PROJECT REPORTS

Everything begins with dialogue

Nine reports from SSF Ingenieure
on the occasion of the open day in Munich
February 17th 2009
in the BMW Welt Munich

Directory

BMW Welt Munich

Speaker:
Ferdinand Tremmel

The BMW Welt in the north of Munich is a masterpiece of innovative architecture. Since October 2007, it has served as multifunctional stage for all kinds of events: concerts, exhibitions, conferences, live broadcasts, banquets and much more. The integrated meeting area includes convention rooms of various sizes for conferences, lectures and presentations. Shops and catering opportunities complete the most versatile adventure you experience in the BMW Welt.

The spectacular experience and delivery centre was designed by COOP HIMMELB(L)AU, Vienna. The range of services provided by SSF Ingenieure in the planning and construction phase encompassed the entire execution planning for the architecture and the supporting structure, together with construction supervision for all-trades.

Flexible partitioning on several levels

The inner topography convinces by its varied density of rooms and floating partitioning of the areas.

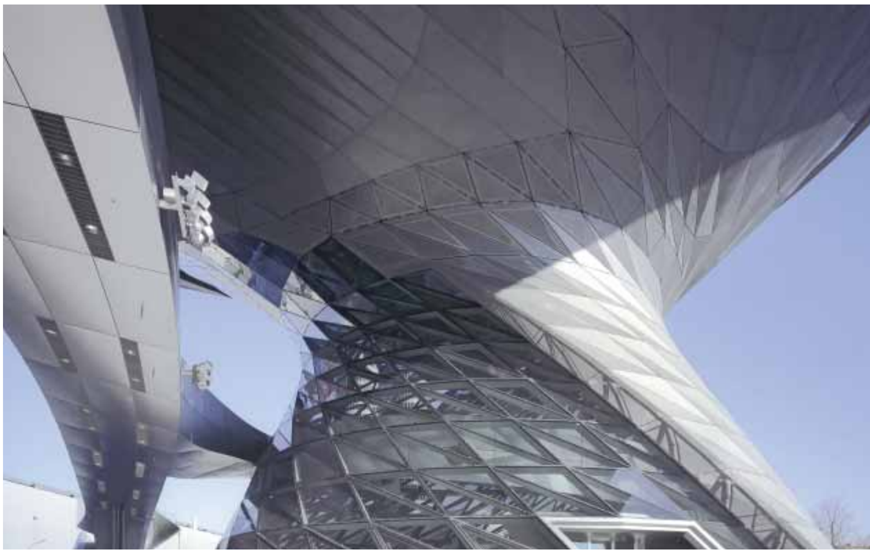
The main element of the BMW Welt is the large, transparent plaza with sculpted roof and a double cone derived from the already existing central building. The plaza is not only a market place for a wide range of different uses but also an unmistakable symbol for the BMW Group. The inner topography stands out with its differing room densities and flexible partitioning of the effective areas. The vehicle delivery zone „Premiere" is the heart of the plaza, with the customer lounges hovering above and offering a view of the event room and BMW headquarters.

Specifications

Number of storeys	8
Plot size	25.000 m²
Effective space	67.400 m²
GFA (gross floor area)	73.000 m²
above ground approx. 40%	28.500 m²
underground approx. 60 %	44.500 m²
Gross cubic space	531,000 m³

Dimensions

max. building length:	approx. 180 m
max. building width:	approx. 130 m
max. building height:	approx. 24 m



Parking

The underground storeys offer parking on 2 levels for around 600 vehicles, together with a fully automatic day storage facility for approx. 250 new vehicles ready for delivery to customers.

The roof structure

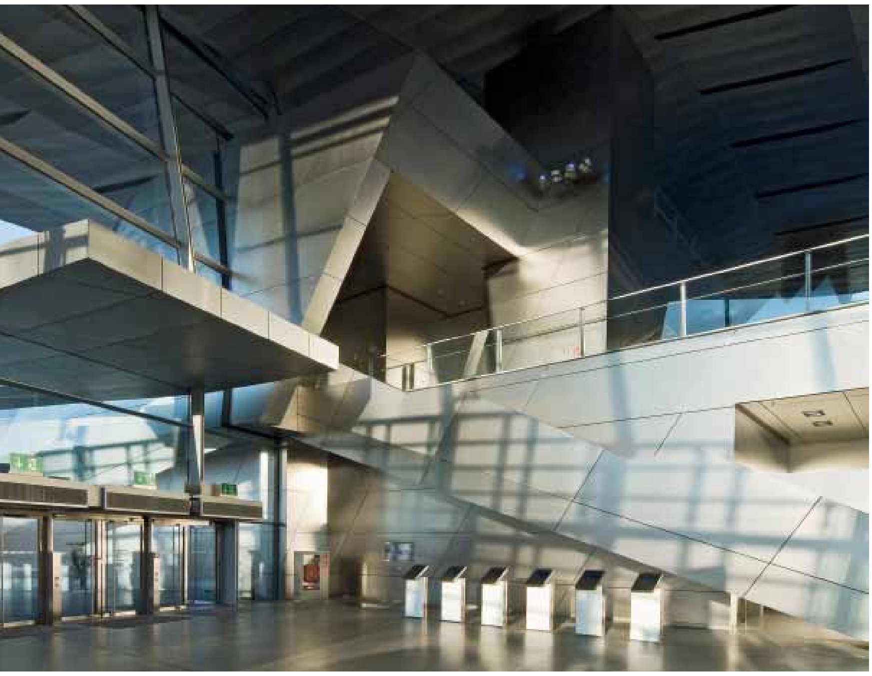
The roof structure measuring around 16,000 m² in size consists basically of an upper and a lower girder grillage with a basic grid of five by five metres. The upper layer is shaped like a cushion at the top. The lower layer is shaped by simulated reactions to the areas below. Between the layers, inserted struts link the two layers of girder grillage, creating a spatial supporting structure.

The facade

The facade is a modified post-and-beam system. A kink in the posts at 7.50 m and further bracing at 15 m reduces the free spans to achieve small post cross-sections in ratio to the facade height. Another advantage of the kink is that vertical deformation of the roof can be absorbed by elastic bending deformation of the posts. This eliminates the need for expansion joints in the roof. The glazing is clamped directly to the beams and adhered to the butt joints.

Technical installations

The building is operated by making full use of natural resources to minimise energy consumption. Enveloping surfaces of glass with low heat transmission coefficient ensure that the requirements of the Heat Insulation Ordinance are met on the one hand, while generating thermally comfortable surface temperatures on the other. Floor and wall structures enhance the storage capability. Thermal uplift currents and also warm air cushions are mostly discharged straight to the outside in the layered part of the roof so that they do not encumber the effective areas below. This saves energy and protects the environment.



Energy-saving and environment friendly

Ventilation of the building is implemented using the large wall areas and partly the edges of the roof. The large wall elements pointing west can be opened as an expedient measure when outside temperatures exceed +5°C throughout the summer months. While this provides specific partial ventilation at lower temperatures, once the outside temperatures exceed +20°C large expanses of glazing are opened to turn the inside areas into exterior space. This generates currents similar to source air in the building; these are then heated by inner heat sources, resulting in a thermal forced-ventilation effect from bottom to top. Solar energy is put to passive and active use in energy generation by means of photovoltaic systems with 810 MW peak output.

Moved air flow	400.000 m³
Cooling capacity	2.700 kW
Heating capacity	3.800 kW

Shell dimensions

Concrete base plate „white tank“	approx. 20.000 m³
Concrete outer wall „white tank“	approx. 3.500 m³
Total reinforcement	10.000 t
Total concrete	approx. 60.000 m³
Total reinforcing steel	approx. 9,000 t
Hand-laid steel bars	3 million m
Total glazing	approx. 14.500 m³

Roof surface	16.000 m²
Net weight lounge	2.500 t
Steel structure roof	3.000 t
Glass facade	15.000 m²
Stainless steel sheeting outside	10.000 m²

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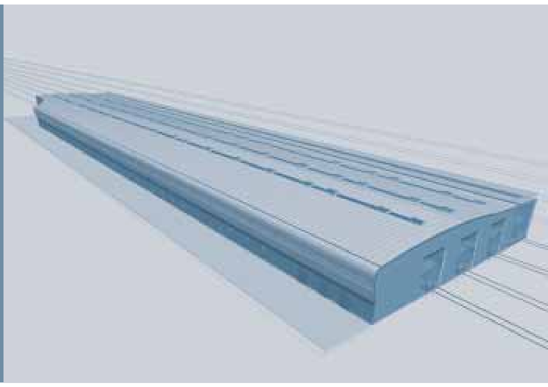
Construction of the new ICE maintenance depot, Leipzig



Speaker:
Peter Voland

Task

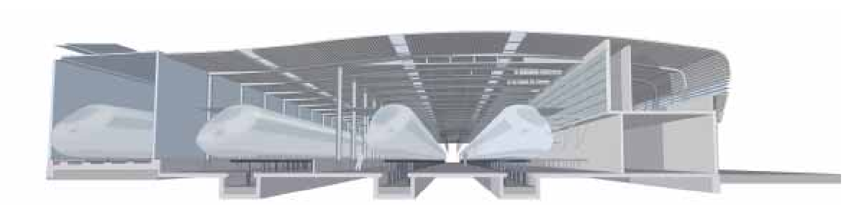
Depot unit with operations building

Floor space	11.200 m²
Span of the roof support structure	65 m
Total lengt	approx. 91 m
Total width	approx. 74 m
Height	18,5 m

UFD building

Floor space	5.250 m²
Total lengt	approx. 74 m
Total width	approx. 64 m
Height	7,5 m

Inside view of the depot unit with operations building – 3rd stage



View: east facade

In the context of invitation to tender issued by DB Fernverkehr AG in February 2006 for construction of the new ICE maintenance depot, SSF was commissioned with the general planning. The invitation to tender was issued on the basis of a predetermined maximum budget for the construction.
In its first stage, the ICE depot consists of a vehicle building measuring 281 m long, 21 m wide and approx. 10 m high with two tracks for inspection and on-site maintenance, servicing and necessary minor repairs to ICE-T and passenger trains. The second optional stage is planned to include extension of the vehicle building to accommodate a third track; the third optional stage entails adding an exterior cleaning facility.

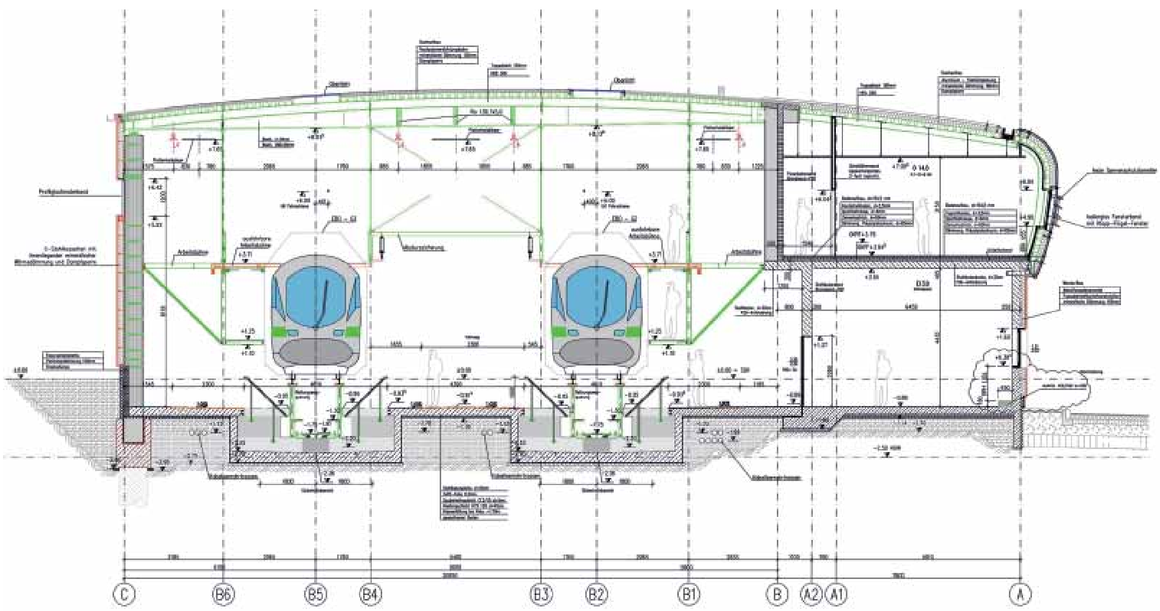
Given the location of the building directly on Rackwitzer Straße, the design was to take account of urban planning aspects as a prestigious industrial structure with a functional reference to the design of the ICE trains being main-tained and to represent the company DB Mobility Fernverkehr. The architectural design of the building together with the supporting structure was expected to take account of the two planned optional stages for including a third track and the exterior cleaning facility in such way that these can be erected without major intervention in the existing support structure and without interrupting on-going operations of the ICE maintenance depot, with re-use of the western outer facade.

In contrast to the client's prerequisite stipulating two separate buildings, the design of the vehicle unit and operations building was based on just one overall structure, i.e. the two-storey operations building with the vehicle unit adjoining at the rear. The cleaning facility is positioned in the middle axis of the building; with the longitudinal wall of the operations building shifted approx. 1.30 m to the east on the ground floor. Given the abbreviated erec-tion of the operations building in the initial stage, the vehicle unit is continued as a stand-alone building to the south west.

Resulting from the concept for the overall building, restrained reinforced concrete round supports were used in the area of the west wall. Reinforced concrete round supports were chosen in the view of the planned building exten-sion; which entails modifying the outer supports to inner building supports once the extension has been com-pleted. The west facade elements are clamped to the reinforced concrete round supports to ensure that they can be easily dismantled and then used again.

The main support structure of the building roof consists of a single-span steel girder in the first stage: its concept and dimensions already take account of the second optional stage including erection of the third track. The roof of the operations building is decoupled from that of the vehicle unit in structural terms, but continues the outer wave-shape of the roof. The structural system is a semi-frame with a slight outwards curve; the support continues directly out of the post and is brought back to the outer wall of the operations building in the lower section. The overall picture is therefore of a curved roof shape.

At the same time and in harmony with the vehicle unit, the corresponding UFD building was developed under urban planning aspects as a prestigious industrial structure



Cross section through the depot building making functional reference to the design of the ICE trains being maintained in the depot. Analogue to the vehicle unit, the design of the building together with the support structure also takes account of installation of the second track as well as upgrading the hollow for the bogies, so that these can be installed subsequently without major intervention in the existing support structure.

Specifications

Client	DB Fernverkehr AG Berlin
Design	SSF Ingenieure / LANG HUGGER RAMP
General planning	SSF Ingenieure
Construction costs	approx. € 13.8 million
Start of work	April 2008

3

Fully welded integral pipe-truss composite bridge

Speaker:
Hans-Joachim Casper

Together with the motorway A71 between Erfurt and Schweinfurt, the A73 from Suhl to Lichtenfels is part of the transportation project German Unity No. 16. The new four-lane highway between the west-east motorways A4 and A70 opens up the south of Thuringia and connects Thuringia's economic centres with Franconia and Bavaria.

Bridge 67-1 in the course of a district road crosses the motorway at km 67+021 in the Bavarian administrative district of Upper Franconia.
The exposed location of the bridge on the northern edge of the Main valley in the direct vicinity of Banz Abbey and the Basilica of the Fourteen Holy Helpers (Vierzehnheiligen) imposed the necessity of creating a suitably pleasant design.

The special characteristics of the bridge achieve a balance of design and force progression, combined with the desire to use the latest production and jointing technology for round steel pipes, creating permanently favourable conditions for maintenance.

Germany's first fully welded integral pipe-truss composite bridge made of large pipes.

For the very first time in German road bridge engineering, the truss nodes of the supporting structure were formed as welded pipe nodes without using cast nodes.

The previously very retentive use of hollow steel profiles when building bridges results from the fact that the seam root is no longer visible and can therefore no longer be checked. Generally in the case of components and joints, subject to high fatigue levels, the seam root is gouged out and back-welded so that the butt weld can be fully welded with the base material.

Insecure seam roots that cannot be checked and the resulting detrimental effects in terms of material fatigue were reason enough to abstain from such supporting structures in Germany up to now. It was therefore common practice to use cast nodes in hollow profile truss-design road and rail bridges, but this involved high supplementary production costs.

In addition, the problems caused by different degrees of stiffness and rotation capabilities were shifted to the weld seam area at the transition between the pipe cast node and the steel pipe. Cast pipe nodes bear problems of insecurity in the structure, which in return led to notch case classifications. Furthermore, considerable problems are encountered when repairing damage caused by cracks. These aspects meant that bridges of this kind tended to be the exception rather than the rule in Germany, in spite of their aesthetic appeal.

The objective of bridge 67-1 was to choose a node form which in the ultimate state of fatigue would show cracks in the front part of the weld in the blunt angles with easy accessibility for production and testing so that the structure also permits long-term maintenance.
Subsequent analysis was based on the failure criterion method developed at the University of Karlsruhe for rating truss nodes subject to fatigue in round hollow profiles. Depending on the node parameters, it is thus possible to ascertain the anticipated type and point of failure.

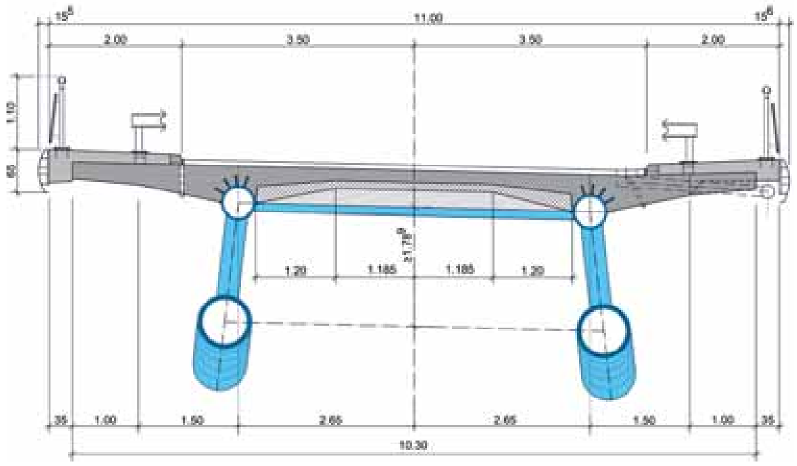
Flat K-nodes are being used for the bridge, with the diagonals not overlapping so as to simplify both the production process and the static appraisal.
Given the chosen diameter and wall thickness ratios, together with the stipulated gap widths, it can be presumed that in these node structures, the ultimate state of fatigue begins in the base material in the transition zone to the front bevel seam.

The pipes with dimensions of 800 mm and walls up to 50 mm thick are welded directly to each other; the truss chords with their high loads can run continuously for long sections without joints to reduce the notch effect with a positive effect on durability.

Based on the expected fracture patterns of the chosen truss nodes, it was possible to produce welds that progress from bevel seams in the blunt angle of the diagonal connections to fillet welds in the pointed angles.
Given the construction's parameters in this case, it was decided to abstain from the difficult and expensive full penetration welding of the complete diagonal cross section as well as from elaborate weld pool backing.

Preparation of the seams demands continuously running spatial intersecting curves that can be produced easily and with great precision on modern cutting machines.

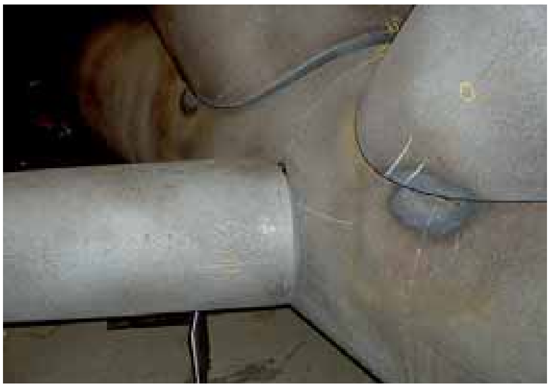
The crossbeams in the area of the carriageway deck were connected to the truss' upper chords with peripheral bevel seams.



standard cross-section

mounting
of the centre section

welding of the structural
elements under enclosure



pipe intersection/cutting at the nodes with edge preparation

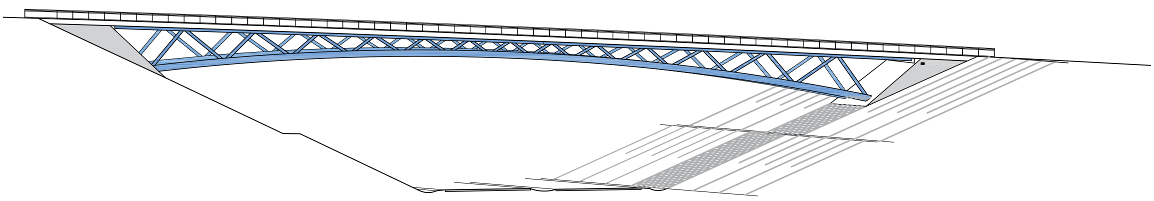
Summary

Hollow profiles, particularly in round shape, have been used for decades in structures that are subject to fatigue, including mobile cranes with great load ratings, offshore structures and conveying systems.

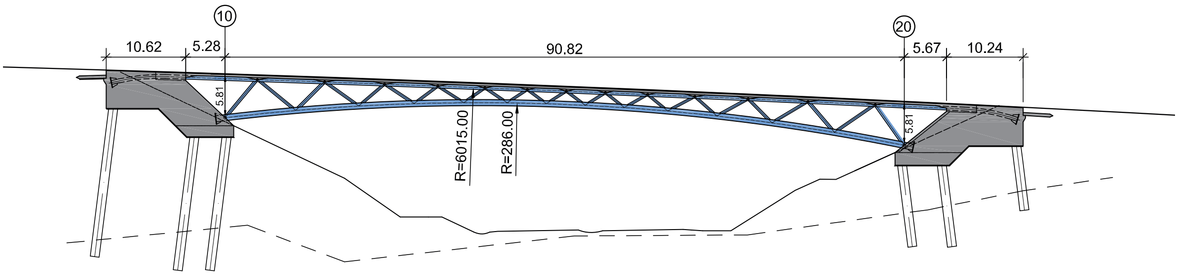
The use of welded pipe nodes in this particular bridge supporting structure is a novelty in German road bridge construction, as up to now, pipe nodes in bridges of this size have been produced as cast nodes. This project has shown that state-of-the-art engineering is capable of producing safe, durable bridges with welded pipe nodes when the basic structure is chosen with an identifiable load-bearing behaviour and with an understanding of the computed failure state. Possible crack formation can be easily detected and repaired during on-going maintenance.

The design of bridge 67-1 deliberately abstained from cast nodes in the interests of greater economic efficiency with easy maintenance and enhanced design. The chosen construction with round hollow profiles combines low-cost production with increased durability and the architectural benefits of the pipe cross-sections.

Pipe-truss bridges with this node design are clearly more economically efficient, durable and considerably more advantageous in terms of maintenance than previous bridges of this type, thanks to the stalwart type of design.



view



longitudinal section

4

Pedestrian bridges for the City of Augsburg

Speaker:
Peter Kotz

3 Pedestrian and bicycle bridges for the impuls arena in Augsburg

At the moment a new football stadium is being built in Augsburg: the impuls arena. It is expected to be completed by mid 2009. Access to local public transport is provided by a new tram stop which will be connected to the sta-dium with pedestrian and bicycle paths along Bürgermeister-Ulrich-Straße. 3 bridges are required in this particular section of the path network, and the city of Augsburg

arranged a competition in the form of a planning survey in 2008. Tenders were requested for solutions to cover design, construction and financial aspects.
The design by SSF Ingenieure / Lang Hugger Rampp received the 1st prize in competition with two rival contestants. The shell construction has already been completed and the three bridges will be handed over for public use in time for the inauguration of the stadium.

Design concept

In the proposed solution, every effort was made to create an unmistakable, similar design for the three cost-effective, robust prestressed concrete frame structures, to invoke pleasant associations with a visit to the stadium.
The chosen curved outline permits a harmonious and organic connection of the bridge structures to the path network following a continuous flowing path. Pedestrians and cyclists notice no abrupt transition from the embankment to the individual bridges. The curved axis development of the bridges gives a particularly dynamic character to the structures.

Seen from the front, this results in very slender, filigree structures whose harmonious overall concept blends in well with the stadium without appearing too dominant. The lower edge of the superstructures curves in arches over the public roadways. Without visible abutments, they merge directly into the vegetated slopes where the frame walls are held securely in deep foundations.

Asymmetrical V-shaped cross sections were chosen with the lowest point shifted towards the outer edge of the curve. The bow line also widens directly before the deliberately vertical transition to the slope to form a smooth surface that caters to the flow of stresses at the corner of the frame. The sculptured geometry creates a varied bottom view of the bridge structures.
This design principle creates generous openings over the roads with a predominance of vegetated sloping areas.

Concrete surfaces have been reduced to a minimum, with only the interestingly shaped superstructures remaining visible.

The sides of the bridges are lined with railings with a stainless steel expanded metal filling whose transparent design harmonizes with the aesthetic proportions of the slender superstructures.

Statics

The bridges consist of prestressed frame structures on bored pile foundations. The abutment walls were kept very small so that they will not be visible later on. This presented a major challenge for the reinforcements, as the frame corner reinforcement had to be continued through to the drilled pile reinforcement to take account of the gripping heads. In structural terms, the pretensioning in the superstructure was continued in a console through to the end of the superstructure and accommodated in the solid reinforcement of the frame corner in front of the gripping heads.

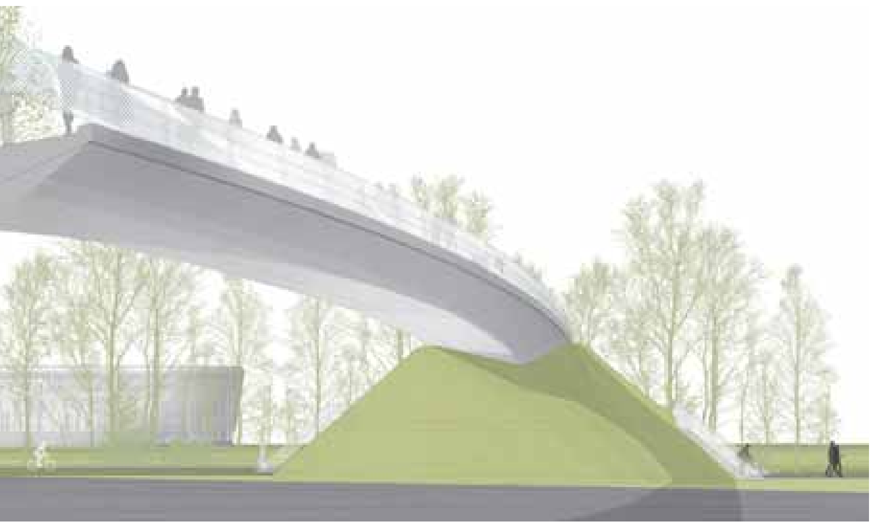
The superstructures were pretensioned in subsequent connection with the tendons, using SUSPA cord tendons type 6-22 with a cord cross section of 150 mm². The section of the tendons had to be adapted to the cross-section contour so that every tendon had its own geometry, making both planning and execution highly complex.

3D planning

These geometrically highly complex structures posed a great challenge for execution planning. The entire planning process was carried out in 3D using the NX program, to take account of the curvature in the outline and elevation, together with the additional haunches. This program actually intended for mechanical engineering, is capable of visualizing these complex structures. The tendons were also included in the 3D model, resulting in synergetic effects for the tensioning plans.

Slender design

The bridges have a maximum slenderness ratio of L/H = 65, and are even more slender in visual terms. The bridges are equipped with integrated vibration absorbers to avoid unpleasant vibrations.



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Planning and design of noise barriers

Speaker:
Peter Radl

Introduction

Noise barriers have been constructed in Germany for about 35 years. Extending and adapting the traffic infrastructure to the growing demands of a functioning economic and cultural region would be simply inconceivable without structural noise protection. Traffic noise is a form of environmental pollution that has to be taken seriously. In the context of approval procedures for implementing construction projects, the German Federal Immission Control Act stipulates binding limit values at the immission sites along new and improved roads which result in the need to construct noise protection systems. An impact analysis is followed by weighing up the protection aims to be achieved as primary cover with structural so-called active noise protection measures. Here there is a choice between noise barriers, noise-reducing asphalt surfaces and noise reduction tunnels. For reasons of economic efficiency, under consideration of capital expenditure entailed in construction and maintenance together with capitalization for replacing the corresponding installation, noise barriers, also in combination with open-pore asphalt surfaces, are usually preferred for installation.

Concrete shells with aluminium cover; porous concrete A9 / Munich-Freimann

Noise reduction tunnels are used mainly in conurbation areas. Additional measures which may be required in order to achieve the protection targets such as the installation of noise protection windows in combination with ventilation systems are so-called passive protection measures. The extent of passive measures should be kept to an absolute minimum in the interests of those in need of protection. Passive measures should only be used when obtaining noise protection by constructional measures is out of all proportion to the expenditure involved.

In all countries, it was possible to observe a pragmatic approach at the start of all efforts towards structural noise protection, limited solely to satisfying the demands for noise protection. Design aspects were rarely involved. State building authorities such as South Bavaria Motorway Authority, responsible among others also for a large number of noise barriers, recognised early on that these systems which in part can achieve a considerable size, have a major impact on the adjoining surroundings, and that good design can be seen as a chance to improve the traffic route.
The noise barrier is all the car driver sees along extensive stretches of road. Its design quality should therefore compensate for the inability to see the environment. As far as residents on the other side of the barriers are concerned, subtle design ideas should counteract the inherent impact of the structures. As with other public building struc-

tures, the quality and variety of noise barriers also have to fulfil high design demands. After all, a society is also defined by the way it deals with such structures in highly exposed positions. Noise barriers are also part of the building culture of their times. The monotony of standard barriers can be relieved by simple means with many interesting structures that harmonise with their surroundings.

Most erected noise barriers are standard barriers as defined early on in the regulations. For the most part, cassette-type wall elements are fitted between steel posts in a grid of 4 – 6 m. These structurally and economically optimised panels dominate our current picture of noise barriers; and thus even slight variations in style are seen as a welcome change.

In the course of our many years of experience in designing noise barriers, also in dialogue with architects, the following design principles have emerged and proven successful. Design is always based on subjective perceptions. The suggestions described below should not be seen as doctrine: on the contrary, they are to be taken as a contribution to improving design quality of engineering structures and should stimulate discussion on this issue.

The way we see it, design develops out of the choice of suitable constructions, and not just from playing around with colours and surfaces.

This article only makes marginal reference to the structural and constructional demands and requirements involved in operation. We hence refer to the comprehensive standards and regulations including ZTV-Lsw 06, DIN EN 14388, DIN EN 1793, DIN EN 1794.

Design principles

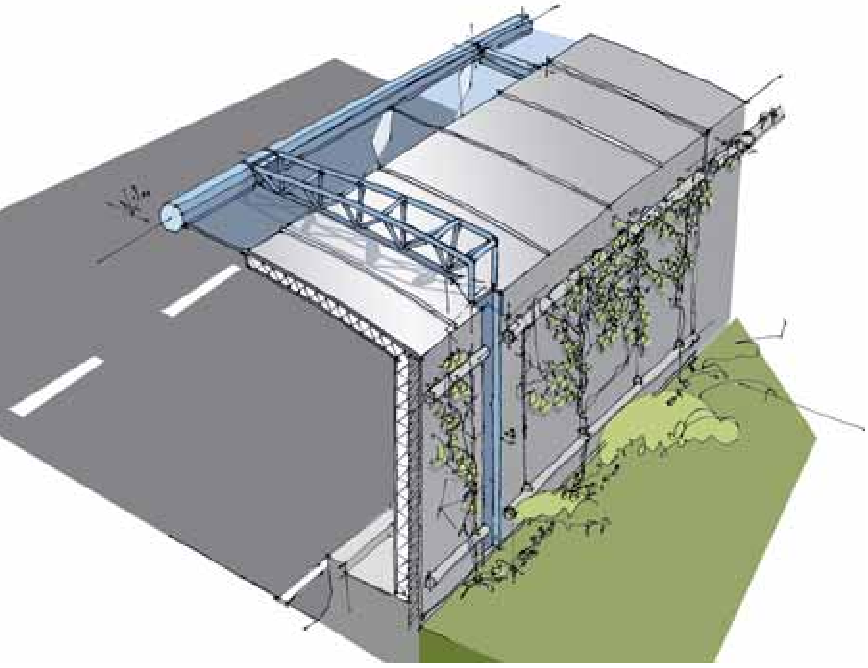
In principle, noise barriers must not be too high, particularly in urban contexts. In addition to the already existing physical divide brought about by the traffic route, it is important to avoid imposing extreme optical barriers within a town area. Many road users and pedestrians in the town will perceive the barriers mostly on a subconscious level. The structures therefore also have the role of being a self-confident representative of the area they are protecting.

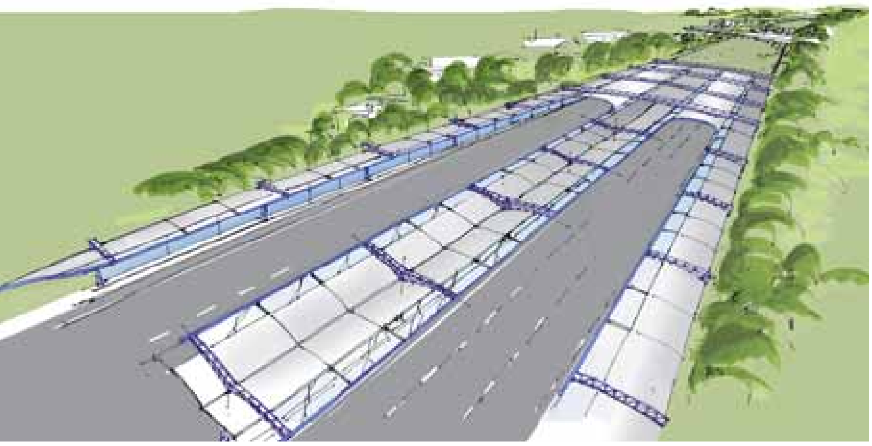
Concrete barrier with aluminium front-mounting shells motorway A99/ Allach

Transparent cross bulkhead at a wide underpass structure motorway A9 / Garching – B471 underpass

Noise protection bridge with planar glazing fastened at individual points motorway A9 / underpass Schleißheim canal near Garching (Munich)

Concrete wall on embankment A9 / near Garching and Eching





Noise barriers should generally be no higher than 9 m or at maximum 6 m when installed on embankments. There must always be a balanced height ratio between embankment and barrier, with the embankment higher than the barrier.

On the side of the barrier facing the road – given the relative speed with which road users drive past – a relatively calm barrier surface should be chosen. Avoiding vertical elements in the structure results in a desirable optical elongation of the barrier, making it seem lower and more dynamic.

On the residents' side, the noise barrier is viewed on a more stationary level, so that greater structuring is desired. Together with horizontal elements e.g. for fastening climbing aids, vertical elements can also be used and be in a geometrically balanced ratio to the barrier height or to the horizontal barrier sections.

Specific vegetation along the noise barriers is desirable on both sides. It is important that this does not lead to overgrowth: instead, the barriers should be enhanced by suitable plants at deliberately chosen intervals. Vegetation must not impair maintenance of the barrier; in addition, the overall visual effect should be of a well-tended system.

The height of many noise barriers is often an exact reflection of the results obtained from the acoustic calculations. These frequently result in a highly varied range of heights which should certainly not be implemented in the actual structure. The many corners and edges lead to surfaces appearing arbitrary and elusive. Changes in height should be kept to a minimum and designed with great care. It is most favourable to generate calm and self-contained barrier sections with constant height. Coupling elements for these barrier sections are for example short slide-over shear panels set in front of the basic layout and connected to the barrier section with transparent cross bulkheads. An optical separation of sections of different height can be obtained by transparent coupling elements.

A suitable geometry is also important in the basic layout. The aim must be for the noise barrier to run parallel to the roadway as far as possible. Changes in axis should be produced by transparent cross bulkheads for example, rather than twisting the barrier itself.

On bridges, transparent elements should be used as much as possible so that the outer effects of the bridge design are not unnecessarily weakened by the attached noise barrier. A smaller grid is required when anchoring the posts on the bridge structure compared to the open road, which also fits in when rating the dimensions of the transparent materials.

We distinguish the two following construction methods

Barriers along traffic routes up to 6 m height
Barriers on embankments
Barriers on buildings
Special areas
High barriers

Outlook

Comprehensive active noise protection can only be provided by noise reduction tunnels over the traffic routes. With high noise barriers rather good results can be achieved at low situated immission sites.

Noise reduction tunnels exceeding 80 m in length have to be equipped with a high level of safety features increasing costs immensely. Up to now, conventional solid tunnels have proven to be the most favourable solution in terms of overall costs – production costs and maintenance. Efforts have been and still are being made to design „light“ and thus low-cost noise reduction tunnels. However, requirements in terms of operational safety and fire protection always implicated costs much higher than expected.

SSF Ingenieure is following a new course with the design of „light“ noise reduction tunnels. The almost fully developed structure leads for the first time to the prospect of reduced overall costs. Still, even this very economical tunnel would bind more resources than high noise barriers.

In future noise barriers will keep their importance as economically efficient constructions. They are combined very efficiently with open-pore asphalt which reduces tyre noise at the source. The potential savings, relatively high compared to continuous tunnelling of traffic routes, implicate in return the commitment to obtain high quality in design and construction. The acceptance of a traffic route is always in direct context with the aesthetics and quality of the constructions.

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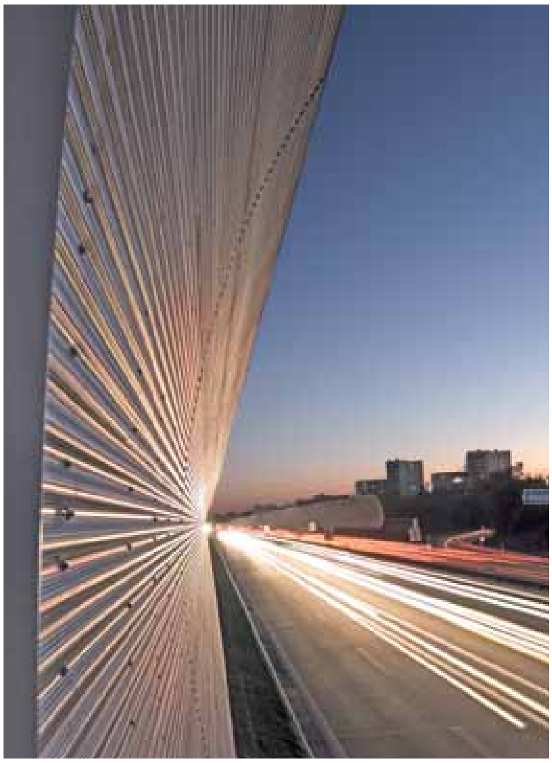

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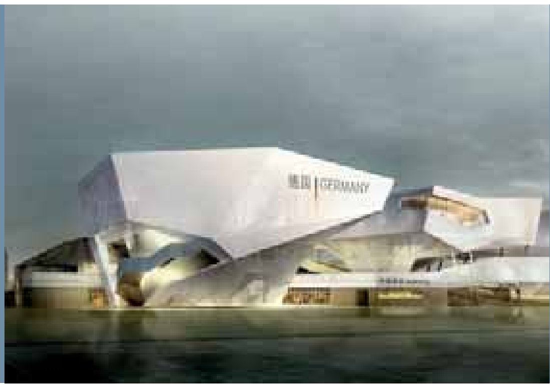
International projects at SSF Ingenieure



Speaker:
Matthias Scholz

SSF Ingenieure: commitment on an international level

Time and again, different cultures, traditions and standards present SSF Ingenieure with major challenges during various commitments in international projects.
Our successful international projects clearly show that good, sustainable planning activities are only possible in intensive dialogue with the customer on the basis of broad project management expertise and the use of multiple engineering disciplines.
The many years of experience and high level of know-how from the core business of SSF Ingenieure make a direct contribution to the efficiency and success of our international activities.

Selected examples and projects illustrate the range of services offered by SSF Ingenieure abroad, together with the many different tasks that are involved.

EXPO 2010 project in Shanghai

Following the Olympic Games in Beijing, Asia's next major event is the EXPO 2010 in Shanghai. A completely new exhibition world is being created in next-to-no time on an old brown-field site on the Pu Dong River.

Together with Baugeologisches Büro Bauer and PECS China, companies where SSF Ingenieure holds a major stake, SSF Ingenieure's contribution to building the new German Pavilion consists of services of soil mechanics, earthwork and foundation engineering, to ascertain the reciprocal effects between the subsoil and the building structure and to stipulate the soil characteristics necessary for the calculations. In addition, the soil, groundwater and ground air are being examined for harmful pollution, drawing up a risk appraisal with regard to executing the construction work and the future use of the building.

At the request of Koelnmesse International GmbH, the Federal Ministry of Economics and Technology and also in support of the consortium Deutscher Pavillon Shanghai GbR (consisting of the partners Milla und Partner Gmbh – Schmidhuber und Kaindl GmbH – Nüssli Deutschland GmbH) SSF has provided the following services through his participation in companies in China, which partly provided services themselves on site for their own account:

- Subsoil investigation and subsoil survey
- Environment survey: soil, water, air
- Foundation consulting
- Design and support structure planning for the foundations
- Consulting for support structure planning
- Supervision of the foundations

Construction work on the future EXPO site began back in August 2006. Old industrial structures are being demolished to make space for the future pavilions; in some cases, these structures are being preserved for integration in the EXPO Park and for use as exhibition halls.
The German Pavilion is being built on approx. 6000 m² of land in the European Zone on the EXPO site in Pudong, approx. 300 m to the west of the Lupu Bridge and approx. 300 m away from the southern bank of the Huanpu River.

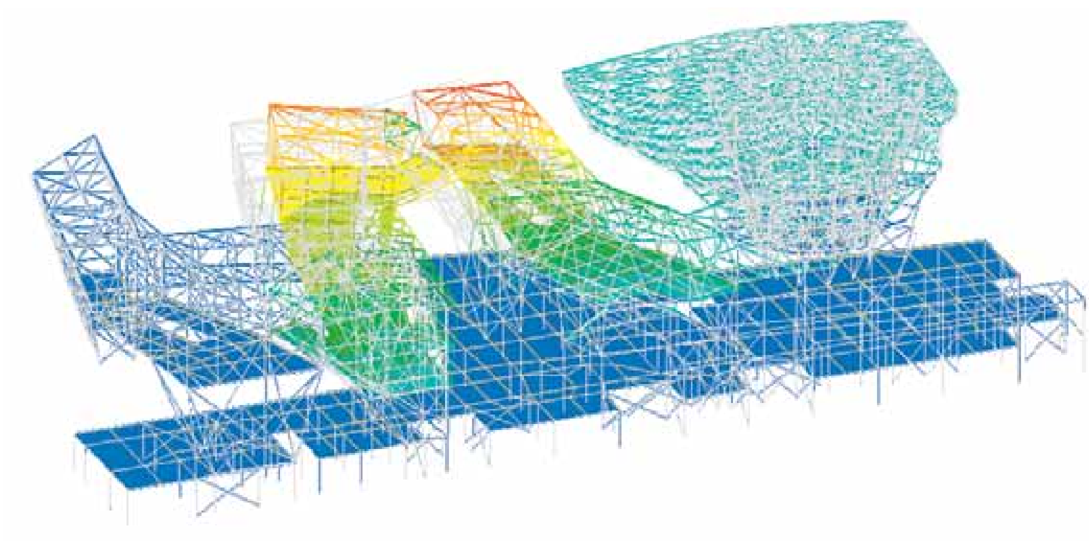
The light, temporary supportive frame structure with a membrane skin consists of 3 exhibition bodies and a large media room similar to a theatre, called Torus.
SSF Ingenieure was initially requested to study the prerequisites for foundations on the site. The brown field site

was to be investigated in geotechnical and environmental terms by an exploration program drawn up by SSF Ingenieure. The soil, air and water were examined in cooperation with Baugeologisches Büro Bauer; computing parameters were then derived and a corresponding suggestion for the foundations elaborated.

The subsoil in the area of the future EXPO Pavilion consists of river deposits such as clay, silt, loam and slight quantities of sand in a highly interbedded stratification carrying large quantities of water, making it unsuitable for taking great loads and very sensitive to subsidence. This resulted in the urgent necessity to use a pile foundation.

As well as on the findings from the soil investigation, SSF Ingenieure's proposal for steel ram pile foundations is based on the company's experience gained from the supervision and planning of high-speed railway lines in China, knowledge of workflows and technologies available in China creating thus the possibility of an economical, efficient, time-saving solution. The steel ram pile foundations were planned according to German safety standards and constitute a highly economical and efficient solution, even fulfilling the demand for possible demolition after the end of the exhibition.

Image: Schmithuber+Kaindl / Milla und Partner Visualisation of the German Pavilion – Expo Shanghai



Examination of supporting structure Subsoil investigation and expertise

In intensive dialogue with the architects and everybody involved in the project SSF Ingenieure are being asked by the construction consortium to elaborate the details for producing the foundations.
Together with the design and tender for the foundations, SSF Ingenieure also supervised the installation of the foundations, the necessary refurbishment work in the subsoil and qualified re-filling. The services provided were both consultation services in the form of consulting reports and as on-site supervision of the construction works.
One special task consists of design supervision for the entire support structure. In the context of functioning German-Chinese cooperation at the EXPO, it was necessary to draw up the design according to German standards and then adapt the submission planning to Chinese standards in view of approvability in China. SSF Ingenieure has thereof been charged to examine the supporting structure according to German and European standards. Recalculations and comparative calculations furnished prove of the required level of security of the supporting structure.

Improving access to the port of Gdansk with the Sucharski link road

Client	DRMG – Dyrekcja Rozbudowy Miasta Gdańska (City of Gdansk Development Department)
Planning period	2008 – 2009
Construction period	2010 – 2013
Costs	approx. € 485 million
Overall length	approx. 8,430 m
Road sections	3 lots
Bridges	15 between 50 m and 700 m in length
Tunnel length	1,175 m

Gdansk inner port/shipyard looking downstream to the future tunnel crossing

Scope of services:

Feasibility study, overall concept for roads, bridges and the tunnel under the Vistula River, variation study for crossing of the Vistula River as tunnel solution (docking method, immersed tunnel, tunnel boring machine), project and execution planning as well as tender planning and technical instructions for implementation and acceptance of construction.

The Sucharski link road to improve access to the port of Gdansk covers an overall length of about 8,430 m and consists of 3 working lots. The general scope of services for SSF Ingenieure in joint venture with EURO-PROJEKT Gdansk and close cooperation with Wagner Ingenieure GmbH covers the overall design together with approval planning through to execution planning.
The link road is to be constructed with 2 lanes in each direction. Initially 3 lanes were intended in the tunnel as a precaution for the future. However, the 3rd lane has been waived after review of the overall investment costs and the predicted traffic development.

Lot 1 with a length of approx. 2,900 m begins at Olszynka junction (from the southern ring – Obwodnica Południowa) and ends at the Elbląska junction.

Lot 2 extends over a length of approx. 2,920 m from Elbląska junction to Ku Ujściu junction (through to crossing over the railway lines after the intended Ku Ujściu junction).

The planned crossing of the Dead Vistula is part of lot 3 with a length of approx. 2,610 m: Ku Ujściu junction to Marynarki Polskiejen junction, with a deep level underpass crossing. The tunnel crosses the Dead Vistula between the Nabrzeże Wiślane and Dworzec Drzewny shores of the port.

One special feature consists of the two-lane traffic island at Marynarki Polskiej junction for connecting the 6 subsequent roads to the Sucharski link road. All road bridges with overall lengths between 50 m and 700 m will be combined in bridge families; they form cost-optimized units in terms of construction and maintenance, and their design and appearance constitutes a consistent characteristic feature for the new link road.
Together with the concept study for integrated road planning of the new link road with regard to a high traffic ef-

fectiveness of the connected network, another crucial main task consisted of the detailed feasibility study for the tunnel crossing below the port under the Dead Vistula.

The first aim of the concept was to analyse the possible construction methods for the tunnel, assess appropriate and technically feasible variants and select the most economically effective execution method with the lowest possible risk.

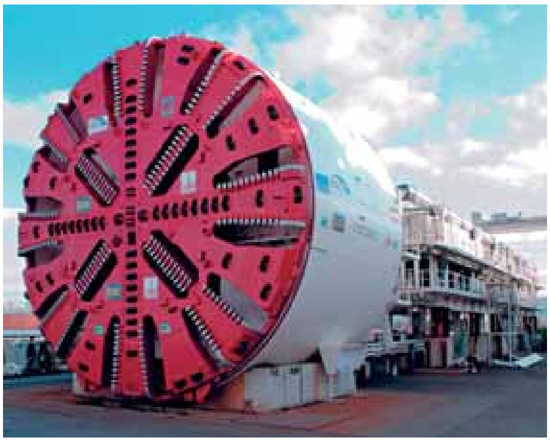
- Variant 1: tunnel built in docking method / in-situ concrete tunnel sections within sheet piling enclosures
- Variant 2: immersed tunnel
- Variant 3: shield tunnelling machine with head race sections

In addition to the general topographical and geological conditions for building a tunnel under the Dead Vistula, together of course with a large number of other important key points, in the end it was the following compelling aspects that led SSF Ingenieure to include the additional variant 3 with a shield tunnelling machine (TBM), in addition to the variants 1 and 2 already defined by the client in his request for service:

Construction of a tunnel using open methods (variant 1 and 2) under the navigable waterway of the Dead Vistula would constitute a huge hindrance for seagoing shipping and busy shipyard operations. In addition, the Vistula which has been partly canalized with many shore reinforcements, mooring quays and jetties, is only navigable as a deep-water fairway with a depth of 11.70 m in the middle. Using variant 1 or 2 to produce the tunnel would mean that depending on building progress, the fairway in the Vistula would have to be moved alternately to the outside, which in return would have significant effects on the quay and bank installations, as these are not sufficient for the corresponding depths, resulting in the need for extensive structural alterations.

The three technically appropriate and possible tunnel construction methods were compared in variant studies, risk analyses and cost estimates, taking account of all factors influencing the planning procedure and subsequent construction, then evaluated with differing significance factors within an extensive decision matrix. Here sensitivity analyses were also carried out with divergent evaluation characteristics in order to safeguard plausibility and verify the results.

Port at the area of the link



TBM mix-shield 13 m diameters – comparable type of the company Herrenknecht
Photo: Herrenknecht AG

The main focus of the analysis and evaluation included among others:

- Geology and subsoil risk
- Construction period and construction logistics
- Necessary intervention in existing building structures (e.g. shore walls and quay installations)
- Necessary intervention in land and surrounding areas in order to carry out the project (advance and construction measures)
- Influence and demands on areas outside the traffic systems
- Organisation of the works, transport of materials, mass balance and logistics
- Impairment and loss-of-service affecting third parties, the port and shipyard facilities
- Investment and follow-up costs for the structure (LCC costs)
- Investment costs for contingency measures
- General risk analysis (subsoil, environment, technical aspects, operation, financing and subsidies, approval, etc.).

As preferred variant, the client opted for the proposal made by SSF Ingenieure using the shield tunnelling machine with an optimised cross section of 12.50 m, in order to proceed with further planning and obtain Polish building permit planning.

This proved to be the best possible solution with regard to:

- Economic efficiency
- Time involved in the execution phase
- Minimising the risks in the execution phase
- Almost no impairment of affected third parties (port structures, shipping lane, adjoining tank farms etc.)
- Partial completion of one tunnel tube possibly by the 2012 World Cup

SSF Ingenieure and EUROPROJEKT worked under great time pressure to draw up the documents necessary for obtaining EU subsidy commitments with regard to the formal and legal necessities. This included in particular comprehensive traffic planning documents and detailed inventories referring to initial investment and subsequent costs, broken down into annual trenches, partial jobs of work, responsibilities and persons affected. This was a comprehensive task where to a certain extent it was also necessary to perform various client functions, for example in dealing with the EU Commission.

One particular challenge consisted of advising the client with regard to the technical, financial and approval-related feasibility under great time pressure in order to fulfil the prerequisites to qualify for subsidies while taking account of all contingencies and non-technical aspects, together with parallel definition of the project objectives. All documents were submitted solely in Polish.

Trial slab track Suining-Chongqing in China

In 2004, the Chinese Ministry of Rail (MOR) decided to test various slab track systems on the Suiyu trial track (Suining – Chongqing).

The Suining-Chongqing trial track measures about 13.2 km in length and is located in the southwest of China. It is part of a high-speed track and a so-called „Passenger Dedicated Line (PDL)". Various types of slab track were chosen for the trials and underwent appraisal by SSF Ingenieure in the context of the consulting commission with regard to their suitability for the specific boundary conditions such as load rating of the subsoil or use on earth structures, on bridges and in tunnels.

The MOR had instructed the renowned Second Survey and Design Institute (SSDI) in Chengdu to proceed with the planning tasks. The task entrusted to SSF Ingenieure as part of the firm's stake in PEC+S (Planning, Engineering, Consulting and Services, Munich and Beijing) was to advise the Chinese colleagues at SSDI on the special topic of slab tracks, to supervise the planning procedures and to draw up improvement and optimisation suggestions.

These consultation services focussed particularly on:

- Formation of slab tracks on long Chinese-built bridges – frame structures
- Formation of slab tracks in soft soil areas and soil with little bearing capacity
- Formation of slab tracks at switch areas
- Formation of slab tracks at transitional points to ballasted track
- Furthermore, SSF Ingenieure provided consulting services for slab track in Chinese method
- Grounding for special signal systems
- Reinforcement methods for special signal systems
- Adapting the drainage systems

Special challenges encountered in the consulting activities for this trial track included:
- First slab track in China on a single box girder bridge 450.7 m in length (crossing the Beibei-Jialing river)
- First switches in slab track design; there is a station with eight switch systems within the trial slab track

Algiers metro: extension L1B_ Hai el Badr - El Harrach Centre; execution planning

The international department of SSF Ingenieure deals with projects which are commissioned either directly by foreign customers and necessitate a corresponding local representative on site, or through construction companies working successfully abroad. That also applies to the Algiers metro project: in this case, SSF Ingenieure was commissioned by one of Germany's largest construction companies to proceed with the complete execution planning for the metro extension. Here the strict demands made of execution planning differed not at all from planning tasks for the German market. The standards that we work by include high quality demands for the planning activities up to German levels, efficient detail and workflow planning, punctual provision of the planning documents and sound project management on site with our own office and a small team.

This first trial slab track in China acted as role model with high empirical value for all other high-speed tracks.
In future, slab track systems are to be used in China as a defined superstructure method for expanding existing tracks. Today already, slab tracks are proving to be a great success in China when building new high-speed passenger dedicated lines.
SSF Ingenieure have been involved in most of these PDL lines implemented in China through their stake in PEC+S Germany and PEC+S China Ltd., providing consulting or supervision services for slab tracks, for individual major structures or for complete sections of track as for example the crossing of the Yangtze River in Nanjing in the course of construction of line Beijing – Shanghai or the line Zengzhou – Xian, Hefei – Nanjing and Wuhan – Guangzhou.

The prime example also implemented with involvement of SSF Ingenieure in China is the Olympic line between Beijing and Shanghai, which is already operating successfully with trains travelling at up to 380 km/h.

This first cooperation in China, cultivated in a sustainable, conscientious manner by PEC+S through SSF Ingenieure in the Suiyu line project, laid the foundations for the start of good, sustainable cooperation in China. The cooperation with MOR and SSDI has developed into a reliable partnership for the Chinese market.

The planning and construction order consists of extending line 1 from Hai el Badr station to El Harrach Centre station, covering a length of altogether about 4.0 km. This stretch of the line includes 4 underground stations (3 x open construction protected by bored piling or slotted walls, 1 x cut-and-cover method with slotted walls and inner shell), a viaduct around 300 m long and a tunnel in mined and open method. In addition, the planning scope also includes the support walls and extension work for a surface station. The intended construction period amounts to 32 months.

SSF Ingenieure has been asked to proceed with integral execution planning of the underground stations, the cut-and-cover tunnel, the bridge and the surface structures. The project encompasses nearly all variants of special underground engineering: Berlin-type pit lining, micro piling, bored piling and bored pile foundations, slotted walls, HPI base, underpinning, nail walls, etc. In addition to open methods, cut-and-cover methods are also used. The transitions between the mined tunnels (with/without pipe roofs) and the various station structures are also being planned by SSF Ingenieure.

SSF Ingenieure is permanently represented on site in the interests of interface communication between building site, client and consultant. Planning activities are to be undertaken in French and basically according to the Eurocodes. The Algerian regulations are only compulsory with regard to earthquake measurements. Planning verification and construction supervision is being carried out by a Portuguese/Spanish firm of engineers. Contractors involved in the project include Dywidag Algerie (subsidiary of Dywidag International, Munich), TREVI (Cesena, Italy) and Cosider (Algiers, Algeria).

7

Highspeed-Railway-Projects in China

Speaker:
Johannes Frühauf

A German-Chinese Cooperation shown on a high-speed railway project in China

In the context of extensive railway infrastructure measures in China – the so called "sixth national speed-up" aims at the large-scale expansion of the railway network. In addition to expanding existing lines, so called Intercity Railway Lines – high-speed lines with high frequency traffic in urban agglomerations – and Passenger Dedicated Lines (PDL) -lines limited to passenger traffic and generally arranged parallel to already existing lines – are built.

Projects of PEC+S / SSF Ingenieure in China

After commissioning of the "Beijing – Tianjing Intercity Line" in time for the Olympic Games in august 2008, the first Chinese railway line operated at 350km/h, the lines Beijing – Shanghai and Wuhan – Guangzhou part of the north-south axis Beijing – Wuhan – Guangzhou are currently under construction.
Since 2005 SSF Ingenieure operates in China together with German partners in the context of a joint venture: the PEC+S (Planning Engineering Consulting & Services Ltd.). Services include, next to mere consulting services, supervision provided by German engineers contributing to guarantee quality and security of the construction.

After successful implementation of the first projects with supervision for the line "Nanjing – Hefei" part of the East-West-link Shanghai – Chengdu (speed 200 ~ 250 km/h) and Beijing – Tianjin, we currently procure consulting and supervision services for the projects "Nanjing Big Bridge" (Nanjing Dashengguan Yangtze Bridge), a large crossing of the Yangtze River part of the line Beijing – Shanghai and "Guangzhou Railway Station and related works" in the context of the line Wuhan – Guangzhou.

1. Wuhan – Guangzhou PDL

The section serviced by PEC+S comprehends DK 2167 to DK 2208 of the Chinese chainage on the line Beijing – Hong Kong and reaches from Huadu, a small village north of Guangzhou, to the southern end of Guangzhou. In addition to numerous single-span girders resulting from the viaduct construction, several earthwork sections, two tunnels and some larger bridges are built. At DK 2169 the station Huadu will be erected, at DK 2172 an existing railway line, the current link Beijing -Guangzhou will be crossed. The crossing point will be converted during works and then linked to the new line.

Technical Data

Overall length of PDL:	968 km double track
Lot JL1, Guangzhou Station:	41.9 km
Construction period:	2006 until the end of 2009

Bridges:
- 6 single-span girders with a length between 340 m and 13,431 m
- 16 continuous girder bridges, thereof 94+168+94 m, 70+125+70 m
- 1 structural truss arch-bridge 99+242+99 m (part of bridge construction on the total line: 79%)

together with
- 2 tunnels with a length of 4,464 m and 200m (11%)
- 7 earthwork section with a total length of 4,260 m (10%), thereof 1,197 m trenches, 3,063 m embankment

1.1. Bridge construction

For production of the single-span girder superstructures two precasting plants were erected parallel to the line at DK 2183 and DK 2203. The precasting plants comprise 8 to 12 production lines and 62 to 90 storage yards and prefabricate a scheduled 260 to 569 elements. On track vehicles move the prefabricated elements that weigh 820 t vertically to the line and portal cranes that are movable parallel to the line mount them on the piers adjoining the precasting plant. For longitudinal transport on the line, a special vehicle weighing 280 t comes to use on which the prefabricated elements are placed after the first prefabricated elements are assembled directly to the piers.
Assemblage of the prefabricated elements is accomplished with a bridge laying device that is being shifted to the next pier after successful mounting.
The principle of prefabrication and mounting follows a standardised construction method that – with minor adaptations to the circumstances on site – is used nowadays a lot in China.
The prefabricated elements are built as prestressed single-span hollow box cross-sections with a length of 32.60 and 4.60 m and a construction height of 3.05 m; the width of the bridge deck is 13.40 m. The reinforcement steel of quality HRB 335 (stressing limit 335 N/mm2) is used at a reinforcement rate of 180 kg per m3. Concrete quality C50 has been chosen. The reinforcing cages of the lower

Precasting plant 2 Wuhan – Guangzhou PDL,DK 2203

cord/web and bridge deck are prefabricated separately, and after mounting of the lower cord/web into the formwork the prefabricated, hydraulically movable inner formwork is installed, then the bridge deck placed upon it. The pretension is applied in three steps. The first step consists of tensioning 20% of the tendons (after ca. 35h); during step two (after 80% concrete strength, ca. 50h) 60% of the tendons are tensioned. The final prestress is achieved after a minimum of 100 days at 100% concrete strength.

1.2. Cast-in-place concrete bridges

For larger cast-in-place concrete bridges, standardised construction methods are used, too, and are constructed for the better part in cantilever method. After fabrication of the initial slat on cantilevers or external pillars welded to the centre piers, the cantilever section (Xihuahai bridge, span 99+168+99m) is built parallel to both sides, each section reaching 3 to 4 meters and weighing up to 327 t. The stability of the cantilevered construction in the balanced cantilever system during construction is assured by external pillars as concrete filled hollow cross-sections, and, concerning larger spans, by temporary bearing plinth between piers and superstructure combined with mild reinforcement or vertical prestressing bars between superstructure and piers.
The dimensioning and choice of the supporting structure, influenced decisively by the parameters of the so called unbalanced moment, is carried out directly by the planning engineer or by the construction company. In the framework of the “Description of construction methods” that

has to be confirmed by the client, the consulting and supervision bodies, an adaptability proof has to be delivered. For the biggest prestressed concrete bridge with a continuous girder, the Xihuahai Bridge, a "framework construction" was considered for the centre span, where the centre piers, designed as double piers, are directly embedded in the superstructure. The arrangement of supplementary temporary supporting measures can thus be relinquished. The continuous girder bridges are haunch shaped hollow box cross-sections with a maximum construction height over the centre pier of 4.05 m (span width 32+48+32m) and 11.00 m (span width 99+168+99m) and a minimum height at the middle of the span of 3.05 m and 5.50 m.

1.3. Tunnel construction

Additionally to a smaller tunnel at the south end of the lot, the 4.4 km long Jin-Shazhou tunnel is part of this construction measure. The tunnel is situated at the outskirts of Guangzhou and passes under low to middle dense populated areas. At DK 2194.7 it crosses under a motorway junction. The main difficulties of this rather demanding tunnel construction consist of the small depth with a minimum of 6 m covering as well as of the difficult geology and hydrology.

The tunnel is divided in one section excavated in bored method and a 1 km long section in open method. The bored section is driven in 8 subdivisions by using blasting and excavating techniques and in some cases manual methods. Additionally to the habitual calotte driving and bench heading, in difficult conditions the CRD method was used: a sequential tunnel driving method with temporary reinforced support for each of the 6 partial areas. Even though the Jin-Shazhou tunnel is mostly in groundwater, technically complex driving methods like pressurised air or pit icing are set aside. Under difficult circumstances, the insinuation and stabilisation of the heading front is achieved by supplementary injection at the heading front or from the surface. To impede the flow of water in extreme cases injection walls are built parallel to the tunnel. In the area of the motorway junction, the Shabei Expressway, where as well as a 6 lane motorway, a 5 lane motorway bridge and an access ramp were crossed, currently a 250 m long temporary bridge is built so as to manage road traffic throughout construction. This bridge was planned subsequently because of the bad state the bridge structure was in and of the settlement to expect in view of the difficult geology.

Jin-Shazhou Tunnel, CRD drive

Jin-Shazhou Tunnel, open construction
Wuhan – Guangzhou PDL, DK 2196.5

Wuhan – Guangzhou PDL
DK 2207
Huadidadaonan Bridge
*46+3*76+46 m*
continuous girder;
left: Expressway Bridge
60+100+60 m
continuous girder

1.4. Supervision

To improve quality and security of the construction, inspections on site are undertaken on a regular basis together with our Chinese partners. The results of these inspections as well as the most recent quality and security defects are assessed in inspection reports and notices of defects. To mend defects, a remedial proposition is in general presented. In the case of overall problems, severe misunderstandings regarding quality and security or to inform the client on a general basis, brief consulting reports are composed and handed over to the client, the construction company or the construction supervision. To improve the successful supervision on the part of our Chinese partners, training courses are organised.
The Shabei Expressway is a good example to epitomise our supervision services. The intervention of German engineers has copiously contributed to improve quality and security. Advertency to the expected settlement improved considerably and meanwhile a whole series of improvement measures concerning security and reduction of settlement have been taken, for example supporting the existing bridge during construction and building temporary bridges whose concept was decisively influenced by the German supervisors.

2. Nanjing Big Bridge

Since the beginning of 2006, a big crossing over the Yangtze River, the Nanjing Bid Bridge, is being built approximately 20 km north of Nanjing, part of an advanced measure in the course of construction of the line Beijing – Shanghai. As well as the line Beijing – Shanghai operated with up to 300 km, the bridge crosses another first category railway line, the Hu-Han-Rong line from Shanghai to Wuhan and Chengdu (v = 200 km/h) and also 2 tracks of the Nanjing metro (v = 80 km/h).

The broadness of the Yangtze River about 200 km before flowing into the Pacific Ocean requires the planning of a 1615 m long bridge construction as steel truss-arch with the main spans being 2 x 336 m. The bridge's cross-section has a very generous design with a total width of 2 x 15 m between the arches and 2 x 5.3 m wide trusses. During a total 3 years of construction, approximately 82,000 t of steel are used – the Nanjing Big Bridge is considered the world's heaviest high-speed railway bridge.

Visualization of the Nanjing Big Bridge

Centre pier at the beginning of structural steelworks

Truss node with bolted connection

The depth of the Yangtze River being up to 41 m at this point and the consideration of shipping operations necessitate main piers of 2 x 107 m and 112 m height. For the bridge foundation 24 bored piles with diameters of 2.5 m and up to 90 m long, have been planed, with pile caps of 47 x 19 x 5 m. To produce the foundations, floating boring platforms were erected – the installation of the large bore piles confronted the responsible construction company with extraordinary endeavors.
The superstructure is essentially produced in cantilever method whereas the segments are anchored temporarily to an auxiliary pylon for the duration of construction.

Technical data

Overall length of the PDL line	1,318 km double track
Construction period	2007 – 2013
Construction period Nanjing Big Bridge	2006 to the end of 2009
Total length with foreshore bridges	9,273 m

Nanjing Big Bridge, view on the foreland bridges and the storage yard

Length of the steel structure	1,615 m
Main bridge spans	108+192+336+336+192+108 m
Arch height main section	84.2 m
Structural truss height	
- in the middle of the arch	12.0 m
- in the piers	56.8 m
Cross-section width	40.5 m
Total quantity of steel	approx. 82,000 t
Total costs	approx. € 430 million

2.1.Consulting

The PEC+S' mission entailed, additionally to supervision on site, design proof and consulting for the static system, the structural formation and assemblage. Amongst others, independent comparative calculations were made, especially to demonstrate the dynamic influence of high-speed traffic. Hence, the static construction was improved considerably at several points. For example the stiffness of the bridge deck was increased significantly by assembling trapezoidal struts. By changing the cross-section of the hangers from a hollow to an open profile, the dynamic behaviour was optimized. Further improvements were achieved on the fully welded construction of the bridge deck.

2.2. Supervision

Besides consulting services, we contribute to guarantee quality and safety of the construction by sending German engineers on site. To the scope of duties conferred to PEC+S, in addition to the overall management and structuring of supervision (organisation of meetings, default management, instruction of Chinese supervision), belong also the partial trades earthworks/ foundations and bridge construction. An essential task in the field of bridge construction is the evaluation and recalculation of associated works foreseen by the executing company.

By closing the gaps at the edges, at the end of 2008, the construction of the Nanjing Big Bridge as pilot project of the line Beijing – Shanghai is in the time schedule and there should be no hindrance to conclude construction in autumn 2009. Our German engineers were repeatedly able to assure themselves that the quality of the bridge construction is exceptionally high.

3. Summary

SSF Ingenieure assumes currently the technical and commercial direction of PEC+S. Besides staff in the Beijing headquarters, the PEC+S disposes of 2 experienced engineers at site in Nanjing, consulting services are handled at SSF in Munich and completed by repeated meetings on the construction site. In Guangzhou we employ at the moment 4 German engineers and geologists. On both construction sites Chinese staff is appointed by PEC+S, and all of the translators are trained engineers. The unchangingly large extent of high-speed railway line constructions gives us confidence concerning our future long-lasting commitment in China. Through activities for the EXPO 2010 in Shanghai, our field of tasks has already been extended beyond pure railway construction. For the future, PEC+S sees good chances to commit in the field of noise and choc protection as well as environment protection, subjects that have gained in importance through the increasing sensitivity in China.

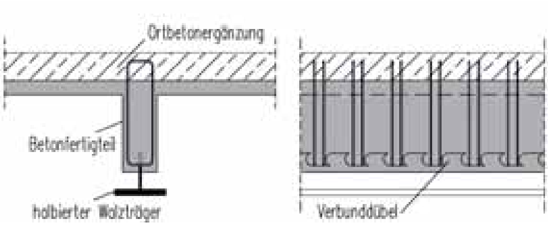
8

Development of new construction systems

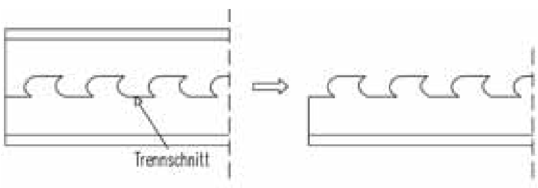
Speaker:
Günter Seidl

VFT-WIB technology

The VFT® technology combines the advantages of a high degree of prefabrication and low transport weights with short installation times, thus minimising downtimes for lifting the precast parts into place. The VFT-WIB® technology is a further development of the VFT® technology that combines these advantages with the robust characteristics of the traditional method of rolled girders in concrete. The new technology stands for composite precast parts with rolled girders in concrete.
The VFT-WIB® girder is a prefabricated composite precast part with a T-shaped steel girder as load-bearing element on the underside of the girder; the steel component consists of a rolled profile without top chord or a welded cross section. Composite dowels which are part of the steel girder itself form a shear-stiff connection between the steel girder and the top chord precast plate. Ideally, the T-shaped steel girders are made from one rolled girder. The girder is cut in two using a geometry which divides it into two simply symmetrical halves while generating the composite dowel geometry at the same time.



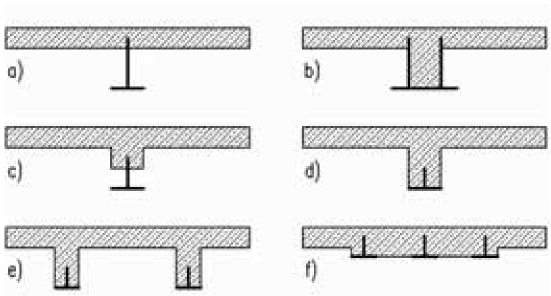
Cross-section and longitudinal section of a VFT-WIB® girder



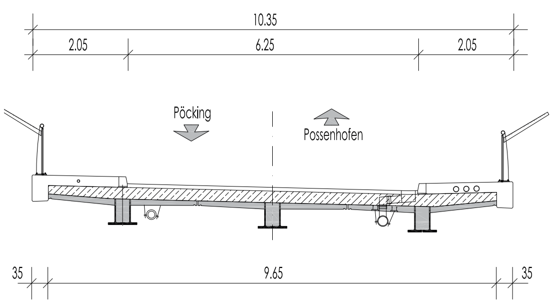
Kerf geometry of a rolled girder

This combination of cut geometry, arrangement and part combination constitutes a future-oriented development for VFT® girders.

The T-shaped steel girder acts as external reinforcement. This new design principle with a shear-resistant connection between steel and concrete also permits new cross sections as shown below.



Cross section b) was applied at the composite bridge in Pöcking over the railway line from Munich to Mittenwald. The replacement of an aging structure more than 100 years old, consisting of rolled girders in concrete (WIB), demanded a very slender new superstructure, so that the following cross section has been chosen for the frame construction. In this particular cross section, the rolled girders are embedded directly in the concrete flange.



The rolled girders are fabricated up to a height of approx. 1100 mm. This means that the cross section with two T-shaped steel girders is limited a structural height including the in-site concrete slab of = 0.85 m.
This permits spans of up to 20 m. For larger spans, the necessary structural height can be achieved with a concrete web.
The steel girders are rolled and cut in the workshop with a gas burner or plasma cutter, with the cut being placed down the middle according to the geometry for the composite dowels. The camber from the tension-free workshop form is applied to the girder. Continuous flow systems then add the head plates and coat the finished processed girders.
Following transport to the precasting plant, the steel girders are reinforced and concreted in a conventional formwork unit for prestressed concrete girders. After a defined rest period, the VFT-WIB® girders are brought to the building site and placed flange-to-flange on the substructures. The in-situ concrete slab is then reinforced and concreted without needing additional formwork.

Oxy-cutting of the rolled girder

Corrosion resistant girder after transport to the precasting plant

The design combines major advantages in terms of economic efficiency and durability:

Economic efficiency in production

- high degree of prefabrication reduces imponderability on the building site
- standardized girders of rolled steel simplify availability and delivery times
- low-cost rolled profile steel without welding in the workshop
- optimum material use for low consumption of structural steel
- standard formwork can be used for the prestressed concrete precast girders; no new investment necessary in the precasting plant
- the girders can be produced in any required height even with concrete haunches, without additional outlay
- small cranes can be used thanks to the low installation weight of the girders

Steel girder at the concreting hall

Economic efficiency in the system

- ideal leverage of the precast concrete flanges as external reinforcement
- VFT-WIB® girders with concrete haunches for adapting to the development of forces

VFT-WIB® girder at the precasting plant

Bridge in Pöcking

Bridge in Vigaun

- simple embedding of the girders in in-situ cross girders
- scarcely any need to close the traffic routes passing under the bridge

Durability
- fatigue-resistant structure with no notch cases
- minimised corrosion protection surfaces
- robust reinforced concrete cross section
- high standard of quality thanks to the large degree of prefabrication in the rolled girders and the precast parts
- good insight into all parts for easy structural inspection
- by welding on the slats, reinforcement is simple to implement

Other than using the VFT-WIB®-method for construction of road bridges, the above mentioned advantages are also of great benefit for railway bridges. Excellent experience has been gathered in building railway bridges using rolled girders in concrete (WIB) for small and medium spans. The majority of these bridges have meanwhile reached the end of their service life.

New replacement bridges will have to fulfil the following requirements:
- slender supportive structures within existing clearance gauges
- low production costs
- minimum interference in operations from construction of the replacement structure
- minimum lifecycle costs
- simple inspection of the substance

VFT-WIB® cross sections fulfil these demands to a very high degree. The prefabricated girders can therefore be put to advantageous use particularly when building replacement bridges over main lines with the requirement for the shortest possible closure times.
Furthermore, this technology makes it possible to erect simple auxiliary bridges at very low costs and for longer service lives in the track network. Steel girder fatigue in such structures is irrelevant.

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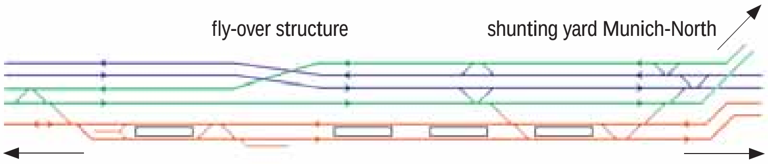
Expansion line Augsburg – Olching
Construction supervision Railway

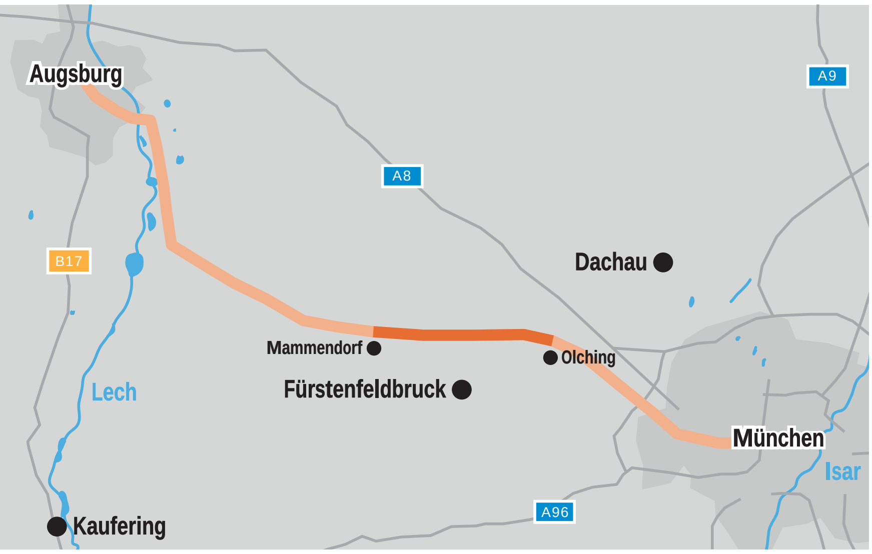
Speaker:
Thomas Bause

Railway line Augsburg – Munich

History

The railway line from Augsburg to Munich with its 62 kilometres is one of the oldest railway lines in Germany. It was commissioned by the Munich-Augsburg Railway Company shortly after finishing the line Nuremberg-Fürth in the years 1838 to 1840.





Today the line is one of the most used lines in Germany and serviced by approximately 300 trains per day; however, because of the current construction works, with only 160 km/h. Between Munich-Pasing and Mammendorf, right next to the tracks of the long distance train lie the tracks of the urban railway.

Expansion

With the four track expansion of the 44 kilometres long section between Augsburg and Olching, the German Railway Company creates new capacities for more rail traffic. The trains of regional (RB, RE) and freight traffic as well as the trains of long distance (IC/ EC) and high-speed traffic (ICE) get their own tracks. Heavy and slow freight vehicles will no longer slow down the fast driving ICE-trains. The admitted top speed for both high-speed tracks will be 230 km/h. The infrastructure for regional traffic will be created for an admitted top speed of 160 km/h.
The expansion of the line is divided in six planning sections. Constructions on the main section between Augsburg and Kissing have already started in 1998. The first new tracks are in service since the beginning of 2003. In the town area of Augsburg, in 2002 a new bridge was built over the river Lech and in the same year the expansion works in the east section between Mering and Olching have been kicked off.
To avoid influence on train traffic during construction, the new tracks are built parallel to the existing line. Between Olching and Mering the two additional tracks are installed north of the existing line, in the section Mering – Augsburg they are installed on the south and west side. Therefore new bridges are built, embankments raised and widened, ballast, rails and sleepers are laid. Finally, catenaries and signal and safety technology are installed.

Moreover, the electronic interlocking tower in Mering is upgraded and connected to the operation centre in Munich. In Augsburg-Hochzoll, Kissing and Haspelmoor the interlocking sub-divisions are extended or conversed, the stations Mammendorf, Maisach and Olching are progressively transformed from all-relay interlocking to electronic interlocking towers and are connected to Mering.

Length: 61 kilometres
Length of expansion sections: 44 kilometres
Speed on the line:
- up to 230 km/h for ICE-traffic
- up to 160 km/h for regional and freight traffic

End of works (estimated): 2011

In the context of expansion, 95.3 ha ground are acquired, 43 kilometres embankment are filled up, 7.5 kilometres of new support walls are produced, 116 km of rail and 104 switches installed, 52 railway and 18 road bridges are renewed and adapted, 46 km of noise barrier erected as well as nine island platforms and three side-boarding platforms adapted or newly built.
The investment master plan until 2010 for traffic infrastructure in Germany envisions investments up to a total amount of 771 million Euros for this expansion line.

Planning sections 5 and 6

For sections 5 and 6, Olching to Mammendorf, our engineering company together with our partners from baulok GmbH is charged with the duties of construction supervision, earth and superstructure works.

In addition to typical engineering services in supervision such as:
- Control of conformity to the plans approved for execution
- Measurement of quantities and auditing
- Keeping construction journals
- Participation at acceptance etc.

we also provide in this project various special services, e.g.:
- Coordination of operations on site,
- Design and control of securing measures
- Establishing of approval documents and documents of the existence

Deconstruction of a road cross-over in section 6

Fly-over structure in section 6

Railway bridge in section 5 and 6

Noise barriers and support walls in section 5 and 6

Road bridge in section 5 and 6

Preparation of track bed in section 5 and 6

Rail construction in section 5 and 6

Enlargement of track bed in section 5 and 6

- Technical representative and responsible for on and off switch of catenaries and electricity installations
- Dispatching, logistics and accounting for superstructure materials
- Coordination of the different construction companies, specialists, suppliers and the equipment trades (catenaries and signal and safety technology)
- Contract and addendum management (evaluation on the merits and the amount as basis of decision-making for the client regarding 12 construction contracts with sums reaching from 1 to 15 million Euro; up to now approx. 300 contract addendums and 500 invoices from companies and suppliers)
- Progress and cost control
- Documentation
- Surveying and geotechnical supervision by our subcontractors Karner-Ingenieure and Dr.-Ing. A. Schubert

The planning section 6 Olching-Maisach distinguishes itself from the other sections by the fact that both tracks newly installed north of the existing line will finally be used under regular service in the direction from Munich to Augsburg; on the already existing tracks, trains will travel from Augsburg to Munich. Right before Maisach is a divergence through an 800 m long fly-over structure as the freight traffic branches off at Olching to the north in the direction of the shunting yard and vice versa.

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