ResearchGate

See discussions, stats, and author profiles for this publication at: https://www.researchgate.net/publication/262905842

Design of semi-integral and integral high-speed railway bridges – Experiences with the Gruben Viaduct and Gaensebach Viaduct

Article *in* IABSE Symposium Report · January 2012

CITATION
1

READS
3,613

3 authors, including:

Philipp Wenger
Schlaich Bergermann und Partner
8 PUBLICATIONS **21** CITATIONS

SEE PROFILE

Arndt Goldack
University of Wuppertal
34 PUBLICATIONS **256** CITATIONS

SEE PROFILE

All content following this page was uploaded by Arndt Goldack on 04 May 2015.

The user has requested enhancement of the downloaded file.

IABSE
AIPC
IVBH

Design of semi-integral and integral high-speed railway bridges – Experiences with the Gruben Viaduct and Gaensebach Viaduct

Journal:	*IABSE Conference Cairo 2012*
Manuscript ID:	Cairo-0130-2012.R1
Theme:	Structural Engineering as part of Multi-disciplinary Systems
Date Submitted by the Author:	n/a
Complete List of Authors:	Keil, Andreas; Schlaich Bergermann und Partner, Wenger, Philipp; Schlaich Bergermann und Partner, Goldack, Arndt; Schlaich Bergermann und Partner,
Type of Structure:	Bridges
Material and Equipment:	Concrete, Prestressing
Other Aspects:	Innovative Structural Systems, Conceptual Design and Realization, Codes and Standards

SCHOLARONE™
Manuscripts

Experiences with semi-integral, high-speed railway bridges during design and construction of the Grubental Valley-Bridge and Gaensebachtal Valley-Bridge

Andreas Keil * **Philipp Wenger **** **Arndt Goldack *****

* schlaich bergermann und partner; Stuttgart, Germany; a.keil@sbp.de
** schlaich bergermann und partner; Stuttgart, Germany; p.wenger@sbp.de
*** schlaich bergermann und partner; Berlin, Germany; a.goldack@sbp.de

Keywords: semi-integral bridge, railway bridge, high-speed railway, pre-stressed concrete bridge, dynamic stability, rail-stress, fatigue, German Railway Authority DB Netz AG, VDE8

In the course of one of the biggest infrastructure developments of the German Railway Authority Deutsche Bahn AG, the New High-Speed Railway route VDE8 (Verkehrsprojekt Deutsche Einheit Nr. 8) between the cities of Nuremberg and Leipzig, several innovative bridge structures have been designed and built or are currently under design and construction, respectively.

A special feature of these bridges is the use of continuous, multi-span pre-stressed concrete girders as well as the waiving of structural bearings for the support of the superstructure. Instead of bearings, monolithic connections of the substructure and the superstructure are used in order to improve transfer of braking forces, robustness and to reduce maintenance efforts for the bearings. These bridge types are therefore called “integral” or “semi-integral” bridges, the latter, since most of the bridges have bearings at the abutments.

Semi-integral railway bridges for high-speed railway traffic raise several technical challenges and furthermore a couple of additional approval procedures, since the semi-integral construction method leads in parts to variations from the general as well as the railway specific design rules. Among the technical challenges themes such as proof of rail-stresses for longer bridges, proof of dynamical stability under design speed, and fatigue behaviour of monolithic connections need particular attention and handling. In addition to the usual structural engineering peer review, all semi-integral bridges required internal approvals from the German Railway Authority DB AG (UiG) as well as governmental “single-case-approvals” (ZiE) of the Federal Railway Authority (EBA) for design and construction due to the variations from the design standards.

The experiences made in the field of the design and the construction of semi-integral high-speed railway bridges shall be demonstrated on the basis of two bridges, which are currently being designed by schlaich bergermann und partner, the new Grubental Valley Bridge and the new Gaensebachtal Valley Bridge.

The Grubental Valley Bridge is a double-track concrete bridge with a total length of 215m, with regular span lengths of 25m and a 90m-arch spanning over the valley floor. Here, the pre-stressed double-beam concrete superstructure is rigidly connected with the very stiff, reinforced concrete arch - in terms of the transfer of the high braking loads of the trains – as well as the longitudinally arranged columns, made of slender, reinforced concrete walls.

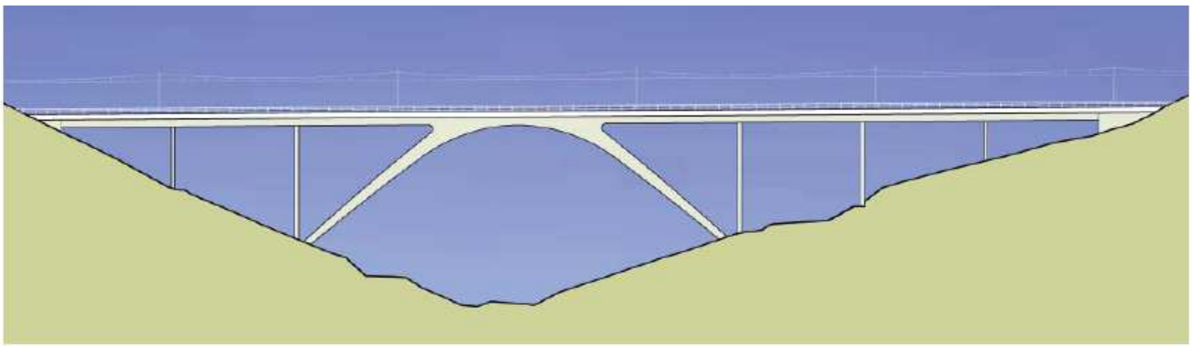


Fig.1: Grubental Valley Bridge, VDE 8.1

The walls allow for a monolithic connection since the bending resistance against constraint stresses like temperature is comparable small. Transversal loads like wind are transferred by the arch and the walls. The bridge ends are supported at the abutments by longitudinally free and transversally fixed spherical sliding bearings.

The stiff frame system formed by the superstructure and by the arch reacts with minimal deflections and longitudinal movements under train load and braking load respectively. Therefore the slab-track that will be applied on the whole route can smoothly be applied on the bridge as well. The bridge is designed for high-speed public railway traffic for a design speed of 300 km/h as well as for heavy weight cargo traffic and shall be opened in 2017.

The Gaensebach Valley Bridge within the course of the new German High-Speed Railyway route VDE8.2 connects Halle with Leipzig. It has been designed as an alternative proposal with a semi-integral concrete superstructure, considering the exposed location of the bridge in the wide, flat valley. Consequently, a slender, filigree bridge structure with a chary embedding in the environment was the design intention.

Fig.2: Gaensebachtal Valley Bridge, VDE 8.2 (Photo: Adam Hörnig Baugesellschaft)

The Gaensebach Valley Bridge was constructed as a pre-stressed double-web concrete superstructure, rigidly connected with the reinforced concrete columns, with a total length between the abutments of 1001m. The superstructure is subdivided into 10 blocks (2x56m + 8x112m), however, with continuous rails without gap. Braking loads are transferred to the foundations through diaphragms made of V-shaped walls in the middle of each block. Similar stiffening with V-shaped walls has been used for transversal forces due to wind or side-impact.
The bridge is designed for high-speed rail traffic for a design speed of 300 km/h as well as for heavy weight cargo traffic and shall be opened in 2017, too.

Both bridges have a series of demanding, individual technical specifics related to the semi-integral construction method. Some interesting examples of the design and the construction shall be presented in the following paper. (pw)

Design of semi-integral and integral high-speed railway bridges – Experiences with the Gruben Viaduct and Gaensebach Viaduct

Andreas Keil
Managing Director
schlaich bergermann und partner
Stuttgart, Germany

Philipp Wenger
Dipl.-Ing.
schlaich bergermann und partner
Stuttgart, Germany

Arndt Goldack
Dr.-Ing.
TU Berlin, schlaich bergermann und partner
Berlin, Germany

Summary

In the course of one of the biggest infrastructure developments of the German Railway Authority Deutsche Bahn AG after the German reunification, the New High-Speed Railway line VDE8 (Verkehrsprojekt Deutsche Einheit Nr. 8) connecting the cities of Nuremberg and Berlin, several innovative bridge structures have been designed and built or are currently under construction, respectively.

A special feature of these bridges is the use of continuous, multi-span pre-stressed concrete girders as well as the waiving of structural bearings for the support of the superstructure. Instead of bearings, monolithic connections of the substructure and the superstructure are used in order to improve robustness and to reduce maintenance cost. These bridge types are therefore called “integral” or “semi-integral” bridges, the latter, since these bridges have bearings only at the abutments.

Integral and semi-integral railway bridges for high-speed railway traffic raise several technical challenges and furthermore a couple of additional approval procedures. Among the technical challenges such as proof of rail-stresses for longer bridges, proof of dynamical stability under design speed, and fatigue behaviour of monolithic connections need particular attention and handling.

The experiences made in the field of the design and the construction of semi-integral high-speed railway bridges shall be demonstrated on the basis of two bridges, which were designed by schlaich bergermann und partner, the new Grubental Bridge and the new Gaensebachtal Bridge.

Keywords: conceptual design; integral bridge; high speed; railway;

1. Introduction Description of the project and the bridges

1.1 German Unity Transport Project VDE8

The German Unity Transport Project VDE 8 (Verkehrsprojekt Deutsche Einheit No. 8) will be a part of the inter-European railway network providing a modern connection between Italy and Scandinavia via Austria and Germany. The project comprises new constructions as well as extensions and developments of existing tracks for a double-track high-speed railway line from Nuremberg – Ebensfeld via Erfurt and Leipzig/Halle up to Berlin [1], [2].

The project is divided into three sections:

- the section 8.1 between Nuremberg and Erfurt, consisting of the upgraded part between Nuremberg and Ebensfeld and the new course between Ebensfeld and Erfurt through the Thuringian Forest.
- the section 8.2, the new course between Erfurt and the Cities of Leipzig/ Halle
- the section 8.3, the upgraded course between the Cities of Leipzig/Halle and Berlin.

The railway track is dimensioned for a design speed of 300 km/h in serviceability limit state SLS (360 km/h for the ultimate limit state ULS) whereas furthermore heavy traffic considered by the application of load models SW/0 and SW/2 is to be taken into account. For the design the current German design rules, the DIN Fachberichte 101 [3] and 102 [4] – generally based on the Eurocodes – as well as the German Railway regulation 'RiL 804' [5] are applicable. Beyond these regulations, all requirements as given by the Technical Specifications for Interoperability (of railways), the TSI, must be fulfilled as well.

For the major part of the new courses the construction of slab track rails is provided. Therefore additional technical rules, given with the requirements for slab-tracks (Anforderungskatalog Feste Fahrbahn) with several demanding design proofs such as the limitation of bridge deflections, have to be considered during the design.

1.2 Modern, integral railway bridges for high speed traffic

It must be mentioned that with the construction of some modern bridge structures, one particularity of the VDE 8 project, the German Railway Authority DB Netze, supported by the recently founded board of bridge advisors ("Brückenbeirat"), expresses its ambition to implement innovation and technical progress at the same time while focusing on the architectural design of the bridges, too. Among these unique bridges are beside the Gruben viaduct and Gaensebach viaduct, the Scherkonde Viaduct, the Unstrut viaduct as well as the Stoebnitz viaduct [6] - [10].

Up to now almost all long viaducts for high speed traffic were built according to an overall standard design of the DB Netz AG from the 1990ties. All these bridges consist of hollow box girders with a structural height of 3.40 m and more. The superstructures with single or multiple spans of 44 m are supported on bearings, which are again placed on massive piers. The piers are designed massive, because amongst others they must be accessible und they have to provide enough space for jacks for replacement of the bearings. A creative adaption of the design to local site and landscape was not envisaged; at best the spans were reduced. Therefore, all the bridges for high speed railway links look similar.

Fig. 1: Standard high speed railway bridge near Vaihingen/Enz, Germany, with a chain of single spans

New paths of conceptual design for railway bridges were presented in the guideline „Design of Railway Bridges“ (“Leitfaden zu Gestaltung von Eisenbhnbrücken”) published by the DB Netz AG [11]. The location and the surrounding of a bridge have a decisive impact on the design of a particular bridge. Therefore, the guideline shows a large variety of bridges for different landscapes, amongst others, bridges for steep and deep valleys in fig. 2 and for broad and plain valleys in fig 3. The conceptual idea for the latter is simple but effective: reducing the spans facilitates comparatively slender superstructures und filigree bridges. Such designs fit much better in a broad and plain valley than a rather clumpsy standard design.

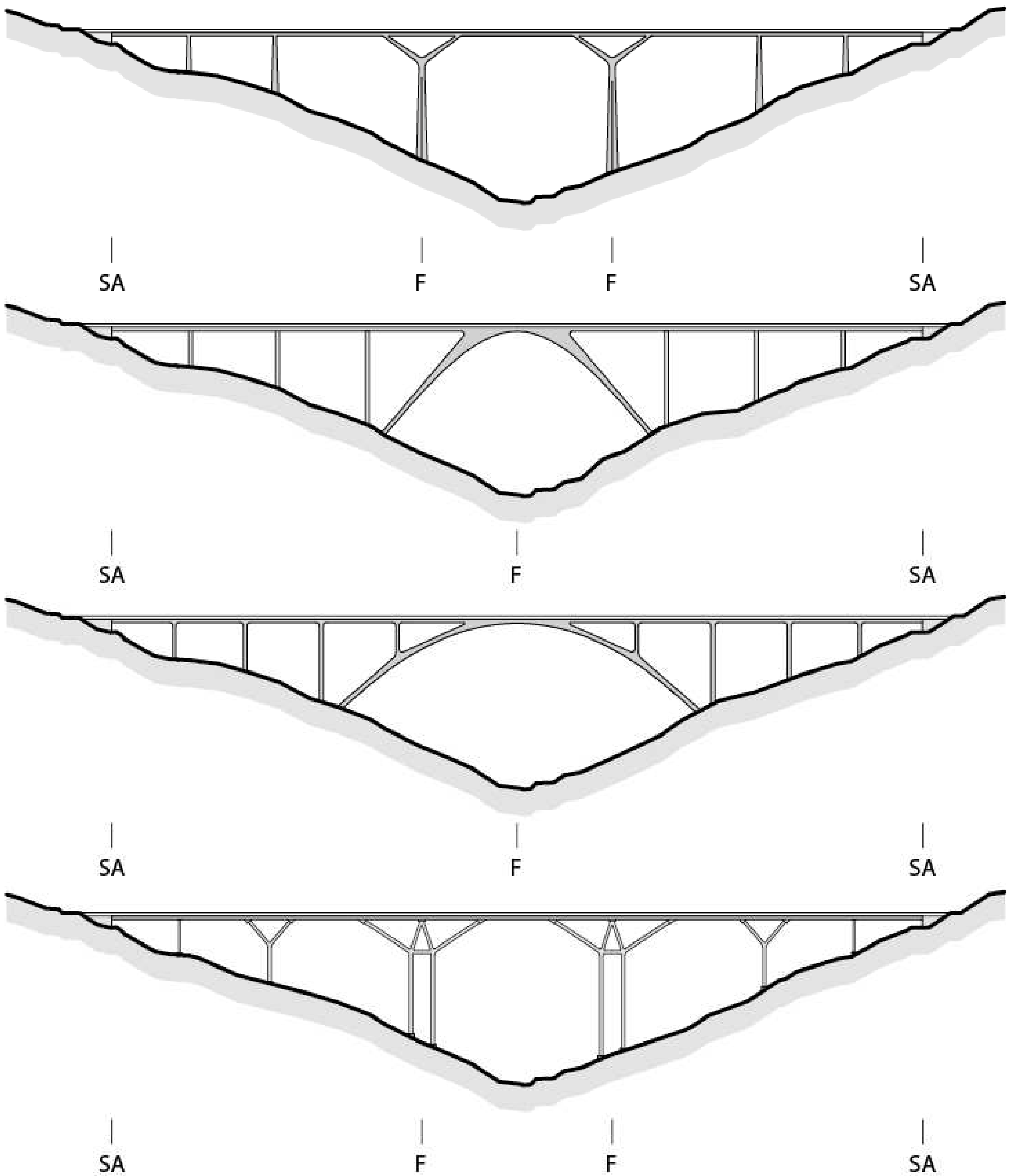


Fig. 2: Layout of different alternative bridges for a steep and deep valley [11]

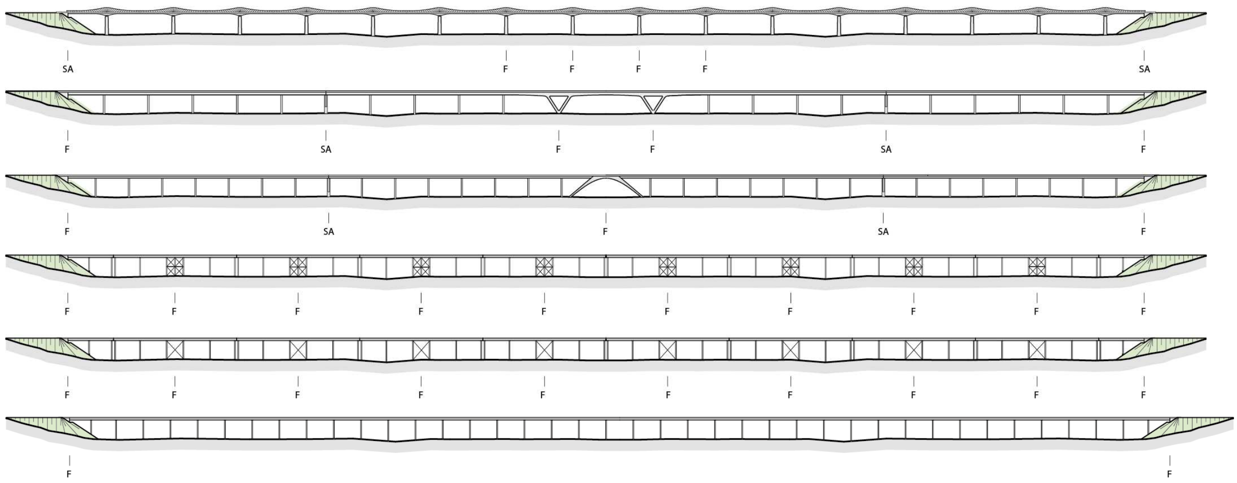


Fig. 3: Layout of different alternative bridges for a broad and plain valley with medium depth [11]

The goal of the guideline is not to provide a new set of standard designs, but to encourage designers to concern their selves with a unique design challenge for each bridge. Furthermore, design is not limited to the overall layout of the bridge, in the same manner it has also to care about the details of the bridges. Here, new possibilities are offered by integral bridges, where the piers are connected monolithically with the superstructure resulting in slender piers without bearings and thus more filigree structures. This robust construction type has been proofed already for long road bridges. For the first time this construction type has been applied in Germany for five new long viaducts for high speed railway courses. Without bearings, the maintenance costs are reduced and paid back during the entire life time of the bridges at the same manufacturing cost compared to the standard design. After all, the new bridges have achieved acceptance in an open tender in direct comparison with the standard designs.

Exemplarily the experiences during the design of the Grubental viaduct which crosses a steep and deep valley and the Gaensebachtal viaduct which crosses a broad and plain valley are reflected below.

2. Design of the (semi-) integral bridges

2.1 The design of the Gruben bridge

The Grubental Bridge is designed as a concrete arch bridge [6]. The bridge is situated in the centre of the Thuringian Forest in section 8.1 of the VDE 8 project and crosses subsequent to the 1,1 km long Goldberg Tunnel the Gruben Valley (“Grubental”) with a maximum height of app. 35m above ground and a total length of 215 m. The semi-integral bridge of the final design is particularly identified by the truss-frame-like double-hinged arch, spanning over 90 m and having a distinct crest. This type of arch enables the execution of similar continuous spans and allows the waiving of columns upon the arch-legs. In the sequel follow the arch bridges Rehtal Bridge, Dunkeltal Bridge and the Massetal Bridge.

Divergent from the tender design, the Grubental Bridge has been designed and awarded as a semi-integral structure with a solid, reinforced concrete arch, solid and slender column-walls as well as a pre-stressed double-web concrete T-beam according to the design-concepts in [11], see fig. 4 to 7.

Fig. 4: Rendering of the Grubental bridge

During the conceptual design, high attention was paid to develop a filigree and transparent structure by using the integral construction type consisting of a monolithic connection between superstructure and substructure as well as the joint less superstructure between the abutments. In particular the waiving of the massive separation piers of the tender design proposal, founded on the abutments of the arch, lead to an accentuation of the arch as the main visual element of the bridge.

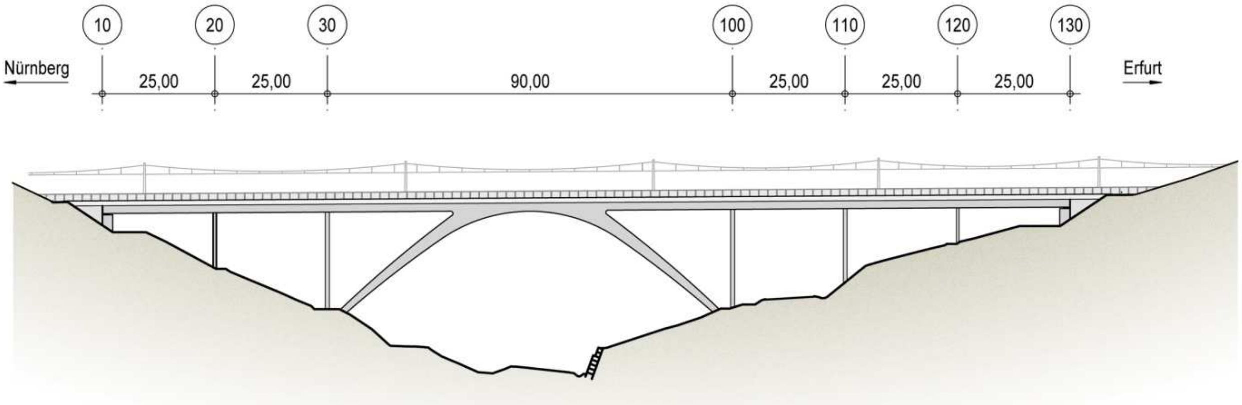


Fig. 5: Elevation semi-integral Grubental bridge

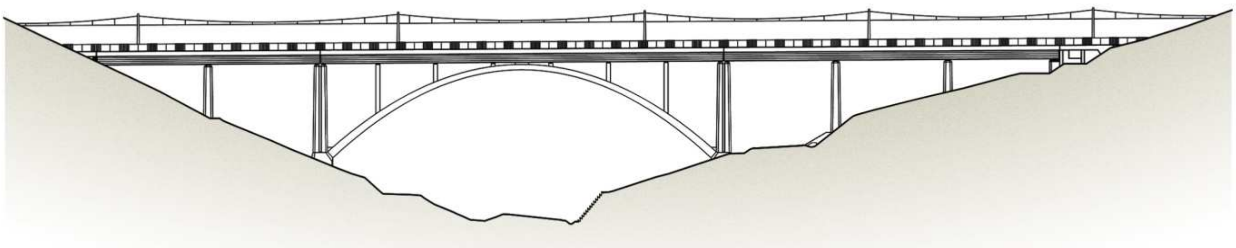


Fig. 6: Elevation standard design proposal

Due to the rigid and torsion-stiff fixation of the superstructure at the column-walls as well as the waiving of intermediate piers upon the arch legs, the forked arch legs could be executed massive and with reduced dimensions. In comparison, the tender design proposal needs a stiff arch structure (made of a hollow-box section) in order to prevent uplift-forces at the separation piers.

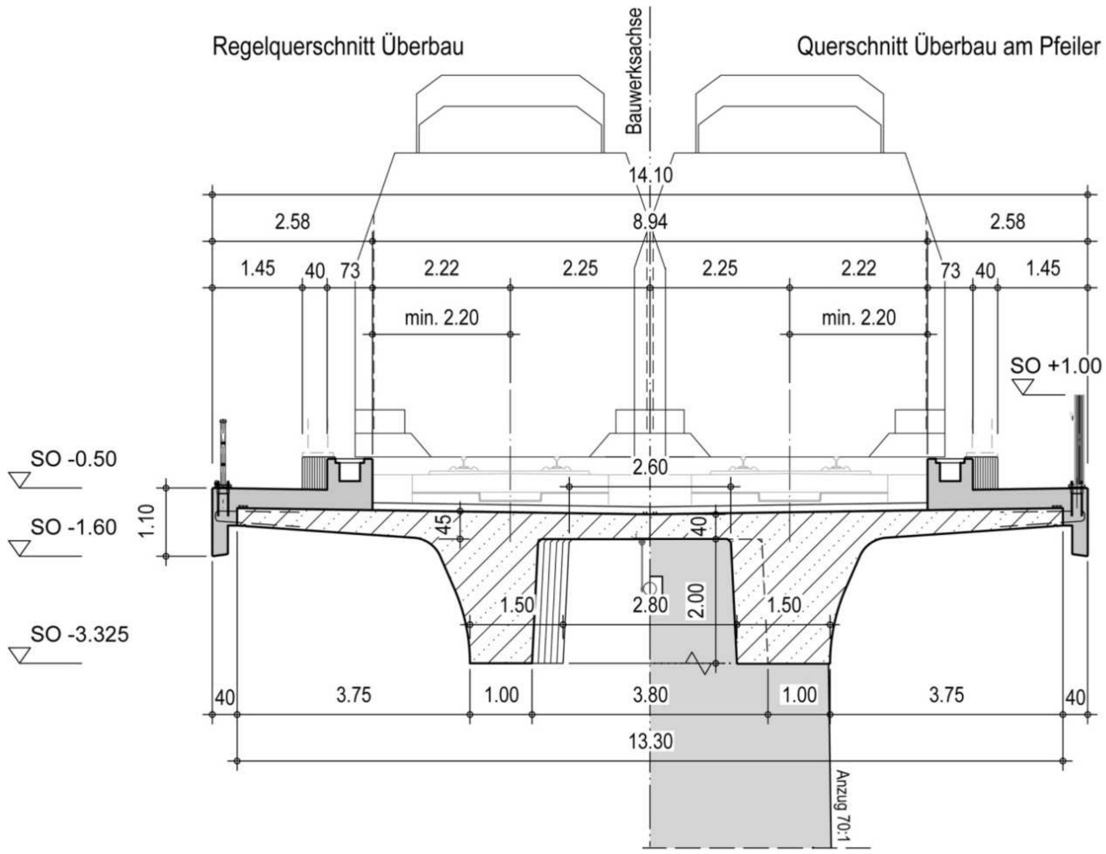


Fig. 7: Typical cross section at span/pier

The superstructure consists of a pre-stressed double-web T-beam with a constant height of 2.40 m, having web-haunches towards the column-walls. The spans are continuous with 25 m and 24 m at the abutment ends. The superstructure is monolithically connected with the column-walls as well as the arch-crest, over a length of app. 35 m.

All column-walls have a uniform width at the connection with the superstructure of 5.90 m and the shape is widening downwards with a ratio of 1:70 in transversal dimension while the column thickness remains constant over the height. Accommodating the integral construction type's specifics, the column thickness are varying between 60 cm (axis 120) and 90 cm (arch-abutment columns), in order to provide sufficient elasticity for constraint actions like constant temperature changes.

The central arch is made of two solid legs, each sub-divided in transversal direction in 2 forked members with rectangular cross section with a height of app. 1.70 m at the bottom increasing towards the monolithically connected crest to a height of app. 3.30 m. Here, the slightly spread forked legs spawn additional tension in the visual appearance of the arch, see fig. 8.

Longitudinal forces due to accelerating and braking can be transferred completely through the stiff arch structure. At the accessible abutments at the bridge ends, the superstructure is supported longitudinally movable on two spherical sliding bearings at each abutment.

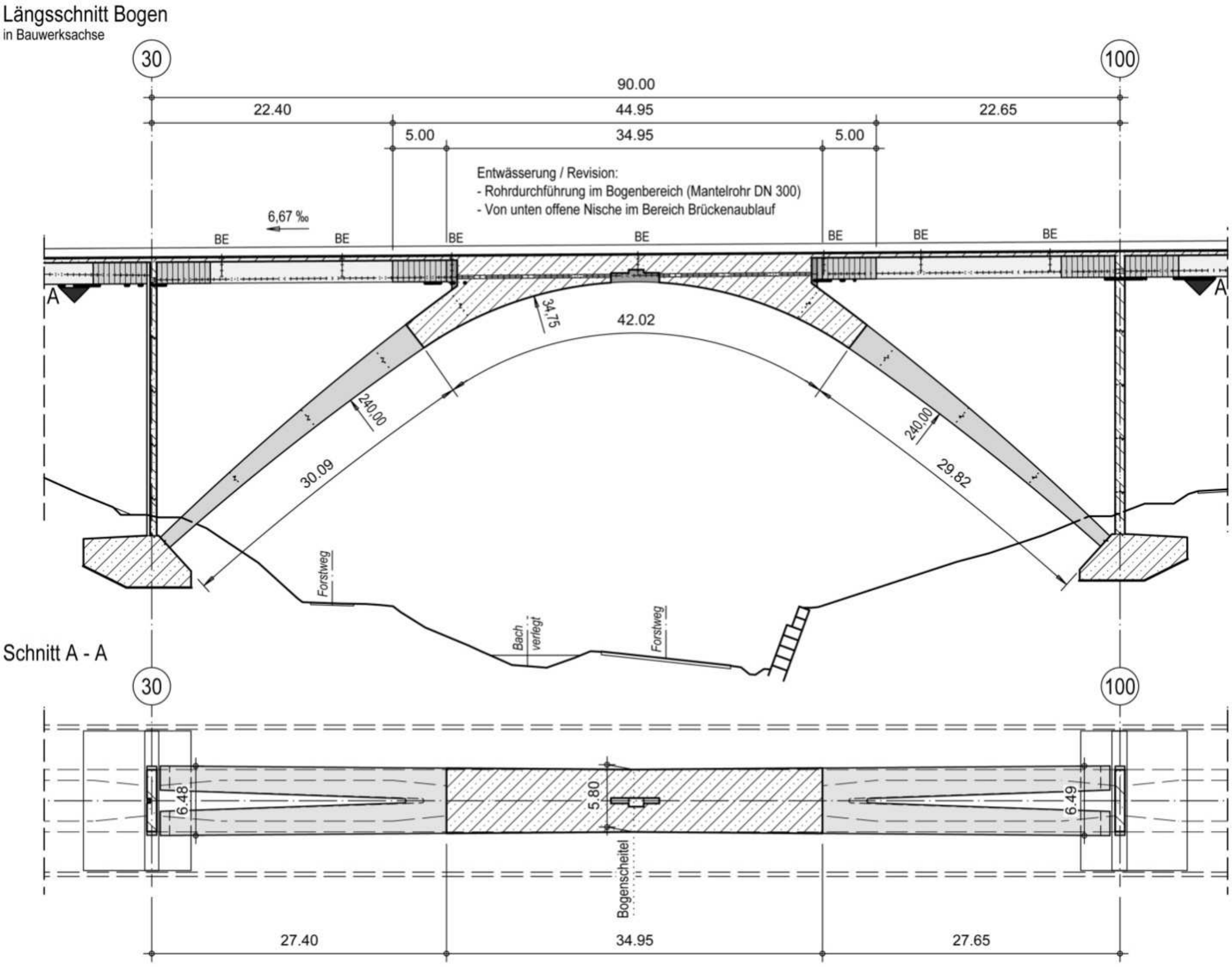


Fig. 8: longitudinal section and plan view of Arch

A concrete type C44/55 was a used for the arch and the superstructure and concrete type C40/50 for the column-walls with an Elastic-Modulus of app. E_c = 28000 MN/m².

2.2 The design of the Gaensebach bridge

The Gaensebach viaduct is located in the north of Weimar and is part of the section 8.2 of the infra-structure project [7]. The Gaensebach valley is a broad and plain valley with medium depth. The basic idea of this alternative design is an integral pre-stressed concrete bridge with a double T-beam for two tracks with a series of segments of 112 m length each and two abutment segments of 52.5 m. The superstructure is monolithically connected to circular reinforced concrete piers. Appropriate for the material involved, the longitudinal stiffness results from V-shaped concrete diaphragms, which transfer the braking forces to the foundations (see fig. 9+10). Accordingly, the transversal stiffness is provided with bracings in transversal direction by v-shaped columns at both ends of each segment (see fig. 11). The double T-beam has a structural height of 2.08 m and a width of 13.84 m. Alterna-tively a design with steel tube columns and steel bracings was investigated, but not built due to higher cost.

The piers of the Gaensebach viaduct have a diameter of 1.0 m at both ends of each segment and a diameter of 1.1 m between the end and the v-shaped diaphragm. The height of the piers varies be-tween app. 12 and 19 m. Each segment of the frame-like structure has spans of

1.5+24.5+24.5+11+24.5+24.5+1.5m = 112 m.

Both 52.5 m long end-segments at the abutment consist of a two span frame bridge and an abutment with abutment walls. The total length of the bridge results in 52.5 m+8*112 m+52.5 m = 1001 m.

The length of the v-shaped diaphragms varies between 10 m and 12 m due to the height above ground and the soil condition, so that the spans deviate negligibly from the mean value of 24 5 m. To meet the requirements of slab-tracks und to avoid a lateral displacement between neighbouring segments, horizontal couplings between those segments are used, which are mounted on cantilevering slab between the two webs of the superstructure.

The foundations consist of bored piles which are place in only on row transversal to the superstructure and connect by a beam to the piers. A concrete type C40/50 was a used for the superstructure and concrete type C30/37 for the piers both with an E-Modulus of E=27000 MN/m².

Summing up, the alternative design is more filigree and fits better in the surrounding than the standard design.

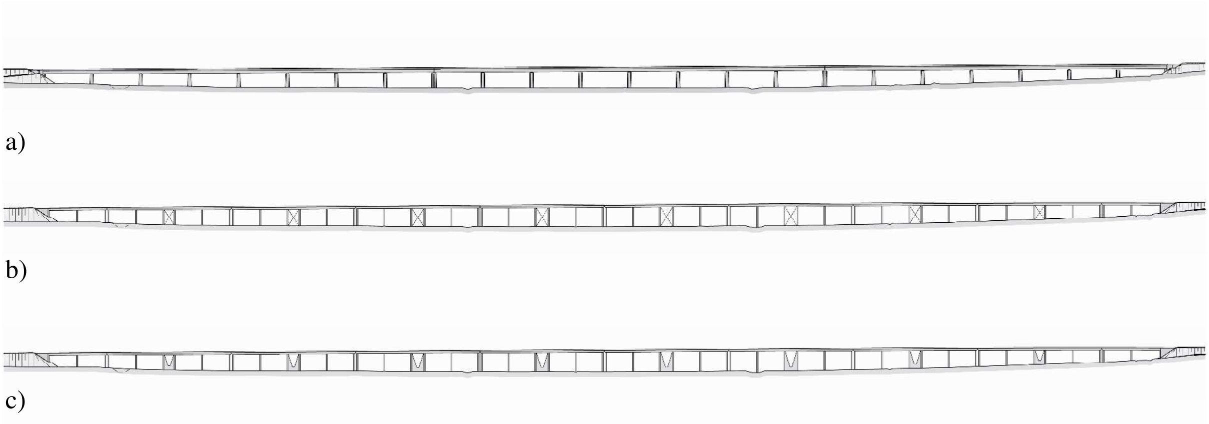
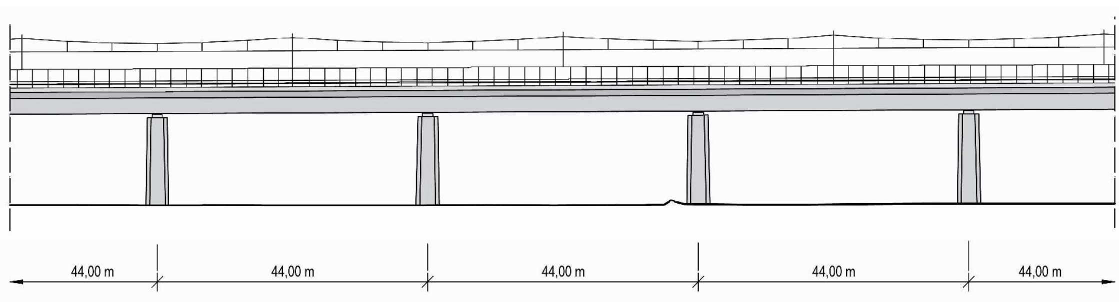
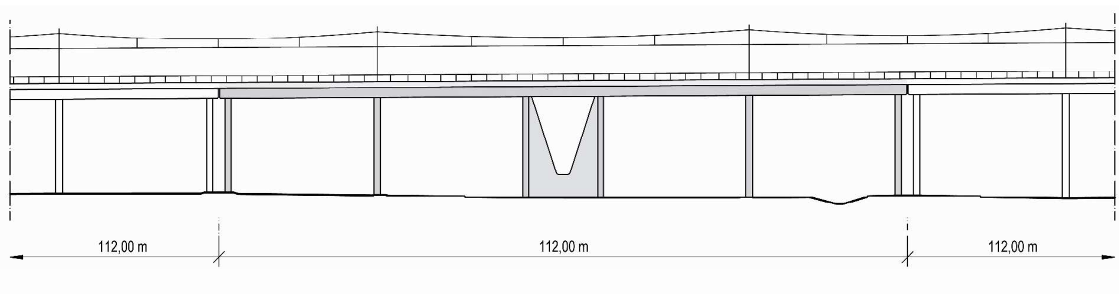


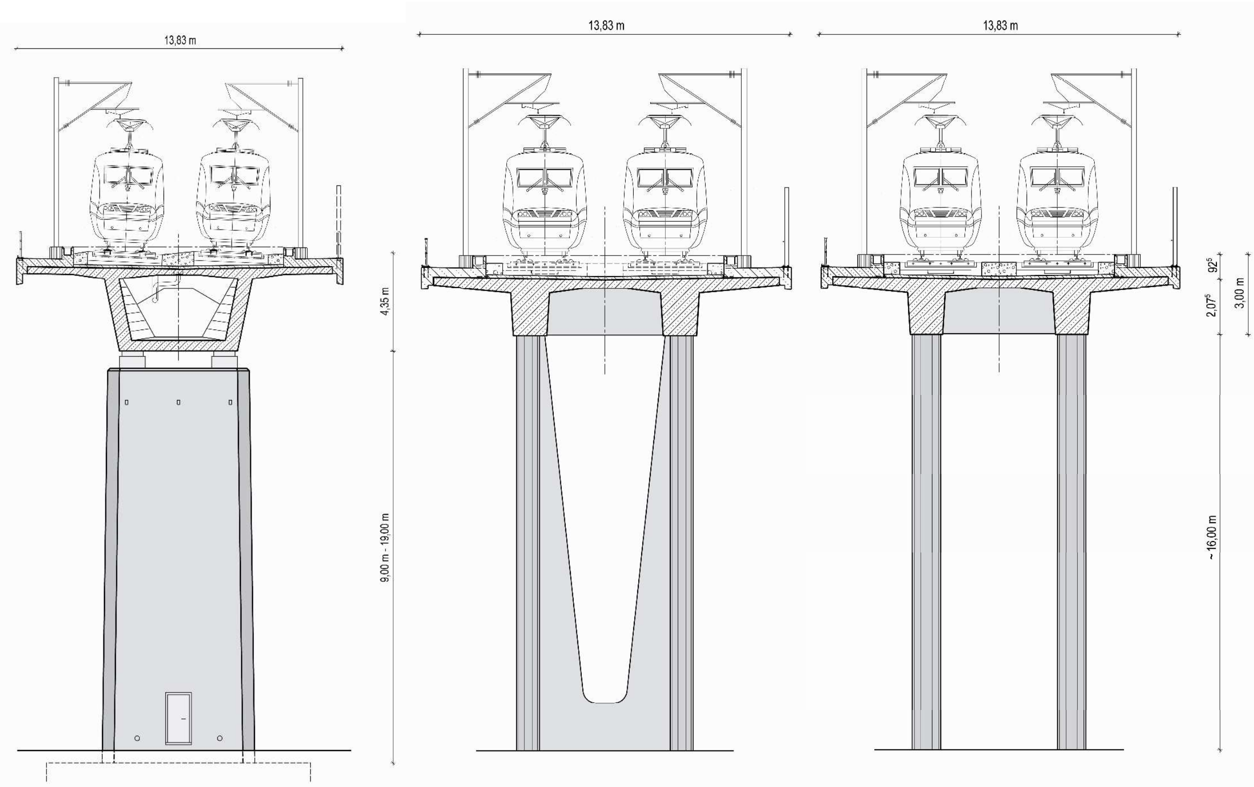
Fig. 9: Comparison a) original design
b) alternative design (steel tube columns)
c) alternative design (concrete columns)



a) Elevation of a section of the original design



b) Elevation of a 112m segment of the alternative design
Fig. 10: Detailed elevations



a) original design with hollow-box *b) alternative design with transversal bracing* *c) typical columns*

Fig. 11: Cross sections of the original standard design (left) and alternative design

Fig. 12: Gaensebach bridge during construction

The foundations are all made of bored piles which are placed in a single row transversal to the superstructure and connected with a pile-cap-beam to the piers. A concrete type C40/50 was a used for the superstructure and concrete type C30/37 for the piers both with an E-Modulus of $E_c = 27000$ MN/m².

2.3 Comparison of the two bridges

The conceptual design of both integral bridges is based on the ideas presented in the design guideline [11]. In both cases, the integral structure type was handled differently, however adapting to the different boundary conditions such as the topology, the total bridge length and soil conditions.

First to mention, the transfer of horizontal braking forces is an important design issue. The longitudinal stiffness of the combined system consisting of substructure and superstructure needs to be sufficiently high in order to keep the longitudinal movements of the bridge caused by braking loads small enough to keep the rail-stresses at the joints within the determined limits ($\leq \pm 92$ N/mm², [6], [8]). Otherwise rail-expansions are needed, which are costly at installation and maintenance.

The Grubental Bridge has its fixed point naturally for the structure-type at the crest of the arch. Longitudinal forces are transferred in compression and tension through the legs of the arch, which could be well founded within the slopes of the steep valley. Correspondingly and due to the rigid, integral superstructure, longitudinal movements are small. Nevertheless, the free length of the northern superstructure of app. 120 m leads to larger longitudinal movements due to temperature actions. Therefore rail extensions at the northern abutment (axis 130) couldn’t be avoided.

At the Gaensebachtal Bridge, the superstructure is divided into segments where each segment has its own fixed point, structurally realized by V-shaped diaphragms between two columns. Here, due to the limited free length of a single segment, also temperature induced longitudinal movements could be kept small and the V-columns provide sufficient stiffness to reduce the rail-stresses at the joints below the limit.

The major construction works of the Gaensebachtal Bridge have been finished in autumn 2011. The termination of construction works of the Grubental Bridge is expected in spring 2012, opening to traffic shall be in 2018.

The following table concludes the major characteristics of the two bridges described above.

	Grubental bridge	**Gaensebachtal bridge**
Total length	215m	1001m; 10 sections with 2 x 52.5m + 8*112 m
Spans	24+25+90+25+25+24 m	1.5+2*24.5+11+2*24.5+1.5m = 112 m
Height above ground	max. 35m	12-18m
Superstructure	double-web pre-stressed concrete T-beam	double-web pre-stressed concrete T-beam
Width of superstructure / total width	13.30 m / 14,10 m	13,84 m
Structure height (at bridge axis)	2,40 m	2,08 m
Pre-stressing (Post-tensioning)	longitudinal and transversal	longitudinal
app. Cost of work	4,5 Mio. Euro	14 Mio. Euro

Tab. 1: technical data for Grubental and Gaensebach bridge

3. Technical challenges

Besides all the technical challenges, an important aspect during the design phase was to get the approvals right in time, because this usually has a direct impact on the construction time schedule. For the integral and semi-integral bridge designs, two special approvals were mandatory since integral structures do currently not belong to ‘proven construction types’ in Germany [5]. Shortly after awarding the contractors with the alternative designs presented above, internal Approvals of the German Railway Authority DB Netze (UiG) for both bridges were achieved. The implementation of all in the UiG formulated special conditions and requirements for the design and construction of the semi-integral bridge have been verified during the independent checking of the detailed design as a major condition for the governmental “single-case-approval” of the Federal Railway Authority (EBA). The single-case approvals were issued in the course of the detailed design, including some further regulations such as a full sensitivity analysis and long-term monitoring programs to observe and verify actions and dynamic behaviour of the bridge in particular.

The semi-integral and integral construction type is accompanied by a couple of technical specifics and challenges, which have to be taken into particular account during the design such as:

- Interaction between structure, foundation and ground with uncertainty of soil parameters.
- Sensitivity analyses: Variation of stiffness parameters for soil and E-Modulus of concrete as well as variation in creep and shrinkage parameters and influence of concrete cracking result in multiple calculations for several service limit state checks and ultimate limit state.
- Dynamic calculations for at least ten HSLM-A trains in the speed range of 160 km/h up to 360 km/h in 5 km/h steps and check of resonance.
- Calculation of rail-stresses including an investigation of stiffness variation.
- Fatigue checks especially for highly stressed members such as the connection of piers to superstructure. Due to the lack of an operation program for the railway link the fatigue check is based on the fatigue endurance strength.
- Mock-ups in 1:1 scale of monolithic connection between end columns and superstructure to check reinforcement layout and concreting (Gaensebachtal Bridge).
- Determination of E-Modulus of concrete to be used because the E-Modulus can deviate from the values in Eurocode by 30%. Control of E-Modulus on site.
- Check of deformation limits for slab-tracks

Integral bridges are hyper static systems. Therefore, the variation of stiffness of the soil condition and of the structure itself has an impact on the distribution of inner reactive forces. To reduce inner reactive forces in the structure e.g. due to temperature effects and shortening of the superstructure due to pre-stressing as well as creep and shrinkage, the stiffness of the foundations and piers should be preferably low. On the other hand a certain longitudinal stiffness for the braking forces is required to limit additional stresses of the rails, as mentioned above.

While the design of the Gaensebachtal bridge verified the waiving of any bearing at all, longitudinally sliding bearings at the abutments couldn’t be omitted at the Grubental bridge, since the bridge could not be separated into shorter ‘segments’ with limited elastic elongations. Hence, constraint reactions at the connection between substructure and superstructure particularly due to temperature actions have to be taken into account as one ruling action for the design of the bridge. Therefore inner forces must be calculated on the basis of linear-elastic calculations, without more realistic consideration of reduced elastic stiffness of structural parts due to crack-growth in the concrete-members (non-linear material behaviour).

In absence of appropriate design rules or exceptional rules for integral structures, the normative requirements result not rarely in rather conservative designs.

All the proofs and additional checks clearly show that these slender sub- and superstructure meets all the requirements for high speed traffic and slab-tracks. Small variations in stiffness parameters like E-Modulus of concrete as well as the concrete cracking have no great impact on the overall design itself.

It shall not be unmentioned, that the design of such integral bridges in the frame of the current codes and technical regulations demand for comparatively high efforts, especially regarding the engineering. From the point of the designers the question is coming up, if the current technical regulations and codes are to their full extend adequate for integral bridges in general and especially for their application to high speed traffic, so that this construction type can be planned, approved and built economically.

4. Conclusions

Based on the guideline for the design of railway bridges two alternative designs for the Grubental Bridge and the Gaensebachtal Bridge were developed, which were favored over the standard design and built as specific proposals of the contractors. Two outstanding samples for a 'not new' but unusual and non-standard construction type were described with the aim of a better understanding of structural, functional as well as aesthetical and economic considerations which have embossed the individual designs. Both bridges, seen from the authors' point of view, are successful samples for integral bridges for high speed lines. They exceed all requirements in terms of structural capacity, robustness and durability as well as economic matters, installation cost and life-cycle cost.

Further generations of design standards may profit of the existing experiences in design and construction of integral bridges and may even be responsive to the individual characteristics of the structural behaviour of these integral bridges, with the purpose to improve structural safety as well as public efforts for high building technology of transit networks. Envisaged monitoring programs will certainly provide more substantial information and will allow more precise prediction of life-cycle stresses such as fatigue-actions and their damage potential on the structures.

Apart from further development of the design rules also approval procedures might take profit from the experiences of the anew structures, built within the project VDE8. The authors wish to share their experiences hereby to advance and enhance structural engineering in all concerned fields.

5. References

[1] Schenkel, M.: Verkehrsprojekt Deutsche Einheit (VDE 8.2): Eisenbahn- Neubaustrecke Erfurt-Leipzig/Halle – Herausragende aktuelle Baumaßnahmen. VDI-Bautechnik Jahresausgabe 2010/2011. S. 41-51.

[2] Schenkel, M.; Marx, S.; Krontal, L.: Innovative Großbrücken im Eisenbahn-Hochgeschwindigkeitsverkehr am Beispiel der Neubaustrecke Erfurt-Leipzig/Halle. Beton- und Stahlbetonbau 104 (2009), Heft 11, S. 782-789, Ernst & Sohn Verlag.

[3] DIN-Fachbericht 101, Einwirkungen auf Brücken. Beuth Verlag GmbH, März 2009

[4] DIN-Fachbericht 102, Betonbrücken. Beuth Verlag GmbH, März 2009

[5] RIL 804, Richtlinie 804, Eisenbahnbrücken – planen, bauen und instand halten. DB Netz AG (2003)

[6] Keil, A.; Wenger, P.; Fackler, T.; Schilling, J.: Die semiintegrale Grubentalbrücke – Besonderheiten bei der Planung. Bautechnik 88 (2011), Heft 10, S. 723-730, Ernst & Sohn

Verlag.

[7] Schenkel, M., Goldack, A., Schlaich, J., Kraft, S.; Die Gänsebachtalbrücke, eine integrale Talbrücke der DB AG auf der Neubaustrecke Erfurt-Leipzig/Halle. Beton- und Stahlbetonbau 105 (2010), Heft 9

[8] Marx, S., Krontal, L., Bätz, S., Vehlow, A.: Die Scherkondetalbrücke, die erste semi-integrale Talbrücke der DB AG auf der Neubaustrecke Erfurt-Leipzig/Halle VDE 8.2. Beton- und Stahlbetonbau 105 (2010), Heft 3, S. 134 – 141.

[9] Jung, R.; Marx, S.; Schenkel, M.; Stockmann, R.: Entwurf und Ausführungsplanung der Stöbnitztalbrücke. Beton- und Stahlbetonbau 106 (2011), Heft 2, S. 81-88, Ernst & Sohn Verlag.

[10] Rimane, T.: Der Bau der Eisenbahnüberführung Unstruttalbrücke. DBV-Heft 21, S.69-70, Deutscher Bautechnik-Tag 2011.

[11] Schlaich, J.; Schmitt, V.; Marx, S.: Leitfaden Gestalten von Eisenbahnbrücken. 1. Auflage; Berlin: DB Netze AG, Dezember 2008, 91 Seiten.

View publication stats