BW 67-1
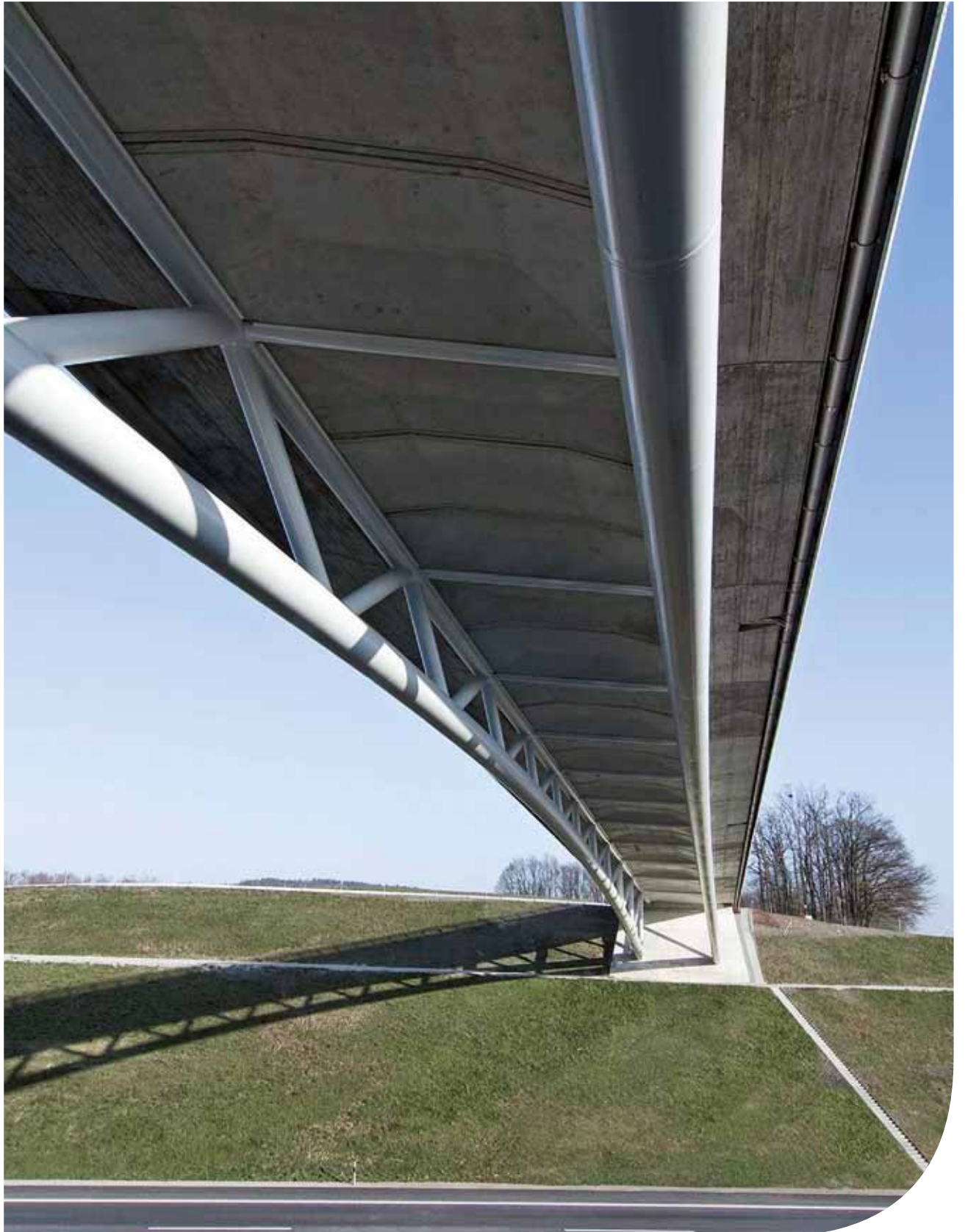
A graceful and innovative bridge over the A73

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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
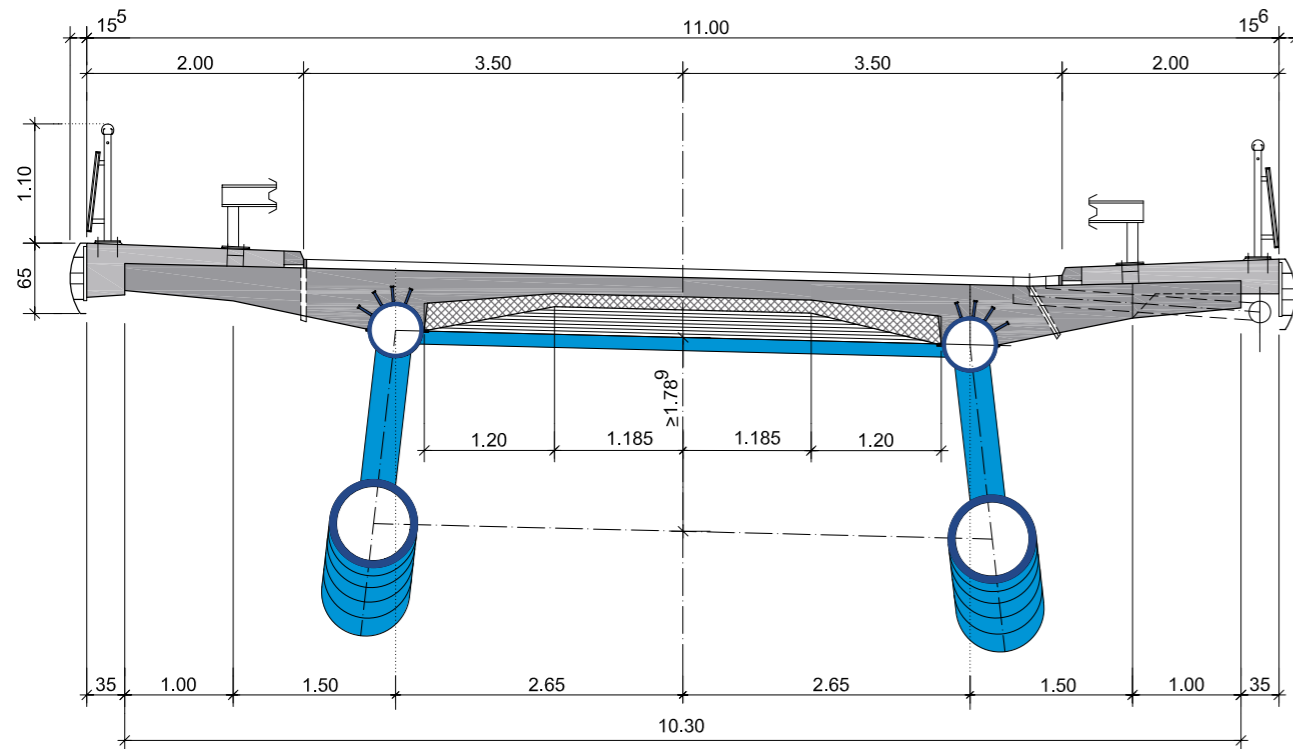
1 Lifting of a shear frame
2+3 Mounting of a lateral element
4 On site welding of joints

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 mainte

nance 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 and longitudinal section

10.62   5.28   90.82   5.67   10.24

R=6015.00   R=286.00
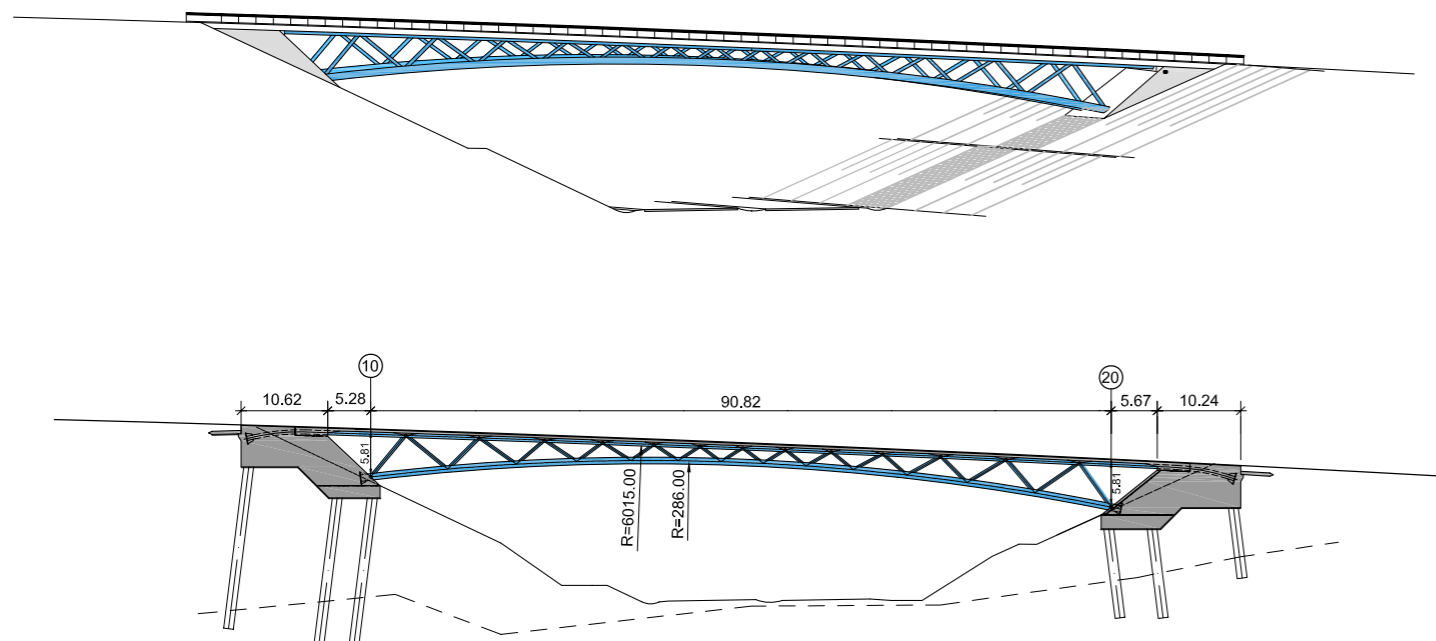
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