# Pilot application of UHPFRC in railway bridge construction – Part 1: Background, conception, planning and scientific support

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# Pilot application of UHPFRC in railway bridge construction - Part 1: Background, conception, planning and scientific support

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## 1 Introduction

Ultra-high performance fibre-reinforced concrete (UHPFRC) is characterized by an extremely dense microstructure and thus very high strengths as well as excellent durability properties. This enables a material-saving and weight-reduced, slim construction method that opens up completely new possibilities and areas of application in precast bridge construction. In the course of the superstructure renewal of an existing old railway bridge over the creek Dürnbach, on the railway network of the Tegernseebahn close to the lake Tegernsee in Bavaria, the material could now be used for the first time in Germany for a railway bridge in a particularly practical and advantageous way. This part 1 of the contribution deals with the background, the conception as well as the planning and scientific supervision of the bridge.

## 2 Pilot application of UHPFRC in railway bridge construction

**Background**
With a view to the simplest possible construction process and a larger flow cross-section for the transferred stream, the aim was to achieve the most slender structure possible with a significantly lower construction height compared to a conventional solution. The use of UHPFRC made it possible to design a new bridge superstructure that could be lifted onto the existing abutments as a comparatively light prefabricated element during a short track closure break. For further information see also [1], [2], [3].

**Conceptual design**
The standard cross-section of the bridge can be seen in Figure 1.

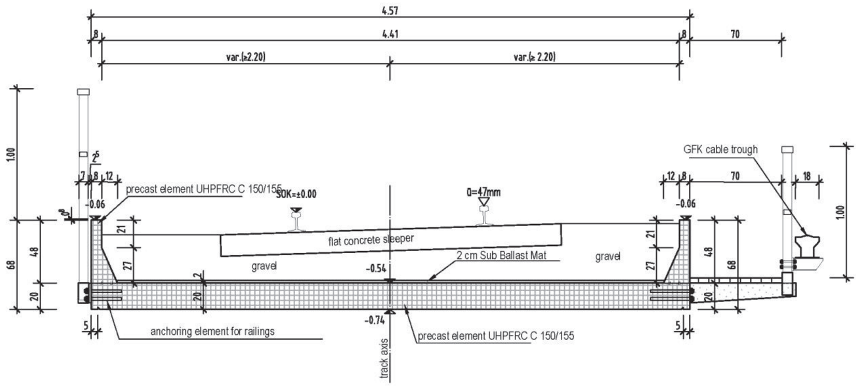


*Figure 1: Standard cross section of the EÜ Dürnbach*

The superstructure of the bridge was realised as a prestressed trough-shaped slab. Thanks to the use of the high-performance material, the slab thickness of the bridge under the rails was extremely low at only 20 cm. The overall height is only 74 cm and it was possible to integrate the ballast holders (with a minimum thickness of only 8 cm) into the component in a load-bearing manner. Due to the excellent durability properties as well as the high degree of density and resistance to mechanical stress, a separate waterproofing and the otherwise required protective concrete was not necessary. Together with a new type of flat concrete sleepers, the required clearance measured from the upper edge of the rail to the lower edge of the construction could be reduced by a total of about 25 cm compared to a conventional concrete solution and thus also the required increase in the flow cross-section during floods could be achieved. The precast element has a longitudinal prestressing and a transverse post-tensioning in the support areas. For the superstructure, a UHPFRC C 150/155 with 2.5 % by volume micro steel fibres was used. Conventional bar steel reinforcement was only installed locally and for the connection of the ballast holders, which were subsequently concreted in a second work step, and - to increase robustness and as minimum reinforcement to avoid failure without prior notice - in the central slab area as lower transverse reinforcement.

## 3 Scientific investigations and measurement supervision

In order to be able to determine in particular the losses of the prestressing due to creep and shrinkage as well as the development of the hydration heat in the real component, appropriate measurement equipment was integrated in the slab and the production was accompanied with measurement technology. In addition, a measurement supervision and scientific support in railway operation was carried out. Besides that, a test concreting in the mixing plant was carried out in advance. In this context extensive accompanying tests to determine the material properties and assumed values for the strengths were carried out. Furthermore, a mock-up slab element with a full-scale cross-section height of 20 cm was produced and then subjected to a 3-point bending test until failure, in order to determine the maximum bending moment that could be achieved for a fibre orientation similar to that in the later component, as well as the linear elastic tensile stress at the edge of the slab when cracking occurred and completed.

## 4 Conclusion

Within the framework of the pilot application of UHPFRC for the railway bridge "EÜ Dürnbach", important practical findings and experiences could be gained. The project shows the advantages of the construction method, such as the low superstructure height, the possible avoidance of coatings and a simple and fast lifting as well as the preservation of the old abutments due to the low dead weight. In addition to the laboratory experience, the measurement supervision could provide further insights in real operation.

## References

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