally the turbine of EDF's logo. The facade consists of a white membrane. The dynamic room volume is designed with curved and twisted floor and ceiling contours. The visitor is guided from a waiting area through a cinema to a curved round that informs about aspects of CO_2-free energy supply. The final highlight is the energy column: a room-filling LED sculpture interactively supplied with energy via floor panels; the visitors' movements illuminate the sculpture, thus making energy visible.

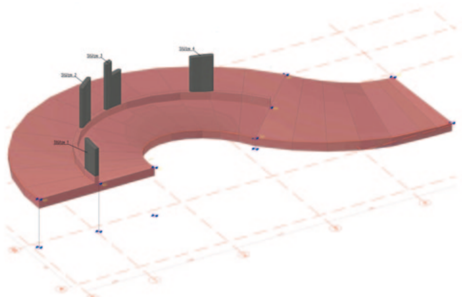
Particularities

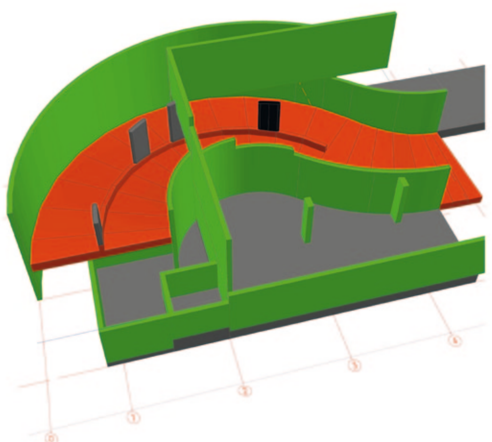
- temporary steel skeleton structure with membrane envelop of the facade
- exhibition design with light cable structure on the inside
- use of architectural model for 3D construction of steel load-bearing structure
- 3D system model of the load-bearing structure as basis of the workshop design

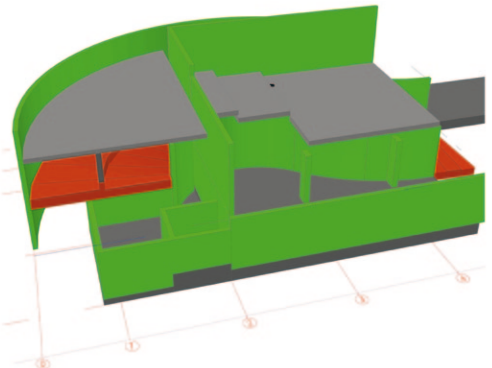


New construction of a hotel and business complex at Station Moosacher Bahnhof

Client	MO-Projekt GmbH, Munich
Client	bucher properties GmbH, Munich Geiger Schlüsselfertiges Bauen GmbH
Design	KP Plitzko Architekten, Munich
Planning period	2009 – 2010
Completion	2010
Services	projekt planning § 43 HOAI work phases 3 (partially), 5 joint venture SSF Ingenieure AG and Lang Hugger Rampp GmbH Architekten







This new construction of a hotel, medical centre and office buildings is situated in the north of Munich. The five-storey, around 17 m wide and 110 m long building has a basement over its full length with 48 parking spaces. The hotel area consists of 3,000 m^2 usable area for 94 rooms. Due to the adjoining railway line, a vibration decoupled bearing as well as the integration of an access to the local underground were required.

Particularities

- 3-dimensional development of spiral entry ramp to the underground car park to define geometry and analyse collisions
- 3D model of the basement as discussion basis with the client
- comprehensive coordination of all building technology trades with the aim to optimally harmonise the alignments
- minimisation of constructional and structural works and area use for TGA alignment as well as guaranteeing a flawless construction process
- concept of an elastic building bearing to minimise structure-borne noise from the adjoining railway line (in close collaboration with company internal construction dynamic engineers)
- construction pits with back-anchored sheet piles and groundwater retention with dewatering wells; permission as per water law act

Feuerbach-Tunnel Stuttgart double-tracked railway tunnel, design section PFA 1.5 Stuttgart

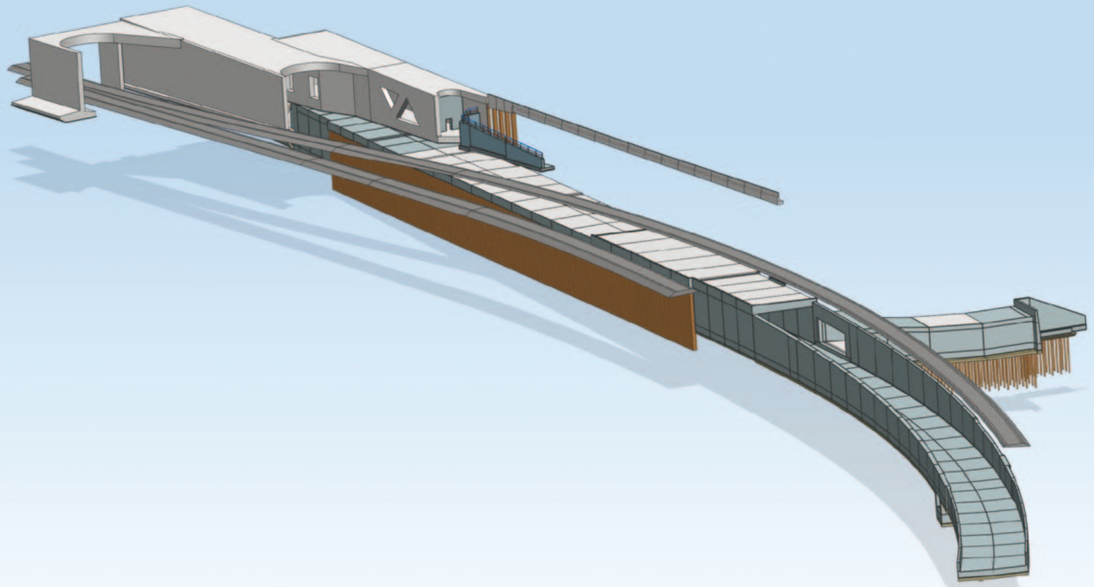
Client	DB Projekt Stuttgart - Ulm GmbH
Tunnel length	238 m
Planning period	2015 – 2018
Completion	2019
Services	projekt planning § 43 HOAI work phases 2, 3, 5, 6 transport installations § 47 HOAI work phases 3, 5 structural engineering § 51 HOAI work phases 2 – 6 general planning and construction accompanying track superstructure and engineering works for transport installation planning

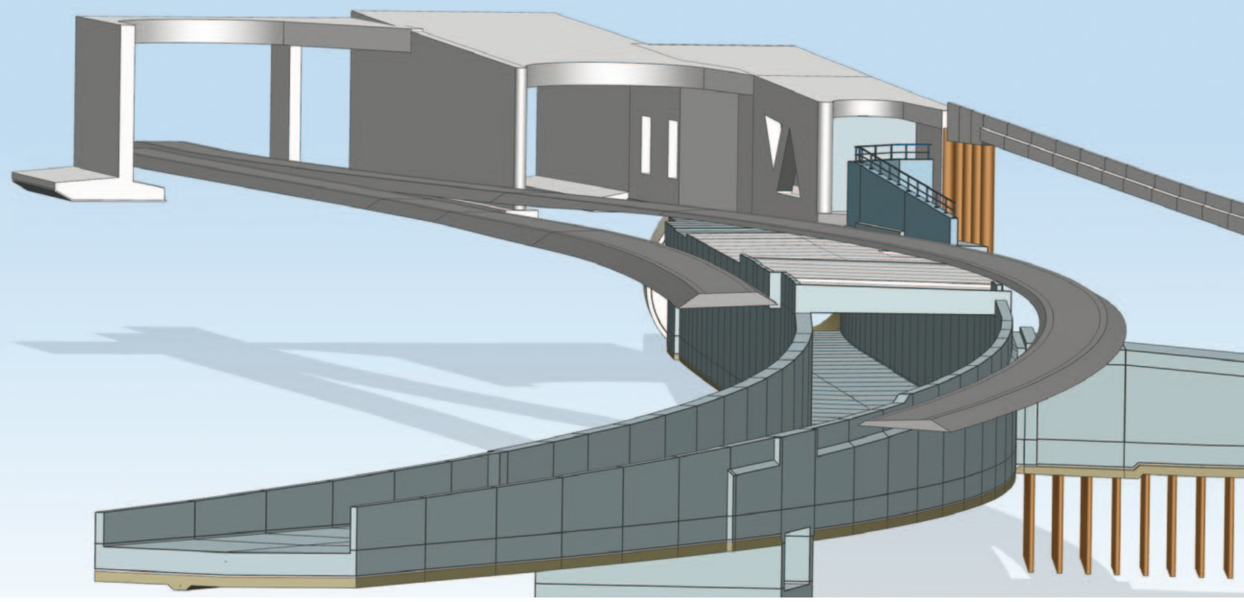
A double track runs through tunnel Feuerbach, built by mining technique, on a length of around 238 m starting at the portal until the trough structure. Blocs 1 to 9 are built by a special technique in the area of the existing regional train tunnel.

As the tender design had to be completely modified, this area was optimised in a special variant. The current draft design comprises blocs 1 to 28. Blocs 10 to 24 are built by cut-and-cover method varying from the tender design, blocs 25 to 28 are built by top-down method as originally planned. The construction of blocs 1 to 9 is basically implemented by mining technique.

Particularities

- NX (Siemens) as interactive CAD system for a completely continuous 3D planning
- difficult geometry for underpinning of the existing tunnel (connections existing structure – new structure)
- draft and formwork plans entirely derived from the 3D model
- individual construction stages comprehensively demonstrated at the 3D model
- simple transfer of quantities and areas of individual components
- use of 3D model as basis for structural analysis
- the overall 3D model allows to coordinate all constructional influences during tunnel underpinning – excavation, temporary constructions, required traffic management and track placing
- simple coordination with geotechnical experts with the 3D model

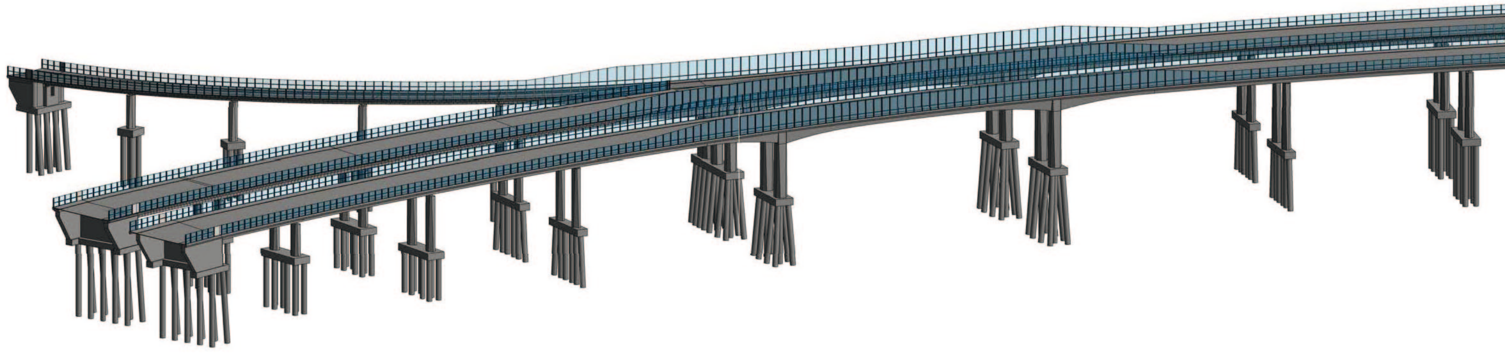




Motorway A44, junction Waldkappel – junction Ringsau new construktion of Wehretal Viaduct

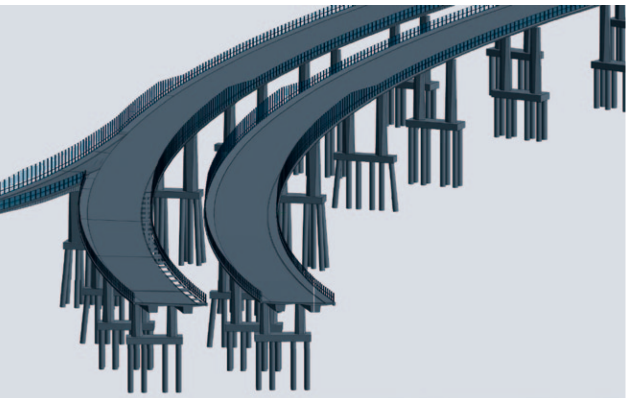
Client	DEGES Deutsche Einheit Fernstraßenplanungs- und -bau GmbH
Span widths	30.00 m + 2 x 43.00 m + 55.10 m + 67.50 m + 56.00 m + 8 x 43.00 m + 30.00 m = 668.60 m
Planning period	2013 – 2015
Completion	2018
Services	projekt planning § 43 HOAI work phases 1, 2, 3, 6 structural engineering § 51 HOAI work phases 2, 3, 6

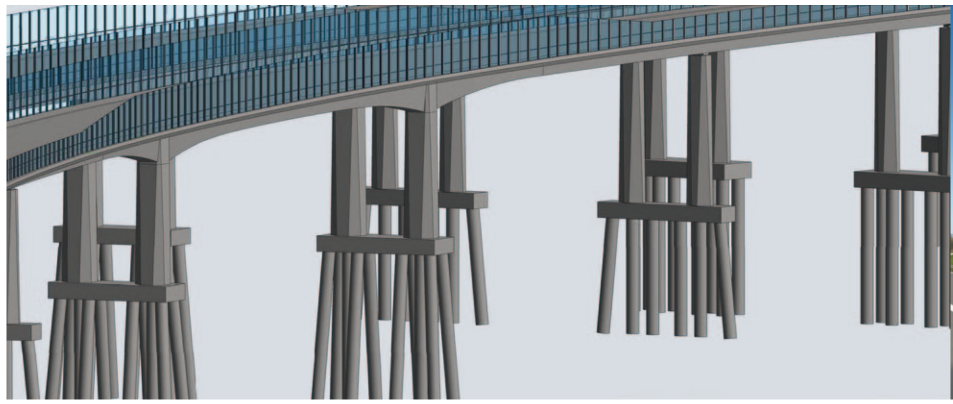
The viaduct over the Wehre valley is part of the new construction of motorway A44 Kassel-Herleshausen and is implemented as a two-part cross section with double-web prestressed concrete T-beams each with integrated ramp structures at junction Eschwege. In the area of the river Wehre, the superstructure is haunched in accordance with the large span width.
The bridge is located between the two tunnels Trimmberg and Spitzenberg and crosses the railway line 3600 Frankfurt/Main Central Station – Göttingen, the national roads B27 and B452 and several agricultural roads.



Particularities

- Autodesk Revit as interactive CAD system for a completely continuous 3D planning
- draft plans entirely derived from the 3D model
- individual construction stages comprehensively demonstrated at the 3D model in view of coordination
- simple transfer of quantities and areas of individual components
- use of 3D model as basis for structural analysis
- the overall 3D model allows to coordinate all constructional influences as well as traffic management and track placing
- easy coordination with geotechnical experts with the 3D model



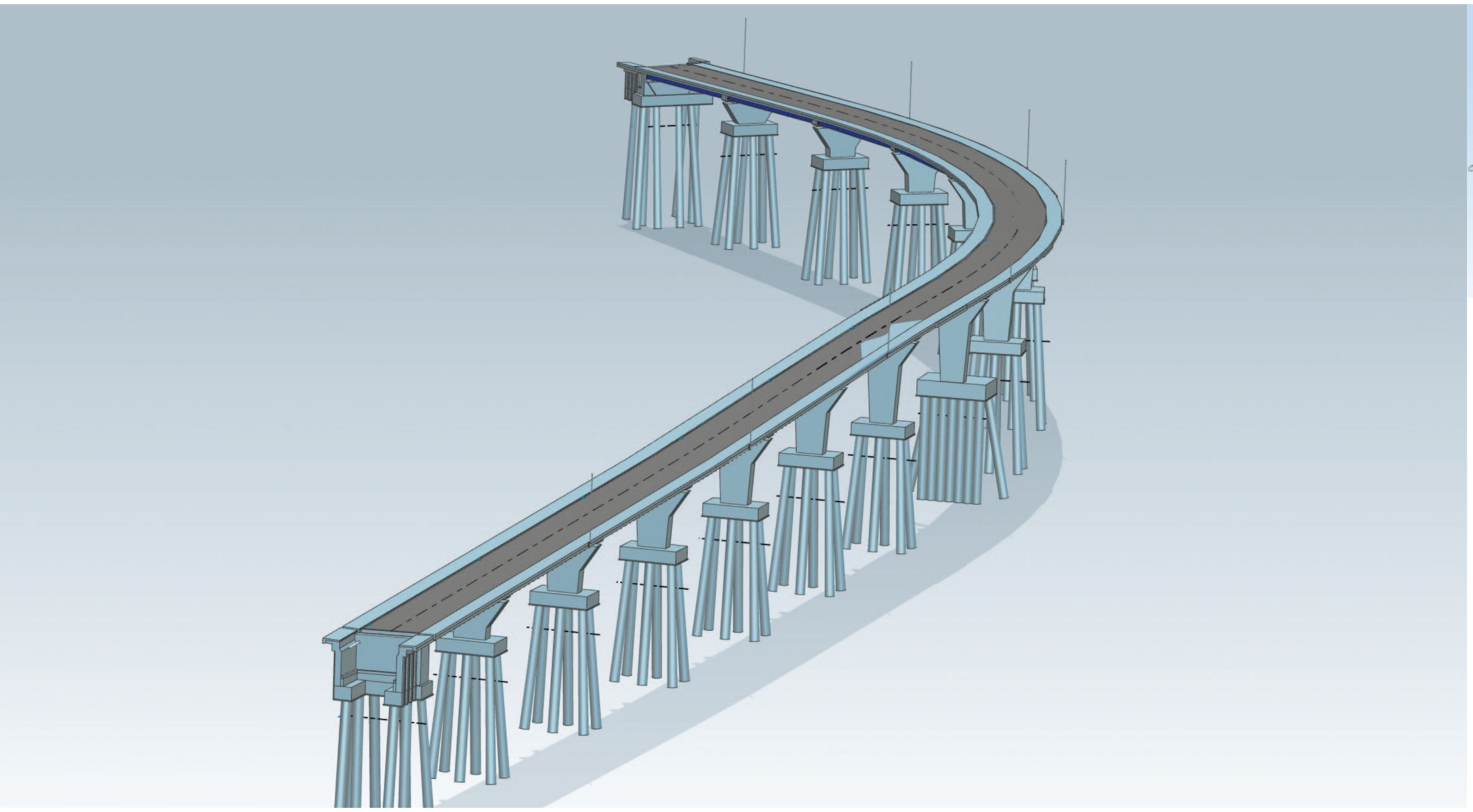


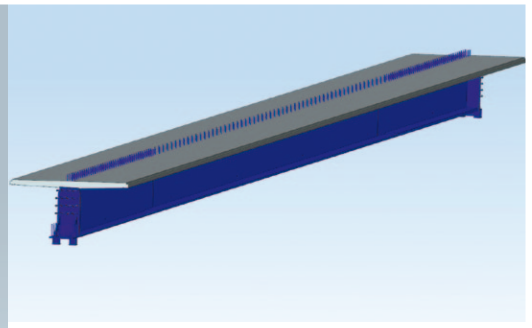
SSF Ingenieure

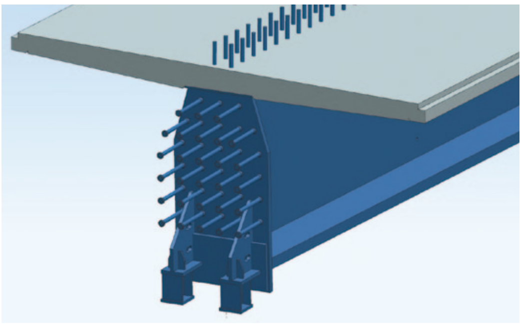
New construction railway bridge Kattwyk, Hamburg land side development east

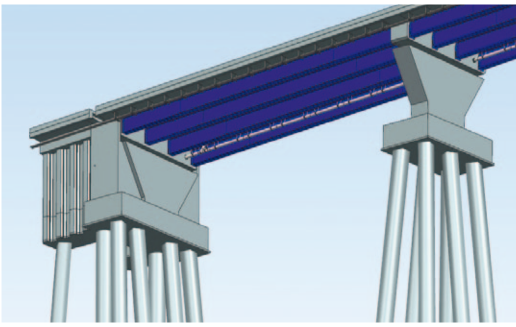
Client	Hamburg Port Authority AöR
Span widths	25.50 m + 5 x 30.00 m + 31.50 m + 27.25 m + 6 x 30.00 m + 26.70 m = 440.95 m
Planning period	2014 – 2015
Completion	2016
Services	structural engineering § 51 HOAI work phases 4, 5 project planning § 43 HOAI work phases 5

The Hamburg Port Authority AöR (HPA) planned the crossing of the South Elbe by the harbour railway on a new construction of the railway bridge Kattwyk (structure BW220) in form of a double-tracked lift bridge. In the context of this construction project, comprehensive constructions are required land side (land side west = Moorburg; land side east = Hohe Schaar) to connect the harbour railway, to reorganize the local road network and to adapt the floodwater protection. In addition to the harbour railway lines, road arrangement and floodwater protection, several bridges, retaining walls and operational buildings are part of the project.
The herein presented structure 223, designed as continuous girder superstructure in VFT construction method with cast-in situ supplement, crosses Kattwykstraße over the Kattwyk dam as well as railway tracks of the new Kattwyk railway bridge. Kattwykstraße reconnects in the southeast to Kattwyk dam. At the abutments, ramps of 100.00 m and 32.00 m respectively are designed.









Particularities

- NX (Siemens) as interactive CAD system for a completely continuous 3D planning
- two different radii in the ground plan and four clothoids on the bridge structures
- fabrication of straight VFT girders per span (polygonal representation of the alignment)
- very narrow construction terrain
- formwork plans entirely derived from the 3D model
- detailed elaboration of axle width (longitudinal girder – cross girder)
- separation of assembly parts and collision examination
- 3D model supports the reinforcement design
- simple transfer of quantities and areas of individual components
- handover of 3D PDF to the construction company and client in view of comprehensive coordination

SSF Ingenieure

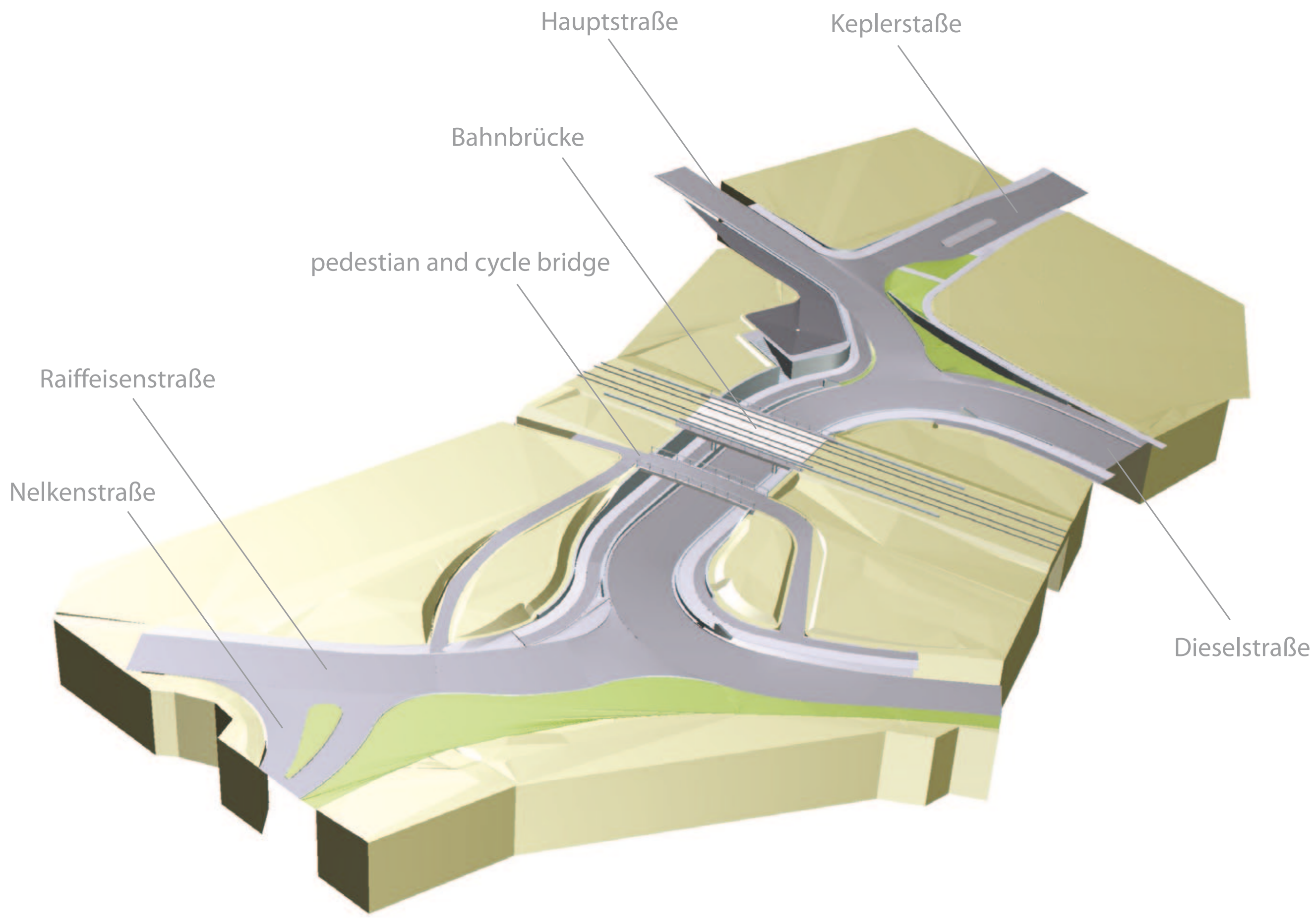
New railway bridge in the framework of railway bridge removal Unterschleißheim, line 5500 Munich – Regensburg

Client	Municipality Unterschleißheim
Span widths	railway bridge 4.55 m + 11.10 m + 4.55 m pedestrian bridge 21.20 m, groundwater trough 122.85 m
Planning period	11/2010 – 07/2015
Completion	12/2015
Services	projekt planning § 43 HOAI work phases1 – 7 transport installations § 47 HOAI work phases 1 – 8, construction supervision structural engineering § 51 HOAI work phases 1 – 6 road planning, operational technology, environmental sustainability

The railway crossing in Unterschleißheim is implemented by a railway bridge with groundwater trough, lifting installation and pedestrian bridge. The railway bridge is a three-span full frame with two lines of piles founded on a footing.
The groundwater trough is built with impermeable concrete. The structure was built by top-down method due to the soil conditions. The highly permeable quaternary soil material and the high groundwater required an impermeable pit lining which had to include the tertiary soil layers. The pit lining was mostly removed after backfilling the structure.

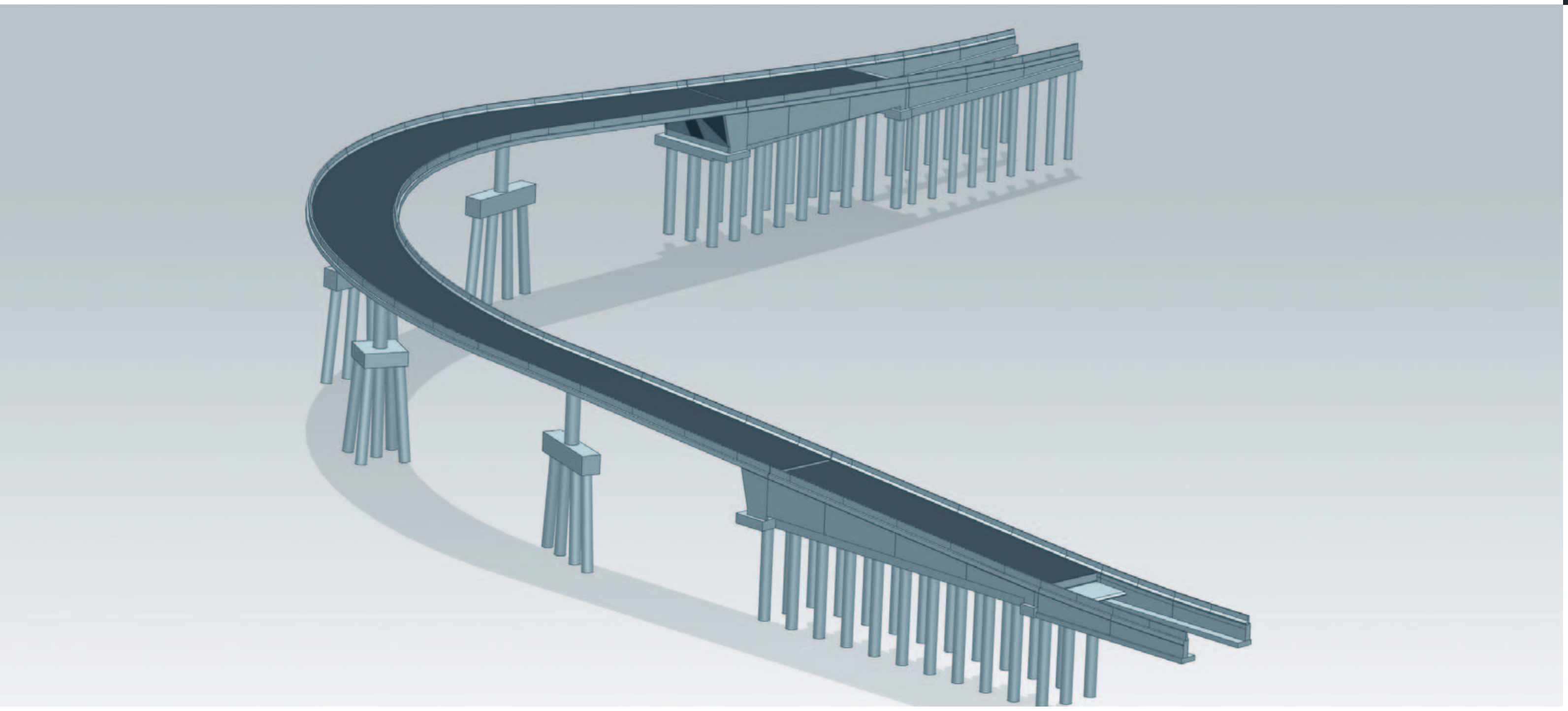
Particularities

- construction of the groundwater trough within an impermeable pit lining with dewatering system made of cast-in situ concrete
- planning of technical equipment of the groundwater trough (pumping installation) and operational buildings

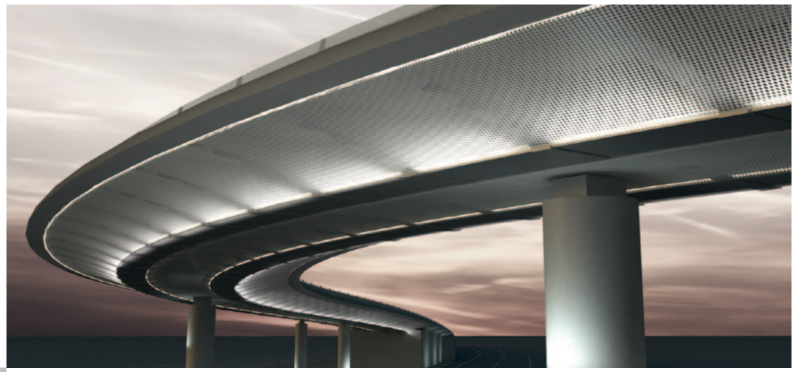


Flyover – Viaduto São Paulo, Brazil

Client	Wtorre São Paulo Empreendimentos Imobiliários S.A. São Paulo, Brasil
Span widths	28.00 m + 28.00 m + 28.15 m + 35 m + 34 m + 32 m + 29.15 m + 41.00 m + 15.00 m = 270.30 m
Planning period	2011 – 2012
Construction period	2011 – 2013
Services	projekt planning § 43 HOAI work phases 2, 3, 5, 6 transport installations § 47 HOAI work phases 3 structural engineering § 51 HOAI work phases 2 – 6 lighting design of Viaduto, »façade planning« Viaduto assembly supervision VFT girders



In the framework of new construction of the luxury shopping mall »Complexo WTorre JK« in the business district Morumbi, the access situation of Avenida Presidente Juscelino Kubitschek onto Marginal Pinheiros/Avenida das Nações Unidas, one of São Paulo's main traffic axes, was newly designed. To directly connect Av. Kubitschek to the superordinate traffic lane of Av. das Nações Unidas a new flyover was built. The highly bent prestressed concrete bridge, forming a curve in the ground plan (inner radius 55m) and a crest in the elevation, holds two lanes. The structure was designed semi-integrally with fixations at both abutments and dynamic abutment formations.



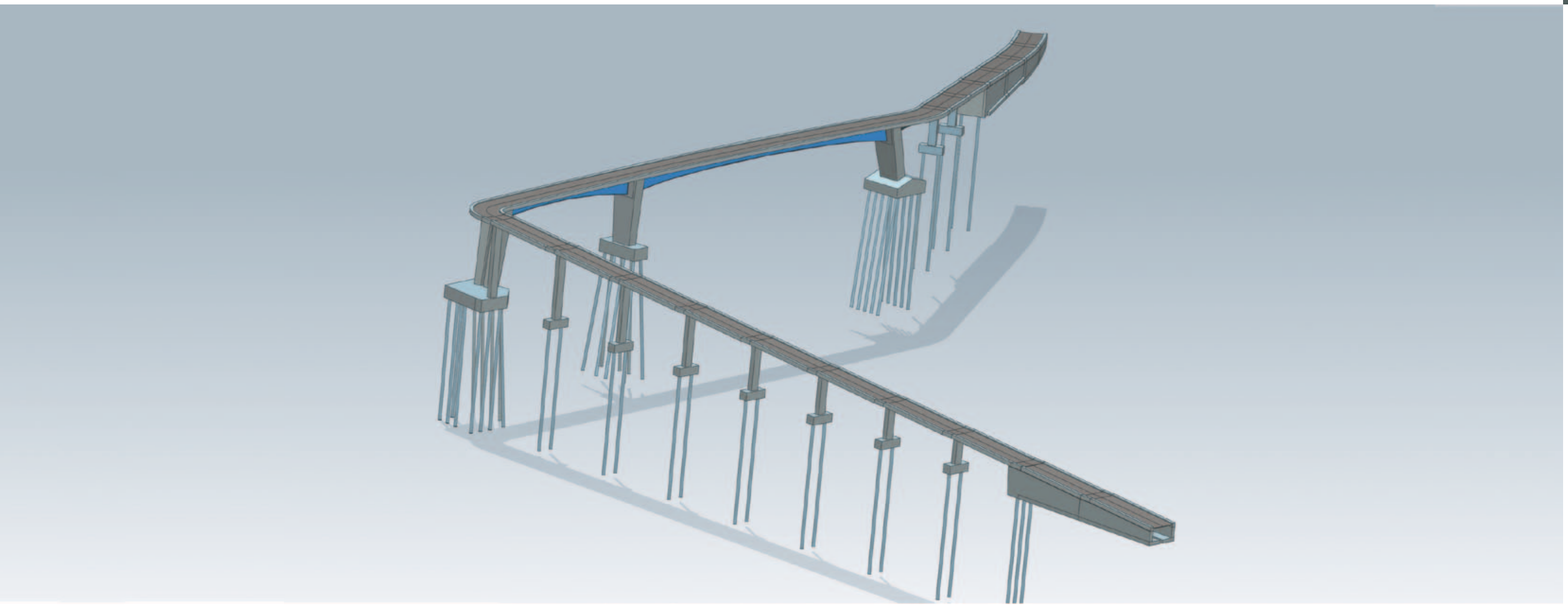
Particularities

- demanding design with narrow alignment radius of 65 m
- longitudinal incline of tangent 8%; variable transverse incline (i.e. spatial bend)
- superstructure with perforated sheet panels and LED lighting
- complete, continuous 3D design from the draft to the final design in one model (incl. form finding and construction variants)
- establishing of a construction process simulation in the context of fitting the bridge into an 11-lane city highway in complicated spatial and traffic conditions
- draft and formwork plans entirely derived from the 3D model
- use of the 3D model as basis for structural analysis
- use of the 3D model as basis for precise quantity definition
- use of the 3D model for three-dimensional lighting calculations
- use of the 3D model for workshop design of perforated sheets (around 230 different sheets due to the spatial bend)
- continuous BIM planning in 3D with Siemens NX

Passarela over Marginal Pinheiros/Avenida das Nações Unidas, São Paulo, Brazil

Client	Wtorre São Paulo Empreendimentos Imobiliários S.A. São Paulo, Brasil
Span widths	127.70 m + 23.50 m + 47.80 m + 85.70 m = 284.70 m
Planning period	2011 – 2012
Execution	2014
Services	project planning § 43 HOAI work phases 2, 3, 5, 6 structural engineering § 51 HOAI work phases 2, 3, 4, 5

The bridge crosses the 11-lane Avenida das Nacoes Unidas and the double-tracked, electrified metro line CPTM. The modern bicycle bridge connects Parque do Povo to the new bicycle lane along Rio Pinheiros. On both sides of the crossing up to 80 m long and 8 m high ramps are required for this connection.



Road and metro are elegantly spanned by a slender, haunched prefabricated composite superstructure with span widths of 23.50 m and almost 48 m. The VFT girders, single-cell, tightly welded hollow boxes with composite slab, are connected fully integrally to both abutment bastions and to the intermediate supports. The ramps are filigree reinforced concrete structures of great slenderness and are also fully integral.

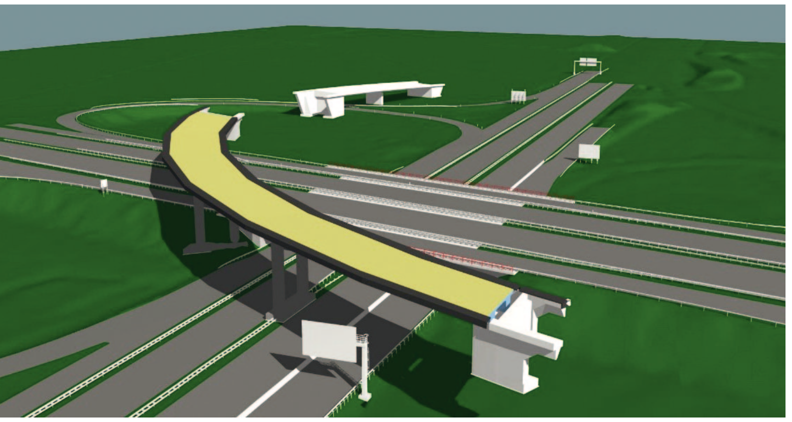
Particularities

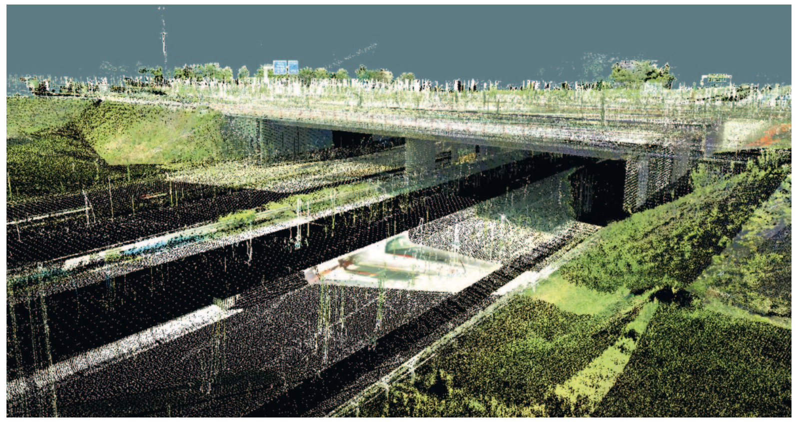
- demanding design with inclined, conical supports and haunched steel girders
- connection of the reinforced concrete ramps within a narrow bend
- complete, continuous 3D design from the draft to the final design in one model (incl. form finding and construction variants)
- draft and formwork plans entirely derived from the 3D model
- use of the 3D model as basis for structural analysis
- use of the 3D model as basis for precise quantity definition
- use of the 3D model for workshop design of perforated sheets
- BIM oriented 3D planning with Siemens NX
- Construction/assembly supervision of VFT girders
- 3D construction process planning – VFT girder assembly

Motorway A9, expansion of interchange Neufahrn – Flyover

Client	Authority of Motorways South Bavaria
Span widths	structure BW 13/01: 34.50 m
	structure BW 13/02: 53.00 m + 59.91 m + 46.50 m + 55.00 m
	structure BW 13/03: 40.50 m + 40.50 m
	structure BW 13/04: 25.50 m
Planning period	2009 – 2010
Completion	2010 – 2011
Services	project planning § 43 HOAI work phases 3, 6
	structural engineering § 51 HOAI work phases 3 – 6

Motorway junction Neufahrn connects motorways A 9 Nuremberg – Munich and A 92 Munich – Deggendorf north of Munich. The average daily traffic volume in direction Munich on the A 92 is predicted to increase by more than 50 % by 2020. To augment the capacity of this important traffic hub between Bavaria's capital and Munich Airport and to durably maintain and improve traffic safety and flow, traffic layout and alignment have been optimised at the junction and a direct ramp as fly-over structure in direction Munich has been built. The construction of this direct ramp required four new bridges implemented as prestressed concrete structures as well as adaptations at existing structures.





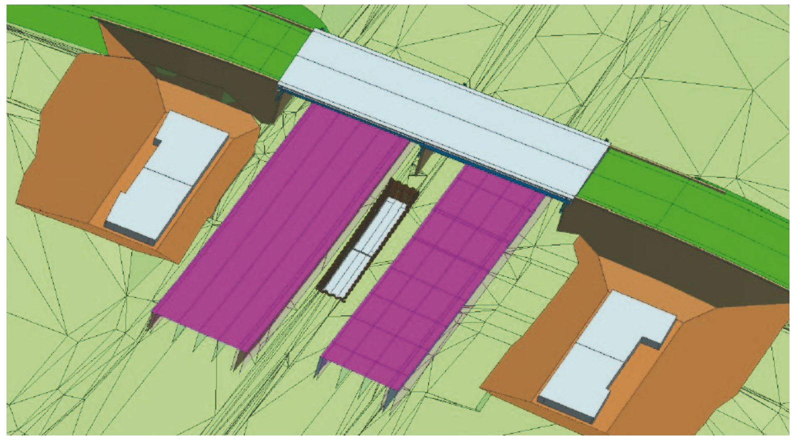
Particularities

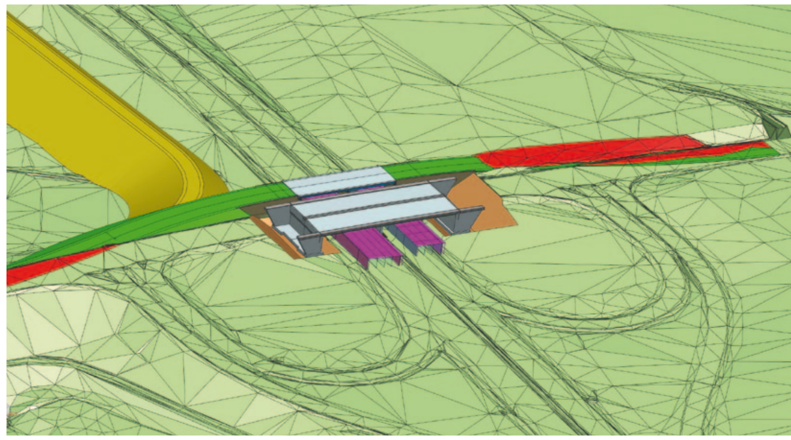
- main focus was set on potential collisions with existing objects
- by laser scanning the terrain, the data was developed into an as-built model of the motorway interchange which allowed to verify the clear heights during all traffic phases
- complete, continuous 3D design
- draft design in 3D by using laser scan data
- formwork plans entirely derived from the 3D model
- collision examination with existing construction components, safety barriers, sign gantries

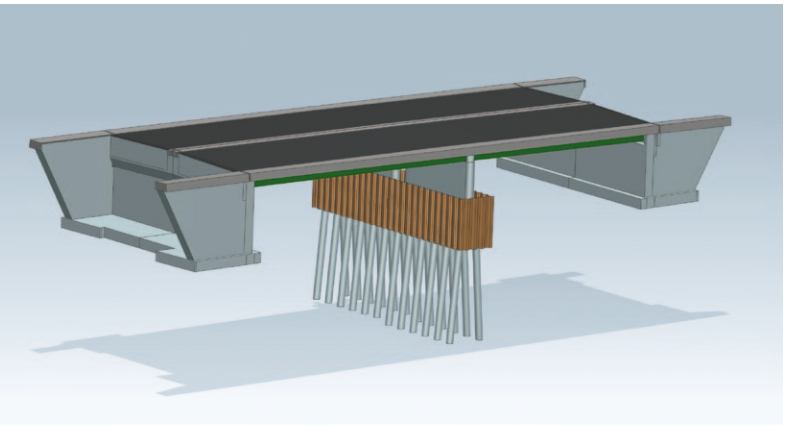
Motorway A3, 6-lane motorway expansion Frankfurt – Nuremberg near Heidingsfeld; structure BW 287a crossing of national road B19

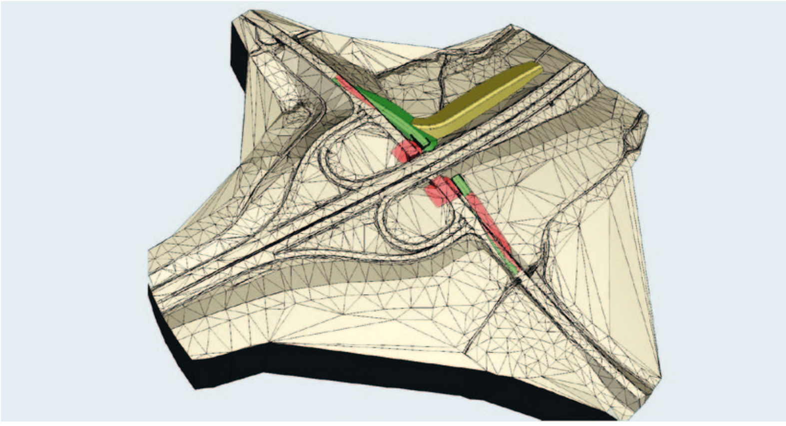
Client	Authority of Motorways, North Bavaria
Span widths	29.62 m + 36.61 m = 66.23 m
Planning period	2011 – 2014
Completion	2015
Services	project planning § 43 HOAI work phases 1, 2, 3, 6 structural engineering § 51 HOAI work phases 2, 3, 6

The 6-lane expansion of motorway A3 Frankfurt-Nuremberg requires the renewal of the crossing of national road B19 near Heidingsfeld with a larger clearance. In addition to the actual structure, the contract comprised the temporary bridges serving as bypass during construction and the demolition of the old bridge.
The new bridge was built as semi-integral structure on a mixed foundation and with a 2-span, T-beam superstructure with prestressed concrete prefabricated components. From the beginning, a 3D design was implemented – from the first draft to the final design, including all analysed variants.









Particularities

- From the digital terrain model as well as the 3D model of the designed new building a lot of information was gained in view of construction operation as well as the construction process
- 3D model as basis for precise definition of all quantities and required earthworks for final and intermediate states, also quantities to be added and to be removed for different variants during preliminary design (clarification of dependencies and interactions of new structure and earthworks)
- The 3D model allowed to coordinate all construction and traffic influences during demolition, the construction phases with earthworks, temporary constructions as well as the traffic management phases required for the new structure. The visualisation made the entire project very transparent. Influencing factors, having timely and financial consequences, were already identified during the design
- draft and formwork plans entirely derived from the 3D model
- use of the 3D model as basis for structural analysis

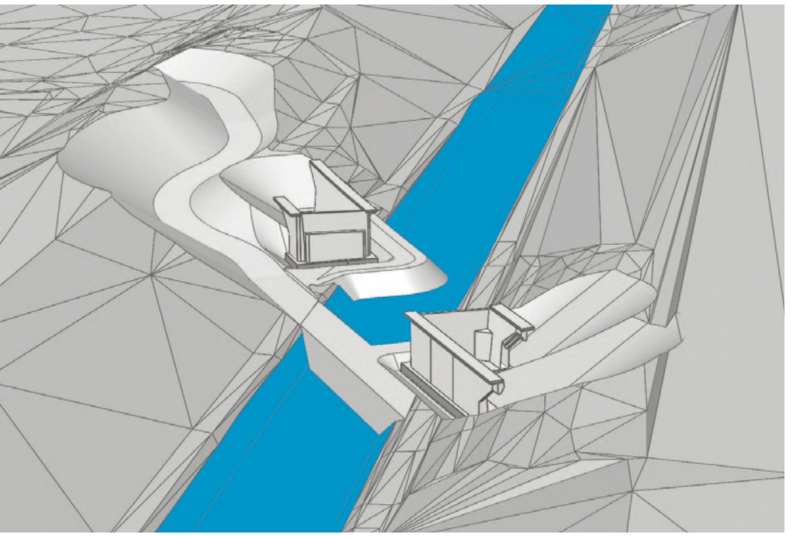
National road B299, town bypass near Sengenthal

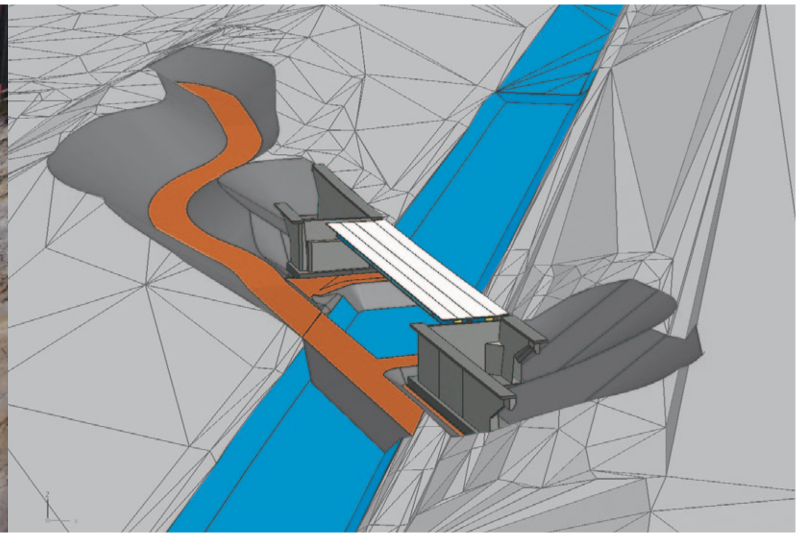
Client	Max Bögl Bauunternehmung GmbH & Co.KG
Span widths	43.60 m
Planning period	2006 – 2007
Execution	2007
Services	structural engineering § 51 HOAI work phases 4, 5

The structure is a single-span VFT steel composite bridge over an existing canal. The main challenge was the limited construction field as well as the unfavourable topography and soil coefficients: rolling terrain with inclined slope sections and sandy ground. Moreover, a construction road had to be built to supply the construction site. The large prefabricated components to be lifted had a length of 47 m.

Particularities

- precise 3-dimensional representation of the structure incl. construction pits, construction road
- collision examination
- formwork plans entirely derived from the 3D model
- use of the 3D model as basis for precise quantity definition, areas to be cleared/surveying
- establishing of a 3D model as pilot project
- simulation of the complete construction process
- design of workshop form of VFT girders

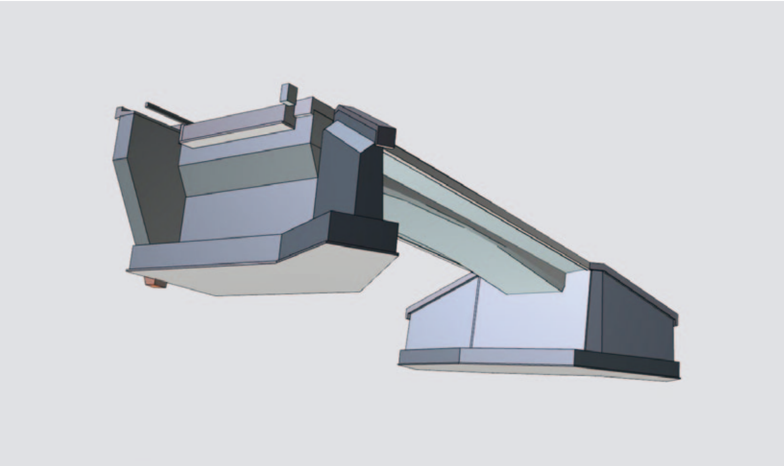


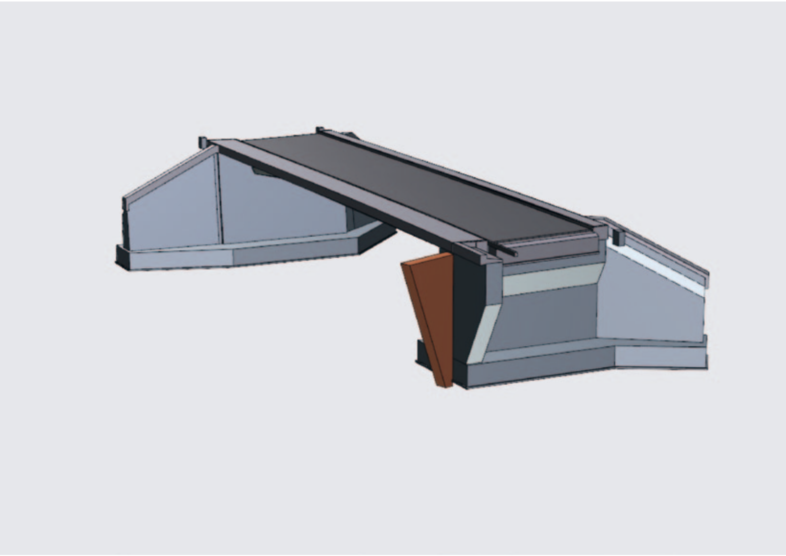


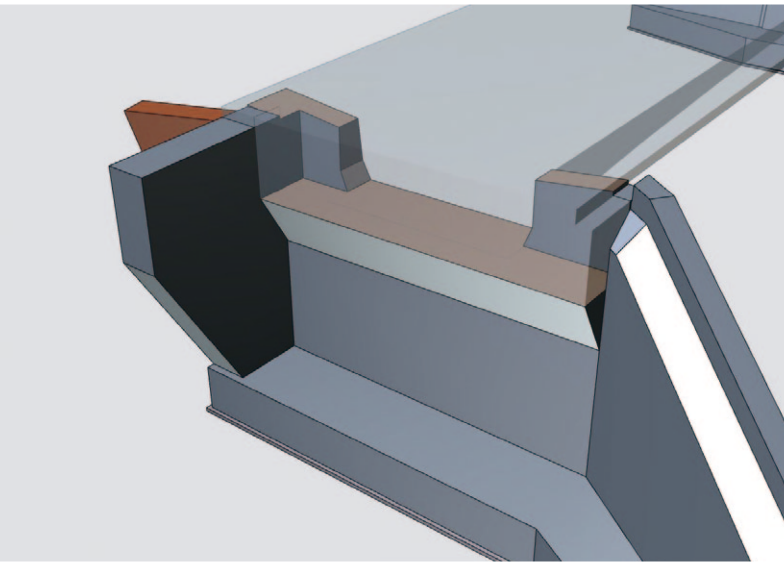
Structure BW 2, bridge over river Flöha part of road S236 thoroughfare Leubsdorf/Schellenberg

Client	Free State of Saxony, office for road construction and transportation, branch Zschopau
Span widths	35.00 m
Planning period	04/2014 until 07/2014
Completion	10/2015
Services	structural engineering § 51 HOAI work phases 4, 5

As the bridge over river Flöha was in a very bad state and the passage width of the adjoining railway bridge was very small, it became necessary to renew these two structures.
The herein presented structure 02 crosses road S236 in Leubsdorf/Schellenberg over river Flöha. It is a single-span frame bridge with oblique wings on a footing. The superstructure's longitudinal as well as transversal cross sections are haunched, and the superstructure is erected with pretensioning and subsequent composite. The front edge of the abutments is oblique but intersects with the oblique wings in an exact vertical line.







Particularities

- NX (Siemens) as interactive CAD system for a completely continuous 3D planning
- demanding spatial haunch in the superstructure
- complex geometry of the abutments (intersection)
- formwork plans entirely derived from the 3D model
- accurate intersection of wings and front walls in 3D
- reinforcement design supported by the 3D model
- easy coordination of the construction process with the 3D model
- determination of work joints at the 3D model with the construction company
- simple transfer of quantities and areas of individual components
- handover of 3D PDF to the construction company

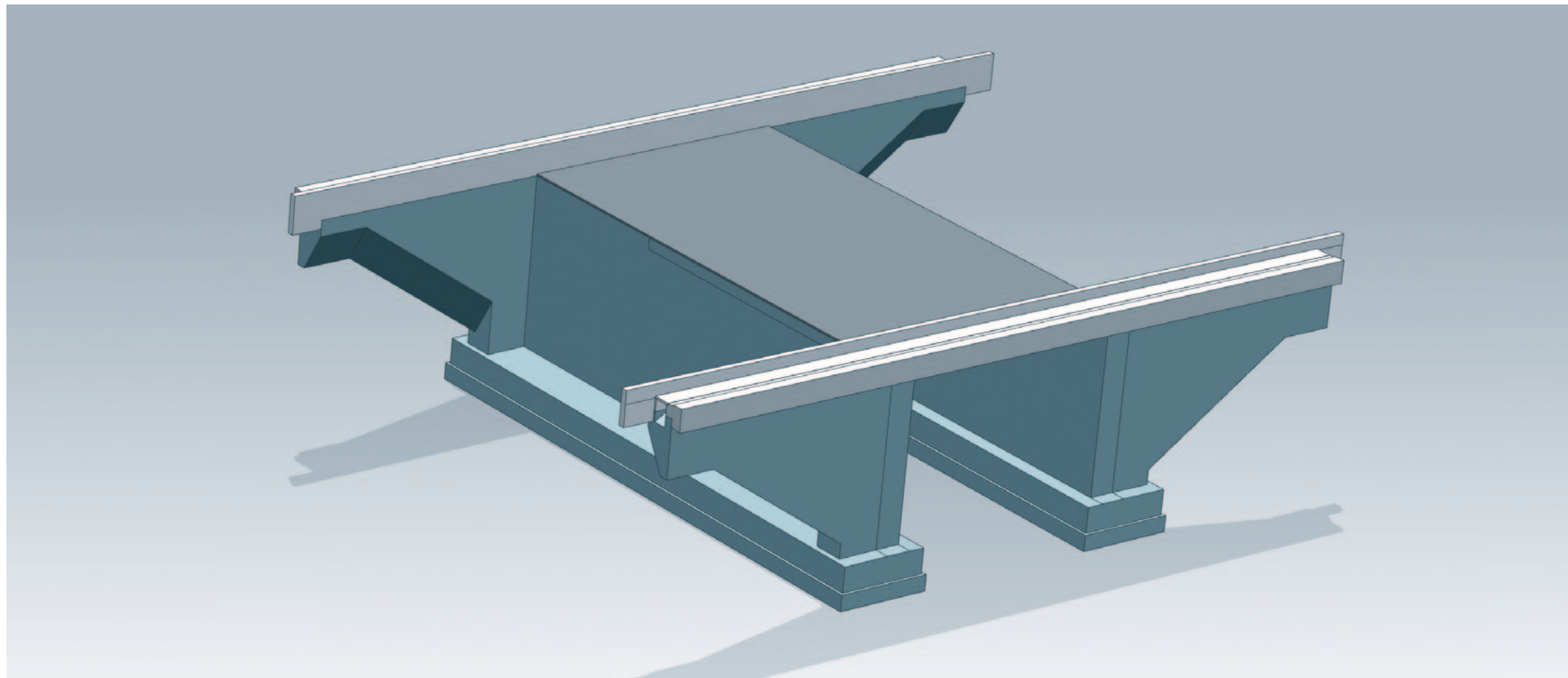
Replacement of railway bridge at km 65.222 over Süßmilchstraße, line 6212 Görlitz – Dresden

Client	DB Netz AG / DB ProjektBau GmbH
Span widths	7.80 m
Planning period	2013 – 2014
Completion	2014
Services	structural engineering § 51 HOAI work phases 4, 5

A three-track structure was planned to replace the old railway bridge over Süßmilchstraße in Bischofswerda. It is a reinforced concrete frame built by cast-in situ construction method. The substructures are built on a footing; the bridge is connected to the adjoin terrain by track-parallel wings. The superstructure was first built under temporary bridges in a lowered position. Only after concreting and lifting of the superstructure followed the concreting of the frame walls.

Particularities

- NX (Siemens) as interactive CAD system with the advantage that the construction company directly used the 3D model for their further planning
- draft and formwork plans entirely derived from the 3D model



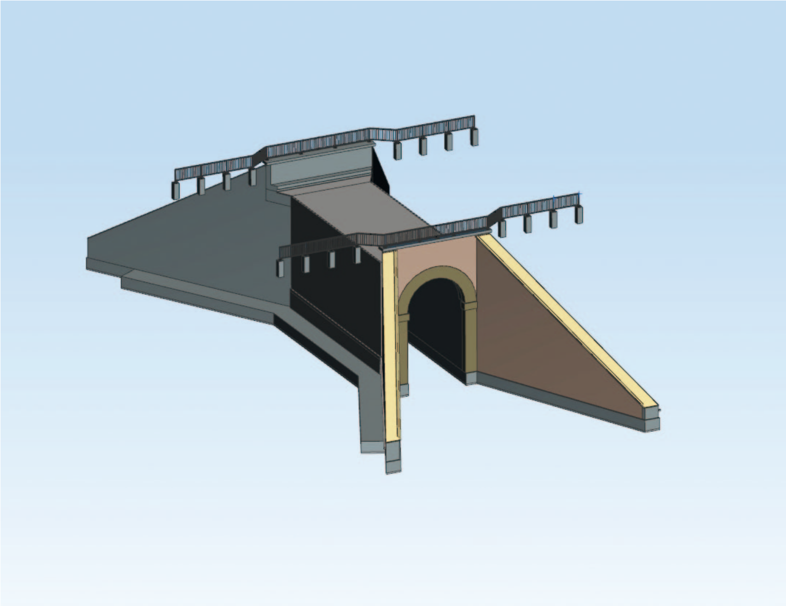
Replacement of railway bridge at km 90.510 over Weißiger Straße, line 6212 Görlitz – Dresden

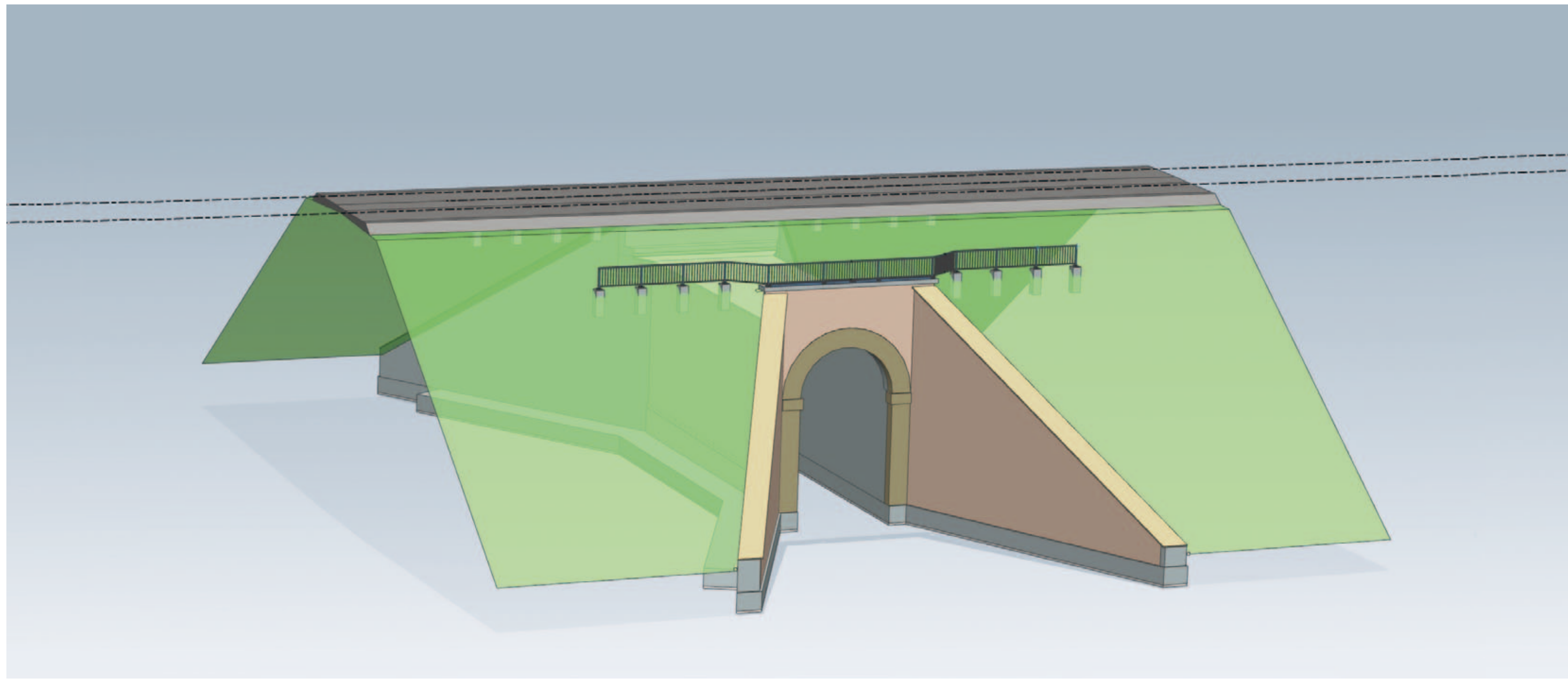
Client	DB Netz AG / DB ProjektBau GmbH
Span widths	5.30 m
Planning period	2014 – 2015
Completion	2015
Services	structural engineering § 51 HOAI work phases 4, 5

A double-tracked structure with a length of 20.90 m and a width of 46.60 m was designed to replace the existing vault of the railway bridge over Weißiger Straße in Langebrück. It is a reinforced concrete frame built by cast-in situ construction method. The substructures are built on a footing, partially on the existing foundation of the old vault. The structure is connected to the adjoin terrain by oblique wings.

Particularities

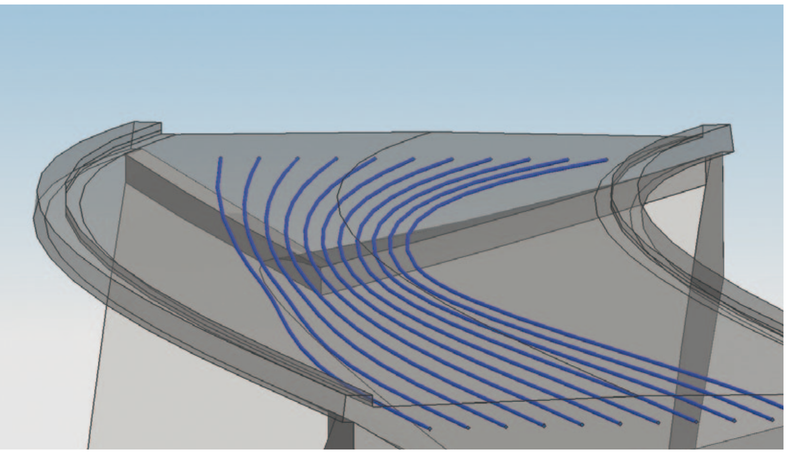
- NX (Siemens) as interactive CAD system with the advantage that the construction company directly used the 3D model for their further planning
- NX model for comprehensive and effective coordination with the client and the construction company



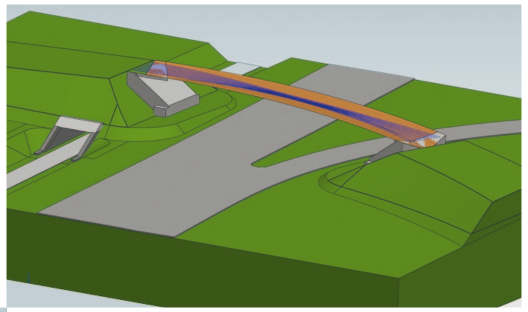


Pedestrian and cycle bridge as part of the stadium connection in Augsburg

Client	Municipality Augsburg, infrastructure department
Architects	Lang Hugger Rampp GmbH Architekten
Span widths	33.30 m / 44.50 m / 39.66 m
Planning period	2008 – 2009
Completion	2009 – 2010
Services	project planning § 43 HOAI work phases 1, 2, 3 – 6, partially 7 structural engineering § 51 HOAI work phases 1 – 6 construction supervision



To connect a new tramway stop with Augsburg's new football stadium, three pedestrian and cycle bridges crossing public roads became necessary. SSF Ingenieure AG together with the architects of Lang Hugger Rampp GmbH convinced with their concept to integrate an organically formed, slender, not too dominant yet distinctive frame bridge made of prestressed concrete into the surroundings of the stadium.
The three single-span bridges (footpath and cycle path) are of the same construction type and belong to one »bridge family«. In the ground plan, they are curved, prestressed frame structures without joints and bearings. The abutments placed high on the embankment are founded on bored piles. The superstructures with arc-shaped lower edges connect directly to the planted embankment without visible link to the abutments. In the cross section, asymmetric V-shaped cross sections were selected.
In addition, at the embankment area of the largest structure, a closed reinforced concrete frame, which seems to lie underneath the abutment, is arranged for the crossing pedestrian and cycle traffic.



Besonderheiten

- NX (Siemens) as interactive CAD system for a continuous 3D planning
- demanding spatial haunch in the superstructure
- complex formwork plans derived from the 3D model
- reinforcement design supported by the 3D model
- difficult geometry of substructures (intersections)
- accurate intersection of wing and front wall in 3D
- determination of work joints with the construction company at the 3D model
- optimum coordination of the construction process with the construction company at the 3D model
- simple transfer of quantities and areas of individual components
- handover of 3D PDF to the construction company

Picture credits

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page	23	bottom right pic.	Florian Schreiber Fotografie
page	23	bottom left pic.	Lang Hugger Rampp GmbH
page	26	pic.	Municipality Unterschleißheim/Firmengruppe Max Bögl
page	33	pic.	ediundsepp Gestaltungsgesellschaft mbH
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