Replacement of the Superstructure of the Nitelva Railway Bridge

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Summary

This paper presents the replacement of a one 100 years old railway steel bridge in two spans with two concrete post-tensioned box girder elements made of High Strength Lightweight Aggregate Concrete LC60. The removal of the old bridge and erection of the new one was done during two train stops of 24 hours in a very special way, which is described in more details.

Keywords: high strength concrete, precast, railway bridge, post-tensioning

1. Introduction

In 2001 Multiconsult AS was engaged by the Norwegian Railway Authorities to undertake a thorough investigation of the condition of Nitelva Bridge at Lillestrøm, 30 km from the capital Oslo. The bridge, which is situated on the main railway system in Norway, consists of two freely supported spans, one span is a truss bridge, length 27 m, and the other span is a steel girder bridge with span length 19 m, Fig. 1. Both bridges are 100 years old. They are exposed to very heavy traffic from early morning to late evening. The conclusion of the investigation was that the superstructure of the bridge had to be replaced. Multiconsult AS was engaged to propose a design for a new superstructure. As the foundations were made of solid granite blocks, they needed only small repair works and could be used as support also for the new superstructure.

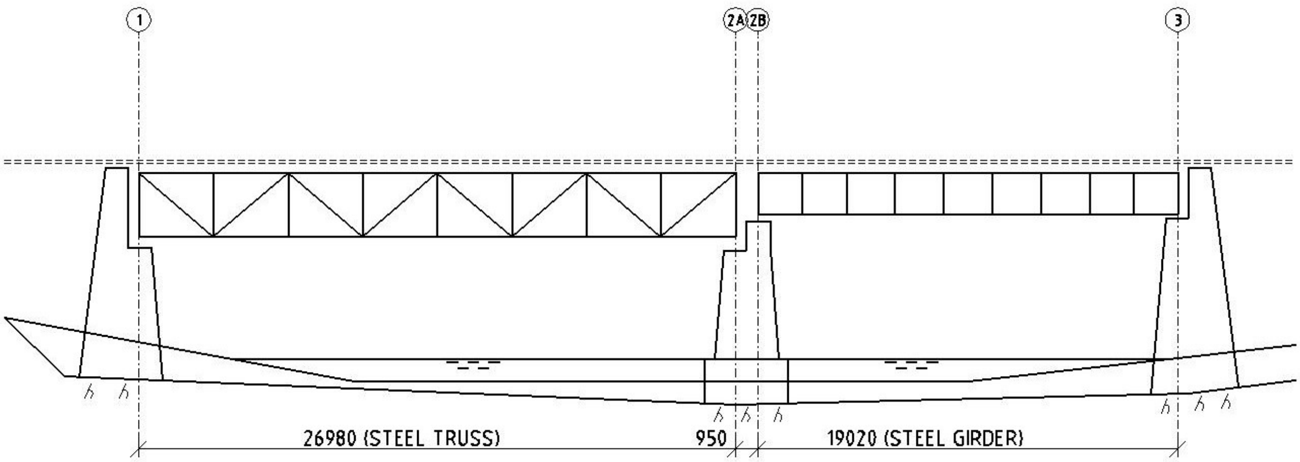

Fig. 1 Elevation existing bridge

2. New superstructure

We proposed to replace the steel superstructure with two pre-cast, post-tensioned box girder elements in High Strength Lightweight Aggregate Concrete LC60, as shown in Fig. 2 and 3, with Leca as the lightweight aggregate. Use of lightweight concrete was in order to save dead load during the installation, because the elements had to be transported on the existing bridges under the replacement sequence.

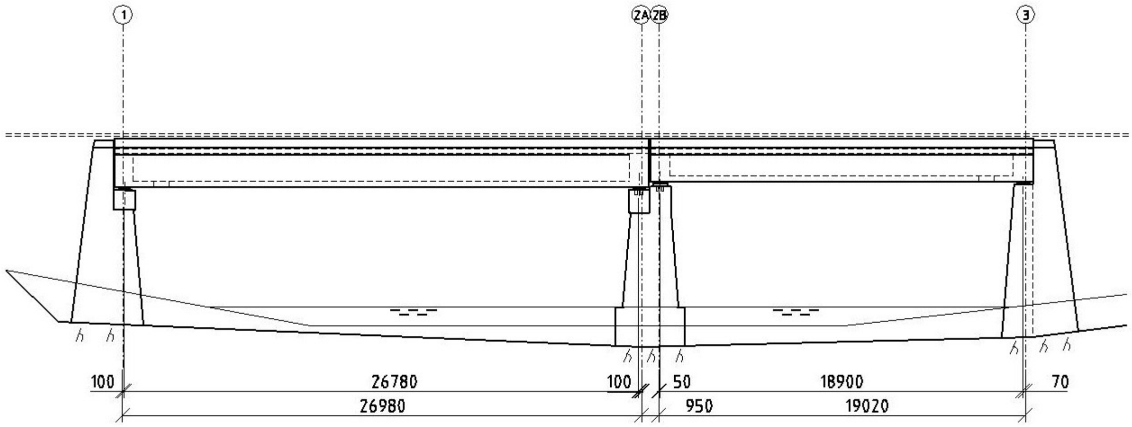

Fig. 2 Elevation new bridge

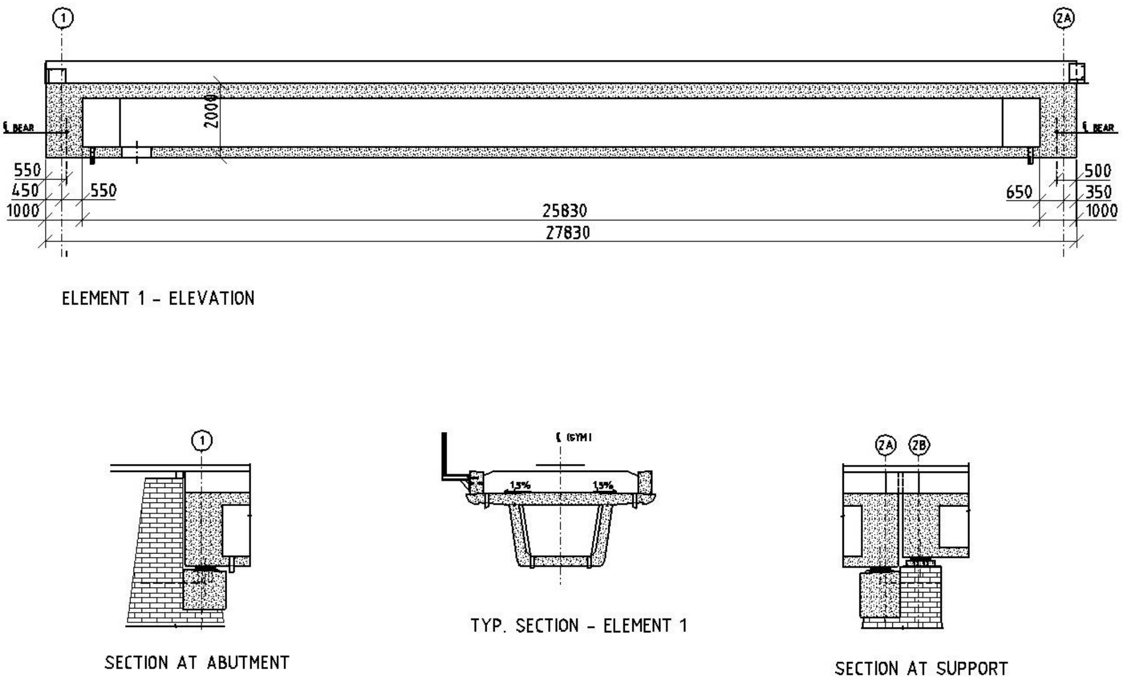

Fig. 3 Pre-cast element

The elements were produced on bogies supported on the rails on a site close to the Lillestrøm station area, ca. 500 m from the bridge. Net weight was 150 tons for the shortest element (L=20m) and 210 tons for the longest (L=28m). In addition the new rails and most of the ballast were placed on top of the elements before transportation to the bridge site in order to save time during the very short installation period. This increased the weight of the elements to 290 tons for the biggest one and 180 tons for the smallest one see Fig. 4.

Fig. 4 Element 1 ready for transport to site

3. Erection of elements

The elements were installed by a special system consisting of 2 railway wagons, one at each end of the element. A counterweight of pre-cast concrete blocks was placed in the middle of each wagon. A pair of steel beams were fixed between the blocks by Dywidag bars at the rear end and freely supported in the front by a steel frame during transportation. The two wagons and the element are towed into position by a railway truck. Once in position two steel towers are lowered and supported on a steel crossbeam properly supported on ground. The Dywidag bars anchored into each end of the element are fixed and anchored to the steel beams by wire jacks, see Fig. 5a.
Vertical Dywidag bars are threaded through holes in the deck slab of the element and fixed to steel beams under the existing bridge. The load of the old steel truss girder is transformed from the bearings to the new element by using wire jacks, and the truss is carried by the counterweight lifting system, see Fig. 5b.
The steel truss is cut into 3 pieces and the central part is lowered down on a pontoon in the river below the truss. The two end parts are then cut down and lowered on the same pontoon, see Fig. 5c and Fig. 6.
When all the steel parts from the old truss bridge has been removed, the preparation for the installation of the bearings is performed on the supports: drilling holes for the bolts for fixing the bearings, installation of formwork for the bedding grout and installation of shims for preliminary support of the bearings. Before the elements left the construction site, the bearings were installed and fixed to the bottom slab of the elements.
The element is lowered using the wire jacks on the Dywidag bars, see Fig. 5d. Once the element is in correct position, supported on the shims, the bedding grout is placed under the bearings, more ballast is moved in, the rails are adjusted in correct elevation and the sleepers are fixed. At each end vertical steel plates are installed to stop the ballast to drop down on the bearing supports in the opening between the existing abutment and the end of the element.

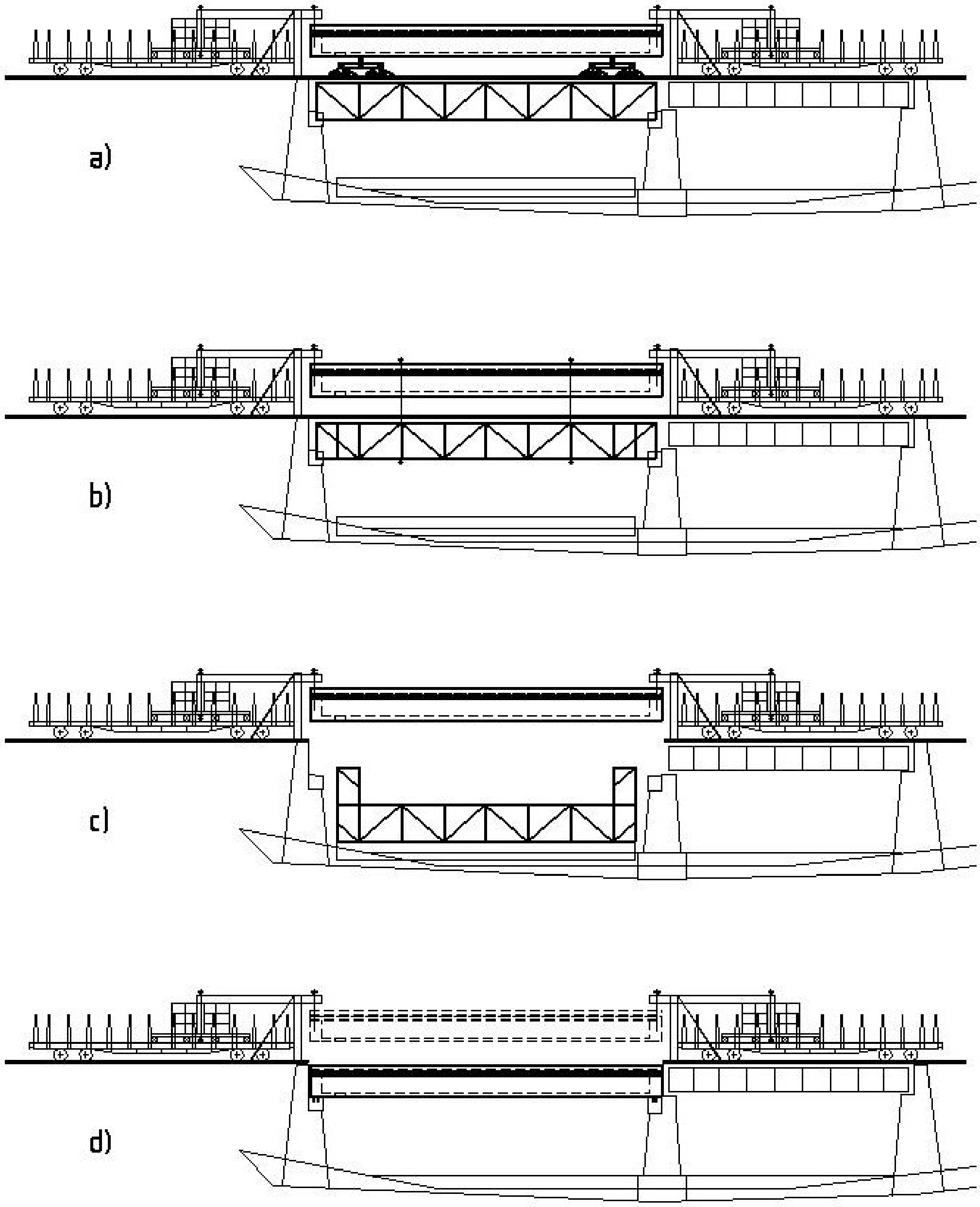

Fig. 5 Erection sequences

In a 24 hours train stop period the following working sequences were performed:

- The element transported to site on bogies and positioned over the actual bridge to be replaced.
- Rails cut at each end of the bridge.
- Lifting steel towers erected at each end of the bridge, supported on the ground (lifting capacity 200 tons at each end).
- The existing bridge superstructure was fixed to the element by using Dywidag bars by use of wire jacks on the bars.
- The existing superstructure was cut into 3 pieces by gas while it was hanging in the Dywidag bars.

Fig. 6 Element 1 in position, ready to be lowered, existing steel truss cut down and lowered on pontoons

- The main part of the existing superstructure was lowered down on pontoons in the river below the bridge.
- The end parts were cut into pieces and lowered on pontoons.
- The new element was lowered down onto cast in situ supports on the existing abutment and foundation where shims for the bearings had been installed just after the removal of the steel parts.
- Re-establishing of railway track with ballast, sleepers and rails.

Fig. 7 Completed bridge

The Contractor Betonmast AS successfully performed the replacement work in two weekends, one weekend for each span, in September 2002, as shown in Fig. 7.