Lietvesi Bridge, Puumala (Finland)

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5. Lietvesi Bridge, Puumala (Finland)

Owner:	*Finnish Roads and Waterways Administration (RWA)*
Design:	*RWA and Insinööritoimisto Pontek Ky*
Contractor:	*OMP-Yhtymä Oy*
Construction Work Duration:	*18 months*
Completion:	*1986*

Lietvesi bridge is situated in southeast Finland. When completed, it replaced a ferry-route.

The landscape at the bridge site is exceptionally beautiful. Therefore, every effort has been made to design the bridge to fit the surroundings. A special, very detailed landscaping plan has been produced for the bridge site and its surroundings by an architect.

The horizontal alignment has been designed in such a way that the rocky landscape and the trees remain untouched. A rest area and scenic look out will be constructed on the highest point of the island at the southern end of the bridge. Here the traveller may stop to admire the beautiful view.

The bridge is a three-span composite girder bridge spanning 88 + 112 + 88 meters. Its horizontal clearance is 8.5 meters. The main girders are haunched. At midspan the structural depth of the superstructure is 3.32 meters, and the steel girder is 2.85 meters deep. At the intermediate piers the total depths are 5.41 and 4.94 meters respectively. At the bridge location, the required clear headway is 12.5 meters.

One abutment is founded on rock, and the other one on compaction piling. The bridge piers are founded 20 meters below water surface. One pier is based on a blasted benched rock foundation, and the other one on hard boulder clay. The piers were cast using tremie concrete to a water level 1.0 meters below normal. The foundation slab and stem were cast in one. This required 800 m^3 of concrete for one pier. Special attention was paid to quality control of the tremie concrete. The submerged parts of the piers were subjected to water pressure tests, ultrasonic testing, compression testing of samples, and a colour video film was taken of the entire submerged structure. A total of 2000 m^3 of concrete was used for the substructures. Two thirds of this was tremie concrete. A total of 70 tons of reinforcing steel was used, half of which was used for underwater structures.

The bridge has a composite superstructure. The steel main girders are 5.0 meters apart. They are connected by cross frames at c/c 8.0 meters, by lateral bracing located 2.6 meters below the upper flange of the girder, and by a reinforced non-tensioned concrete deck slab. The superstructure was analysed using an element model. The result of the analysis consisted of the member forces of the cross as well as the lateral frames and of the forces of the main girders.

The main girders were manufactured according to Finnish Standards SFS 255 fine grained steel Fe 355E (corresp. TStE 355/DIN 17102). A total of 800 tons were used for the bridge. The main girder chords are 800 mm wide at their largest point, and their maximum thickness is 120 mm. The web thickness varies from 16 to 24 mm. At the piers, the lower chord is «bent», using a 10 meters radius. The cross and lateral frames are K-frames. Their members are made of square tubes steel grade Fe 520 according to Finnish Standard SFS 200 (St 52-3/DIN 17100). For the frames 40 tons of steel was used.

For the non-tensioned bridge slab 750 m^3 of concrete and 160 tons of reinforced steel were used. The longitudinal slab reinforcement is, at the intermediate supports, about 2% and even in the span about 1% of the concrete cross-sectional area. In this way the crack width has been considerably limited. The price of reinforcing steel is only half the price of structural steel. It is therefore, at the intermediate supports, economical to use it «as the upper chord of the main girder».

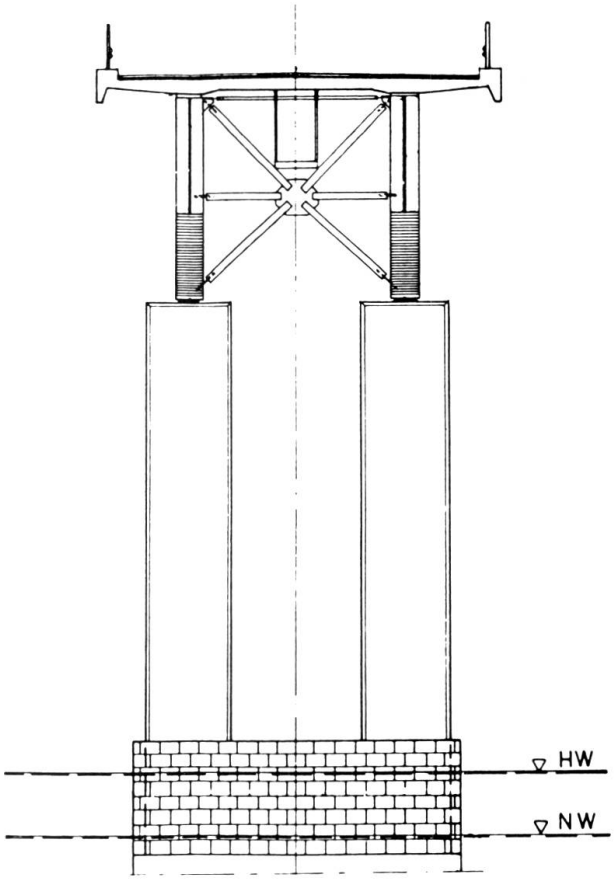

Fig. 1 Bridge cross-section

The bridge halves were welded together on opposite shores of the sound, and then they were, partly supported by pontoons, pushed in place. At the middle of the bridge the halves were connected using a friction grip bolted connection, the only bolted connection in the bridge. At the machine shop, the bridge main girders were made 0.5 meters «too high up» at the point of the abutments. When the friction grip connection was completed, the structure was, at both abutment locations, lowered 1.0 meters below its final position, and, as the reinforced concrete deck slab reached its design strength, the structure was hoisted into its final position. Through these measures the tension in the deck slab was decreased, and thus also the crack widths at the intermediate supports.

(J. Hyvönen)

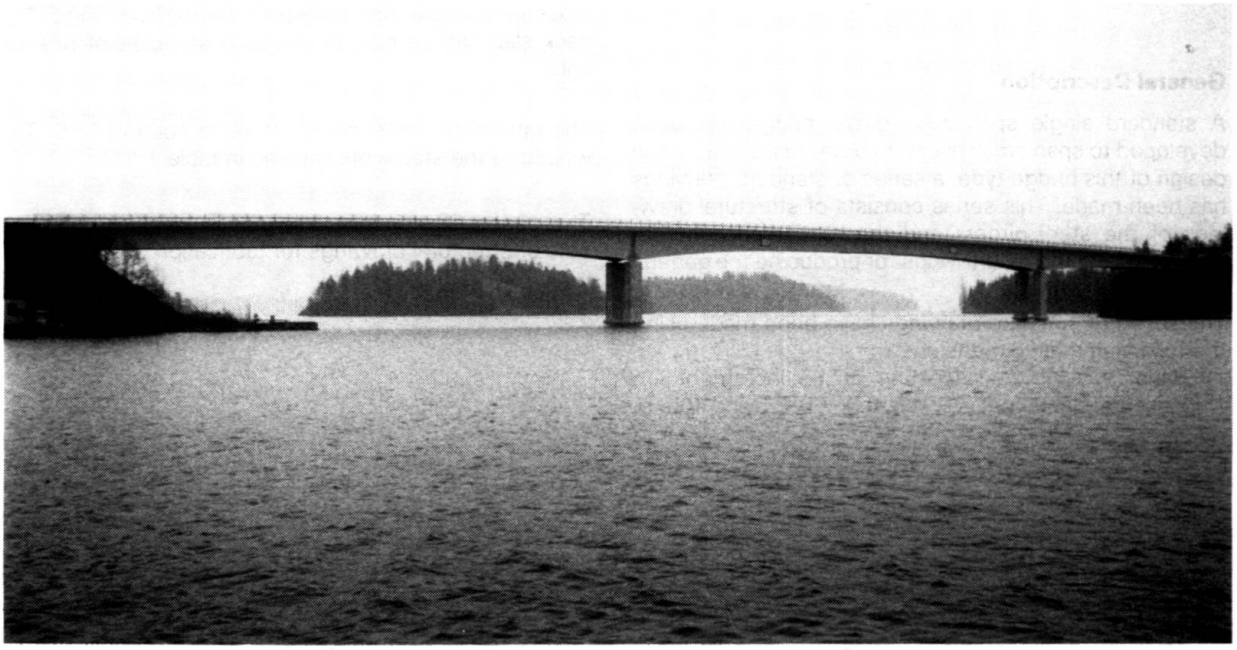

Fig. 2 View from the lake

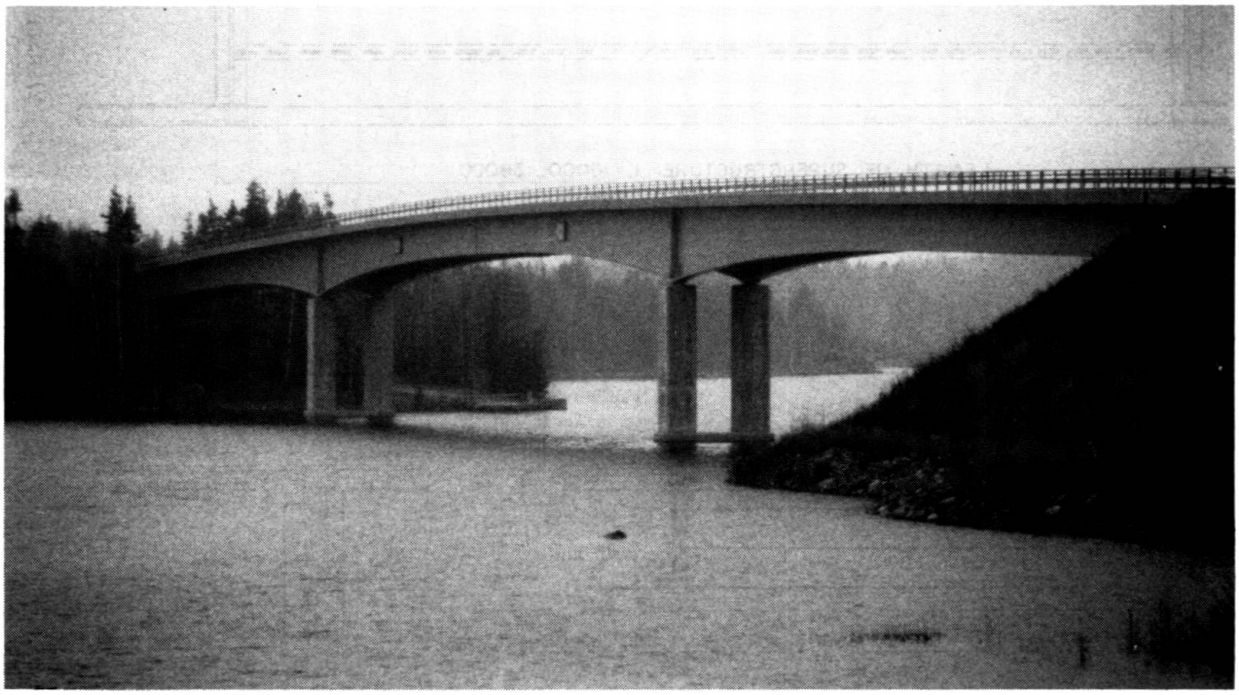

Fig. 3 View from a nearby shore