Repair and Strengthening of an orthotropic slab with UHPFRC wearing course Bridge at Illzach in France : first return from experience

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Summary

Built in 1970, this bridge located in Illzach in the East of France crosses Huningue Canal between Mulhouse and Rixheim. It comprises a single 106 m span carrying a two lanes motorway, with two lateral steel trusses and an orthotropic slab with transverse floor beams. After the detection in 2009 of numerous cracks in the deck welds, a repair solution, based upon the replacement of the bituminous wearing course by a UHPFRC layer, with local connection to the orthotropic slab, was ultimately adopted. This solution had been thoroughly analyzed and tested in a research program, Orthoplus, on orthotropic slab fatigue issues. The works were performed during the summer of 2011, and the bridge was successfully tested and commissioned afterwards.

This paper presents the design, planning, implementation and monitoring of this innovative repair, after more than one year of operation and associated follow-up investigations.

Keywords: steel orthotropic deck; repair; UHPFRC; monitoring.

1. The Bridge in Illzach and its innovative repair

The through-bridge, built in 1970, has a single isostatic span consisting of 106-m-long Warren girders supporting an orthotropic steel deck (photo 1). The deck carries an 8-m-wide two-way carriageway.

Photo 1 : the bridge over the Canal de Huningue, (Photo : G. Forquet, Sétra)

The deck exhibited large numbers of cracks, located at the weld toe, connecting trough ribs to crossbeams, generally at the crossbeam webs, sometimes at the level of the steel decking. Water presence in trough ribs indicated that fatigue cracking might be occurring in the deck plate. There are also signs of much corrosion on the diagonals of the Warren girders and beneath the deck. In general, though, the loadbearing structure of the bridge appeared to be in good operational condition.

A appropriate repair solution involves local stiffening of the deck by rigidly connecting it to a thin slab of UHPFRC 50mm thick

This innovative repair solution, named “Orthodalle”, involved a combination of precasting and in-situ stitching and resulted from the Orthoplus research program.

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Traffic on the bridge was disrupted from June 14th to August 31st 2011 [2]. The final wearing course, composed of a resin with grits was eventually placed on top of the UHPFRC slab. The overall thickness of the new wearing course is 10 mm and its density 19.9 kg/m².

This repair solution was part of a French National Program to support innovation on Road Constructions and benefits from a 10-year monitoring program [3]. It aims at checking the effectiveness of the repair and its durability through the years.

Photo 2 : Precast slabs placed on the dec (photo : G. Forquet, Sétra)

2. Results of trials before and after works

The first loading trials before repair work took place on June 14th, 2011, before the bituminous wearing course removal. The loading trials after repair work took place on August 30th, 2011.

The first comparisons between measures and calculations before and after repair works show a relatively good concordance for longitudinal bending in main beams, cross beams and trough ribs in deflections as well as stress. The neutral axis of the orthotropic deck is moved into the UHPRFC layer, proving the effectiveness of the connection.

Regarding local bending in the trough ribs flanks, measures are highly sensitive to the exact position of the wheels thus difficult to examine in details. Generally speaking, the average extreme stresses in trough ribs flanks are reduced by 30%, while the stresses in the deck are reduced by 50%. The UHPFRC also tends to distribute the loads between three adjacent trough ribs, reducing the risk of punching shear in the through ribs [4].

3. Conclusion

The two measurement campaigns were able to confirm an efficient mechanical connection between the slabs and the deck as a composite section. This allows reducing stresses in the orthotropic deck and potentially, extending the bridge lifetime. After one year of service, the repaired bridge did not encounter any issue related to the new wearing course. Thus one can consider Orthodalle innovative repair method as a relevant solution for repairing and reinforcing steel orthotropic deck.

Those conclusions though are provided based on a one year visual surveillance and two measurement campaigns, but have to be validated on the long term by the next measurement campaigns which will also check on the wearing course's durability.

4. Acknowledgements

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5. References

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