# The new Pinel Bridge in Rouen, the fifth French road bridge using ultra high performance fibre-reinforced concrete components

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## Summary

This paper describes the design and construction of the third Pinel Bridge in Rouen (France), in 2007, whose 27 m long deck combines a conventional slab of standard reinforced concrete with 17 parallel contiguous beams made of ultra high performance fibre-reinforced concrete (UHPFRC).

**Keywords:** bridges, prefabricated beams, UHPFRC, design, prestressing

## 1. Introduction

Located just outside Rouen, existing Pinel Bridge is 27 m long, has a high skew angle and crosses three railroad tracks. It has a concrete substructure units and carry two lanes on two parallel filler-beam decks connected only by a longitudinal expansion joint. As from summer 2008, Pinel Bridge will support temporarily the traffic of a new expressway. For this reason, it must be widened from two lanes to five. This paper briefly describes the design and construction of the innovative built solution which combines UHPFRC beams, placed edge to edge, with a conventional concrete deck slab (C35/45). The new Pinel Bridge is the fifth French road bridge to incorporate UHPFRC structural components.

## 2. General data of the bridge

The main geometrical characteristics of the new Pinel Bridge are single span of 27 m, 14 m wide, 64 gons (57°) skew and crossfall of 2.5%. As originally designed, the deck was supposed to be a filler-beam deck with 17 HEB700 rolled profile. An alternative bid submitted by Eiffage TP proposed to replace the filler-beam deck by 17 contiguous UHPFRC beams connected to an ordinary C35/45 concrete deck slab (see figures 1 et 2). In this solution, the 17 beams, quite identical, are prestressed by 28 T15.7/1860 MPa strands all placed in the bottom flange and connected to the slab by rebar stirrups placed in the top flange. The deck slab, whose thickness varies from 21 to 32 cm to obtain the circular longitudinal section, is built using cast-in-place concrete of normal strength (C35/45).

## 3. Construction design

Conventional French construction regulations were used for general calculations and French document "UHPFRC – Interim Recommendations" to check beams design. The beams can easily withstand normal stress but are slightly understrength with respect to shear forces. The maximum shear stress—including effects due to torsion and prestressing force distribution—was notably very high in the left-hand and right-hand beams and slightly higher than the permissible value. It was finally decided, therefore, to adopt two kinds of beams: 'typical' interior beams as already described and exterior beams in which the webs and top flanges are 3 cm wider. To limit tensile force at the upper fiber of exterior beams, a single strand was added in the top flange.

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Fig. 1: Cross-section of the built deck

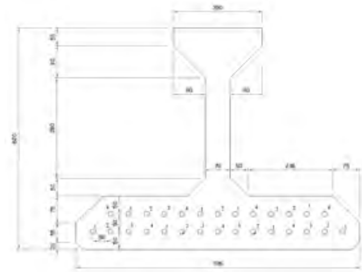

Fig. 2: Typical UHPFRC beams cross-section

## 4. Construction

The beams were cast near Eindhoven by a Dutch contractor using the same 165 MPa concrete as the one used for the Millau viaduct tollgate roof. The beams construction methodology is very similar to that for conventional prestressed beams and uses a tensioning unit. However, because of the big difference between the web thickness and the width of the bottom flange, the beams have been concreted in two stages, first, the bottom flange, then the web and the small top flange, after adding the upper part of the mold and the reinforcement for connection (see figure 3). The beams were transported in Rouen by train and by truck. They were lifted into place by a 300-tonne truck-mounted crane during track closure (see figure 4). The deck slab was built with sacrificial precast panels and a C35/45 ordinary concrete topping.

## 5. Advantages of built solution

The beams used on this project are UHPFRC beams developed by French contractor Eiffage TP as main component of a new deck structure seen as an economical alternative to filler-beam decks, particularly when spans are longer than 20 m and cross roads or railroads. The main advantages of this structure are the excellent durability of UHPFRC beams, the possibility of designing very thin decks, the stability of beams during construction and the rapidity of work to be conducted after beam erection.

Fig. 3: Installing the top part of the mold

Fig. 4: Beams placement