יהודה שטאנג ובניו בע"מ חברה לבנין והנדסה אזרחית
רח' אימבר 7 קרית אריה, ת.ד. 10154 פ"ת 49001 טל: 03-9217206 פקס: 03-9217214
www.shtang.co.il E-mail: ys&sons@shtang.co.il

BOX JACKING SEMINAR

July 3rd, 2006

SCHEDULE

08:30 **Registration and reception**

09:30 **Welcome: Shmuel Shtang**

Greetings

- MK Moshe Kachlon, Chairman of the Knesset Finance Committee
- Mr. Yochanan Bilev, Director General, Israel-Germany Chamber of Commerce and Industry
- Dr. Yoav Serena, Chairman, Building and Infrastructure Engineers Association
- **Representative of the Ministry of Transport:**

- Representative of Israel Railways Authority – Mr. Ilya Valkov, Deputy Director, Planning and Development

09:30 **Lecture: Mr. Gunter Konrad, Eng.**
Head of Pipe, Box Jacking Division of Ed. Züblin AG, Tunneling Department. Under his supervision, Züblin tenders and executes pipe and box jacking projects worldwide.

10:15 **Mr. Baldur Rogener, Eng.**
Former head of railway bridge construction for Bundesbahn (German national railway) for 18 years.

Mr. Magnus Hellmich
Construction supervisor, bridge construction, at Eisenbahn Bundesamt (government institution controlling security and safety of railway construction)

10:45 **MID-MORNING BREAK**

11:30 Case Study – **Nachsholim Crossing: Mr. Gunter Konrad, Eng.**

12:00 **Ballastless Track – Mr. Viktor Enoekl,** Züblin AG

13:00 **Discussion and Summary – Mr. Eldad Spivak,** Eldad Spivak Engineering Co. Ltd.

14:00 **LUNCH**

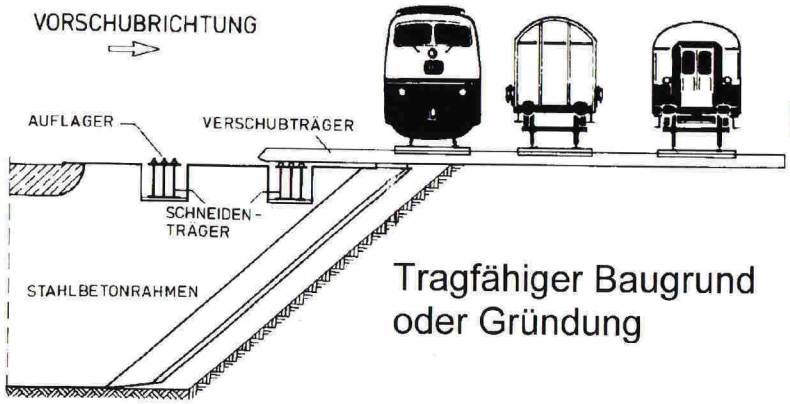
VDEI

Verband Deutscher Eisenbahningenieure e.V. -
Berufsverband der Ingenieure im
System spurgeführter Verkehr

Lecture „Construction Method – RSGS“©

- Jacking of Railway Bridges -

Eurail.-Ing., Dipl.-Ing.(FH), Ing.
Magnus Hellmich
Dipl.-Ing.(FH), EWE
Baldur Rögener



VDEI

Organization of German Railway Engineers (VDEI)
Professional Organization of Engineers in
Systems of Track Guided Traffic

Eurail.-Ing., Dipl.-Ing. (FH), Ing. Magnus Hellmich

- graduated in mechanical engineering/rail car technology in Dresden, Germany and post graduated in civil engineering/railway construction
- has been employed in several railway administrations in divisions of railway environment, site management and construction engineering
- is employed today in the division of construction supervision "Construction Engineering/Railway Bridge Construction" of the German Federal Railway Authority

Dipl.-Ing. (FH), EWE Baldur Rögener

- graduated in civil engineering in Karlsruhe, Germany
- has been employed by Deutsche Bundesbahn with additional technical expertise in railway construction (special graduation in soil mechanics, concrete and sealing technology, testing stress analyst – special focus on railway bridge construction)
- retired since 1998 and today freelancing mainly for Deutsche Bahn AG

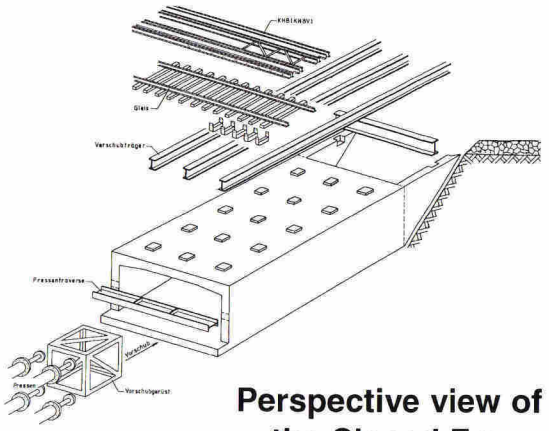
Lecture „Construction Method – RSGS“© - Replacement substructure by girders instead of sleepers (RSGS) -

Eurail.-Ing., Dipl.-Ing.(FH), Ing.
Magnus Hellmich
Dipl.-Ing.(FH), EWE
Baldur Rögener

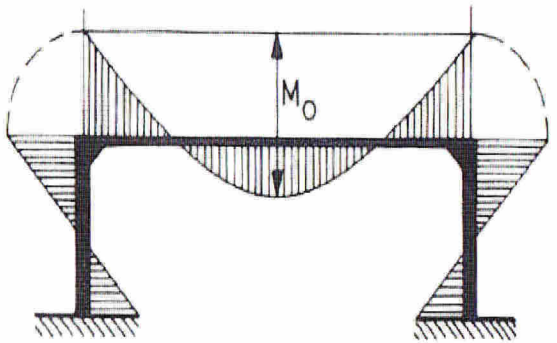
Replacement Substructure by Girders instead of Sleepers (RSGS) or Schwellenersatzträgerverfahren (SETV)

– a proven Method of Construction of Deutsche Bahn AG – acc. to Standard/ Guideline 804. 4120 or 9051

- RSGS is a construction method permitting jacking or pushing of structures in regular breaks during railway operation.
- RSGS can be applied, whenever the new structure can be built up next to the tracks and jacking or pushing is possible
- In particular when
  - a considerable obstruction of the railway operation has to be excluded („Construction under turning wheels“)
  - special structures to be built at point areas
  - only limited height for construction is available for temporary measures
- The RSGS enables the design of a railway bridge with the advantageous static shape of a closed frame. By force redistribution a shallow construction height is possible. The RSGS it is very well suitable for bad ground conditions, half frames are also possible as well as only ceilings/superstructures



Perspective view of the Closed Frame



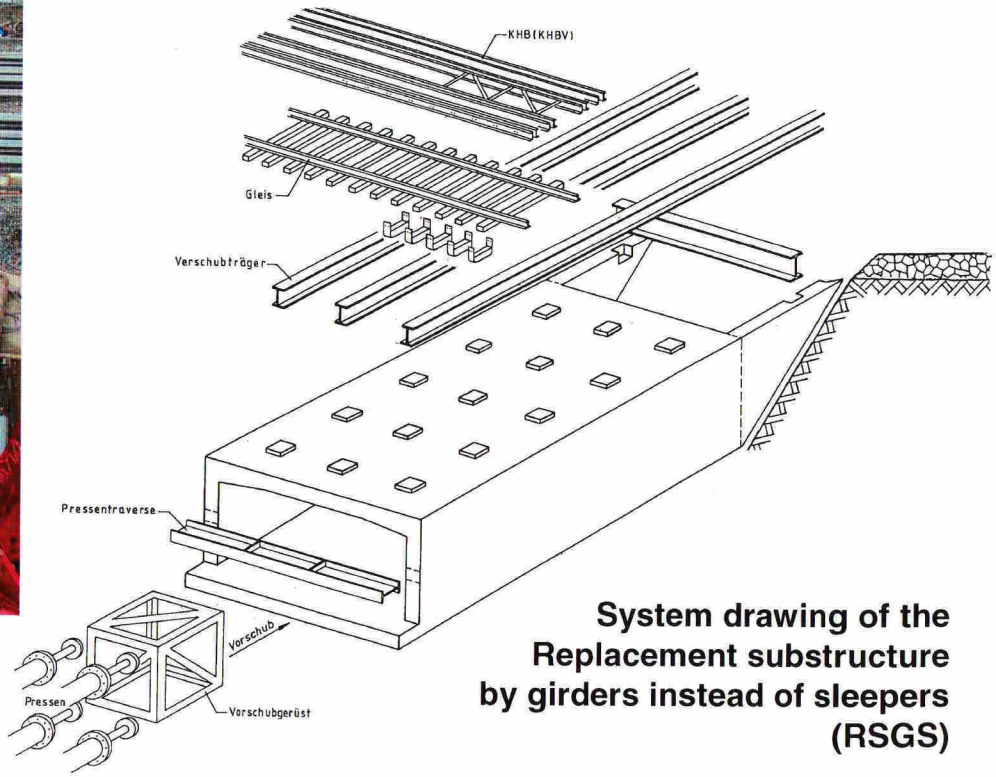
Design Model of the Half Frame

Lecture „Construction Method – RSGS“© - View RSGS/ Detail Ancillary Bridge -

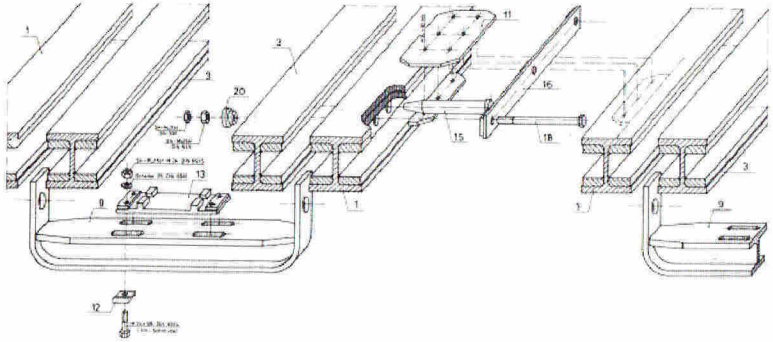
Eurail.-Ing., Dipl.-Ing.(FH), Ing.
Magnus Hellmich
Dipl.-Ing.(FH), EWE
Baldur Rögener

Replacement substructure by girders instead of sleepers (RSGS) – proven construction method of Deutsche Bahn AG – acc. to Standard/ Guideline 804. 4120 and 9051

Secure railway operation during the jacking operation



System drawing of the Replacement substructure by girders instead of sleepers (RSGS)



Strengthened minor ancillary bridge as connecting element between track and the replacement substructure by girders instead of sleepers

Lecture „Construction Method – RSGS“©

- Basics – RiL 804.4120/ 9051 -

Eurail.-Ing., Dipl.-Ing.(FH), Ing.
Magnus Hellmich
Dipl.-Ing.(FH), EWE
Baldur Rögener

RSGS – Construction Method of Deutsche Bahn AG – regulated by drawing templates since 1972

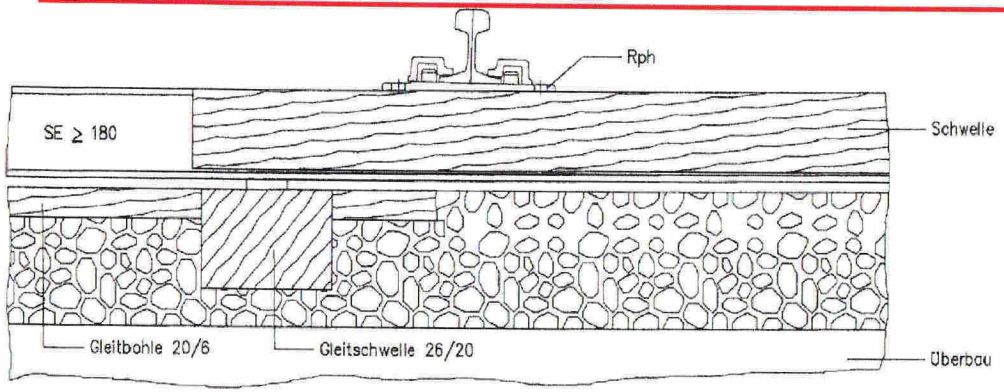
- Law – EBO
- Standards – DIN
- Guidelines
- Drawing Templates

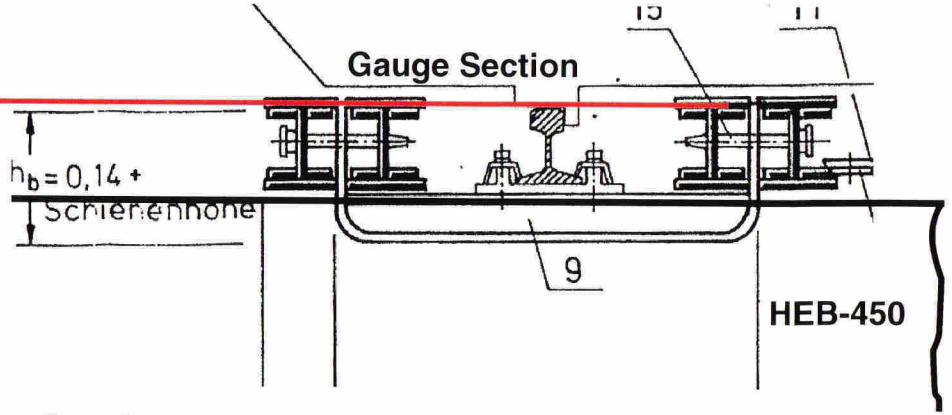
Basics – RiL 804.4120/ 9051

RSGS is in general differentiated in

- Regular sections with min. HEM-180/ HEB-220
  - Application especially in point areas with special constructions (railway bridges in point areas)
  - Cross beam with replacement sub-structure by girders instead of sleepers on sliding sleepers right underneath the rails
- Large sections with min. HEB-450
  - Application on straight rails in connection with minor ancillary bridges (Kleinhilfsbrücken - KHB) or strengthened minor ancillary bridges 12,51m (Verstärkte Kleinhilfsbrücken - KHBv)
  - large sections in approximately every third crib in the rail grid underneath the (strengthened) minor ancillary bridges
  - Note: Ancillary structure with limited construction height

Drawing Template: **Construction Stage of the rails with regular sections**





Drawing Template: **Rails with installed strengthened minor ancillary bridge**

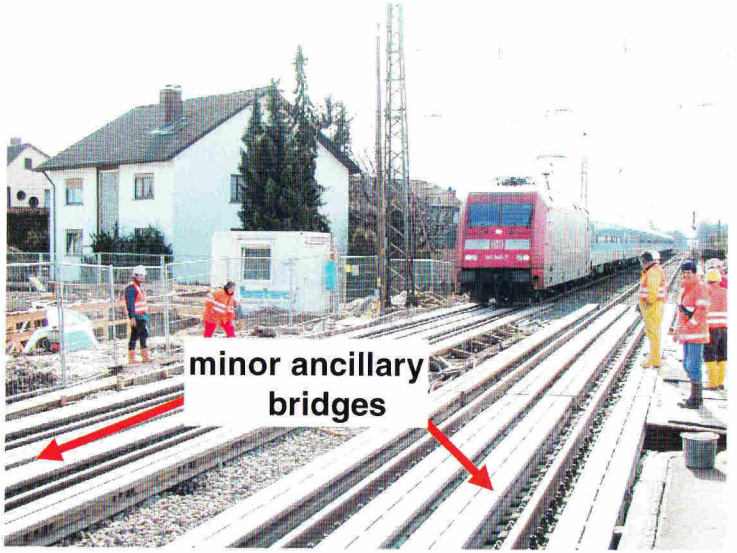
Lecture „Construction Method – RSGS“© - Track Protection -

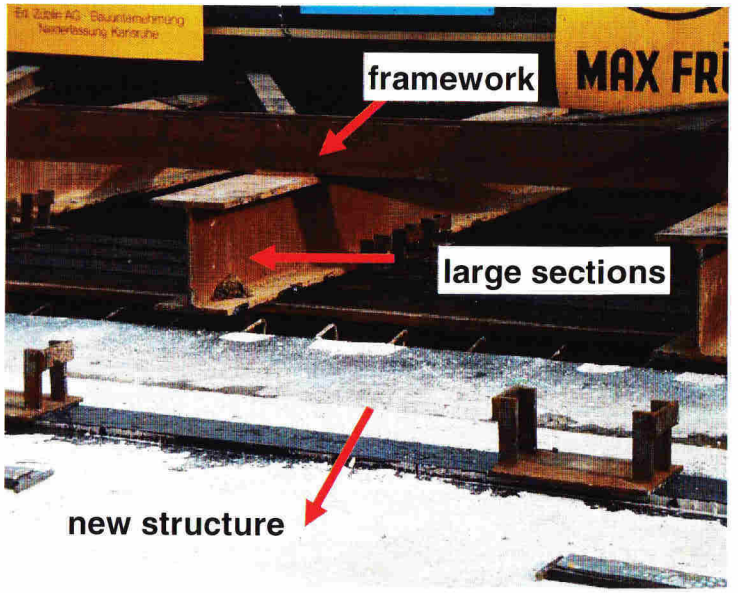
Eurail.-Ing., Dipl.-Ing.(FH), Ing.
Magnus Hellmich
Dipl.-Ing.(FH), EWE
Baldur Rögener

Technical measures for safe railway operations are required along the tracks.

Preliminary structures for track protection

- Bearing structures for traffic and railway wheel load transfer consisting of
  - minor ancillary bridges
  - regular and large section
  - Alternative 1 - Soil conditions according to DIN1054
  - Alternative 2 - Pile driving according to German construction standard as bore piles or driven piles using wood or steel beams (DIN 4014 - Bore piles, DIN 4026 - Driven piles, DIN 4128 - Pile injections)
  - Alternative 3 - Soil freezing after case by case approval (Zustimmung im Einzelfall - ZiE)
- The transverse sliding beams are to be anchored against horizontal loads during transverse sliding for instance underpinning as framework on driving beam or sheet pile



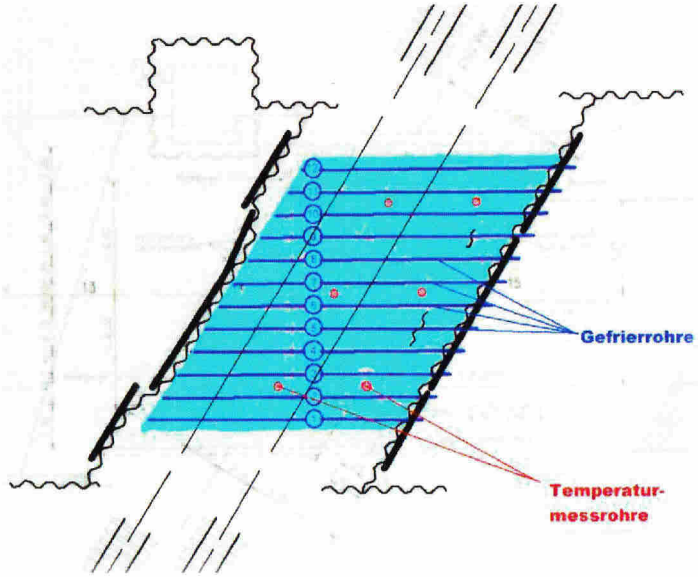


Technical measures for safe railway operations are required for protection of construction pits (sheeting)

Preliminary structures for protection of construction pits (sheeting)

- low-deformation sheeting – head deflection <20mm to secure the track bed or to avoid misalignment of tracks (instrumentation survey)
- parallel to tracks – normally sheet piling
- across or underneath the tracks during jacking operations
  - with track closure sheet piling
  - without track closure jet grouting (HDI) or soil freezing
- in groundwater, base sealing with gel injections to achieve impermeable foundations
- for structures with temporary cutting blades (launching noses) no lateral protection underneath the track in jacking direction is required for the jacking method – only longitudinal track protection for start or target pit reasonable for optimization of jacking route or jacking phase.

Sheeting design and construction sequence

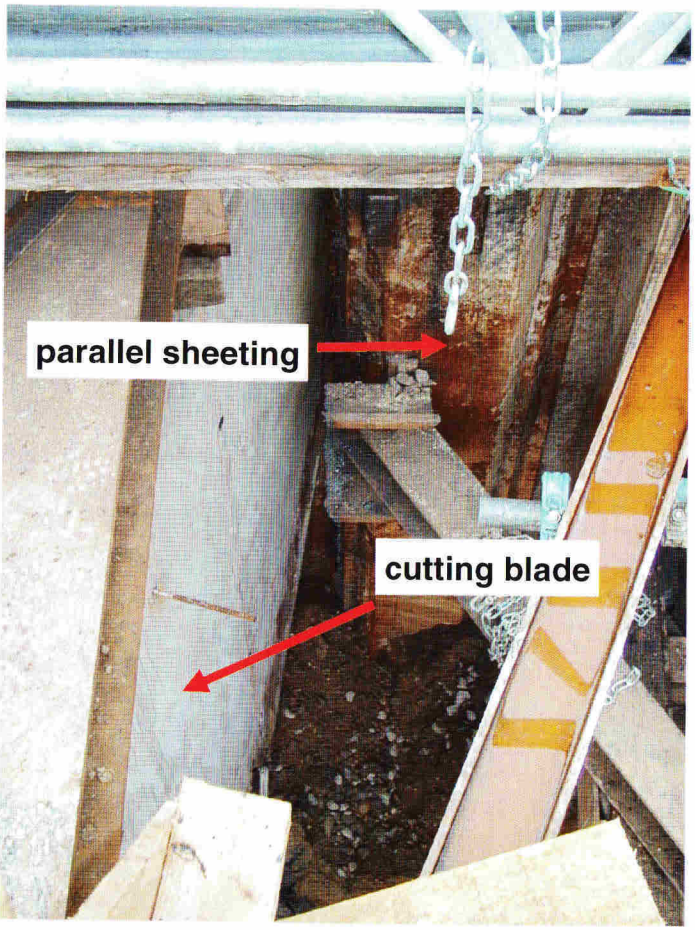


Lecture „Construction Method – RSGS“©

- Temporary Sheeting -

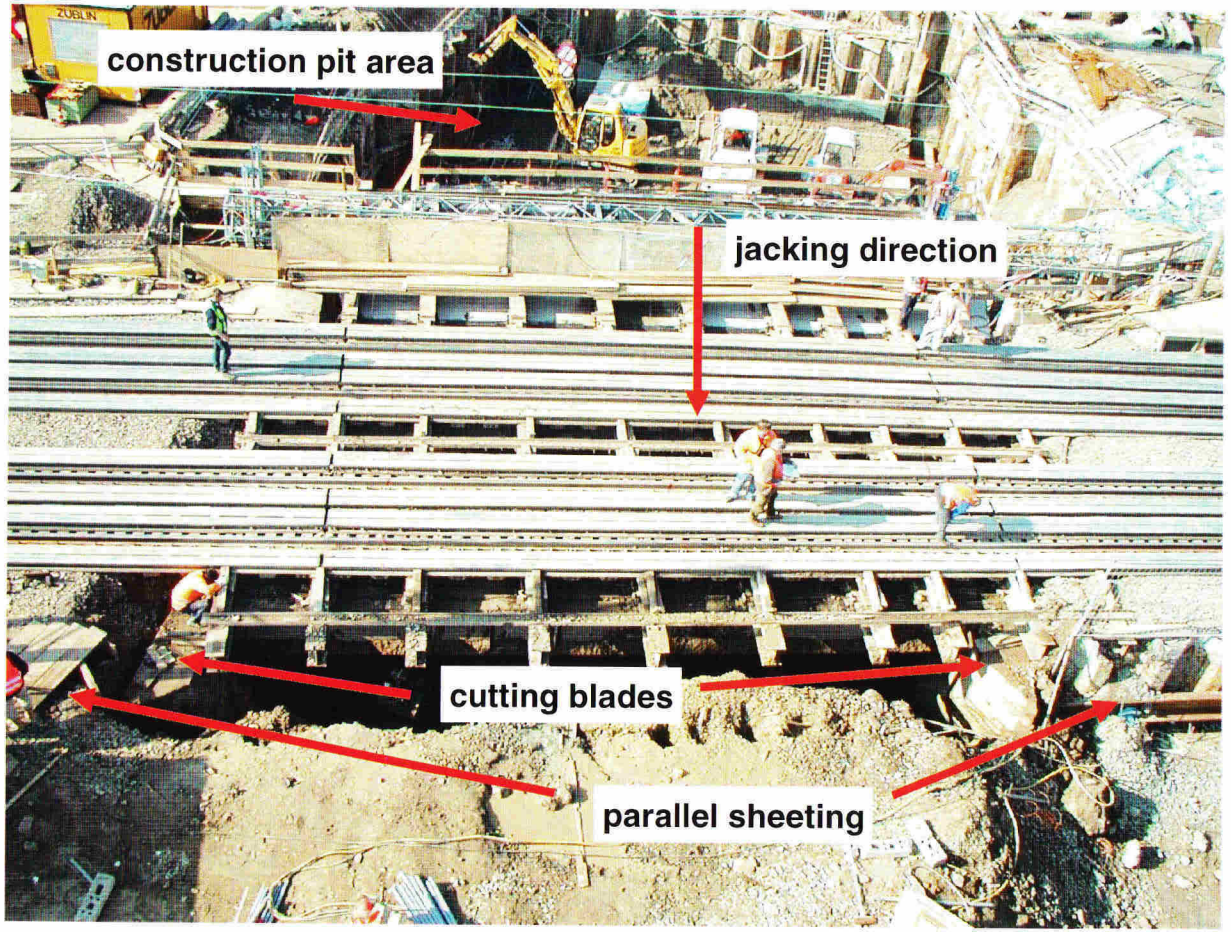
Eurail.-Ing., Dipl.-Ing.(FH), Ing.
Magnus Hellmich
Dipl.-Ing.(FH), EWE
Baldur Rögener

Technical measures for safe railway operations are required for protection of construction pits (sheeting)



Cutting blade/ Sheeting

View of construction pit with jacking area



Lecture „Construction Method – RSGS“© - Advantages and Disadvantages of the RSGS -

Eurail.-Ing., Dipl.-Ing.(FH), Ing.
Magnus Hellmich
Dipl.-Ing.(FH), EWE
Baldur Rögener

For the RSGS method, the decision-making is based on construction site requirements – therefore advantages prevail

Advantages

- Savings of costs for severe conditions, hence overall lower costs
- Approved construction method according to Deutsche Bahn AG guideline 804.4120/9051
- Limited affect on railway operation, normally slow zone 90 km/h
- Smaller ancillary structures – minor ancillary bridges – in contrast to construction methods with ancillary bridges
- Quicker than traditional construction on site, also at right angled intersection
- Execution as full or half frame or only ceiling or superstructure possible
- Also multiple elements placed subsequently or opposing, up to date max. length 51.56m (2 frame blocks)

Disadvantages

- Relatively high construction costs against conventional construction methods without consideration of hampered operating costs (diversions, track closures, rail replacement traffic) and other imponderables (timeliness, no train cancellation or diversions …)
- To be executed only by experienced contractors

Closed frame during jacking operation

Lecture „Construction Method – RSGS“© - Geotechnical Basics -

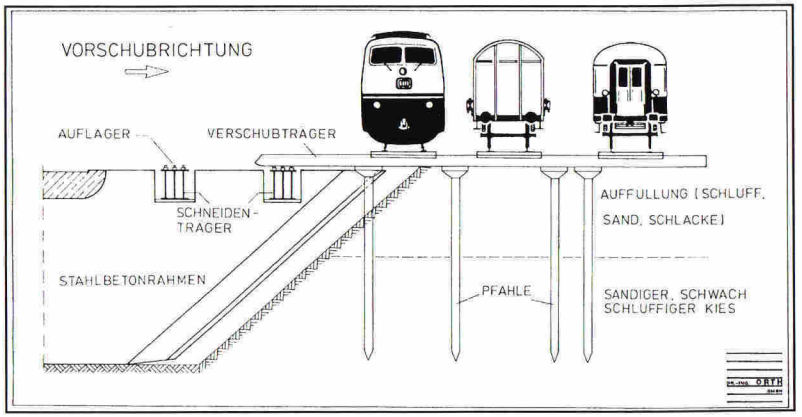
Eurail.-Ing., Dipl.-Ing.(FH), Ing.
Magnus Hellmich
Dipl.-Ing.(FH), EWE
Baldur Rögener

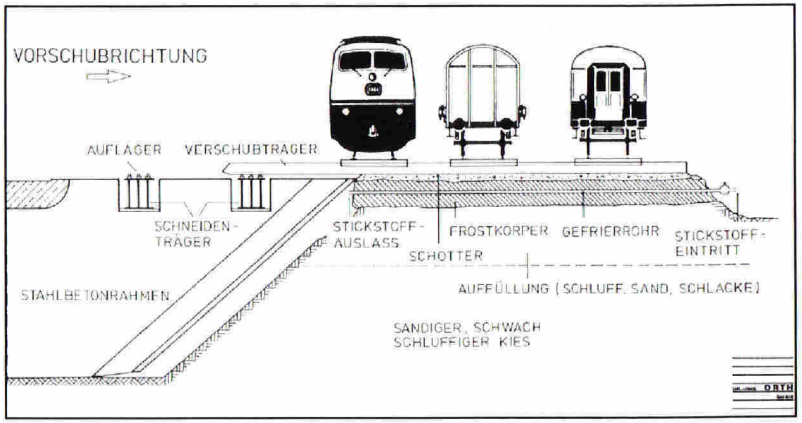
Expert opinion of a soil expert – in Germany possibly an accepted expert for earth-moving and soil mechanics according to sample regulation about the acceptance of experts for earth-moving and soil mechanics following Federal State Building Order dated 18.09.1997 or as approved by the Federal Railway Authority (Eisenbahnbundesamt - EBA)

Boundary Conditions

- Soil mechanic parameters are basic for stability against face collapse and bearing of the girders
- Decision for piling with wood, steel, GEWI-piles acc. to DIN German standard or bearing of beams and transfer of traffic loads with cohesive and loose soil
- If applicable ground stabilization
  – in loose soil by means of injections with silica gel
  – in cohesive soil by means of soil freezing
- Construction in areas of high groundwater level by means of the dock method (impermeable construction pit)
- Pushing base min. 50cm above existing or lowered groundwater level, otherwise risk of ground failure along excavation slope in front of the pushing structure

Foundations for replacement sub-structure by girders instead of sleepers (RSGS) with piles or soil freezing



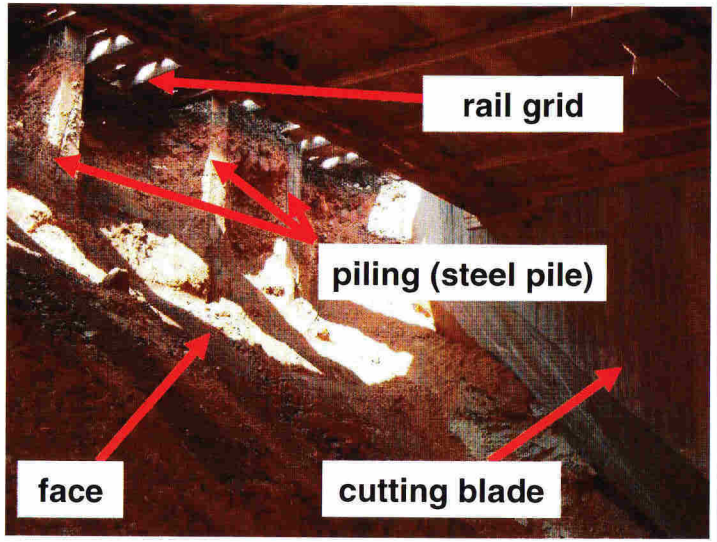


Lecture „Construction Method – RSGS“© - Structural performance of the replacement substructure by girders instead of sleepers -

Eurail.-Ing., Dipl.-Ing.(FH), Ing.
Magnus Hellmich
Dipl.-Ing.(FH), EWE
Baldur Rögener

The replacement substructure by girders instead of sleepers are technically the transfer element for wheel loads through rails and sleepers into the underlying soil, temporary structures or the final structure

Replacement substructure by girders instead of sleepers



- Guarantee
  - good structural performance – load distribution/ transfer as substitute ballast bed – properly executed
  - good stability of rail position and vehicle dynamics during the jacking operation
- Enable
  - similar to ancillary bridges a span up to approx. 30m
  - velocities of ≥ 90 to 120km/h for instance with RSGS with rigid frost slab with special permit possible
  - ≤ 90km/h on straight rails with standard velocity or slow velocity sections
  - UIC-wheel loads up to max. 250Nm (single load) or 80 Nm/m (continuous load)
  - raised tracks of max. 100mm (special construction required)
- Require
  - cutting beam with temporary crossbeams at the new railway overpass
  - additional support and guiding on the new railway overpass
  - controlled soil stability on the face during excavation
- Secure the required transportation comfort for passengers and goods

Besides the placement of the replacement substructure by girders instead of sleepers and the minor ancillary bridges, the construction works are executed outside of the tracks or danger zones

Guarantee of a high level of safety by means of

- High reliability during railway operation
- Low risk of accidents on site
- Pushing or jacking of structures during normal train or operational breaks
- Sufficient work and safety space in the jacking/thrust area
- Permanent contact of the work groups Jacking/Face or Excavation/Superstructure (see Work Instruction)
- Permanent qualified monitoring of tracks or the superstructure after each jacking phase visually or manually (with instrumentation)
- Permanent positioning of the structure to be pushed or jacked
- Permanent or automatic monitoring of the jack steering (hydraulic pressure)
- Permanent connection to operational and driving staff (immediate emergency stop possible)
- Controlled excavation to guarantee stability of the face and piling

Lecture „Construction Method – RSGS“© - Consideration of Profitability -

Eurail.-Ing., Dipl.-Ing.(FH), Ing.
Magnus Hellmich
Dipl.-Ing.(FH), EWE
Baldur Rögener

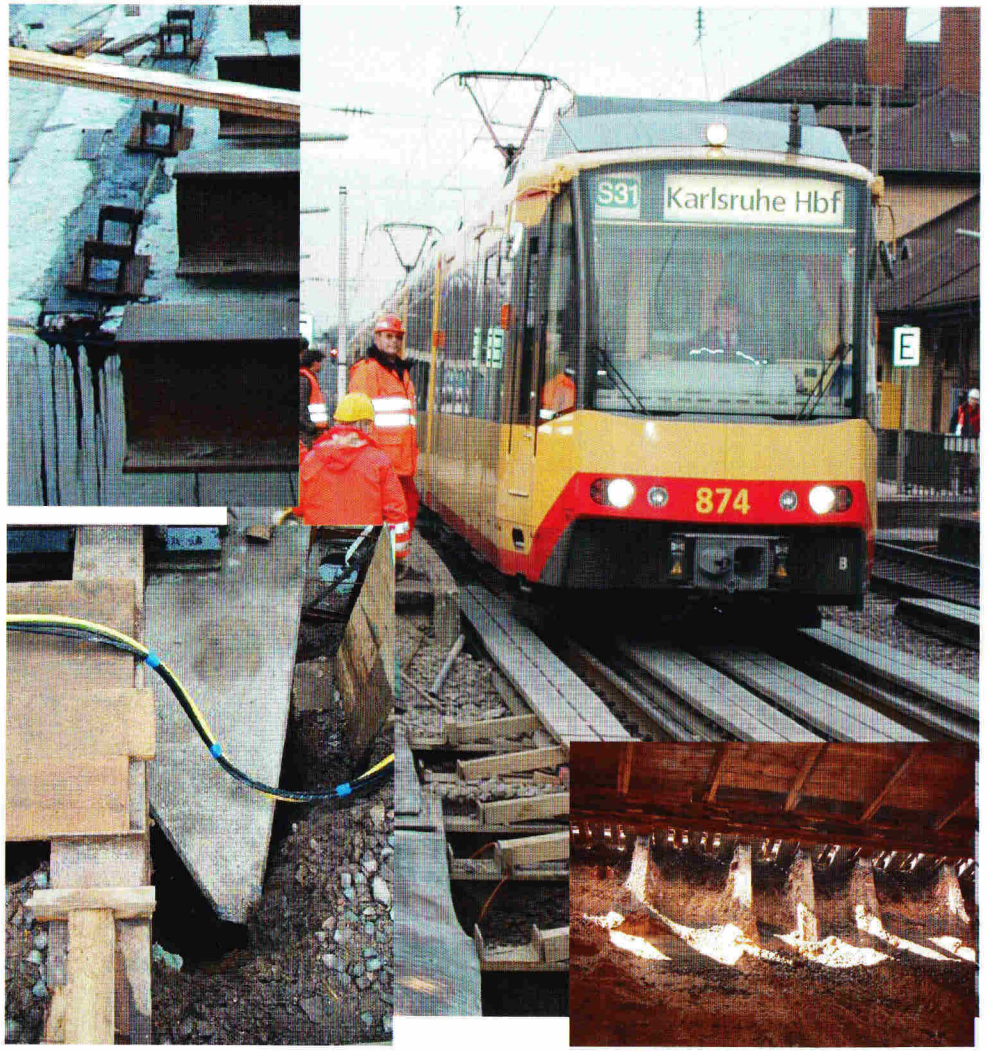
The RSGS includes much know-how, hard to evaluate monetary. However, supported by the cost coding of the Deutsche Bahn AG an economic evaluation is positive.

Economic advantages – Railway Operation:

- Limited loss of driving time due to a slow velocity section of max. 90km/h, no cancellations of trains or only limited delays
- Only short-term affect (off-time) in the railway operation for the construction of the replacement substructure by girders instead of sleepers and during the pushing or jacking
- Limited risk of accidents
- Possible increase of velocity up to 120km/h

Economic advantages – Financing:

- Shorter construction period
- More effective amortization



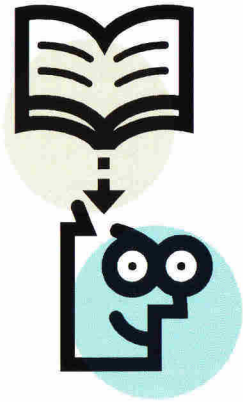
Lecture „Construction Method – RSGS“©

- Execution -

Eurail.-Ing., Dipl.-Ing.(FH), Ing.
Magnus Hellmich
Dipl.-Ing.(FH), EWE
Baldur Rögener

The execution of the RSGS bears high requirements on all involved – Designer, Contractor, Experts, Authorities, Site Supervision.

General and special requirements



- **Good preliminary investigation and design** already with detail solutions for tendering in cooperation with experts of earth-moving and soil mechanics and a special contractor qualified for this job.
- **High experience and expertise** of the designer for tendering and the designer for execution
- **Limited tendering** and proof of qualification to submit a tender, award to capable contractors (references)
- **Long-term experience** of the contractor in ground and civil engineering including references with technical equipment involved
- **Detailed Work Instruction** for Execution (Who, what, when, how?)

- Contractor with **experience in railway construction** with additional structures among others:
  - civil engineering
  - ground engineering – pipe and box jacking techniques
  - superstructures/track construction
- Contractor with **general site management for the entire job**/ experience with the working method and section engineers/general foremen for special sections

Lecture „Construction Method – RSGS“© - Alternatives/ Variations of the RSGS -

Eurail.-Ing., Dipl.-Ing.(FH), Ing.
Magnus Hellmich
Dipl.-Ing.(FH), EWE
Baldur Rögener

Usage of ancillary bridges is possible as alternative solution – the variations of the RSGS differ apart from the regular and large sections also from the way of bearing

Basics for decision-making are technical or geological boundary conditions

- *Track closure possible?* – particularly advantageous during pushing as well as jacking several structures simultaneously along the same route (synergy effects)
- *Coverage of the structure or required measurement between structure and upper level of rails ≥ 70cm + deflection?* – substantial for the erection of ancillary bridges or minor ancillary bridges
- *Permissible soil bearing load?* – decides the application of regular sections or large sections
- *Groundwater level above pit or pushing level (max. -0.5m)?* – Type of execution of the pit (impermeable) or groundwater lowering
  - also at jacking/receiving area (start/target pit)

Pushing of structures inside or across during railway operation

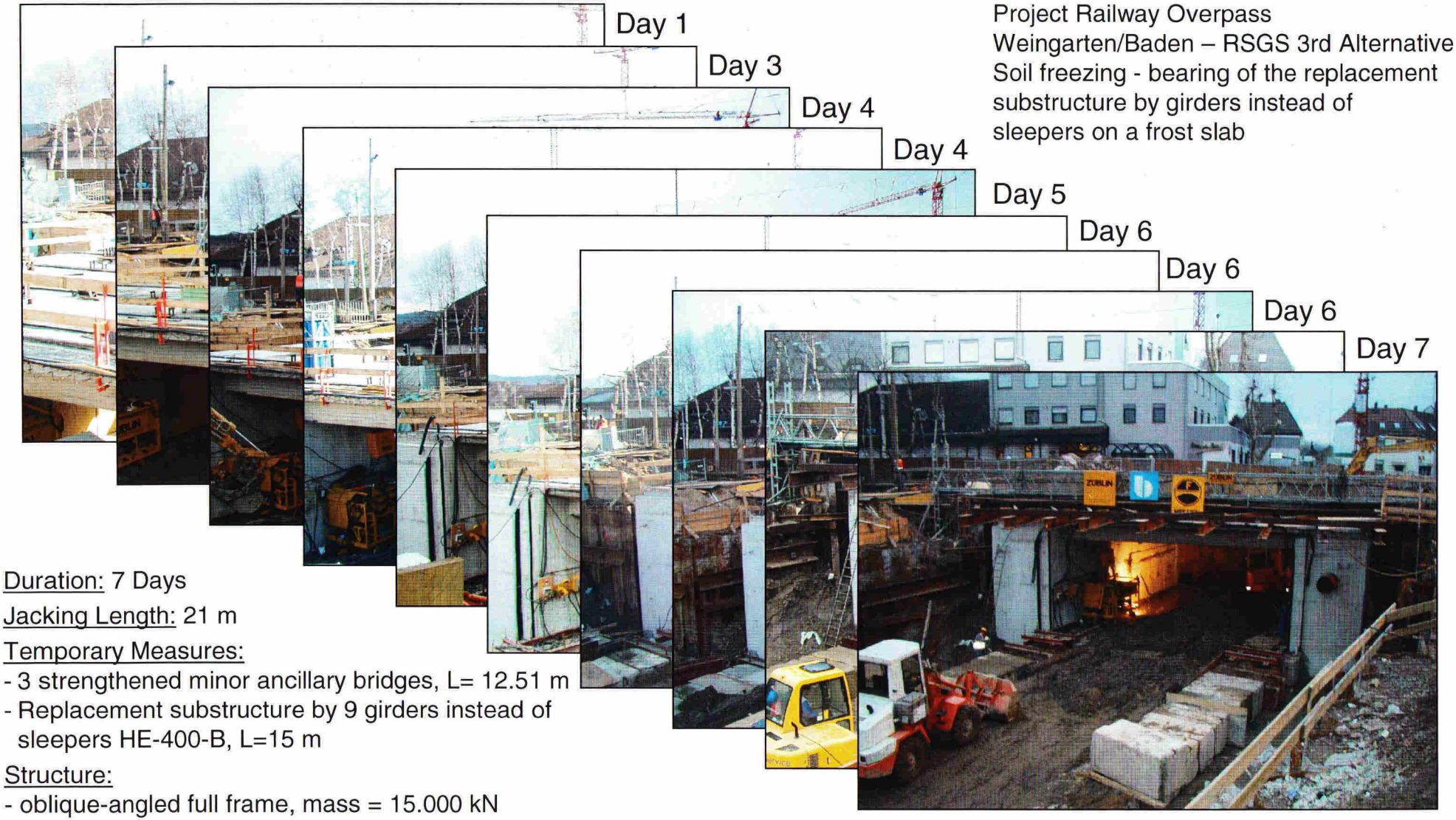
- Usage of ancillary bridges protected by lateral and longitudinal track sheeting
- if necessary construction of an impermeable pit required at start or at reception area required

Pushing of structures inside or across without railway operation

- with track closure
- with open pits with or without temporary structures/sheeting

Eurail.-Ing., Dipl.-Ing.(FH), Ing.
Magnus Hellmich
Dipl.-Ing.(FH), EWE
Baldur Rögener

Realization of a box jacking (RSGS with soil freezing) in 7 days



Project Railway Overpass
Weingarten/Baden – RSGS 3rd Alternative
Soil freezing - bearing of the replacement substructure by girders instead of sleepers on a frost slab

Duration: 7 Days

Jacking Length: 21 m

Temporary Measures:

- 3 strengthened minor ancillary bridges, L= 12.51 m
- Replacement substructure by 9 girders instead of sleepers HE-400-B, L=15 m

Structure:

- oblique-angled full frame, mass = 15.000 kN
- length = 14.8m; width = 11.6m; height = 5.6m

Lecture „Construction Method – RSGS“©

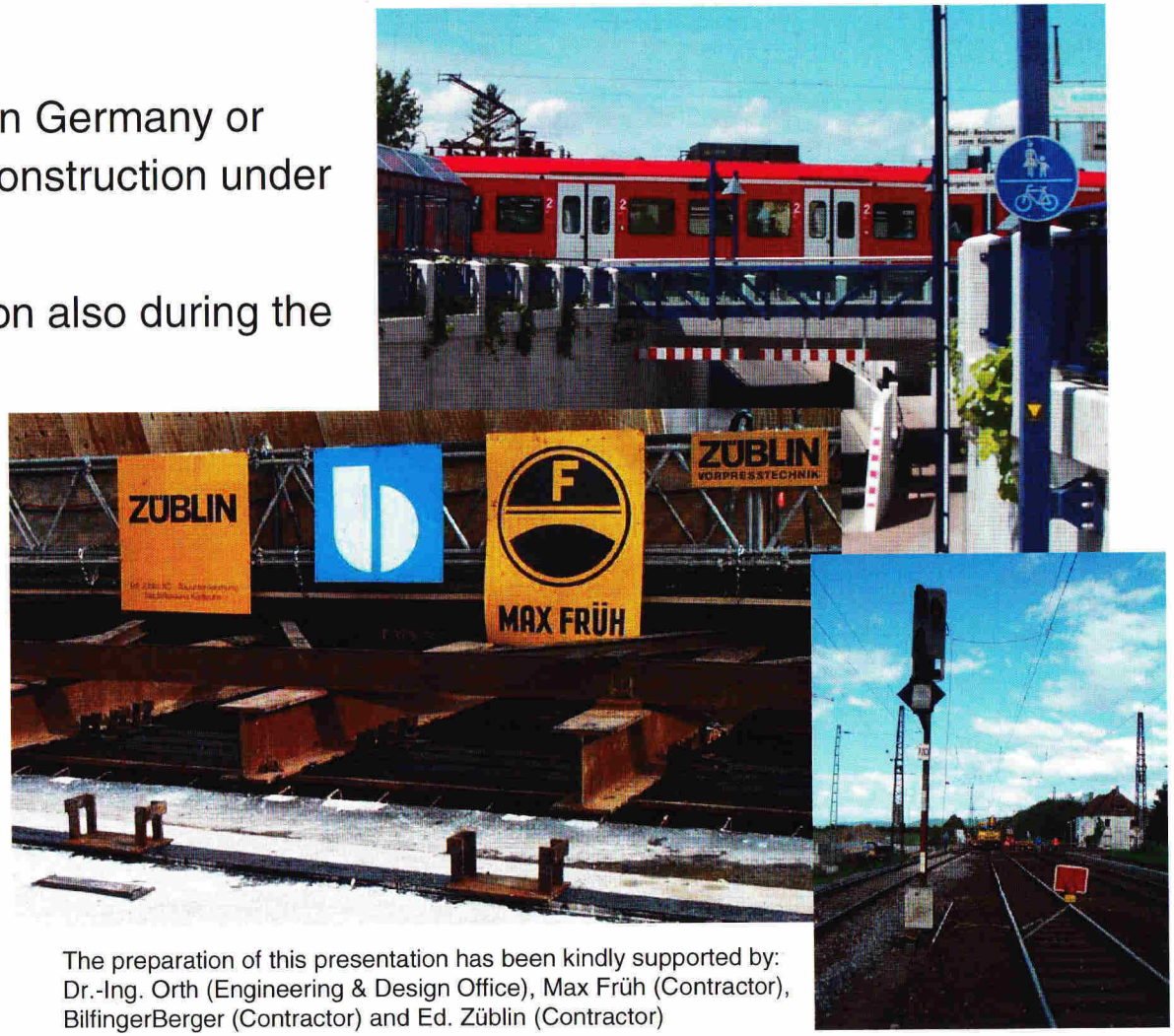
- Summary -

Eurail.-Ing., Dipl.-Ing.(FH), Ing.
Magnus Hellmich
Dipl.-Ing.(FH), EWE
Baldur Rögener

The RSGS is an established method of construction in Germany, which is successful as long as the required basic parameters are applied.

The RSGS is

- Preferred method of construction in Germany or with Deutsche Bahn AG during „Construction under turning wheels“
- Security for a safe railway operation also during the construction period
- Proof for a quick and low-cost construction method
- Confirmation for strong adherence to completion dates at optimized construction periods
- Successfully applied method of construction applied already also in Italy and Austria



Thank you for your attention!

The preparation of this presentation has been kindly supported by: Dr.-Ing. Orth (Engineering & Design Office), Max Früh (Contractor), BilfingerBerger (Contractor) and Ed. Züblin (Contractor)