Zollhaus Bridge: a Typical Hybrid Structural System

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Summary

An hybrid structural system has been considered for the replacement of an old reinforced concrete bridge. The new bridge is characterized by a strong skew geometry and a 25 m span. It is composed of a reinforced concrete deck, two longitudinal arches in glue-laminated timber and pairs of steel tie-rods which are inclined transversally to the arch plane. The structure is innovative, uses natural resources of the neighborhood and has a pleasing appearance in the alpine environment, illustrating that hybrid structural systems have to be considered.

On a mountain road close to Fribourg in Switzerland, the Zollhaus bridge, a reinforced concrete bridge built in 1917, had to be replaced. This bridge was perpendicularly crossing the river "Singine chaude" with a span of 12 m. The new bridge deck is characterized by a strong skew of 52° and a span of 25 m in order to allow higher traffic speed and to increase the clear space above the river to avoid flood of the neighborhood.

An hybrid structural system was considered, which is composed of:

1. A reinforced concrete deck, as it best carries the high concentrated wheel loads and the torsion and bending induced by the skew geometry.
2. Two longitudinal arches in glue-laminated timber placed at the edges of the bridge, so that the transverse direction is activated as main load carrying span of the deck.
3. Pairs of tie-rods in "stainless" steel between the concrete deck and the arches.

The bridge is designed according to the Swiss standards for normal traffic conditions and also by considering the failure of one pair of tie-rod (for example due to impact of a vehicle) as an accidental action. The resulting dimensions are presented in fig. 1 and 2.

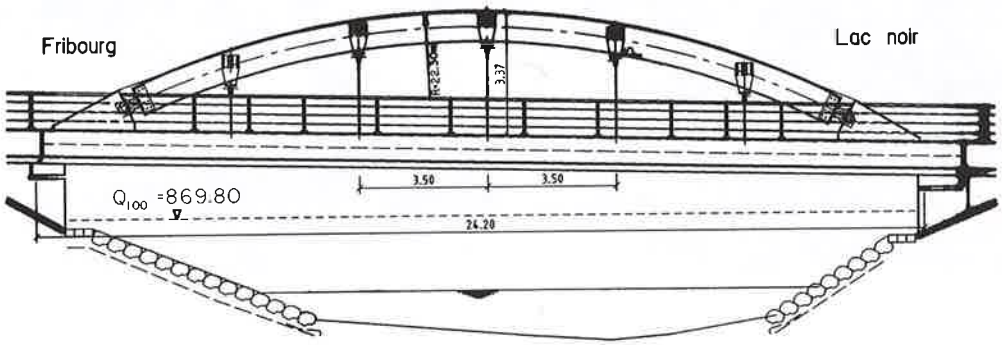

Fig. 1 Elevation of the bridge

The construction of the deck slab was performed on a fixed scaffold with camber. Once the concrete deck hardened, the timber arches were installed with a mobile-crane and the tie-rods were assembled. Then, the scaffold was lowered activating tie-rods and arches.

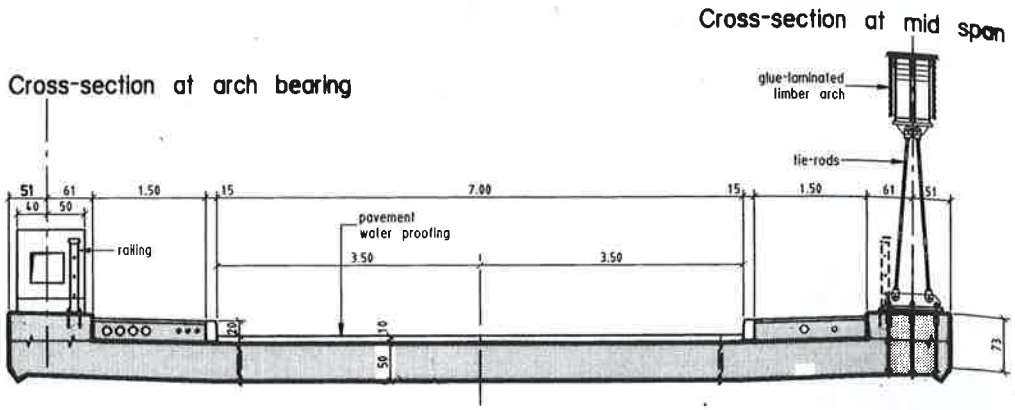

Fig. 2 Cross-sections of the bridge

The stability of the bridge depends on the stability of the timber arches as they are the only highly compressed elements of the bridge with risk of buckling-instability. Consequently, the pairs of tie-rods were disposed transversally in a A-shape arrangement in order to enhance the lateral stabilizing effect of the arches so that the arches are self-stabilizing.

The bridge deck is protected against chloride contaminated water penetration with water proofing located below the pavement. The timber arches are protected against rain and ultra-violet rays with copper plates on the top surface and spaced timber planks on the lateral faces. The bridge is shown in fig. 3 and further information is given by Menétrey and Python [1].

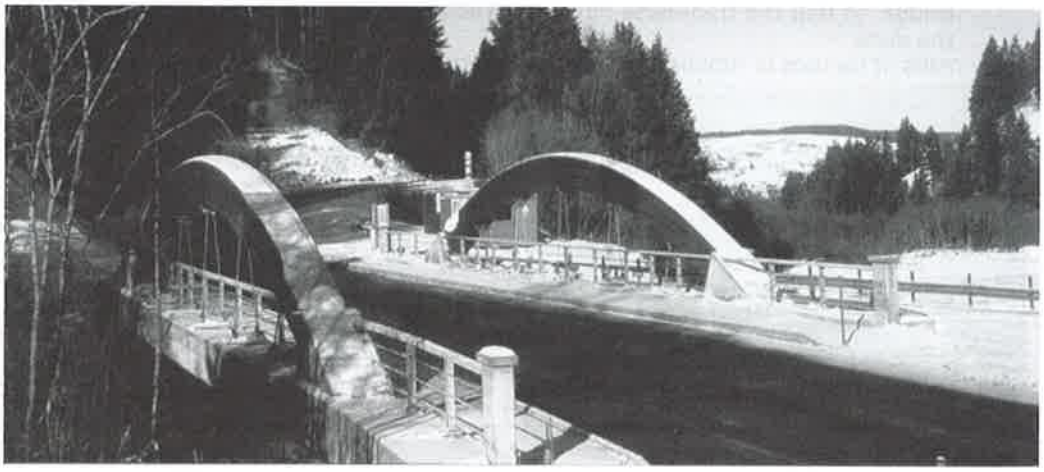

Fig. 3 View of the bridge

A nice cooperation between the client, the structural engineers and the contractors allows to realize this hybrid structural system within the time-schedule, the budget and the quality requirements. The bridge was opened to traffic in October 1998 after having sustained successfully the load-testing. Due to it's appearance, the bridge represents a new symbol of the link between the valley and a famous sky-resort.

Reference

[1] Ph. Menétrey and J.-F. Python, Pont de Zollhaus, *Ingénieurs et arch. suisses*, 6, 1999.