International projects at SSF Ingenieure

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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.

Picture credit: Schmidhuber+Kaindl / Milla und Partner

Visualisation of the German Pavilion – Expo Shanghai

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.

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 refilling. The services provided were both consultation services in the form of consulting reports and as onsite 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.

Picture credits:1+2 SSF Ingenieure GmbH

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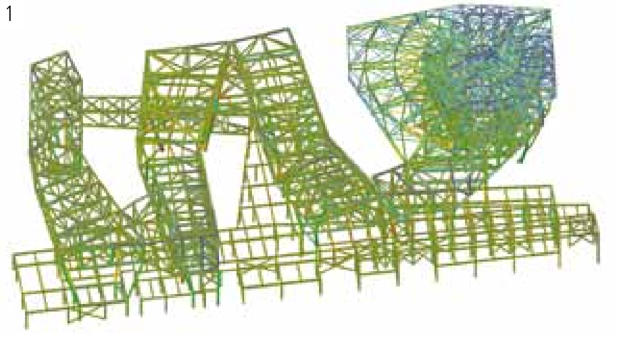

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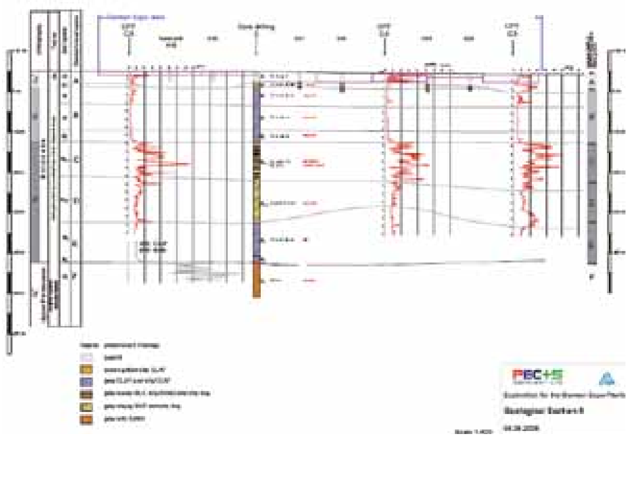

1 Examination of supporting structure
2 Subsoil investigation and expertise

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

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
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 effectiveness 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.

Picture credits: **1+2** port Gdańsk / **3** 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.

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1 Gdansk inner port
shipyard looking downstream to the future tunnel crossing
2 Port at the area of the link
3 TBM mix-shield 13 m diameters –
comparable type of the company Herrenknecht

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

Picture credits: Métro D'Algier

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.

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).

Algiers metro, extension L1B_ Hai el Badr – El Harrach Centre	
Client	EMA (Entreprise Metro d'Alger)
Contractor	GAAMEX, Algiers (DiG Algeria with Cosider, Algeria)
Planning of mined tunnels	Müller-Hereth, Karlsruhe
Consultant	ENSITRANS, Portugal

Stations in detail:

Bachdjarah 1	
Dimensions (l x w x d)	117 x 20 x 25 m
Construction	open method (bottom up)
Pit enclosure	separate bore piling, back anchored (pressure-grouted anchors), Berlin-type pit lining, back anchored (pressure-grouted anchors)
Station	base, walls: in-situ concrete ceilings: prestressed concrete FT with supplementary in-situ concrete, ancillary areas in in-situ concrete platforms: precast reinforced concrete parts

The outer walls are concreted directly against the separate bore pilings. In finished state, the bore pilings and outer walls therefore share the load transfer. For the planning process, this means that both the corresponding construction pit and also each particular finished state have to be rated accordingly so that the bore pilings can be installed. The station base is located above groundwater.

For the buildings located immediately next to the bottom of the construction pit, in some cases elaborate measures will be necessary to safeguard the existing foundations in terms of reasonable and permissible deformation values. Extensive monitoring documents the results and assures the subsequent control of deformations/subsidence.

Nail wall (under construction)

Picture credits: SSF Ingenieure GmbH

Bachdjarah 2	
Dimensions (l x w x d)	117 x 20 x 25 m
Construction	open method (bottom up)
Pit enclosure	separate bore piling, back anchored (pressure-grouted anchors), Berlin-type pit lining, back anchored (pressure-grouted anchors) HDI base for construction pit reinforcement (under the bottom plate)
Station	base, walls: in-situ concrete ceilings: prestressed concrete FT with supplementary in-situ concrete, ancillary areas in in-situ concrete platforms: precast reinforced concrete parts

In construction and design, the station is the same as Bachdjarah 1 station. An HDI base is planned to reinforce the pilings below the bottom plate.

El Harrach Gare	
Dimensions (l x w x d)	180 x 22 x 30 m
Construction	open method (bottom up)
Pit enclosure	slotted wall, back anchored (pressure-grouted anchors), Berlin-type pit lining, back anchored (pressure-grouted anchors)
Station	base, walls: in-situ concrete ceilings: in-situ concrete platforms: precast reinforced concrete parts

The station is in the groundwater level. A sealing solution with corresponding drainage is provided between the slotted walls and the outer walls. The final ceiling is vaulted for the most part.

El Harrach Centre	
Dimensions (l x w x d)	180 x 25 x 17 m
Construction	cut-and-cover method (top down)
Pit enclosure	slotted wall, back anchored (pressure-grouted anchors), Berlin-type pit lining, back anchored (pressure-grouted anchors)
Station	base, walls: in-situ concrete ceilings: in-situ concrete platforms: precast reinforced concrete parts

This station is also completely in the groundwater level.

Trial slab track Suining-Chongqing in China

Summary of other engineering structures:

Platform extension	
Dimensions (lxw):	113 x 7 m
Construction	spread foundation
Structure	in-situ concrete
Nail wall	
Dimensions (lxh)	290 x 8 m
Construction	retaining wall
Structure	nail wall (ground nails, shotcrete shell)
Viaduct	
Dimensions (lxw)	280 x 10 – 13 m
Construction	bridge
Superstructure	prestressed concrete FT with supplementary in-situ concrete, in-situ concrete QT
Bridge bearing	elastomeric cup-and-ball bearing, earthquake dampers
Substructure	Pfeiler und Widerlager aus Stahlbeton, Bohrpfahlgründung
Tunnel, open method	
Dimensions (lxwxd)	380 x 12 x 9 – 19 m
Construction	open method (bottom up)
Pit enclosure	separate bore piling, back anchored (pressure-grouted anchors)
Structure	base, walls, ceiling: in-situ concrete (with flexible mobile tunnel carriage)
Tunnel, cut-and-cover method	
Dimensions (lxwxd)	180 x 12 x 12 – 17 m
Construction method	slotted wall, back anchored (pressure-grouted anchors) or reinforced
Pit enclosure	slotted wall, back anchored (pressure-grouted anchors) or reinforced
Structure	base, walls (inner shell), ceiling: in-situ concrete

Other structures
Retaining walls in in-situ concrete, with spread foundations and founded on bored piles)
Temporary bridges (road, railway)
Pedestrian tunnel under the railway protected by temporary bridges
Operations building
Extension to the station buildings
Engineering structures as required for construction site facilities (crane foundations and crane tracks, foundations for silos, water tanks...)
Other temporary construction site measures (sheeting as Berlin-type pit lining, micro-pilings, underpinning…)

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

This first trial slab track in China acted as role model with high empirical value for all other high-speed tracks.

Picture credits: SSF Ingenieure GmbH

Types of slab track on the trail line

Substructure		length (m)	number
Earth structure		5,398	
Bridges	Beibei-Jialing-River	450.70	1
	ZhangJiaYuanZi	101.1	1
	ZhiChangGou	159.92	1
	Total number of bridges	711.7	3
Tunnels	LongFeng Tunnel	5,217	1
	WanLiTou-Tunnel	207	1
	ErYan-Tunnel	987	1
	MuYuShan-Tunnel	569	1
	Total number of tunnels	6,980	4
Switches on slab track	8 Stk		

Length of the different types of slab track on test line

Types of slab track	length of trail track (m)
Prefabricated slabs of superstructure Type A (comparable to Japanese slab track)	2,291
Prefabricated slabs of superstructure Type VA (Type A with elastic mat)	320
Prefabricated frame (uncoupled)	4,037
Prefabricated slabs coupled in longitudinal direction	752
Supporting slab with double bloc open-web girder sleepers (comparable to Rheda 2000)	5,285
Supporting slab with monobloc prestressed sleepers	412
Total	13,157

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1 First slab track in China on a 450,7 m long bridge Single Box Girder 1 (crossing of the Beibei-Jialing-River)
2 First switch in slab track method: a station with eight switches is situated on the test line

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.

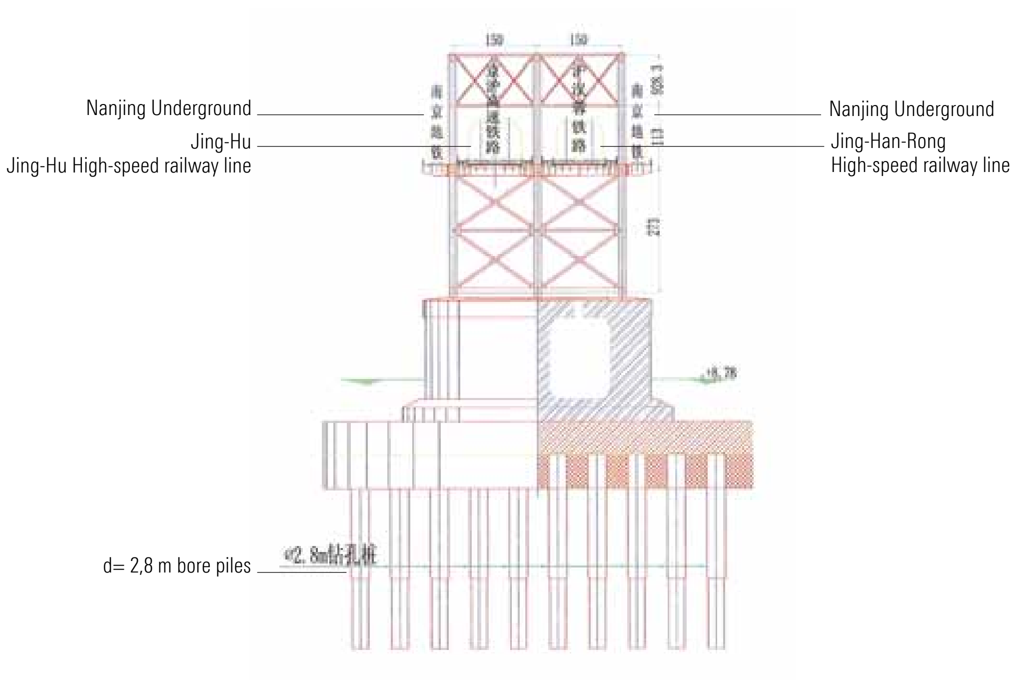
SSF Ingenieure have been involved in most of these PDL lines implemented in China through their stake in PEC+S Germany and PEC+S China Ltd., providing consulting or supervision services for slab tracks, for individual major structures or for complete sections of track as for example the crossing of the 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

Picture credits: SSF Ingenieure GmbH

Railway Bridge over the Yangtze River in Nanjing PR China – design consulting and supervision

Technical data	
Overall length of the PDL line	1,318 km double track
Construction period Nanjing Big Bridge	2006 – Ende 2009
Total length with foreshore bridges	9,273 m
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 - in the piers	 12.0 m 56.8 m
Cross-section width	40.5 m
Total quantity of steel	ca. 82,000 t
Total costs	ca. 430 Mio. €



Picture credits: CARS (China Academy of Railway Science)

Cross-section

cooperation in China. The cooperation with MOR and SSDI has developed into a reliable partnership for the Chinese market.
Since March 2006, the „Big Bridge" is being built in Nanjing over the Yangtze River on the passenger dedicated line (PDL) from Beijing to Shanghai over a total length of around 9.3 km.
The foreshore bridges consist of 266 individual system girders type "32 m box girders" together with individual continuous beams that have been built mainly in cantilever method. Due to the bad ground conditions, large bored pile foundations were applied for the whole construction.

The steel truss arched bridge measuring 1,615 m in length spans the Yangtze River with two central main openings of 336 m. The steel structure is produced in cantilever method with temporary rope restraints to brace the segments being fitted. The bridge's foundations consist of large bore piles with a diameter of 2.8m. The three piers in the area of the two main spans were each arranged with 46 piles with a length of 105m.

The estimated 3-year total construction period is consuming around 82,000 tonnes of steel in the superstructure together with around 1,225 million m³ of concrete for the substructures and foreshore bridges. As far as the quantities of material are concerned, this makes the Nanjing Big Bridge one of the largest bridges ever built for high-speed tracks.

The bridge carries 2 directional tracks of the high-speed PDL for trains travelling up to 300 km/h, together with another first category railway line from Shanghai to Wuhan - Chengdu (v= 200 km/h) and 2 tracks for Nanjing Metro (v= 80 km/h).

PEC+S with SSF Ingenieure working solely on this project were - together with the CARS (China Academy of Railway Science) - commissioned by the Ministry of Rail (MOR) to provide consulting services for the structural engineering involved in this particular project, looking at the special issues of fatigue, fatigue-free construction, orthotropic plate, aerodynamics, impact of shipping collision, superstructure for high-speed traffic on steel bridges and for elaborating the detailed aspects of the steel truss nodes.
SSF Ingenieure was commissioned with on-site supervision throughout the entire construction period for implementation and monitoring of the strictest quality standards during production, installation and construction supervision. To this end, an efficient SSF team consisting of experts in construction management and construction supervision was deployed on the building site in Nanjing.

The Nanjing Bridge project is a good example for comprehensive planning consultation in cooperative dialogue with the Chinese client and for top quality supervision of implementation of the consulting results simultaneous to the construction process.

Over recent years, it has been possible to enhance and safeguard the confidence of our Chinese clients in the long run through the strong commitment shown by SSF Ingenieure in affiliation with PEC+S, through value-enhancing planning and consulting services tailor-made to the client's needs and through conscientious staff deployment on site. Together with the Chinese design institutes or on behalf of MOR, SSF Ingenieure and PEC+S will continue to deal with interesting new projects in China in the future, including other areas in addition to the railways.

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