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Artikel: Widening of arch bridge Färjsund in Åland (Finland)

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2. Widening of Arch Bridge Färjsund in Åland (Finland)

Owner:	*The Provincial Government of the Åland Islands*
Designer:	*Y-S Engineering*
Contractor:	*Mynämäki Land Construction Ltd.*
Works' duration:	*10 months*
Commissioning year:	*1981*
Span of arch:	*130 m*

Material quantities

Abutments:	Concrete	146 m^3
	Reinforcement	12.4 t
Arches:	Concrete	615 m^3
	Reinforcement	112 t
	Prestressing steel	9.2 t
Columns:	Concrete	257 m^3
	Reinforcement	39 t
Bridge deck:	Concrete	830 m^3
	Reinforcement	192 t
Total:	Concrete	1848 m^3
	Steel	364.6 t

The bridge crosses a strait called Färjsund on the border of the communes of Finström and Saltvik in the Åland Island, approximately 17 kilometers northeast of Mariehamn.

The old reinforced concrete bridge arch was built in the thirties across the 130 meters wide and 20 – 30 meters deep strait. The width of the bridge was 6 meters. Planning was carried out by a Swedish engineering bureau and the bridge was built by a Danish firm.

Public opinion considered the old bridge well adapted to the landscape, but due to its narrowness and poor visibility, dangerous particularly for pedestrians, and due to load restrictions, it was uneconomical for present-day heavy transport.

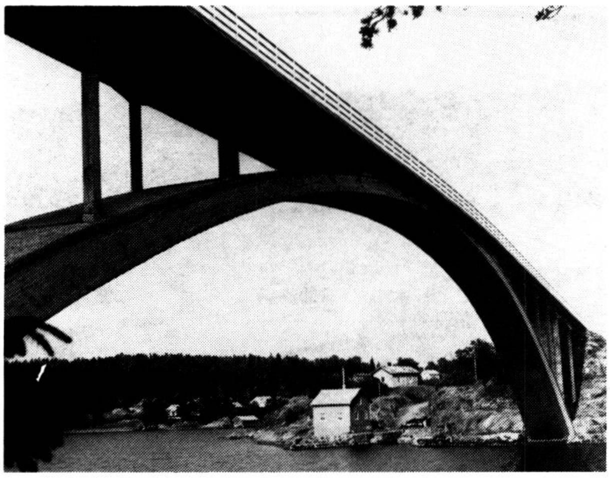

Fig. 1 The old bridge; horizontal clearance 6 m

The following directives were given for planning:

- The current appearance of the bridge was to be preserved, as much as possible
- Dimensioning was to be based on traffic loads corresponding to current highway traffic amounts
- The bridge deck was to be widened to two lanes, and provided with a lane for light traffic on one side
- The possible new bridge was to be located in the place of the old bridge, or in its immediate vicinity.

The solution, in which additional arches were built on both sides of the basis formed by the old arch, proved to be economically and technically most advantageous. The new arches were spanned together with the old arch into a new entity, on which a wider road was built, using the old bridge at the same time as a site road and a lane for light traffic, and as scaffolding for the new bridge deck.

In the dimensioning calculations of the arches, special attention was paid to the combined functioning of the old and the new structures. In concrete structures of different ages, creeping of new structures will, unless special measures are taken, slowly move the loads onto the old structures. This could be avoided at the construction stage by moving part of the old bridge's weight onto the new arches, i.e. by overloading them.

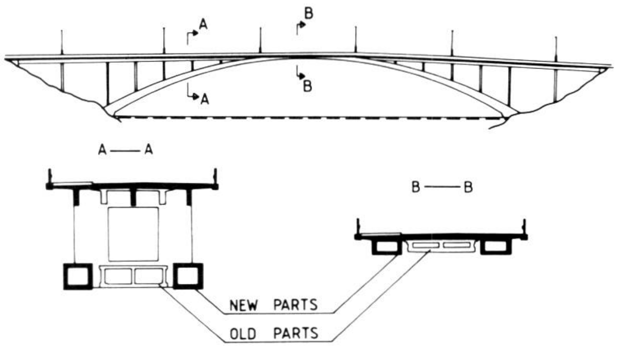

Fig. 2 Elevation and cross-sections of the bridge

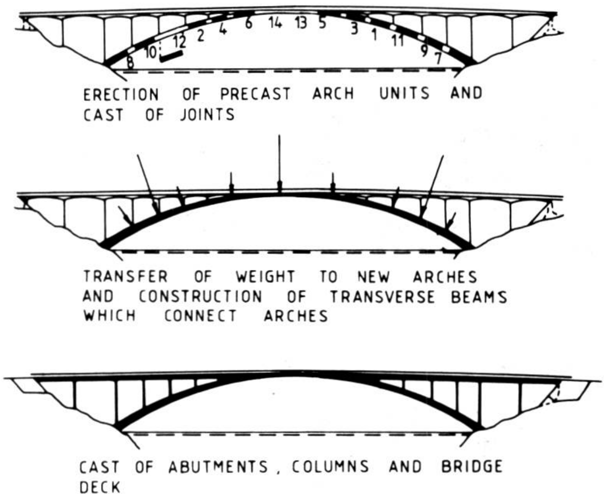

Fig. 3 Main phases of the construction process

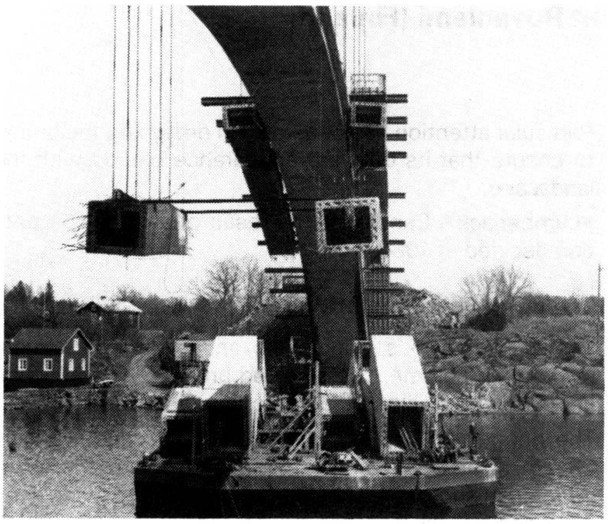

Fig. 4 Erection of the arch elements

However, this method is not a very exact one, as the creep and shrinkage values vary considerably. For this reason, the calculations were at that point carried out by employing limit values to indicate sizes of magnitude.

Construction work was commenced in the winter of 1980, by anchoring the lower ends of the arches to rock. For the arches, the contractor decided to use prefabricated elements which were hydraulically lifted up in pairs to their final locations with the aid of tension bars.

During the lifting operation, changes in the form of the bridge were controlled by means of a precise levelling instrument and the results were compared with theoretical values calculated in advance. Differences between the measured and the calculated values were surprisingly small and in many cases could be explained as measurement errors. Consequently, it was concluded that the stresses in the old arch remained within permitted limits.

The arch halves were loosened from their supports simultaneously on both sides, at the highest point of the arch, using a force of 550 tons (5.5 MN) from hydraulic jacks placed between the arch ends. This made it possible to obtain a desired change in the stresses of the arch before casting the last joint at the top of the arch.

By using the lifting bars of the elements, part of the old bridge's weight was moved onto the new arches. In order to secure the functioning of the joints between different parts of the arch, the parts were spanned to each other at crossbeams with transverse tendons.

As the old bridge deck and its columns were in use throughout the construction process, they were not pulled down off the new building's way. The new bridge's columns were cast round the very slim old columns, and new abutments were made behind the old ones. The old bridge deck was used as a formwork for the new deck. Finally, the old abutments were removed.

By using the old bridge for support and by utilizing parts of the old structure, it was possible to build a bridge as good as new, with a carrying capacity for liveload about seven times higher than before. At the same time the excellence of an arch structure was established. Provided it is correctly loaded, its load carrying capacity is quite considerable. During the construction, the old bridge's excess load was over 1100 tons.

The Central Association of the Finnish Concrete Industry chose the Färjsund Bridge for the Concrete Structure of the year 1981.

The Association of Finnish Civil Engineers arranges a competition in construction engineering about every three years. The Färjsund Bridge was nominated for the Construction Engineering Achievement in 1981.

(Jouni Nieminen, Heikki Rautakorpi)

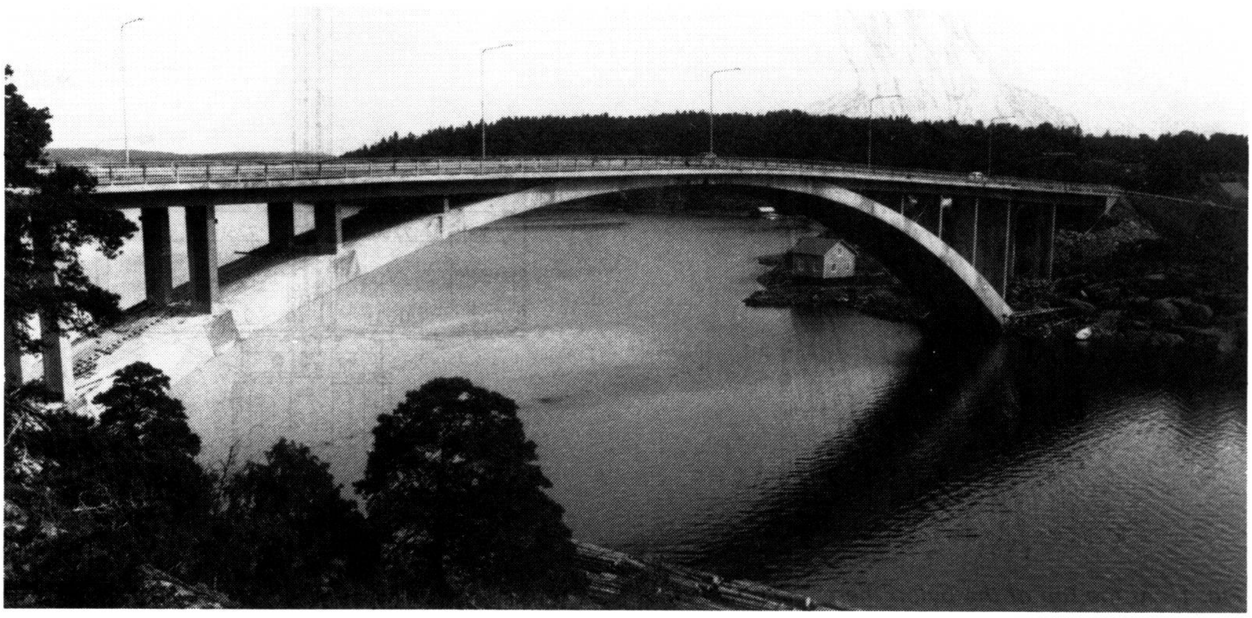

Fig. 5 The final bridge; horizontal clearance 11 m